Trade Liberalization, Input-output Linkage and Markup (very preliminary)

Yong Wang and Wei Xiang

Peking University

yongwang@nsd.pku.edu.cn; xiangwei@pku.edu.cn

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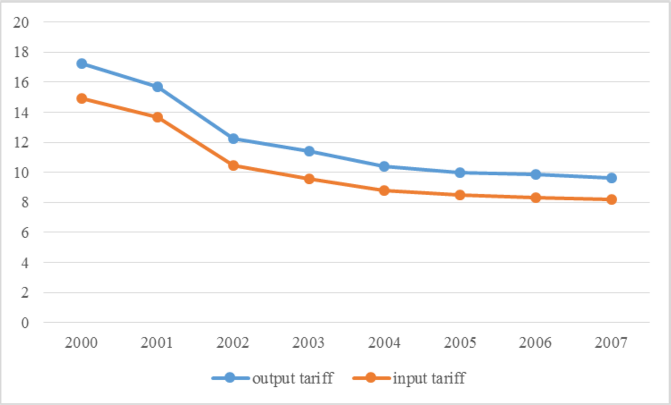
Figure 1

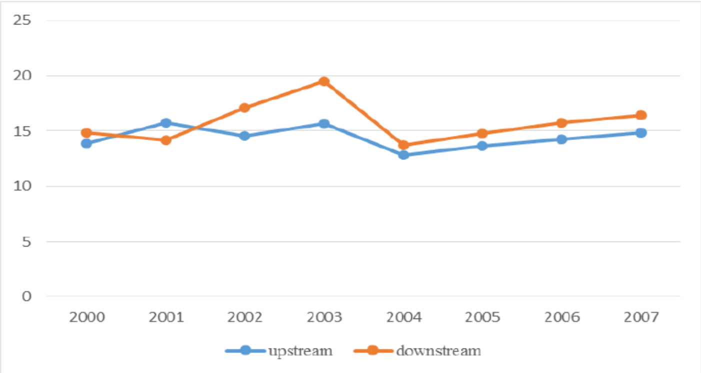
Figure 1: The average output tariff and input tariff 2000-2007



Data Source: WTO and the trade analysis and information system (TRAINS). Calculated by the author.

Figure 2

Figure 2: The average markups in upstream and downstream 2000-2007



Data Source: Chinese firm-level data from China's National Bureau of Statistics (NBS) 2000-2007. Calculated by the authors.

Table 1

Table 1: Markup, TFP, input tariff and output tariff

	markup			TFP			input tariff			output tariff		
year	observations	mean	std error	observations	mean	std error	observations	mean	std error	observations	mean	std error
2000				26,720	1.003	0.441	26,152	14.94	4.299	26,720	17.27	8.265
2001				32,528	1.006	0.412	31,839	13.65	3.506	26,720	17.27	8.265
2002				35,617	1.033	0.415	34,890	10.45	2.829	35,617	12.27	5.779
2003				72,864	1.054	0.465	70,957	9.543	2.150	72,864	11.42	5.127
2004				102,832	1.051	0.385	100,600	8.788	1.673	102,832	10.37	4.033
2005				119,153	1.023	0.400	116,526	8.504	1.489	119,153	9.998	3.672
2006				138,650	1.038	0.422	135,581	8.342	1.432	138,650	9.860	3.594
2007				165,006	1.039	0.418	161,265	8.170	1.437	165,006	9.608	3.757

Note: The measures are calculated by the author. The data used to estimate the firm markup and TFP are collected and maintained by China's National Bureau of Statistics (NBS) in an annual survey of manufacturing enterprises 2002-2007. The data used to calculate the output tariff are from WTO and the trade analysis and information system (TRAINS). Combining TRAINS and 2002 China's I-O table, we compute the input tariff.

Table 2

Table2: The index of industry upstreamness

2-digit CIC	Upstreamness	# of firms
13	2.163	40,108
14	2.135	15,565
15	2.574	11,084
16	3.712	865
17	3.164	61,445
18	3.880	23,277
19	3.467	10,531
20	3.793	15,875
21	2.782	7,762
22	4.063	24,189
23	3.874	17,395
24	3.068	4,397
25	2.397	7,585
26	3.435	63,147
27	2.409	14,202
28	3.200	5,234
29	1.133	9,358
31	2.263	68,713
32	3.470	24,586
33	2.877	16,415
34	2.659	29,861
35	2.893	61,266
37	2.966	33,463
39	2.638	25,137
40	1.962	16,138
41	1.670	9,377
42	2.060	7,263

Note: The data used in this table are collected and maintained by China's National Bureau of Statistics (NBS) in an annual survey of manufacturing enterprises 2000-2007 and 2002 China I-O Table.

Figure 1 in Li, Liu and Wang (2016)

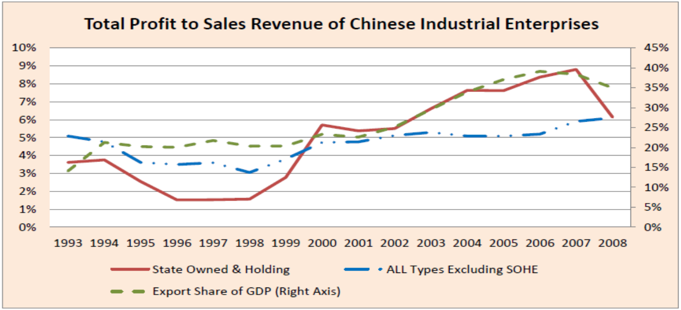


Figure 1: Total profit to sales revenue of Chinese enterprises in the industrial sector. We use CEIC (Table CN.BF: Industrial Financial Data: By Enterprise Type) to obtain total profit to sales revenue. In this table, CEIC categorizes industrial enterprises into state owned & holding, private, HMT & foreign, collective owned, shareholding corporations, foreign funded, and Hong Kong, Macau & Taiwan funded. We divide all the industrial enterprises into state owned & holding and the rest.

Figure 3 in Li, Liu and Wang (2016)

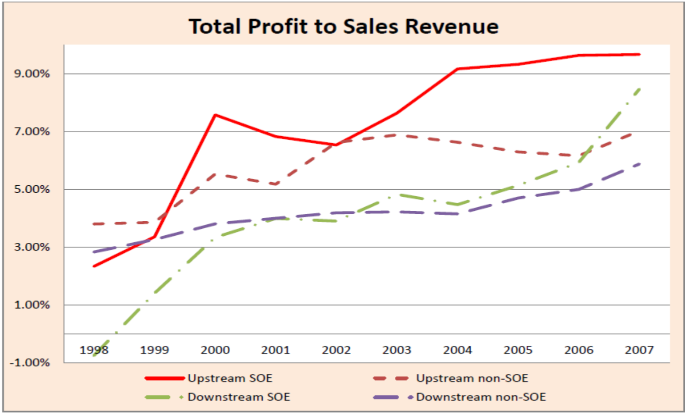


Figure 3: Total profit to sales revenue of Chinese enterprises in the industrial sector. We us NBS industrial enterprises data to obtain total profit to sales revenue and divide all the industrial enterprises into stat owned & holding and the rest.

Table 2 in Li, Liu and Wang (2016)

Table 2. Several Features of Different Industrial Sectors in China: 1998-2007

Industry	Lerner Index	Export Exposure	Herfindahl-Hirschman Index
Average across all upstream enterprises	0.0257	0.0554	0.0065
Average across all midstream enterprises	0.0153	0.0324	0.0024
Average across all downstream enterprises	0.0073	0.2188	0.0028

Data Source: NBS.

Li, Liu and Wang (2016)

- A Model of China's State Capitalism (Li, Liu and Wang 2016)
  - To show how SOEs in upstream sectors extract monopoly rents from downstream liberalized sectors in the process of structural transformation (industrialization) and trade globalization.
  - key insights: vertical structure differs from horizontal structure (Hsieh and Klenow 2009, Restuccia and Rogerson 2008)
- Limitations:
  - downstream aggregate productivity is exogenous
  - identical markup across downstream firms (because homogeneous productivities)
  - constant upstream markup when downstream production functions are Cobb-Douglas
  - upstream is not traded.

Novelty of This Paper

- By embedding Melitz and Ottaviano (2008) into the downstream sector of Li, Liu and Wang (2016), we explore how important firm heterogeneity is for markups in upstream and downstream firms, welfare, structural transformation, and GDP in both autarky and trade environment:
  - add sectoral linkage with asymmetric market structures to Melitz and Ottaviano (2008)
  - oligopoly in the upstream sector
  - upstream goods are also tradable
  - endogenous and heterogeneous markups
  - more general, not specific to China or SOEs
- Quantitative (in progress):
  - to test the model predictions about the impact of trade liberalization with input-output linkages and asymmetric market structures
  - counterfactual analyses

Model Environment

- Two countries: H and F.
- L (L^*) identical households, each endowed with one unit of labor inelastically supplied
- Three sectors: agriculture q_0, non-agriculture (upstream sector m and downstream sector $i \in \Omega$)
- Firm Heterogeneity: Melitz and Ottaviano (2008)
- Vertical Structure: Li, Liu and Wang (2016)

Preference

$$U = q_0^c + \alpha \int_{i\in\Omega} q_i^c di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^c)^2 di - \frac{1}{2}\eta\left(\int_{i\in\Omega} q_i^c di\right)^2$$

- q_0^c and q_i^c denote the consumption levels of the agriculture good and each variety $i \in \Omega$.
- α and η govern the substitution pattern between $Q^c \equiv \int_{i\in\Omega} q_i^c di$ and the numeraire.
- γ governs the degree of differentiation across the varieties.

Demand

The inverse demand function for variety $i \in \Omega$ by one household:

$$p_i = \alpha - \gamma q_i^c - \eta Q^c$$

Domestic market demand for variety i :

$$q_i \equiv L q_i^c = \frac{\alpha L}{\eta N + \gamma} - \frac{L}{\gamma} p_i + \frac{L}{\gamma} \frac{\eta N}{\eta N + \gamma} \bar{p}, \forall i \in \Omega^s,$$

where

- N is the total measure of consumed varieties: $\Omega^s \equiv \{ i \,|\, q_i^c > 0, i \in \Omega \}$
- $\bar{p} \equiv (1/N) \int_{i \in \Omega^s} p_i di$

$$p_i \leq p_{max} \equiv \frac{1}{\eta N + \gamma} (\gamma \alpha + \eta N \bar{p})$$

Technology

- The production function for a final good (variety) is given by:

$$q(\varphi, l, m) = \varphi(\frac{l}{\alpha_l})^{\alpha_l}(\frac{m}{\alpha_m})^{\alpha_m}, \quad \alpha_l + \alpha_m = 1. \qquad (1)$$

  where φ is the productivity drawn from distribution $G(\varphi)$.

- The production function of the intermediate good m by an upstream firm is:

$$q_m(\phi_m, l_m) = \phi_m l_m, \qquad (2)$$

  where productivity ϕ_m is exogenously given.
- The production function of the agriculture good q^0 is $q^0 = l^0$.

Market Structure

- Labor market and the agriculture market are both perfectly competitive.
- Each downstream firm produces a different variety $i \in \Omega$, engaged in monopolistic competition.
- (Homogeneous) input m is produced by M firms with Cournot competition.

Timing

1. All the upstream firms perfectly foresee the aggregate demand function for good m and are engaged in Cournot competition.
2. Then the price of the intermediate good p_m and the total supply Q_m^s are realized and become publicly observable.
3. Each dowstream firm takes p_m as given when making decisions on entry, exit, output and price.
4. The realized aggregate demand for m from the downstream industry Q_m^d is equal to Q_m^s at price p_m.

Cost Function

- The cost function of a downstream firm with productivity φ:

$$c(\varphi, q, w, p_m) = \frac{w^{\alpha_l} {p_m}^{\alpha_m}}{\varphi} q(\varphi)$$

- Whenever the agriculture (numeraire) output $q^0 > 0$, we have $w = 1$ and

$$\begin{aligned} c(\varphi, q, p_m) &= \frac{p_m^{\alpha_m}}{\varphi} q(\varphi) \\ mc_D(\varphi) &= \frac{p_m^{\alpha_m}}{\varphi} \\ mc_X(\varphi) &= \tau^* \frac{p_m^{\alpha_m}}{\varphi} \end{aligned}$$

τ^* is the iceberg trade cost imposed by foreign country.

Intermediate Good

- By Shepard Lemma, the demand for m from a downstream firm with productivity φ:

$$m(\varphi) = \frac{\alpha_m}{\varphi} p_m^{-\alpha_l} q(\varphi)$$

and its demand for labor:

$$l(\varphi) = \frac{\alpha_l}{\varphi} p_m^{\alpha_m} q(\varphi)$$

- The supplies by a firm with productivity φ at the domestic and foreign markets:

$$\begin{aligned} q_D(\varphi) &= \frac{L}{\gamma}[p_D(\varphi) - mc_D(\varphi)] \\ q_X(\varphi) &= \frac{L^*}{\gamma}[p_X(\varphi) - mc_X(\varphi)] \end{aligned}$$

Cut- off Productivity

The cut-off productivities of the domestic and exporting firms are:

$$\varphi_D = inf\{\varphi : \pi_D(\varphi) > 0\} = \frac{(p_m)^{\alpha_m}}{p_{max}},$$

$$\varphi_X = inf\{\varphi : \pi_X(\varphi) > 0\} = \frac{(p_m)^{\alpha_m}}{p^*_{max}}\tau^*.$$

Define firm markup

$$\mu_\iota \equiv p_\iota(\varphi)/mc_\iota(\varphi)$$

Firm profit after paying fixed cost f_E is given by

$$\pi_\iota(\varphi) = q_\iota(\varphi)\left[p_\iota(\varphi) - mc_\iota(\varphi)\right]$$

Equilibrium

prices

$$p_D(\varphi) = \frac{(p_m)^{\alpha_m}}{2}(\frac{1}{\varphi_D} + \frac{1}{\varphi}), p_X(\varphi) = \frac{(p_m)^{\alpha_m}}{2}\tau^*(\frac{1}{\phi_X} + \frac{1}{\varphi});$$

output

$$q_D(\varphi) = \frac{L(p_m)^{\alpha_m}}{2\gamma}(\frac{1}{\varphi_D} - \frac{1}{\varphi}), q_X(\varphi) = \frac{L^*(p_m)^{\alpha_m}}{2\gamma}\tau^*(\frac{1}{\varphi_X} - \frac{1}{\varphi});$$

markups

$$\mu_D(\varphi) = \frac{\varphi}{2}(\frac{1}{\varphi_D}) + \frac{1}{2}, \mu_X(\varphi) = \frac{\varphi}{2}(\frac{1}{\varphi_X}) + \frac{1}{2};$$

profits

$$\pi_D(\varphi) = \frac{{p_m}^{2\alpha_m}}{4\gamma}(\frac{1}{\varphi_D} - \frac{1}{\varphi})^2 L, \pi_X(\varphi) = \frac{{p_m}^{2\alpha_m}}{4\gamma}(\frac{1}{\varphi_X} - \frac{1}{\varphi})^2 L^* \tau^{*2}.$$

Free Entry Condition

Free entry implies

$$\int_{\varphi_D}^{\infty} \pi_D(\varphi) dG(\varphi) + \int_{\varphi_X}^{\infty} \pi_X(\varphi) dG(\varphi) = f_E$$

Assume Pareto distribution:

$$G(\varphi) = 1 - (\frac{\varphi_{min}}{\varphi})^k ; g(\varphi) = k(\varphi_{min})^k \varphi^{-(k+1)}.$$

The cut-off productivities of the firms in H:

$$\begin{aligned} \varphi_D &= [\frac{1-\rho\rho^*}{(p_m)^{-2\alpha_m} - (p_m^*)^{-2\alpha_m}\rho^*} \frac{L}{\xi\gamma}]^{\frac{1}{k+2}} \\ \varphi_X &= \tau^* [\frac{1-\rho\rho^*}{(p_m^*)^{-2\alpha_m} - (p_m)^{-2\alpha_m}\rho^*} \frac{L^*}{\xi\gamma}]^{\frac{1}{k+2}} \end{aligned}$$

where

$$\rho \equiv \tau^{-k}, \rho^* \equiv \tau^{*-k}, \xi \equiv \frac{2(k+1)(k+2) f_E}{\varphi_{min}^k}.$$

Cut-off Productivities

The cut-off productivities when F and H are symmetric:

$$\varphi_D = [\frac{L(1+\rho)p_m^{2\alpha_m}}{\xi\gamma}]^{\frac{1}{k+2}},$$

$$\varphi_X = \tau[\frac{L(1+\rho)p_m^{2\alpha_m}}{\xi\gamma}]^{\frac{1}{k+2}},$$

The measure of total entering firms:

$$N_E = \frac{2(k+1)\gamma}{\eta(1+\rho)\varphi_{min}^k}[\frac{\alpha\varphi_D^{k+1} - p_m^{\alpha_m}\varphi_D^k}{p_m^{\alpha_m}}]$$

Cut-off Productivities

- From the free entry condition, we have:

$$\varphi_D = [\frac{Lp_m^{2\alpha_m}(\varphi_{min})^k}{2(k+1)(k+2)\gamma f_E}]^{1/(k+2)} \quad (3)$$

- The total measure of the varieties is:

$$\begin{aligned} N &= N_E(1 - G(\varphi_D)) + N_E(1 - G(\varphi_X)) && (4) \\ &= \frac{2\gamma(k+1)}{\eta} \frac{\alpha\varphi_D - p_m^{\alpha_m}}{p_m^{\alpha_m}} && (5) \end{aligned}$$

Demand and Supply of the Intermediate Good

$$Q_m^d = \theta \frac{\psi p_m^{2\alpha_m/(k+2)} - p_m^{\alpha_m}}{p_m^{\alpha_m+1}} \tag{6}$$

where

$$\begin{aligned} \theta &= \frac{2\gamma k(k+1)}{\eta}\alpha_m k f_E \frac{1+\rho^{2+\frac{1}{k}}}{(1+\rho)^2}, \\ \psi &= \alpha[\frac{(1+\rho)L(\varphi_{min})^k}{2(k+1)(k+2)\gamma f_E}]^{1/(k+2)}. \end{aligned}$$

$$Q_m^s(p_m) = M\theta\{\psi[\frac{k}{k+2}\alpha_m + 1]p_m^{-\frac{k}{k+2}\alpha_m - 2} - p_m^{-2}\}(p_m - \frac{1}{\phi})$$

Equilibrium Characterization

Lemma

There exists a unique equilibrium.

Equilibrium Characterization

Theorem

Trade liberalization in the downstream sector lowers average markups of the downstream firms but raises markups of the upstream firms when $M = 1$*.*

Equilibrium Characterization

Theorem

Trade liberalization of the intermediate good leads to higher average markups of the downstream firms producing final goods and lower markups of the upstream firms.

Future Work

- Optimal firm number in the upstream.
- Empirical Test.
  - Data: ASIF and Custom Data
  - The index of upstremness: Antras and Chor (Econometrica 2013)
  - The estimation of markup: De Loecker and Warzynski(AER 2012); De Loecker et al.(Econometrica 2016)
  - The estimation of TFP: augmented Olley-Pakes TFP(Olley and Pakes Econometrica 1996; Amiti and Konings AER 2007; Yu EJ 2015).