The US-China Trade War and Global Value Chains

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Motivation

The US-China Trade War: The biggest trade war since 1930 (Smoot-Hawley)

- Chinese goods: $\$550$ billion announced, $\$362$ billion implemented
- US goods: $\$185$ billion announced, $\$110$ billion implemented
- US tariffs on Chinese goods $3.1\% \rightarrow 19.3\%$ Tariff Change
- China's tariffs on US goods $8.0\% \rightarrow 20.3\%$

US increased tariffs in two rounds, by Broad Economic Categories (BEC):

- **Round 1**: intermediate goods
- **Round 2**: intermediate + consumption goods Top Targeted Industries

Questions and Findings

Research Question: What is the impact of the trade war on different industries and countries in the presence of global value chains? Who wins? Who loses?

Quantifies the two rounds:

- Tariff on intermediate goods:
  - reduces US downstream exports,outputs and employment.
  - especially hits the US industries that heavily rely on targeted Chinses intermediate goods.
  - benefits the US industries that produce the same types of products.
- Tariff on consumption goods:
  - has a greater impact on US consumer in terms of CPI

Welfare Effects:

- Jan 2018 - Dec 2019, in terms of real income, the trade war
  - costs China $\$35.2$ billion (0.29% GDP)
  - costs US $\$15.6$ billion (0.08% GDP)

Literature

My paper Builds a two-stage Eaton-Kortum model to study the impacts of the trade war taking GVC reshaping into account

Literature

- **the US-China trade war**

  Handley and Kamal (2020), Bown et al.(2020), Amiti Redding and Weinstein (2019), Fajgelbaum et al.(2019)

- **Global Value Chains**

  Antras and de Gortari (2020), Caliendo and Parro (2015)

My Contribution

- take GVC reshaping into account, long-run impact
- multi-country general equilibrium model
- add tariffs, productivity parameters calibrated to disaggregated trade data
- two-stage model including linkage within industry and linkage across industries

Model

- **Economy**:

  Multi-country, multi-sector, perfect competitive

  All goods are tradeable and imported from the place offering the lowest price

  Labor fixed within country, mobile across sectors

- **Preference**:

  Utility is an aggregator of consumption from each sector

- **Technology**:

  Final output in each sector produced through two stages:

  Stage 1: labor, and composite intermediates

  Stage 2: stage-1 output, labor, and composite intermediates

- **Trade Costs**:

  Iceberg

  Tariff

Model

Preference: country i, sector s, variety z

$$\max_{C_{is}} U_i = \prod_{s=1}^{S} (C_{is})^{b_s} \tag{1}$$

$$C_{is} = \left(\int_0^1 c_{is}(z)^{(\sigma-1)/\sigma} dz\right)^{\sigma/(\sigma-1)} \tag{2}$$

Technology (omit z for simplicity)

stage1 occurs in country i:

$$y_{is}^1 = \frac{1}{a_{is}^1} (L_{is}^1)^{\gamma_{is}} (I_{is}^1)^{1-\gamma_{is}} \tag{3}$$

stage2 occurs in country i:

$$y_{is}^2 = \left[\frac{1}{a_{is}^2} (L_{is}^2)^{\gamma_{is}} (I_{is}^2)^{1-\gamma_{is}}\right]^{\alpha_s} \left[\overbrace{x_{is}^1}^{stage-1\ product} \right]^{1-\alpha_s} \tag{4}$$

I: Cobb-Douglas aggregator as the utility U production structure

Rationale for Such Production Structure

Depicts Two Types of GVC Linkages

- **Linkage within industry**:
  intermediate goods x^1 (stage-1 outputs) connect two production stages—-"snake" intermediates

- **Linkage across industries**:
  intermediate goods in I (composite intermediates) connect production in different industries—"roundabout" intermediates

Analytical Solution to the Model

- **The 2-stage production mechanism generates production paths**

  J countries, 2 stages, J^2 production paths

  Each final good is produced under one of the J^2 production paths

- **Assumption**

  The productivity of a production path follows a Frechet distribution

$$Pr[(a_i^1)^{(1-\alpha)}(a_j^2)^{\alpha} \geq a] = exp\{-a^{\theta}(T_i)^{(1-\alpha)}(T_j)^{\alpha}\} \tag{5}$$

- **Analytical solution**

  π : country's expenditure share on goods produced under each production path

  π decreases in the tariffs along the production path Details

Key Parameters

Parameter	Definition	Specific by
T_{js}^{n}	productivity	country,sector,stage
γ_{js}	equipped labor share	country,sector
α_{s}	share of stage2 production in final output	sector

Calibration

Economy

- countries: CHN, USA, ROW
- industries: 18 industries more

Data Source

tariff data:

- UNCTAD: Trade Analysis Information System (TRAINS)
- the Office of the United States Trade Representative
- Ministry of Finance of the People's Republic of China

other data:

- OECD: Inter-Country Input-Output (ICIO) Table ICIO Tabel
- US Census Bureau: US International Trade in Goods and Services Reports

Calibration T_{js}^{n}, α_s, γ_{js} (country j, sector s, stage n)

productivity T calibrated to trade data

Step 1: Determine the upstream and downstream products in each of the 18 industries

- Use US Input-Output Matrices (451 products) to measure each product's weighted average distance from final use.

  For example: one-country, one-sector economy, $\$100$ output:

  - If $\$100$ used as final consumption

    upstreamness $= 1 \times \frac{100}{100} = 1$
  - If $\$50$ used as final consumption, $\$50$ used as intermediate inputs

    $\$0.5$ intermediates needed to produce $\$1$ output [unit requirements]

    upstreamness $= 1 \times \frac{50}{100} + 2 \times \frac{\frac{1}{2}50}{100} + 3 \times \frac{\frac{1}{2}^{2}50}{100} \ldots = 2$
- choose a cut-off such that each of the 18 industries has both upstream and downstream products
- cut-off: 1.9

  products with upstreamness $\geq$ 1.9: upstream

  products with upstreamness $<$ 1.9: downstream

Calibration T_{js}^n, α_s, γ_{js} (country j, sector s, stage n)

Step 2: Calibrate productivity T using disaggregate trade data

- In each of the 18 industries, aggregate trade flows of upstream and downstream products
- T_{js}^n targets US imports share $\frac{IM_{j,us}^n}{\sum_{i \in \mathcal{J}} IM_{i,us}^n}$ data evidence

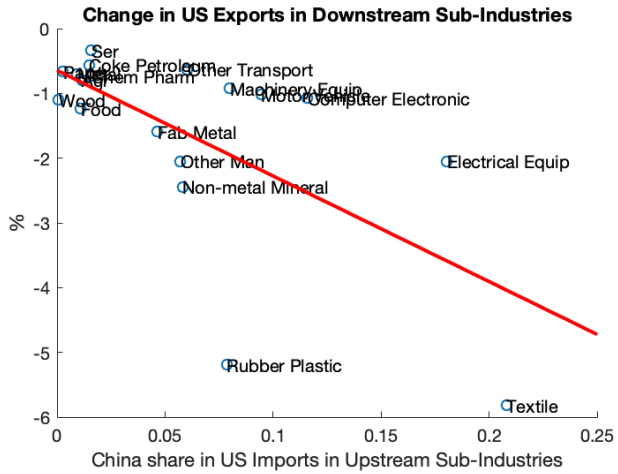
stage share α and labor share γ calibrated to gross output and value added data

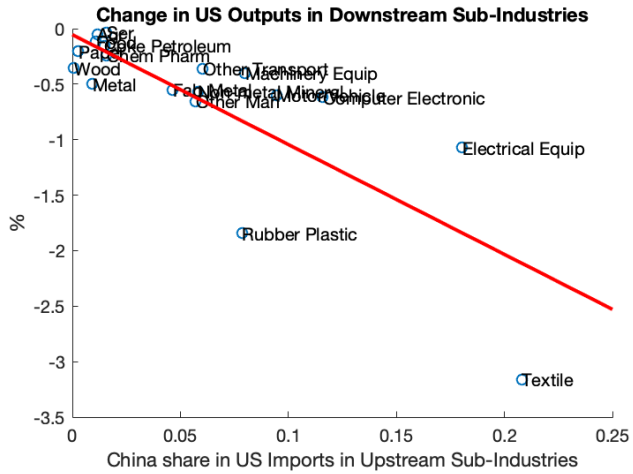
- α_s measured by gross output of upstream products over gross output $\frac{GO_s^1}{GO_s}$
- given α_s, calibrate γ_{js} to target value added over gross output $\frac{VA_{js}}{GO_{js}}$

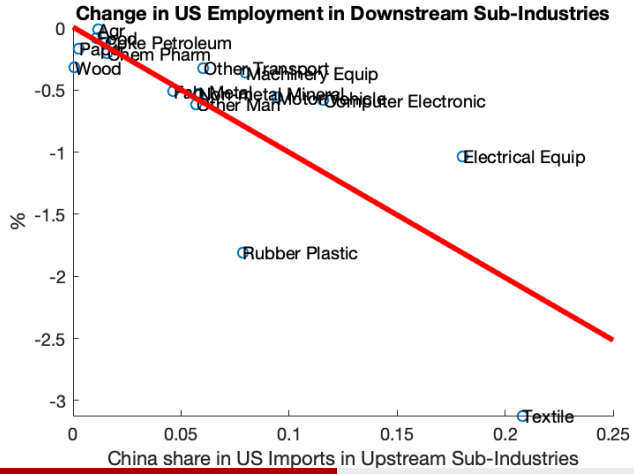
Counterfactual Analysis: Impacts through Within-Industry Linkage

Increase tariff on upstream products in all 18 industries

Check domestic downstream sub-industries in all 18 industries

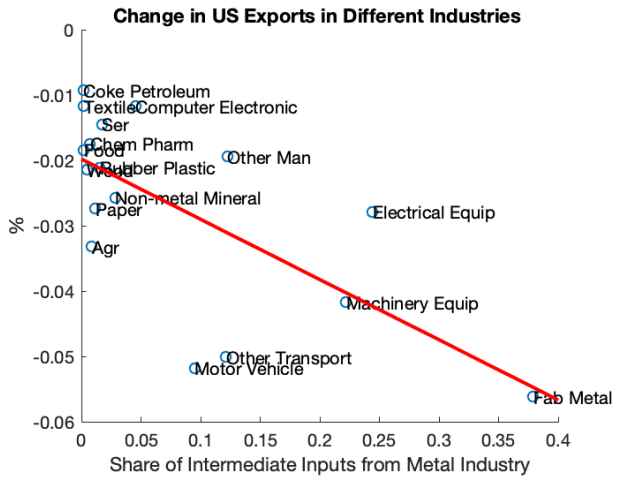


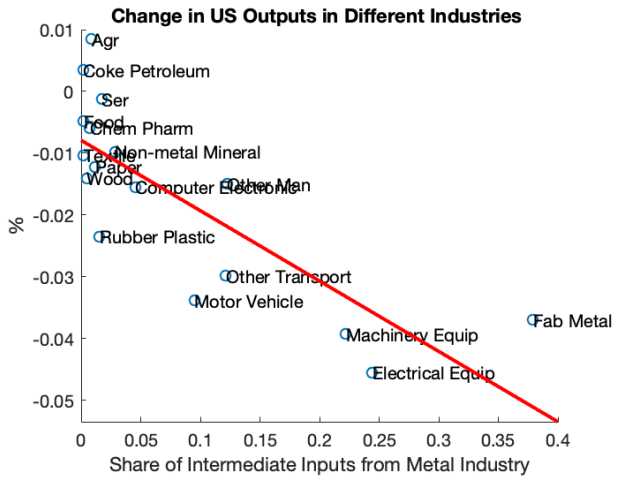


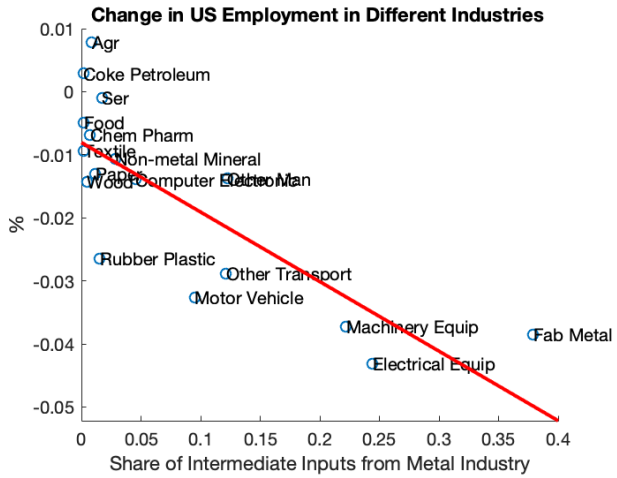


Counterfactual Analysis: Impacts through Across-Industry Linkage

Increase tariff on metal, check other industries







Counterfactual Analysis

Compare two cases:

i) ↑ tariffs on Chinese upstream products from all the 18 industries

ii) ↑ tariffs on Chinese downstream products from all the 18 industries

% change in US	tariffs on upstream products	tariffs on downstream products
price index	0.03%	0.10%
upstream employment	0.01%	-0.04%
upstream outputs	0.01%	-0.08%
downstream employment	-0.13%	0.64%
downstream outputs	-0.04%	0.09%

Tariffs on imports from China:

hurts US industries that rely on the targeted Chinse products

benefits US industries that produce the same type of products

Results: Round 1 v.s Round 2

Table: Round 1 % Change in Output

Top Hit		Top Benefit	
Automotive	-2.81%	Electrical Machinery	4.32%
Agriculture	-0.65%	Machinery	0.58%

Table: Round 2 % Change in Output

Top Hit		Top Benefit	
Chemical	-1.31%	Textile	0.98%
Agriculture	-0.32%	Rubber and Plastic	0.05%

Table: % Change in CPI

Round 1	0.09%	Round 2	0.22%

Results: Welfare Effect

Real income in country i

$$\frac{w_i L_i + Tr_i}{P_i} \tag{6}$$

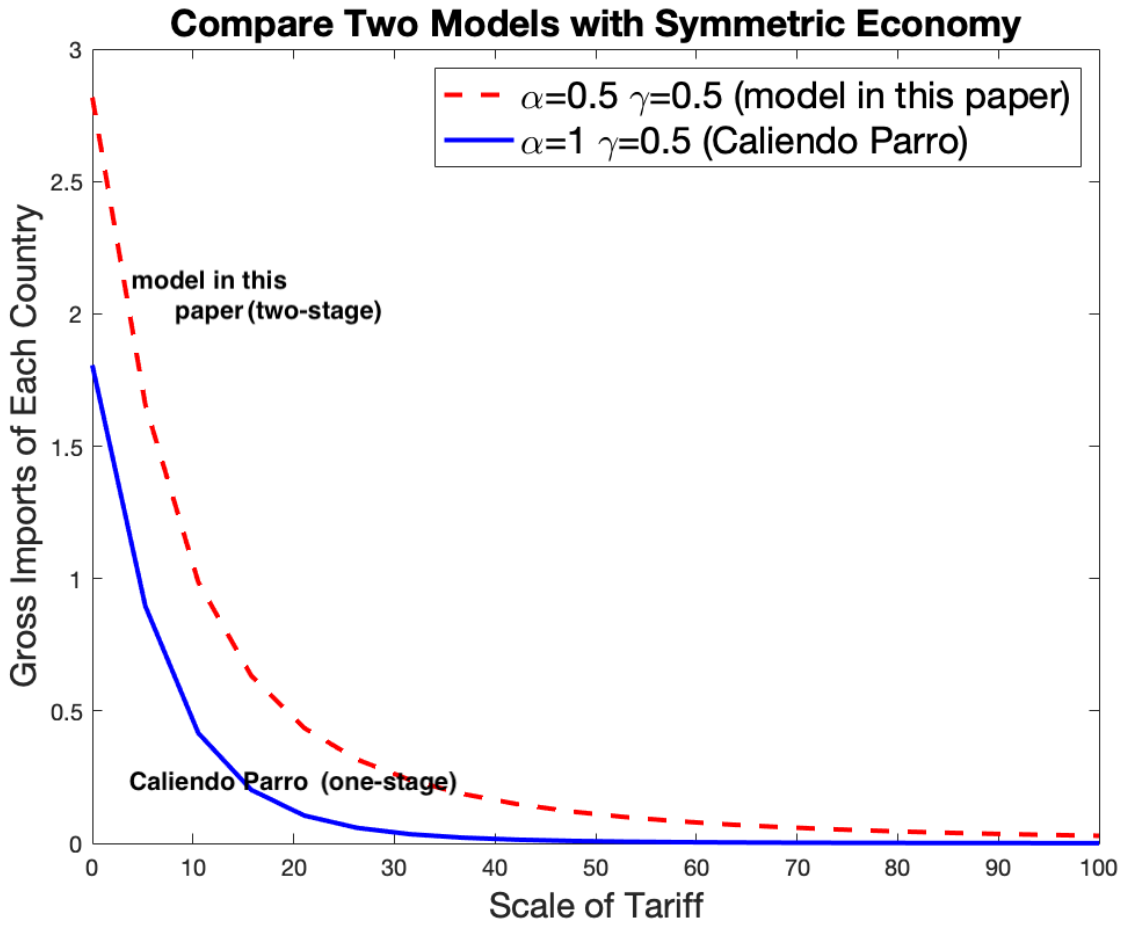
Table: % Change in Real Income

	My model(tariff+iceberg)	Antras model (iceberg)
CHN	-0.29	-3.2
USA	-0.08	-1.3
ROW	0.01	0.01

Jan 2018 - Dec 2019, in terms of real income, the trade war:

- costs China $\$35.2$ billion
- costs US $\$15.6$ billion

Model Comparison



Tariff Change in the Trade War

source: Chad Bown, PIIE

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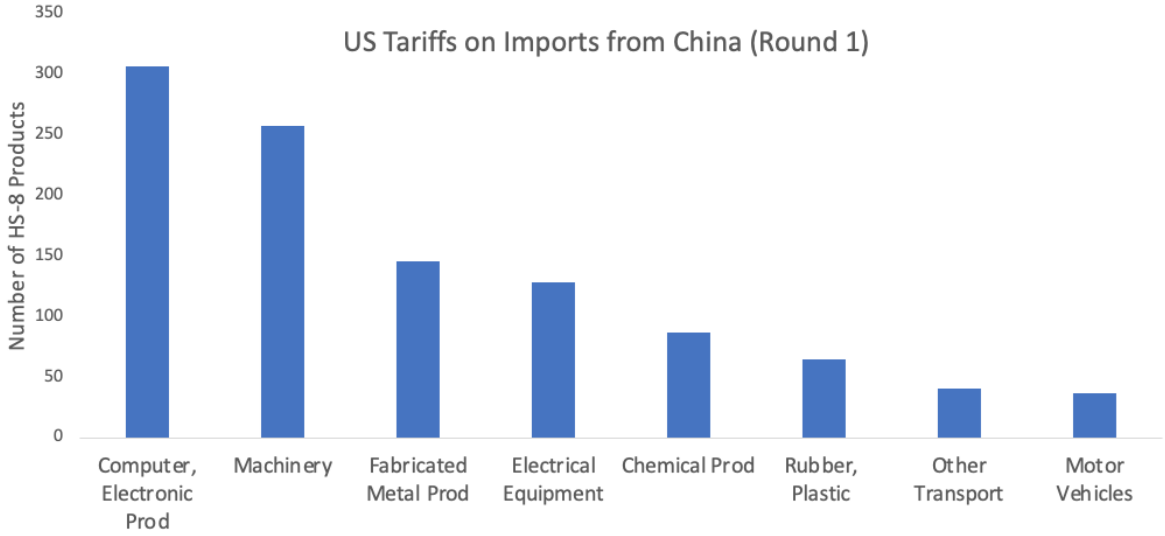
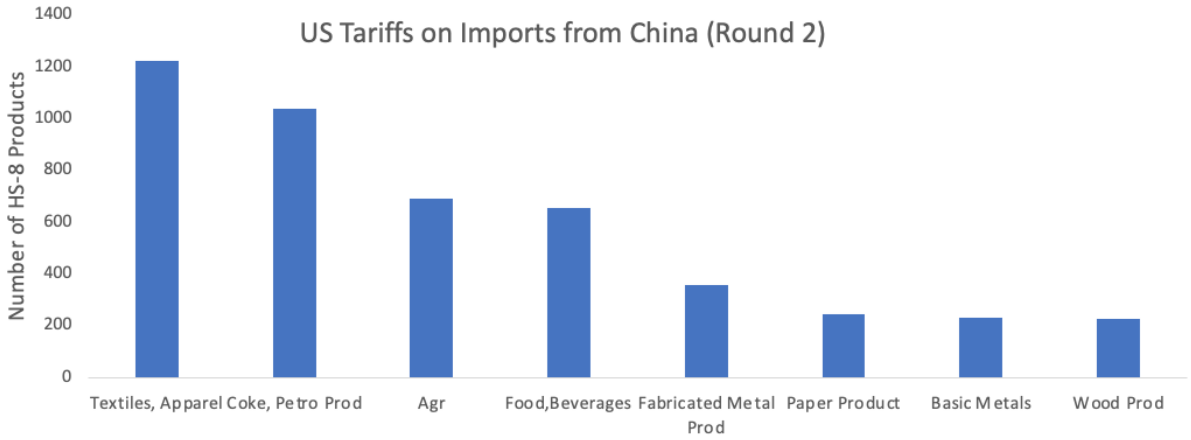
Top Targeted Chinese Industries in the Two Rounds





source: the Office of the United States Trade Representative

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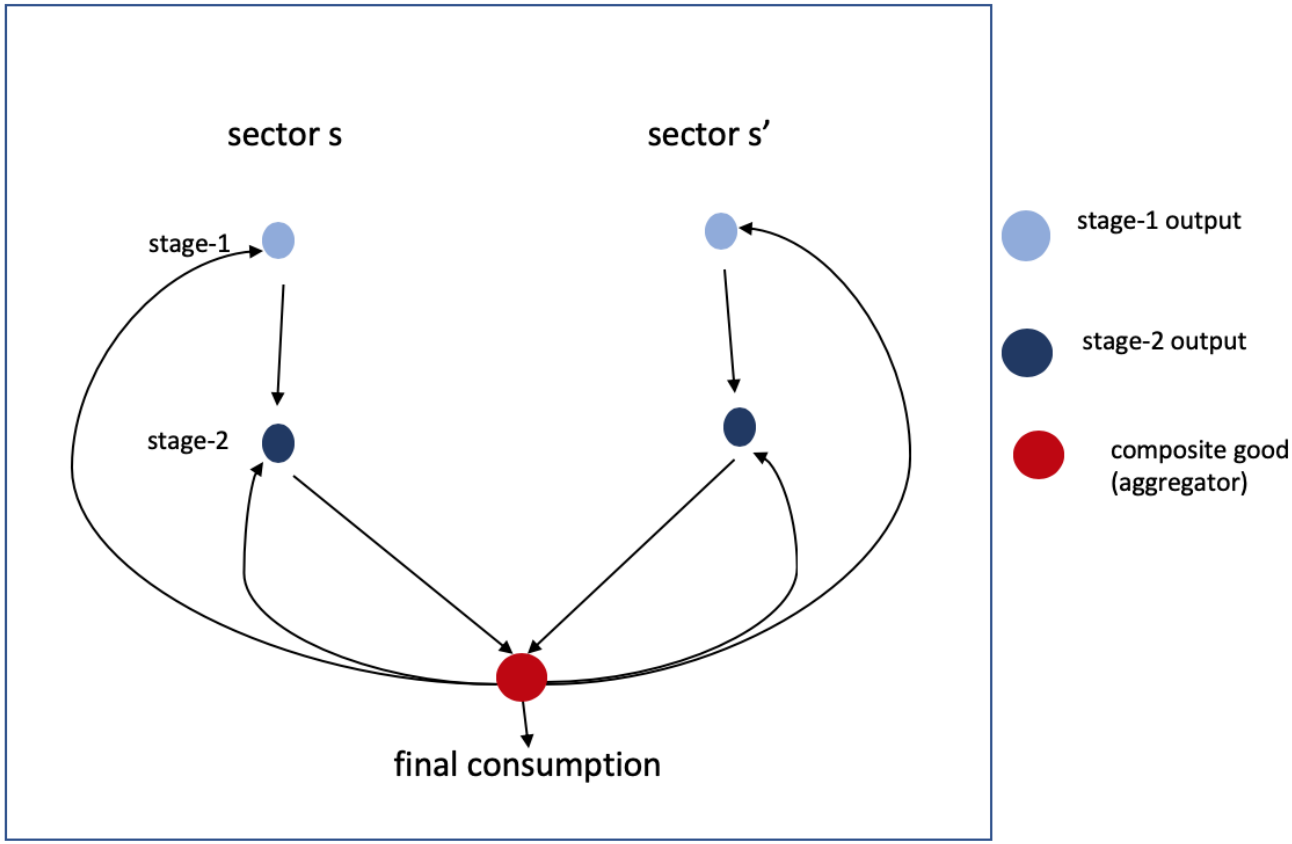
Production Diagram



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Assumption:

$$Pr[(a_i^1)^{(1-\alpha)}(a_j^2)^{\alpha} \geq a] = exp\{-a^{\theta}(T_i)^{(1-\alpha)}(T_j)^{\alpha}\} \tag{7}$$

Analytical solution: Let $l_j^{*1} = i,\ l_j^{*2} = k$

$$\pi_{l_j^*} = \frac{(T_i(v_i\tau_{ik})^{-\theta})^{1-\alpha} \times T_k^{\alpha}(v_k{}^{\alpha}\tau_{kj})^{-\theta}}{\Theta_j} \tag{8}$$

where

$$v_i = \gamma_i^{-\gamma_i}(1-\gamma_i)^{\gamma_i - 1} w_i^{\gamma_i} P_i^{1-\gamma_i} \tag{9}$$

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ICIO Table for Calibration

	country1_sector1	country1_sector2	...	countryJ_sectorM	country_1	country_2	...	country_J	Gross_Output
country1_sector1	Intermediate Transactions				Final Demand				Output at Basic Prices
country1_sector2									
...									
country1_sectorM									
country2_sector1									
...									
countryJ_sectorM									
country1	Tax Less Subsidies on Intermediate Goods				Tax Less Subsidies on Final Goods				
country2									
...									
countryJ									
Value_Added	Value Added at Basic Prices								
Gross_Output	Output at Basic Prices								

Source: OECD

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The Eighteen Industries

Code	Industry
D01T09	Agriculture, forestry, fishing, mining
D10T12	Food products, beverages and tobacco
D13T15	Textiles, wearing apparel, leather and related products
D16	Wood and products of wood and cork
D17T18	Paper products and printing
D19	Coke and refined petroleum products
D20T21	Chemicals and pharmaceutical products
D22	Rubber and plastic products
D23	Other non-metallic mineral products
D24	Basic metals
D25	Fabricated metal products
D26	Computer, electronic and optical products
D27	Electrical equipment
D28	Machinery and equipment
D29	Motor vehicles, trailers and semi-trailers
D30	Other transport equipment
D31T33	Other manufacturing; repair and installation of machinery and equipment
D35T98	Service

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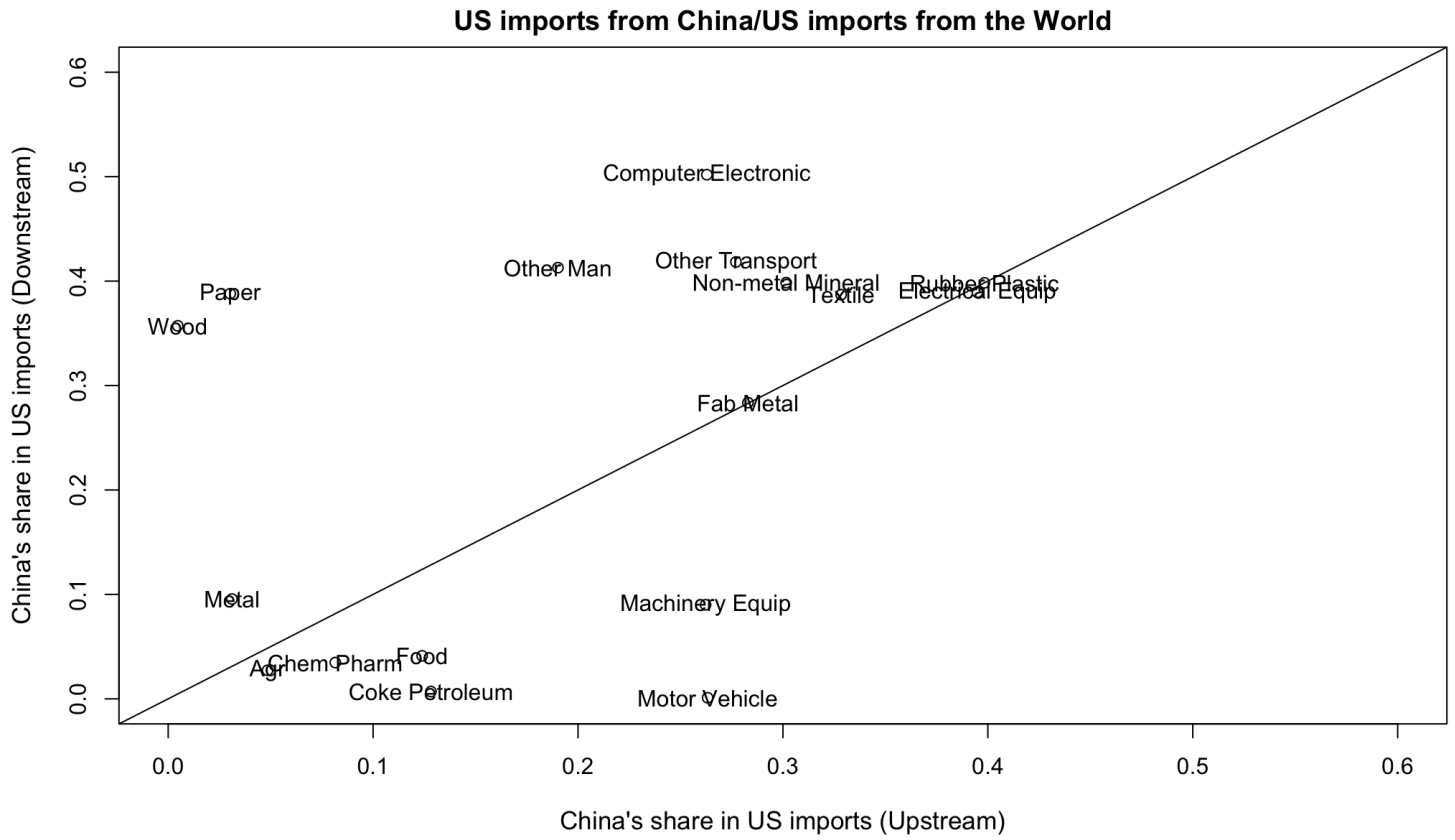
My Paper

- calibrate T using US Census Bureau trade data
- set T as stage-specific
- parameterization is supported by evidence from data



Data Source: US Census Bureau back

		CHN	USA	ROW	
	α	γ	γ	γ	b
Agriculture	0.24	0.96	0.99	0.99	0.037
D10T12	0.44	0.46	0.32	0.42	0.054
D13T15	0.72	0.31	0.39	0.46	0.015
D16	0.01	0.98	0.91	0.61	0.001
D17T18	0.01	0.68	0.80	0.55	0.003
D19	0.01	0.39	0.46	0.29	0.012
D20T21	0.13	0.46	0.87	0.58	0.020
D22	0.01	0.55	0.77	0.56	0.003
D23	0.28	0.53	0.78	0.61	0.002
D24	0.01	0.53	0.45	0.42	0.001
D25	0.47	0.34	0.61	0.62	0.006
D26	0.79	0.23	0.83	0.42	0.019
D27	0.83	0.23	0.48	0.38	0.011
D28	0.84	0.26	0.40	0.40	0.026
D29	0.95	0.18	0.24	0.26	0.031
D30	0.96	0.27	0.39	0.33	0.011
D31T33	0.77	0.38	0.56	0.49	0.014
Service	0.99	0.49	0.61	0.56	0.734

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	CHN		USA		ROW	
	$stage\ 1$	$stage\ 2$	$stage\ 1$	$stage\ 2$	$stage\ 1$	$stage\ 2$
	T	T	T	T	T	T
Agriculture	0.60	1.11	50	50	0.02	0.12
D10T12	1.50	12.00	50	50	0.65	9.88
D13T15	6.00	25.00	50	50	7.89	10.21
D16	0.83	6.00	50	50	0.20	0.48
D17T18	0.85	3.50	50	50	0.22	0.08
D19	8.00	0.01	50	50	0.33	0.42
D20T21	1.80	4.60	50	50	0.22	0.25
D22	9.00	9.00	50	50	0.40	0.40
D23	2.81	5.12	50	50	0.20	1.10
D24	5.00	5.00	50	50	1.50	1.50
D25	0.82	10.00	50	50	0.03	0.61
D26	0.007	4.50	50	50	0.05	1.00
D27	0.10	28.00	50	50	0.02	3.00
D28	0.002	5.00	50	50	0.02	3.00
D29	6.00	0.15	50	50	5.00	3.00
D30	$1E-5$	3.5	50	50	$1E-5$	0.33
D31T33	0.008	8.20	50	50	0.015	2.00
Service	1.40	1.40	50	50	0.006	0.006

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