An Accounting of the Decline in China's Trade

Yang Pei
University of Houston

Midwest Macroeconomics Meetings
Texas Tech University
Lubbock, TX

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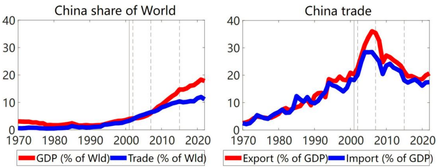
Motivation



Source: WDI Database

Over the past 30 years, China's economy has grown enormously

- 1990-2019, Real GDP growth rate: 9.2% per year

A key feature of its growth is participation in the global economy

- 1990-2019, China's Real Trade growth rate: 10.6% per year

▸ Detail

Motivation

Despite China's increasing importance in global trade, its trade share of GDP has been declining since 2006

- At the sector level (During 2002 to 2007 and 2007 to 2015) ▸ Detail
  - *Heavy industry* trade accounts for about 89% of trade share change

In parallel, China's internal economic integration also grows dramatically

- From 2002 to 2015, China's inner trade share of GDP almost doubled

- Household registration system reform: labor moves to Coastal areas
  - From 2000 to 2015, internal migrants almost doubled

Research Question and Methodology

Research Question:

- What forces have driven China's declining trade share?
  - What is the relative importance of each?

What I do

- Develop a multi-sector, multi-region Ricardian trade model (Caliendo and Parro, 2015):
  - International trade.
  - Inter-regional trade within China.
  - Labor mobility frictions across regions within China. (Tombe and Zhu, 2018)

- Calibrate (sector-region) exogenous shocks through gravity regression:
  - Total factor productivity (TFP) shocks
  - Asymmetric Trade cost shocks: **Intranational** trade and **International** trade
  - Labor mobility cost shocks

- Feed each shock separately into model to assess importance of each force

Literature Review

- **Ricardian trade model**
  Eaton and Kortum (2002), Caliendo and Parro (2015), Waugh (2010); Rodríguez,et.al(2020), **Tombe and Zhu (2020)**

- **Trade and geographical distribution of labor and economic activity**
  Allen and Arkolakis (2014), Caliendo, Parro, Rossi-Hansberg, and Sarte (2018), , Caliendo, Dvorkin, and Parro (2019), Rodriguez-Clare, Ulate, and Vasquez (2020)

- **Structural accounting decomposition**
  Swiecki (2014); Sposi, et.al(2018); Choi, et.al(2018);

- **Trade and Chinese economy**
  Brandt and Holz (2006), Brandt, Tombe, and Zhu (2013), Brandt and Lim (2020), Fan(2020), Alessandria, Khan, Khederlarian, Ruhl, and Steinberg (2021), Campante, Chor, and Li (2023)

Model

Overview

- Multi-country, multi-sector model with Eaton-Kortum Ricardian trade
  - N_0 China regions plus $N_1 = N - N_0$ other regions
  - Labor move across China's regions under migration costs

Production

$$q_n^j(\omega^j) = Z_n^j(\omega^j) l_n^j(\omega^j)^{\gamma_n^j} \prod_{k=1}^{J} m_n^{k,j}(\omega^j)^{\gamma_n^{k,j}}$$

- Intermediate goods, $q_n^j(\omega^j)$ are produced by labor, and sectoral composite intermediate good
- Variety-specific productivity $z_{n,t}^j(\omega)$ drawn from Fréchet $F_{n,t}^j(z) = exp(-\lambda_{n,t}^j z^{-\theta})$
- Sector composite good used in consumption, and intermediates

Preferences

- Cobb–Douglas aggregator of sectoral composite goods from each sector

Trade

- Asymmetric iceberg costs
- Trade, determined by Ricardian comparative advantage, directly affects sectoral reallocations

$$\pi_{ni}^j = \frac{\lambda_i^j \left(\kappa_{ni}^j c_i^j\right)^{-\theta_j}}{\sum_{i=1}^{N} \lambda_i^j \left(\kappa_{ni}^j c_i^j\right)^{-\theta_j}} \; ; \qquad c_n^j \propto w_n^{\gamma_n^j} \prod_{k=1}^{J} P_n^{k\,\gamma_n^{k,j}}$$

Detail

Model

Labor flow under migration costs

For each worker with registration place (a.k.a *hukou*) in region m moves to region n, the utility is:

$$U^{n,m} = \frac{z(\omega)}{\nu^{n,m}} U(\mathcal{C}_n)$$

- **Deterministic part I** : C_n, real consumption ▸ Detail
- **Deterministic part II**: $\nu^{n,m} \geq 1$, a proportional ratio captures utility loss when people choose to migrate out of registration place
- **Idiosyncratic part (Preference Shiftier for Moving)** : $z(\omega)$ drawn from Frechet Distribution with mean 1 and variance $(1/\kappa)$
  - The utility of people making the same migration chooses (e.g. $m \to n$) are still heterogeneous across individuals

The fraction of people migrate from m to n

$$\mathrm{m}^{n,m} = \frac{\left(\frac{W_n}{\nu^{n,m}}\right)^{\kappa}}{\sum_{n\prime}^{N0}\left(\frac{W_{n\prime}}{\upsilon^{n\prime,m}}\right)^{\kappa}}$$

W_n: real income of representative worker migrates to region n

Model

Equilibrium

Given the model parameters $(\gamma_n^j, \gamma_n^{k,j}, \sigma^j, \alpha_n^k, \theta, \kappa)$, sectoral TFP and bilateral trade costs $(\lambda_n^j, \kappa_{ni})$, labor mobility frictions $(\nu^{n,m})$, and data on each region's trade deficit, initial total population $(D_n, L_n, \bar{L}_m)$, there exist unique values of labor migration share, expenditure share, and wage rate $\pi_{ni}^j, m^{n,m}, w_n$ that can solve the equations in following table.

(F1)	$c_n^j = \Upsilon_n^j w_n{}^{\gamma_n^j} \prod_{k=1}^J P_n^{k\,\gamma_n^{k,j}}$; $\Upsilon_n^j \equiv \prod_{k=1}^J \gamma_n^{k,j\,-\gamma_n^{k,j}} \gamma_n^{j\,-\gamma_n^j}$	$\forall(n,j)$
(F2)	$P_n^j = A^j \left(\sum_{i=1}^N \lambda_i^j \left(\kappa_{ni}^j c_i^j\right)^{-\theta}\right)^{-\frac{1}{\theta}}$; $A^j = \Gamma\left(\frac{1+\theta-\sigma^j}{\theta}\right)^{\frac{1}{(1-\sigma^j)}}$	$\forall(n,j)$
(F3)	$\pi_{ni}^j = \frac{\lambda_i^j \left(c_i^j \kappa_{ni}^j\right)^{-\theta}}{\sum_{m=1}^N \lambda_m^j \left(c_m^j \kappa_{nm}^j\right)^{-\theta}} = \lambda_i^j \left(A^j \frac{c_i^j \kappa_{ni}^j}{P_n^j}\right)^{-\theta}$	$\forall(n,j)$
(H1)	$P_n = \prod_{j=1}^J \left(\frac{P_n^j}{\alpha_n^j}\right)^{\alpha_n^j}$	$\forall(n)$
(H2)	$W_n \equiv \frac{I_n}{P_n L_n}$; $w_n L_n + D_n = I_n$	$\forall(n)$
(H3)	$m^{n,m} = \frac{\left(\frac{W_n}{\nu^{n,m}}\right)^\kappa}{\sum_{n'}^{N0} \left(\frac{W_{n'}}{\nu^{n',m}}\right)^\kappa}$	$\forall(n,m)$
(H4)	$L_n = \sum_m^{N0} m^{n,m} \bar{L}_m$	$\forall(n)$
(M1)	$X_n^j = \alpha_n^j I_n + \sum_{k=1}^J \gamma_n^{j,k} \left(\sum_{i=1}^N X_{in}^k\right)$	$\forall(n,j)$
(M2)	$\sum_{j=1}^J \sum_{i=1}^N X_{ni}^j - D_n = \sum_{j=1}^J \sum_{i=1}^N X_{in}^j$	$\forall(n,j)$
(M2′)	$w_n L_n = \sum_{j=1}^J \gamma_n^j \sum_{i=1}^N \pi_{in}^j X_i^j$	$\forall(n)$

Mechanism

Analytical Solution

Under one-sector version of the model and friction-less trade

$$\text{TradeShareofGDP}_{\text{CHN}} = \frac{1}{\beta}\left(1 - \sum_{i \in \mathbb{N}_0} \pi_{ni}\right) = \frac{1}{\beta}\left(\sum_{i \in \mathbb{N}_1} \pi_{ni}\right) \tag{1}$$

$$\pi_{ni} = (Z_i)^{\frac{1}{1+\beta\theta}} \left[\sum_{i=1}^{N} (Z_i)^{\frac{1}{1+\beta\theta}}\right]^{-1} \tag{2}$$

- N_0 regions within China; $N_1 = N - N_0$ foreign regions
- $\mathbf{Z_n \equiv \lambda_n L_n}^{\theta\beta}$ is defied as **Productive Capacity** of the region n

Under friction-less migration

$$L_n = \frac{(\lambda_n)^{\frac{\kappa}{1+\kappa+\beta\theta}}}{\sum_{n'}^{N_0} (\lambda_{n'})^{\frac{\kappa}{1+\kappa+\beta\theta}}} \sum_{m}^{N_0} \bar{L}_m \tag{3}$$

- Higher TFP regions with higher labor supply

Mechanism

Intuition

Intuition: Comparative Advantage (**CA**) and specialization

- TFP
  - As China's TFP increases, all else equal, because of **CA** forces, China produce more varieties, its share of total spending on domestic goods will increase; hence, the import share will decline.

- Trade cost
  - **International** trade cost increase: China specialize more varieties, trade share decrease
  - **Intranational** trade cost decrease: Foreign specialize relatively less varieties, trade share decrease

- Labor supply and Labor mobility cost
  - **Labor supply** decrease: Small country do not need to specialize in too many goods to be able to consume the goods it needs. The country will specialize on less varieties (right tail of the distribution), thus trade share increase.
  - **Labor mobility cost** decrease: ambiguous aggregate effects
    - ★ high TFP region: labor net inflow, specialize more varieties, trade share decrease
    - ★ low TFP region: labor net outflow, specialize less varieties, trade share increase

Calibration

Date Sources

- **8 China regions plus 3 foreign regions; 2 periods**
  - **8 regions within China mainland**: NorthEast; BeijingTianjin; NorthernCoastal; EasternCoastal; SouthernCoastal; Central; NorthWest; SouthWest
  - **3 foreign regions**: "Asian3": Korean, Taiwan and Japan aggregate together; "G6": G7 country group without Japan; "ROW": aggregate of rest of the world
  - **2 periods**: 2002 to 2007, 2007 to 2015
- **Four broad sectors (ISIC v4)**
  - **Agriculture**: Agriculture, forestry and fishing (A)
  - **Light industry**: Manufacturing (C10-18);
  - **Heavy industry**: Mining and quarrying (B); Manufacturing (C19-33); Electricity, gas, steam and air conditioning supply (D); Water supply, sewerage, waste management and remediation activities (E)
  - **Services**: the remaining sectors from F to S
- **Data sources** Detail
  - China IRIO table; WIOD table; OECD ICIO table; CEPII; Penn World Tables 10.0; The China's National Census Data

Calibration

Parameters and Shocks

Table: Calibration

Time Invariant Parameters		
$\theta = 4$	Trade elasticity	Simonovska and Waugh (2014)
$\kappa = 1.5$	Labor flow elasticity	Tombe and Zhu (2020)
$\sigma = 2$	Intermediate varieties elasticity	Broda and Weinstein (2006)
α_n^j	Expenditure share	*Calculated from IO table and take average across year*
γ_n^j, $\gamma_n^{j,k}$	Production share	
Time Varying Shocks		▸ Detail
λ_n^j	TFP	*Following Tombe and Zhu (2020), calibrated by gravity regression*
κ_{ni}^j	Trade cost	
ν_n^j	Labor flow cost	
$\bar{L}^m$	Labor supply	Get directly from PWT and census

Calibration

Results

TFP Detail

- **2002-2007**: China aggregate TFP increased 24% (weighted by average value-added share)
  - Heavy industry increased 14%
- **2007-2015**:China aggregate TFP increased 57%
  - Heavy industry increased 39%

Trade cost Detail

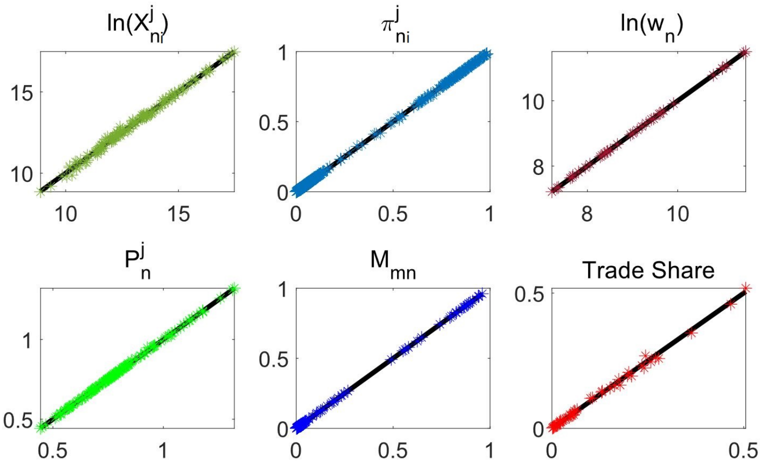
- **2002-2007**: For China,
  - In**tra**national trade cost decreased 17% (weighted by average trade share)
  - In**ter**national trade cost:
    - Export cost decreased 27%
- **2007-2015**: For China,
  - In**tra**national trade cost decreased 4%
  - In**ter**national trade cost:
    - Export cost decreased 23%

Migration cost Detail

- **2002-2007**: Migration cost decreased 25% (weighted by average labor flow share)
- **2007-2015**: Migration cost decreased 4%

Calibration

Calibration Efficiency



Note: The scatter plots have actual data on the x axis and model-generated value on the y axis with the 45 degree line on the diagonal.

Figure: Calibration Efficiency

Calibration

Baseline Model and Data

Table: Model fit

China Trade Share of GDP		***Data***	***Model***	
			Balanced trade	*Exogenous trade deficits*
			Baseline 1	*Baseline 2*
Import (% of GDP)	*2002*	19.68%	**22.09%**	**19.43%**
	2007	25.78%	**29.86%**	**24.58%**
	2015	17.41%	**19.59%**	**18.08%**
Export (% GDP)	*2002*	23.46%	-	**23.19%**
	2007	36.39%	-	**35.25%**
	2015	20.03%	-	**20.69%**
Internal trade (% of GDP)	*2002*	26.95%	23.96%	26.05%
	2007	46.64%	45.79%	45.88%
	2015	50.53%	50.96%	51.79%

- The model reproduces trade share of GDP relatively well
- In the main text, I use ***Baseline 1*** as baseline and do counterfactual under balanced trade
- In the robustness checks, I use ***Baseline 2*** as baseline a do counterfactual with exogenous trade deficit to GDP ratio

Counterfactual

Results: Single shocks

Table: Decompose Marginal effects

Decompose Marginal effects				
	Trade Share of GDP (p.p. change)			
	2002-2007		***2007-2015***	
	External	*Internal*	*External*	*Internal*
All Forces (Baseline)	7.78	21.83	-10.28	5.16
TFP	**-12.55**	2.04	**-10.75**	-0.12
Demographic				
Migration firction	1.99	1.01	-1.84	0.14
Population growth	-0.36	0.08	-0.47	-0.07
Trade cost				
Intranational	-2.31	21.36	-0.24	-0.41
International	**9.86**	-1.65	-4.47	-1.42
Other forces	**6.08**	-1.42	0.37	2.25

Baseline : all shocks realized as actual

Counterfactual : hold specific shock at the base year level while all other shocks realized as actual

Marginal effects of specific shock ≡ Trade share under **Baseline** - Trade share under **Counterfactual**

Counterfactual

Results: Single shocks at disaggregated level

Table: Decompose Marginal effects at disaggregated level

Decompose Marginal effects at the sector level				
	Trade Share of GDP (p.p. change)			
	2002-2007		*2007-2015*	
	External	*Internal*	*External*	*Internal*
All Forces	**7.78**	**21.83**	**-10.28**	**5.16**
Other forces	**6.08**	**-1.42**	**0.37**	**2.25**
Foregin TFP	**5.80**	-1.47	0.67	2.11
Foregin trade cost	-0.41	0.17	-0.68	0.25
Foregin labor	0.76	-0.14	0.56	-0.07
TFP	**-12.55**	**2.04**	**-10.75**	**-0.12**
Agriculture	-0.37	0.05	-4.70	-0.78
Light industry	-1.50	0.47	-0.90	0.03
Heavy industry	**-8.42**	5.41	**-8.63**	5.24
Service	**-8.70**	-4.12	**-13.96**	-4.31
International Trade cost	**9.86**	**-1.65**	**-4.47**	**-1.42**
Agriculture	-0.24	0.00	-1.83	-0.26
Light industry	0.63	-0.14	-0.39	0.08
Heavy industry	**6.74**	-0.23	-0.92	1.00
Service	0.56	-0.78	-4.85	-1.84
Intranational Trade cost	**-2.31**	**21.36**	**-0.24**	**-0.41**
Agriculture	0.01	0.88	0.01	-0.17
Light industry	-0.12	2.69	0.04	-1.21
Heavy industry	-1.98	10.67	0.27	-3.56
Service	0.04	5.72	-0.06	2.36

Conclusions

Build trade model to explain China's trade share change over time

- Key driving forces are China's TFP change and China's export trade cost change

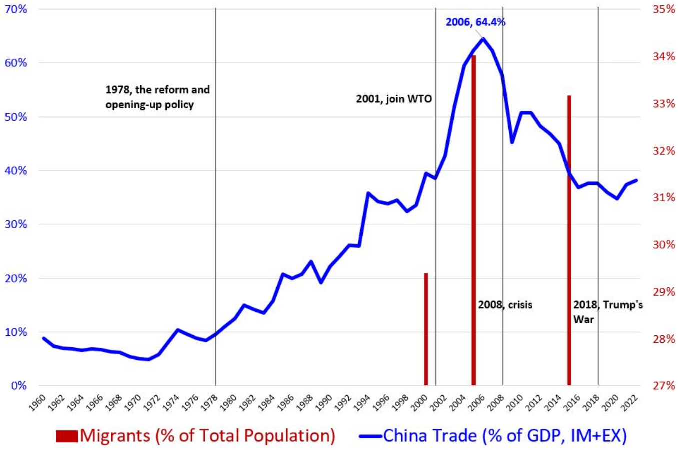
Story for China's trade share of GDP Change

- Overall
  - From 2002 to 2007, China's trade share of GDP increase due to
    - ★ International trade cost decline, foreign regions TFP growth
    - ★ While China's regions TFP growth driven trade share down
  - From 2007 to 2015, China's trade share of GDP decline due to
    - ★ China's TFP growth
- At sector level
  - From 2002 to 2007, the international trade costs decline in the heavy industry is also important
  - In both periods, changes in TFP within the heavy industry sector play a crucial role ▸ Detail
    - ★ Through input-output linkages, changes in TFP within the services sector hold the same level of importance

Thank You

China Trade and Migrants Data

Figure 1.B: China Trade and Migrants Data

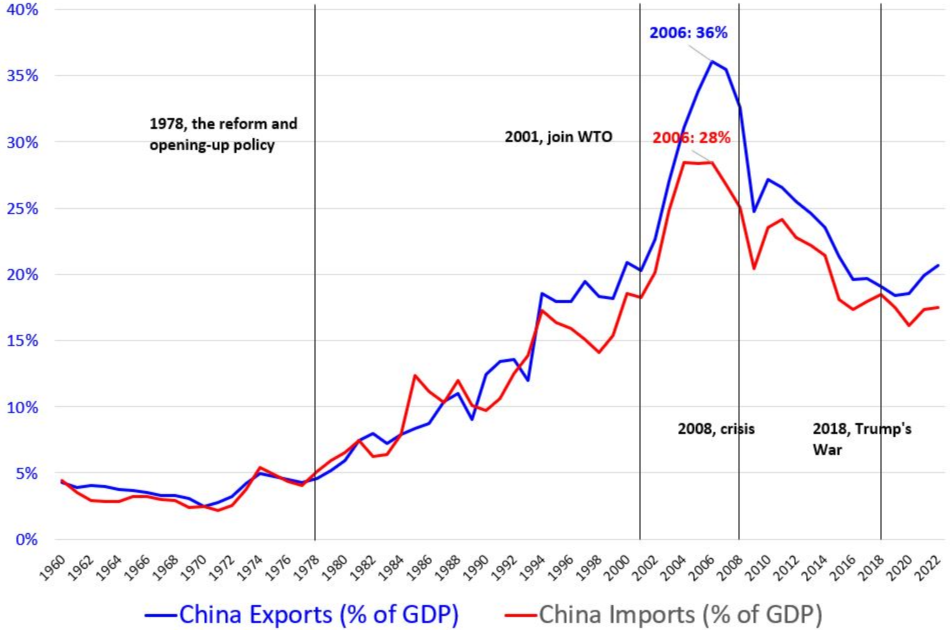


Migrants: people living outside of their registration (*hukou*) province.

Source: WDI Database and China Statistical Yearly book

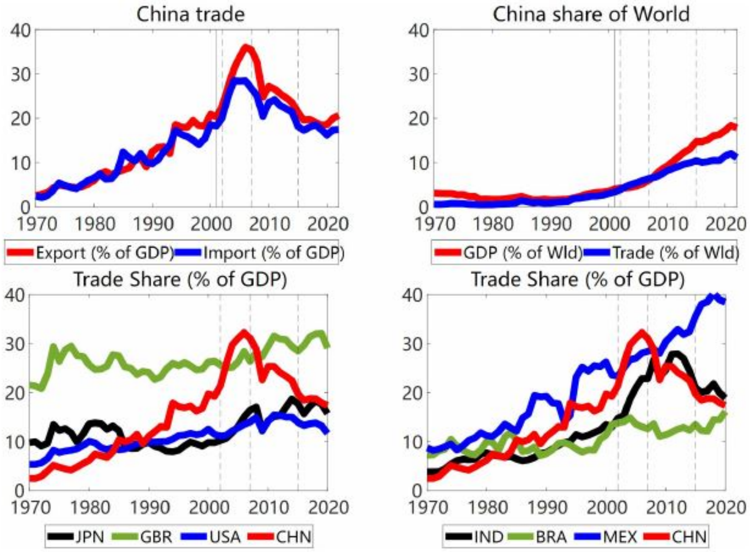
Back

Detail Data



Source: WDI Database Back

Detail Data



Note:The solid line represents the year 2001 when China joined the WTO. The three dotted vertical lines represent the years 2002, 2007, and 2015, respectively. These are the years for which I conducted the counterfactual analysis.

Source: WDI Database Back

China trade share at sector level and migrants share

Table: China trade share at sector level and migrants share

	2002	***2007***	***2015***		***2002***	***2007***	***2015***
Import (% of GDP)	19.68%	25.78%	17.41%	***Export (% of GDP)***	23.46%	36.39%	20.03%
Agricultural Component	0.48%	0.80%	0.61%	*Agricultural Component*	0.37%	0.31%	0.14%
Light Industry Component	2.03%	1.36%	1.07%	*Light Industry Component*	5.21%	6.61%	3.17%
Heavy Industry Component	**15.16%**	**20.77%**	**10.08%**	***Heavy Industry Component***	**12.98%**	**24.22%**	**13.13%**
Services Component	2.01%	2.86%	5.65%	*Services Component*	4.91%	5.51%	3.59%
	2002	***2007***	***2015***		***2002***	***2007***	***2015***
Inner Trade (% of GDP)	26.95%	46.64%	50.53%	***China Trade (% of World)***	4.59%	6.72%	10.05%
Agricultural Component	1.37%	2.31%	2.23%	***China GDP (% of World)***	6.49%	9.24%	14.71%
Light Industry Component	4.51%	5.86%	6.11%				
Heavy Industry Component	**16.33%**	**27.85%**	**24.41%**		***2000***	***2005***	***2015***
Services Component	4.74%	10.61%	17.79%	***China Migrants (% of pop.)***	**29.40%**	**34.00%**	**33.20%**

- Heavy industry trade share change accounts for main change of China's Trade share change
- Migrants share changes more during period 2000-2005 than period 2005-2015

Back

China trade share at regional level

Table: China trade share at regional level

Trade (% of GDP)	*2002*	*2007*	*2015*		*2002*	*2007*	*2015*
Aggregate	21.57%	31.09%	18.72%	-	-	-	-
			Component classified by China regions				
NorthEast (NE)	1.16%	1.96%	0.72%	***SouthernCoastal (SC)***	**8.31%**	**7.55%**	**6.13%**
BeijingTianjin (BT)	1.72%	2.78%	1.58%	*Central (CE)*	0.80%	2.24%	1.02%
NorthernCoastal (NC)	1.58%	2.81%	1.83%	*NorthWest (NW)*	0.39%	1.60%	0.51%
EasternCoastal (EC)	**7.08%**	**10.83%**	**6.14%**	*SouthWest (SW)*	0.53%	1.31%	0.78%
			Component classified by foreign regions				
USA	2.86%	3.97%	3.22%	*AUS*	0.42%	0.73%	0.72%
JPN	2.83%	2.99%	1.52%	*GBR*	0.45%	0.61%	0.38%
KOR	1.33%	1.92%	1.38%	*FRA*	0.42%	0.66%	0.43%
TWN	1.22%	1.54%	0.76%	*IND*	0.21%	0.54%	0.55%
DEU	0.96%	1.68%	0.82%	*ITA*	0.30%	0.47%	0.26%
NLD	0.20%	0.32%	0.15%	*CAN*	0.33%	0.55%	0.42%
RUS	0.31%	0.64%	0.37%	*ROW1*	9.74%	14.47%	7.73%
G6	**5.32%**	**7.93%**	**5.54%**				
AS3	**5.37%**	**6.45%**	**3.66%**	*ROW2*	10.88%	16.70%	9.52%

- Eastern coastal and Southern coastal trade change accounts for main change of China's trade share change
- As main trade partner of China, G6 is as important as Asian3

IO linkages

Input-Output	***Source sector***							
linkages	*Agricultural*	*Light*	*Heavy*	*Services*	*Agricultural*	*Light*	*Heavy*	*Services*
Destination sector	*Average cross China regions*				-			
Agricultural	0.16	0.09	0.11	0.07	-	-	-	-
Light	0.20	0.30	0.10	0.11	-	-	-	-
Heavy	**0.01**	**0.03**	**0.51**	**0.12**	-	-	-	-
Services	0.02	0.05	0.22	0.21	-	-	-	-
Destination sector	*NorthEast*				*BeijingTianjin*			
Agricultural	0.18	0.28	0.01	0.01	0.21	0.13	0.00	0.01
Light	0.14	0.26	0.01	0.05	0.10	0.36	0.01	0.04
Heavy	**0.12**	**0.11**	**0.56**	**0.25**	**0.18**	**0.14**	**0.62**	**0.22**
Services	0.06	0.09	0.12	0.21	0.10	0.12	0.14	0.29
	NorthernCoastal				*EasternCoastal*			
Agricultural	0.18	0.23	0.01	0.01	0.14	0.12	0.01	0.01
Light	0.11	0.35	0.04	0.05	0.13	0.39	0.03	0.04
Heavy	**0.14**	**0.11**	**0.59**	**0.24**	**0.13**	**0.16**	**0.63**	**0.24**
Services	0.04	0.08	0.11	0.20	0.07	0.10	0.11	0.25
	SouthernCoastal				*Central*			
Agricultural	0.15	0.13	0.01	0.01	0.20	0.26	0.01	0.01
Light	0.12	0.38	0.03	0.05	0.10	0.31	0.03	0.05
Heavy	**0.10**	**0.14**	**0.62**	**0.19**	**0.10**	**0.09**	**0.53**	**0.23**
Services	0.07	0.10	0.13	0.24	0.05	0.09	0.14	0.22
	NorthWest				*SouthWest*			
Agricultural	0.19	0.31	0.01	0.01	0.20	0.25	0.01	0.01
Light	0.08	0.22	0.01	0.04	0.09	0.20	0.02	0.05
Heavy	**0.12**	**0.08**	**0.49**	**0.25**	**0.09**	**0.11**	**0.54**	**0.26**
Services	0.07	0.09	0.13	0.21	0.04	0.10	0.15	0.22

Calibration

Time Varying Driving Forces

Back

The structural gravity equation from the model:

$$\ln\left(\frac{X^j_{nit}}{X^j_{nnt}}\right) = \ln\left(\lambda^j_{it}\left(c^j_{it}\right)^{-\theta}\right) - \ln\left(\lambda^j_{nt}\left(c^j_{nt}\right)^{-\theta}\right) - \theta\ln\left(\kappa^j_{nit}\right) \tag{4}$$

I assume that unobserved trade cost terms κ^j_{ni} can be described by a symmetric component and an exporter-specific component, and the symmetric component is well proxied by population-weighted geographic distance:

$$\ln\left(\kappa^j_{ni}\right) = \text{EX}^j_i + \beta^j \ln\text{Dist}_{ni} + \epsilon^j_{ni} \tag{5}$$

Combine 5 and 4, I get the following structural equation:

$$\begin{aligned}\ln\left(\frac{X^j_{ni}}{X^j_{nn}}\right) &= \left\{\ln\left(\lambda^j_i\left(c^j_i\right)^{-\theta}\right) - \theta\text{EX}^j_i\right\} + \left\{-\ln\left(\lambda^j_n\left(c^j_n\right)^{-\theta}\right)\right\} - \theta\beta^j\ln\text{Dist}_{ni} - \theta\epsilon^j_{ni} \\ &= E^j_i + M^j_n + \Theta^j\ln\text{Dist}_{ni} + \nu^j_{ni}\end{aligned} \tag{6}$$

where $E^j_i \equiv S^j_i - \theta\ \text{EX}^j_i, M^j_n \equiv -S^j_n, \Theta^j \equiv -\theta\beta^j$, and $S^j_n \equiv \ln\left(\lambda^j_n\left(c^j_n\right)^{-\theta}\right)$

I run the regression 6 separately for each year and sector, then get estimated fixed effects $\tilde{E}^j_i$ and $\tilde{M}^j_n$.

Regression Results

Calibration

Time Varying Driving Forces

Back

Trade Cost

$$\tilde{\kappa}^j_{ni} = \{\left(\frac{X^j_{ni}}{X^j_{nn}}\right) exp(\tilde{S}^j_n - \tilde{S}^j_i)\}^{-\frac{1}{\theta}} \quad (7)$$

TFP

$$\tilde{c}^j_n = \Upsilon^j_n \tilde{w}_n^{\gamma^j_n} \prod_{k=1}^{J} \tilde{P}_n^{k\,\gamma^{k,j}_n} \quad and \quad \Upsilon^j_n \equiv \prod_{k=1}^{J} \gamma_n^{k,j\,-\gamma^{k,j}_n} \gamma^{j\;-\gamma^j_n}_n \quad (8)$$

$$\tilde{P}^j_n = A^j \left[\left(\frac{exp(\tilde{S}^j_n)}{\pi^j_{nn}}\right)\right]^{-\frac{1}{\theta}} \quad (9)$$

$$\tilde{\lambda}^j_n = \frac{exp\left(\tilde{S}^j_n\right)}{\left(\tilde{c}^j_n\right)^{-\theta}} \quad (10)$$

Migration cost

$$\tilde{\nu}^{n,m} = \left(\frac{\tilde{m}^{n,m}}{\tilde{m}^{m,m}}\right)^{-1/\kappa} \left(\frac{\tilde{W}_n}{\tilde{W}_m}\right) \quad where \quad \tilde{W}_n = \frac{\tilde{w}_n L_n + D_n}{\tilde{P}_n L_n} \quad (11)$$

Regression Results

Back

Table: Gravity Equation Results

Sector	Agriculture			Light industry			Heavy industry			Service		
Year	2002	2007	2015	2002	2007	2015	2002	2007	2015	2002	2007	2015
VARIABLES	ln(Xni/Xnn)											
logdist	-2.18***	-1.80***	-1.30***	-1.82***	-1.65***	-0.94***	-1.77***	-1.44***	-1.11***	-2.09***	-1.81***	-1.05***
	(-6.96)	(-6.18)	(-4.78)	(-7.82)	(-8.66)	(-3.86)	(-8.10)	(-8.66)	(-5.33)	(-7.84)	(-7.65)	(-3.73)
M_2	0.54	2.19***	2.63***	0.84**	0.98***	0.66	0.75**	0.25	0.24	0.63	0.65	0.02
	(1.01)	(4.43)	(5.73)	(2.13)	(3.05)	(1.59)	(2.02)	(0.90)	(0.67)	(1.39)	(1.61)	(0.04)
M_3	-1.26**	1.41***	0.32	-1.00**	-1.27***	-1.71***	-0.42	-0.83***	-1.54***	0.15	-0.04	-0.65
	(-2.35)	(2.84)	(0.70)	(-2.49)	(-3.92)	(-4.11)	(-1.12)	(-2.92)	(-4.33)	(0.33)	(-0.09)	(-1.35)
M_4	-0.15	1.86***	1.13**	-1.24***	-0.75**	-0.62	-0.36	-0.31	-0.02	-0.30	-0.78*	-0.15
	(-0.29)	(3.81)	(2.50)	(-3.16)	(-2.36)	(-1.53)	(-0.98)	(-1.10)	(-0.07)	(-0.67)	(-1.96)	(-0.31)
M_5	-0.31	1.46***	1.80***	0.14	0.22	-0.28	0.96***	0.70**	0.07	1.06**	0.23	0.35
	(-0.60)	(3.03)	(4.04)	(0.37)	(0.72)	(-0.70)	(2.67)	(2.55)	(0.20)	(2.40)	(0.58)	(0.75)
M_6	-1.37**	0.55	-0.28	-1.31***	-1.12***	-1.34***	-0.66*	-0.35	-0.68*	-0.67	0.22	-0.56
	(-2.60)	(1.13)	(-0.61)	(-3.32)	(-3.50)	(-3.27)	(-1.80)	(-1.23)	(-1.95)	(-1.49)	(0.56)	(-1.16)
M_7	0.04	1.42***	-0.12	0.72*	0.78**	-0.17	0.70*	0.40	-0.13	0.72	1.16***	-0.06
	(0.09)	(2.94)	(-0.28)	(1.87)	(2.48)	(-0.43)	(1.93)	(1.46)	(-0.39)	(1.62)	(2.94)	(-0.14)
M_8	-1.64***	0.35	-0.14	-0.83**	-0.07	-0.38	0.02	0.13	-0.07	1.05**	0.75*	-0.16
	(-3.18)	(0.72)	(-0.31)	(-2.15)	(-0.24)	(-0.94)	(0.06)	(0.46)	(-0.20)	(2.38)	(1.93)	(-0.35)
M_9	1.41*	2.05***	0.51	0.81	0.70	-0.51	1.04**	0.35	0.09	0.06	-0.61	-1.84***
	(1.91)	(3.01)	(0.81)	(1.48)	(1.58)	(-0.89)	(2.02)	(0.89)	(0.18)	(0.10)	(-1.10)	(-2.77)
M_10	0.13	1.27**	-0.48	-0.89**	-1.11***	-1.50***	-1.26***	-1.50***	-1.31***	-2.20***	-2.41***	-2.32***
	(0.25)	(2.62)	(-1.05)	(-2.29)	(-3.50)	(-3.70)	(-3.46)	(-5.39)	(-3.79)	(-4.96)	(-6.09)	(-4.91)
M_11	1.04	1.76***	-0.66	0.75	0.29	-1.02*	0.89*	0.13	-0.02	1.97***	0.98*	-1.34**
	(1.58)	(2.87)	(-1.15)	(1.52)	(0.71)	(-1.98)	(1.93)	(0.37)	(-0.04)	(3.50)	(1.95)	(-2.24)
Exporter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	110	110	110	110	110	110	110	110	110	110	110	110
R-squared	0.975	0.977	0.975	0.976	0.979	0.966	0.976	0.980	0.970	0.982	0.981	0.967

t-statistics in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Utility function

Each worker is endowed with 1 unit of labor. For each worker registered in region m, if this worker choosing working in region n, the Cobb-Douglas utility is:

$$U(\mathcal{C}_n) \equiv \mathcal{C}_n \equiv \prod_{k=1}^{J} {\mathcal{C}_n^k}^{\alpha_n^k}, \sum_{k=1}^{J} \alpha_n^k = 1 \tag{12}$$

$$\sum_k P_n^k \mathcal{C}_n^k = P_n \mathcal{C}_n = \mathcal{I}_n \tag{13}$$

$$\mathcal{I}_n L_n = I_n \tag{14}$$

For each individual people choosing to work in region n

- his consumption on sector k composite intermediate good is $\mathcal{C}_n^k$
- his aggregate consumption or utility is defined as $\mathcal{C}_n$
- his wage rate is w_n
- Real income for each individual worker in region n is defined as $W_n \equiv \frac{w_n L_n + D_n}{P_n L_n}$

Back

Calibration

Results: TFP change

Return

Table: TFP change across sectors and regions

Average TFP	*2002 to 2007*				***2007 to 2015***			
Change	*China*	*A7-JPN*	*AS3*	*ROW*	*China*	*A7-JPN*	*AS3*	*ROW*
Aggregate	**1.24**	1.18	1.00	1.46	**1.57**	1.24	1.00	1.42
Agricultural	1.36	1.15	1.00	1.52	1.34	0.87	1.00	1.13
Light Industry	1.14	0.97	1.00	1.16	1.28	1.10	1.00	1.03
Heavy Industry	1.14	1.15	1.00	1.29	1.39	1.02	1.00	0.98
Services	1.30	1.20	1.00	1.53	1.78	1.29	1.00	1.63

- TFP change of Asian3 normalized to 1.
- I aggregate the regional sectoral TFP using average value-added shares (average across year 2002, 2007, and 2015) as weights

Calibration

Results: Labor migration Cost change

Return

Table: Labor migration cost change

Labor migration cost change									
2002 to 2007	***Source***								
Destination	*Ave.*	*NE*	*BT*	*NC*	*EC*	*SC*	*CE*	*NW*	*SW*
Aggregate (Ave)	**0.75**	0.54	2.09	0.89	1.02	0.66	0.63	0.98	0.75
NorthEast (NE)	1.21	1.00	1.81	1.01	1.52	0.77	0.72	1.04	0.83
BeijingTianjin (BT)	0.26	0.24	1.00	0.31	0.44	0.28	0.22	0.35	0.20
NorthernCoastal (NC)	0.77	0.85	1.92	1.00	1.34	0.91	0.76	1.20	0.72
EasternCoastal (EC)	0.63	0.52	1.36	0.53	1.00	0.55	0.46	0.73	0.38
SouthernCoastal (SC)	1.17	0.96	2.53	1.00	1.58	1.00	0.82	1.27	0.80
Central (CE)	1.21	1.25	3.00	1.53	1.76	1.16	1.00	2.11	1.07
NorthWest (NW)	0.77	1.06	1.90	0.85	1.17	0.59	0.57	1.00	0.63
SouthWest (SW)	1.04	1.47	2.65	1.35	1.83	1.32	1.00	2.05	1.00
2007 to 2015	***Source***								
Destination	*Ave.*	*NE*	*BT*	*NC*	*EC*	*SC*	*CE*	*NW*	*SW*
Aggregate (Ave)	**0.96**	0.66	0.23	1.05	1.41	0.57	1.49	0.64	1.26
NorthEast (NE)	1.36	1.00	0.31	2.21	1.57	0.94	2.21	1.17	1.35
BeijingTianjin (BT)	2.21	1.15	1.00	2.21	2.21	1.29	2.72	1.24	2.32
NorthernCoastal (NC)	0.91	0.64	0.30	1.00	0.82	0.39	1.04	0.58	1.06
EasternCoastal (EC)	0.63	0.46	0.26	0.89	1.00	0.56	1.31	0.44	1.14
SouthernCoastal (SC)	1.56	0.80	0.49	1.96	1.59	1.00	2.50	1.19	1.87
Central (CE)	0.46	0.30	0.11	0.64	0.43	0.26	1.00	0.43	0.71
NorthWest (NW)	1.51	0.72	0.30	1.44	1.45	0.69	2.09	1.00	2.14
SouthWest (SW)	0.62	0.34	0.29	0.71	0.63	0.37	1.19	0.45	1.00

- **2002-2007**: average migration cost change is 0.75 (weighted by average labor flow across 3 years)
- **2007-2015**: average migration cost change is 0.96

Calibration

Results: Trade Cost change ◂ Return

Table: Average Trade Cost Change across sectors and regions

Average Trade Cost Change	***China and China***		***Foreign and Foreign***	
	2002 to 2007	*2007 to 2015*	*2002 to 2007*	*2007 to 2015*
Aggregate	**0.83**	0.96	0.96	0.93
Agricultural	0.84	0.92	0.98	1.10
Light Industry	0.85	1.01	1.03	1.05
Heavy Industry	0.82	1.04	0.98	1.00
Services	0.83	0.83	0.93	0.83
	China to Foreign (Ex)		***Foreign to China (Im)***	
	2002 to 2007	*2007 to 2015*	*2002 to 2007*	*2007 to 2015*
Aggregate	**0.73**	**0.77**	**1.00**	**1.16**
Agricultural	0.74	0.64	1.04	1.56
Light Industry	0.74	0.74	1.14	1.34
Heavy Industry	0.70	0.89	0.98	1.12
Services	0.77	0.58	0.99	1.18

- **2002-2007**: For China, both In**tra**national trade cost and in**ter**national trade cost decrease
- **2007-2015**: Trade cost not change to much except the in**ter**national trade cost.

Trade cost, Price and Equilibrium Condition

- Trade cost follow the usual "iceberg" form: For country n, to receive 1 unit good from country i sector j, country i need transport $\kappa_{ni}^{j} \geq 1$ units good.
- c_n^j: The cost of a bundle of labor and sectoral composite intermediate good of country n sector j.
- $p_n^j(\omega^j)$: the price of intermediate good in country n.
- P_n^j: the price of sector composite intermediate good in country n.
- X_{ni}^j: The expenditure in country n of sector j goods from country i.
- X_n^j: The expenditure in country n of sector j goods.
- Trade cost follow the usual "iceberg" form: For country n, to receive 1 unit good from country i sector j, country i need transport $\kappa_{ni}^{j} \geq 1$ units good.

$$c_n^j = \Upsilon_n^j w_n^{\gamma_n^j} \prod_{k=1}^{J} P_n^{k\,\gamma_n^{j,k}},\ p_n^j(\omega^j) = \min_i \frac{c_i^j \kappa_{ni}^j}{z_n^j(\omega^j)},\ P_n^j \underset{a.e}{\rightarrow} A_j \Phi_n^{j\,-\frac{1}{\theta_j}}, \Phi_n^j = \sum_{i=1}^{N} \lambda_i^j \left(\kappa_{ni}^j c_i^j\right)^{-\theta_j},$$

$$\pi_{ni}^j = \frac{X_{ni}^j}{\sum_{m=1}^{N} X_{nm}^j} = \frac{X_{ni}^j}{X_n^j}$$

Back

Back **Under friction-less migration :**

$$L_n = \frac{(\lambda_n)^{\frac{\kappa}{1+\kappa+\beta\theta}}}{\sum_{n'}^{N_0} (\lambda_{n'})^{\frac{\kappa}{1+\kappa+\beta\theta}}} \sum_{m}^{N_0} \bar{L}_m \quad (15)$$

- Higher TFP regions with higher labor supply