Offshoring and Wage Inequality: Theory and Evidence from China

Liugang Sheng
Chinese University of Hong Kong

Dennis T. Yang
University of Virginia

First Research Workshop on China's Economy

Washington D.C., April 28-29, 2016

Motivation

- Globalization and wage inequality is a major topic of research
- Models based on final goods trade cannot explain rising wage inequality in developing countries (Goldberg and Pavcnik, 2007)
- Nature of international trade has changed
  - Offshoring has become a prominent feature of world economy
  - **2/3** of world trade is in intermediate inputs (Johnson and Noguera, 2011)
  - More than **1/3** of offshoring is through FDI

Literature of Offshoring and Wage Inequality

- Recent studies treat offshoring as the core of international trade with focus on developed countries
- Limited studies for developing countries have mixed empirical evidence, e.g., Feenstra and Hanson (1997) and Harrison et. al (2011)
- These studies do not distinguish two types of offshoring: FDI offshoring v.s. arm's length offshoring
- In parallel, extensive studies on firms' organizational forms of offshoring, e.g., Antràs and Helpman (2004) and Helpman (2006), but ignore the distributional effect on factor prices

The Central Idea

Ownership structure of offshoring plays a key role in skill demand in developing countries

- FDI offshoring: skill intensive, has a major effect on wage inequality
- Arm's length offshoring: low-skill content, has limited effect on wage inequality

- A new theory on the ownership structure of offshoring and skill demand in developing countries

- Link our model to empirics by developing an augmented Mincer wage regression

- A natural experiment in China upon its accession to the WTO in 2001
  - Removed restrictions on foreign-owned firms in manufacturing
  - Rich spatial variations in exposure to offshoring across provinces

Fact 1: College Wage Premium

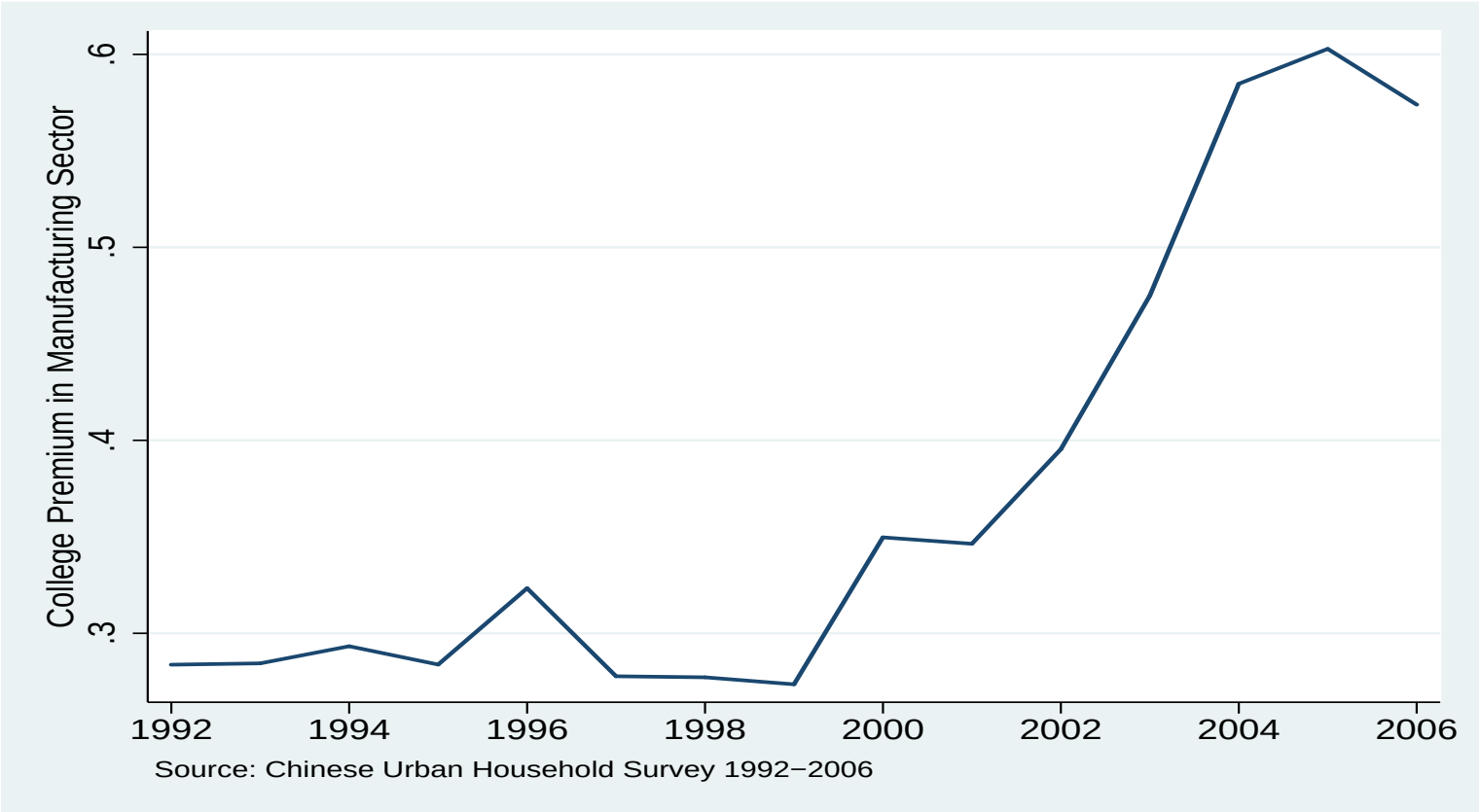


Figure 2: College Premium in Manufacturing Sector: 1992-2006

Fact 2: Ownership Structure in Processing Exports

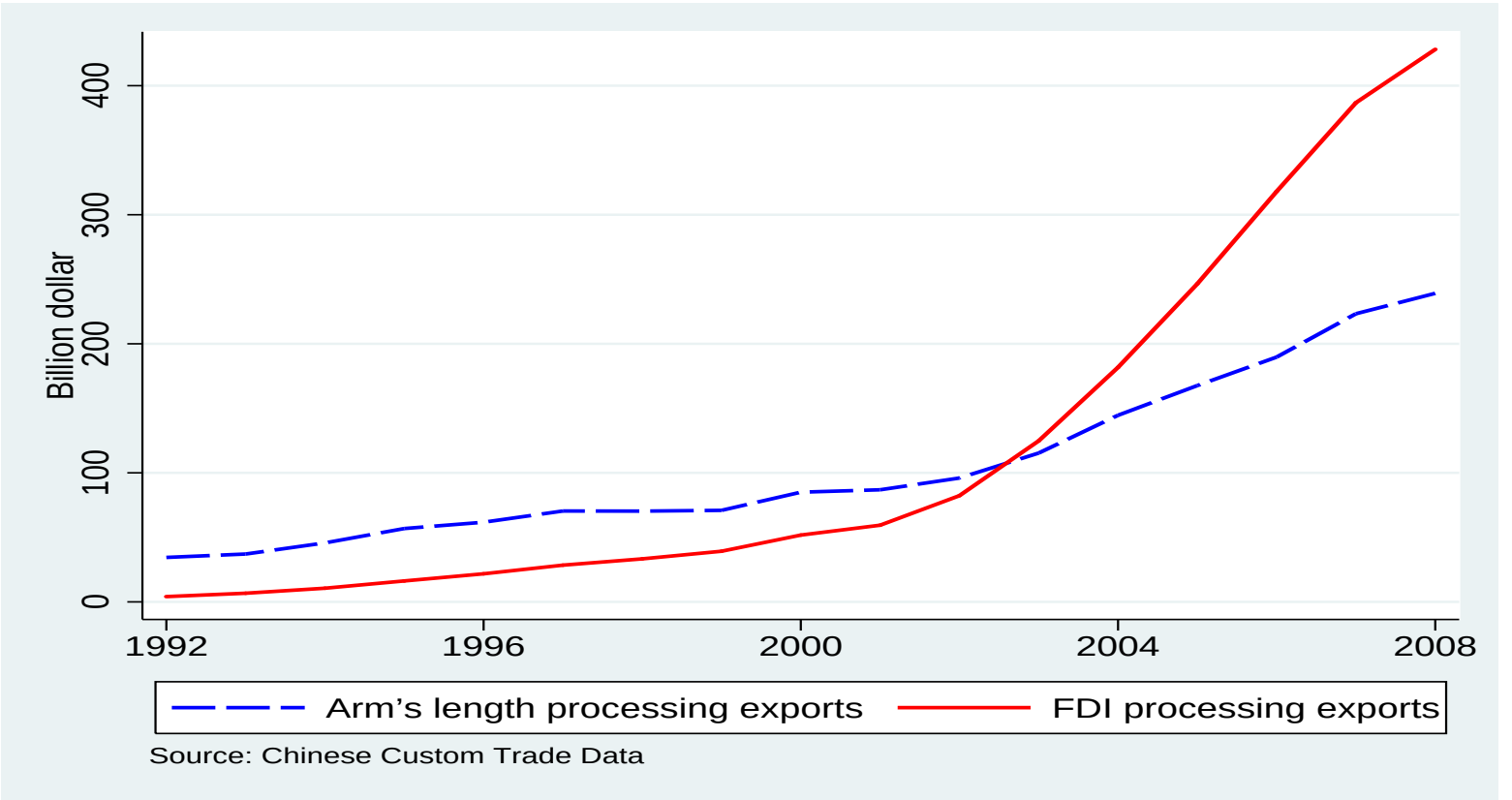


Figure 1: Processing Exports by Firm Ownership Types: 1992-2008

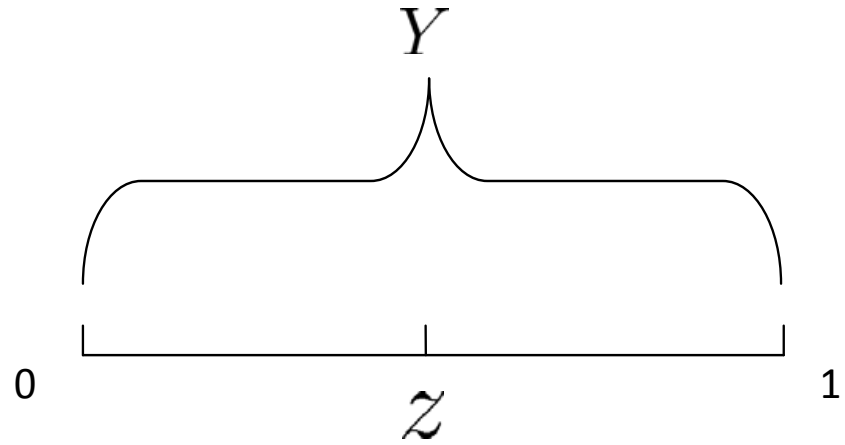
Contributions

- Introduce ownership choice of MNCs into a standard offshoring model of wage determination (Grossman and Hart, 1986, Feenstra and Hanson, 1996, and Antràs, 2005)
- Analyze the mechanisms through which FDI and arms length offshoring affect skill demand in developing countries
- Incorporate our model into an augmented Mincer earnings function
- A new mechanism linking trade and wage inequality in developing countries
- Inclusion of China in the empirical studies of globalization and income inequality (e.g., Han, Liu and Zhang, 2011)

Model Overview

One final good only in North

A continuum of Intermediate goods either in North or South



Two inputs

Supplier of low tech x_l

Contract

Who owns the firm

Northern innovator: high tech x_h

Two types of labor

Low-skilled labor l

High-skilled labor h

Production

- The demand function for $y(z)$ is

$$y(z) = \lambda p(z)^{-1/(1-\alpha)} \quad \text{and} \quad 0 < \alpha < 1 \tag{1}$$

where λ is a function of total expenditure and an aggregate price index.

- Production of intermediate good $y(z)$:

$$y(z) = \xi_z x_h^z x_l^{1-z} \quad \text{and} \quad 0 \leq z \leq 1 \tag{2}$$

where $\xi_z = z^{-z}(1-z)^{-(1-z)}$.

  - A higher z indicates more intensive use of high tech in production
  - Both inputs are tailored specifically to product z
  - Production for each product z is offshorable but not fragmentable
  - Samuelsonian iceberg offshoring cost: the South must send $t > 1$ units of goods for one unit to arrive for sale in the North

Production in the North: Complete Contract

- The revenue is

$$R = \lambda^{1-\alpha} y^{\alpha}$$

- Profit maximization

$$\max_{h^N, l^N} \pi = R - q^N h^N - w^N l^N$$

- Profit for North production

$$\pi^N(z) = (1-\alpha)\lambda[\alpha(1/q^N)^z(1/w^N)^{(1-z)}]^{\alpha/(1-\alpha)} \tag{3}$$

Production in the South: Incomplete Contract

- Let β denote the Northern innovator's Nash bargaining share in revenue
- Northern innovator hires high skilled workers to solve:

$$\max_{h^S} \beta R - q^S h^S \quad \text{s.t.} \quad R = \lambda^{1-\alpha} y^\alpha / t^\alpha$$

- Supplier hires low skilled workers to solve

$$\max_{l^S} (1-\beta) R - w^S l^S \quad \text{s.t.} \quad R = \lambda^{1-\alpha} y^\alpha / t^\alpha$$

- By setting the *ex ante* transfer T equal to supplier's profit, Northern innovator's *ex ante* profit is

$$\begin{aligned} \pi^S(z,\beta) &= \lambda \left(\frac{1}{t}\right)^{\alpha/(1-\alpha)} [\alpha(\beta/q^S)^z((1-\beta)/w^S)^{(1-z)}]^{\alpha/(1-\alpha)} \\ &\quad [1 - \alpha\beta z - \alpha(1-\beta)(1-z)] \end{aligned} \tag{4}$$

where $\alpha \in (0,1)$, and $\beta, z \in [0,1]$.

Ownership Structure

- Two Ownership choices
  - FDI offshoring (F): Innovator can fire the supplier and seize the low-tech input, and produces a fraction $\delta < 1$ of y
  - Arm's length offshoring (D): Supplier can fire innovator and seize the high-tech input, and produces a fraction $\delta < 1$ of y

- Ownership improves the bargaining position of the owner by providing positive outside options. Thus,

$$0 < \beta^D = \frac{1}{2}(1 - \delta^\alpha) < \beta^F = \frac{1}{2}(1 + \delta^\alpha) < 1 \tag{5}$$

The Northern innovator has the higher revenue share in foreign ownership

Location and Ownership Choice

- The Northern innovator's joint decision of location and ownership types:

$$\pi(z) = \max\{\pi^N(z), \pi^S(z, \beta^D), \pi^S(z, \beta^F)\} \tag{6}$$

- Compute the **pseudo profit** $\pi^S(z)$ by assuming the South also has complete contract
- Define the **log profit ratios** of North production relative to $\pi^S(z)$.

$$N(z) \equiv \frac{1-\alpha}{\alpha} \ln(\pi^N(z)/\pi^S(z)) \tag{7}$$

- The **log profit ratios** of South production for two ownership types

$$S(z, \beta^O) \equiv \frac{1-\alpha}{\alpha} \ln(\pi^S(z, \beta^O)/\pi^S(z)) \tag{8}$$

where $O \in \{F, D\}$

Offshoring and Ownership Choice

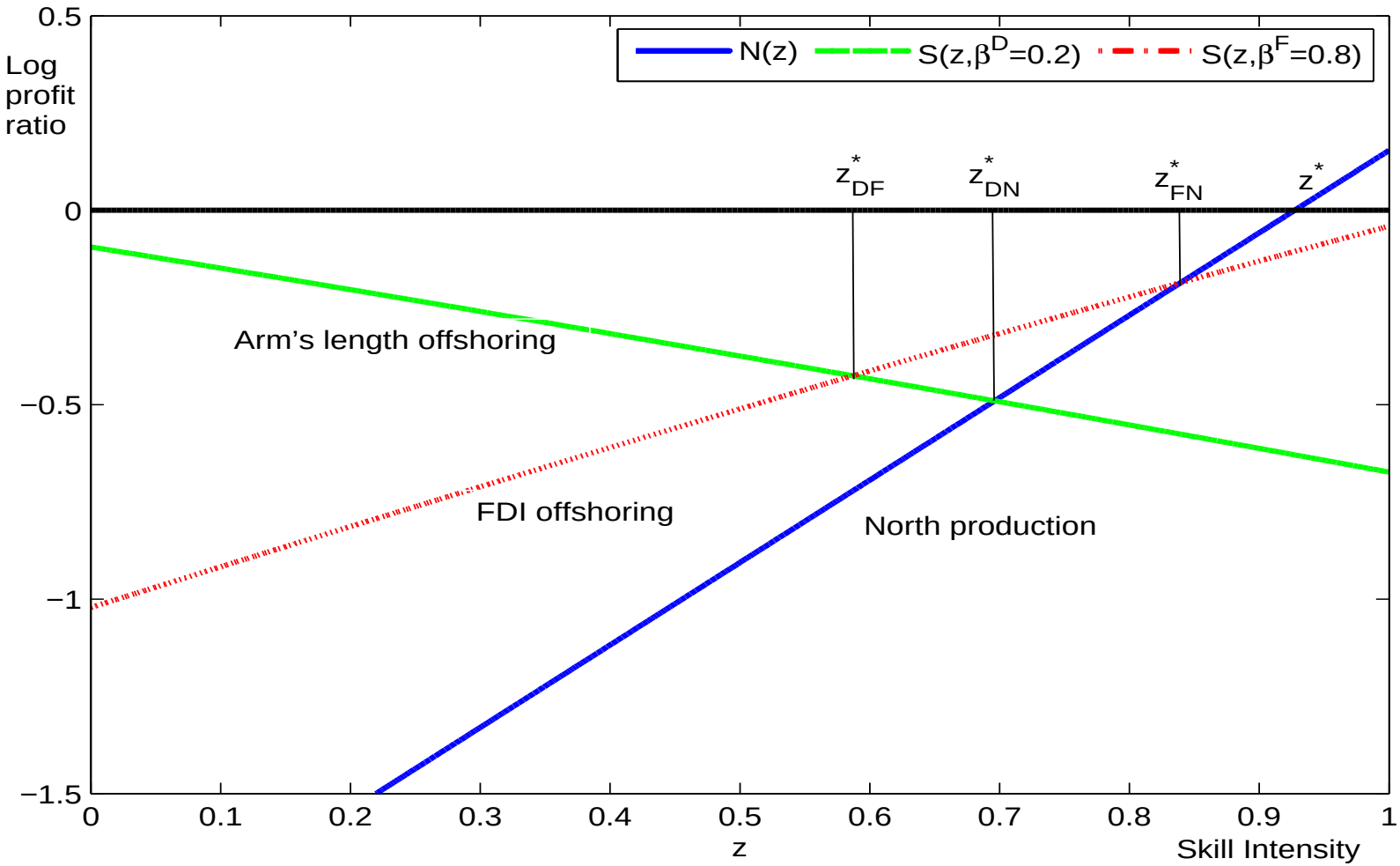


Figure 3: Offshoring, Optimal Ownership and Skill Intensity of Intermediate Goods

Offshoring and Ownership Choice

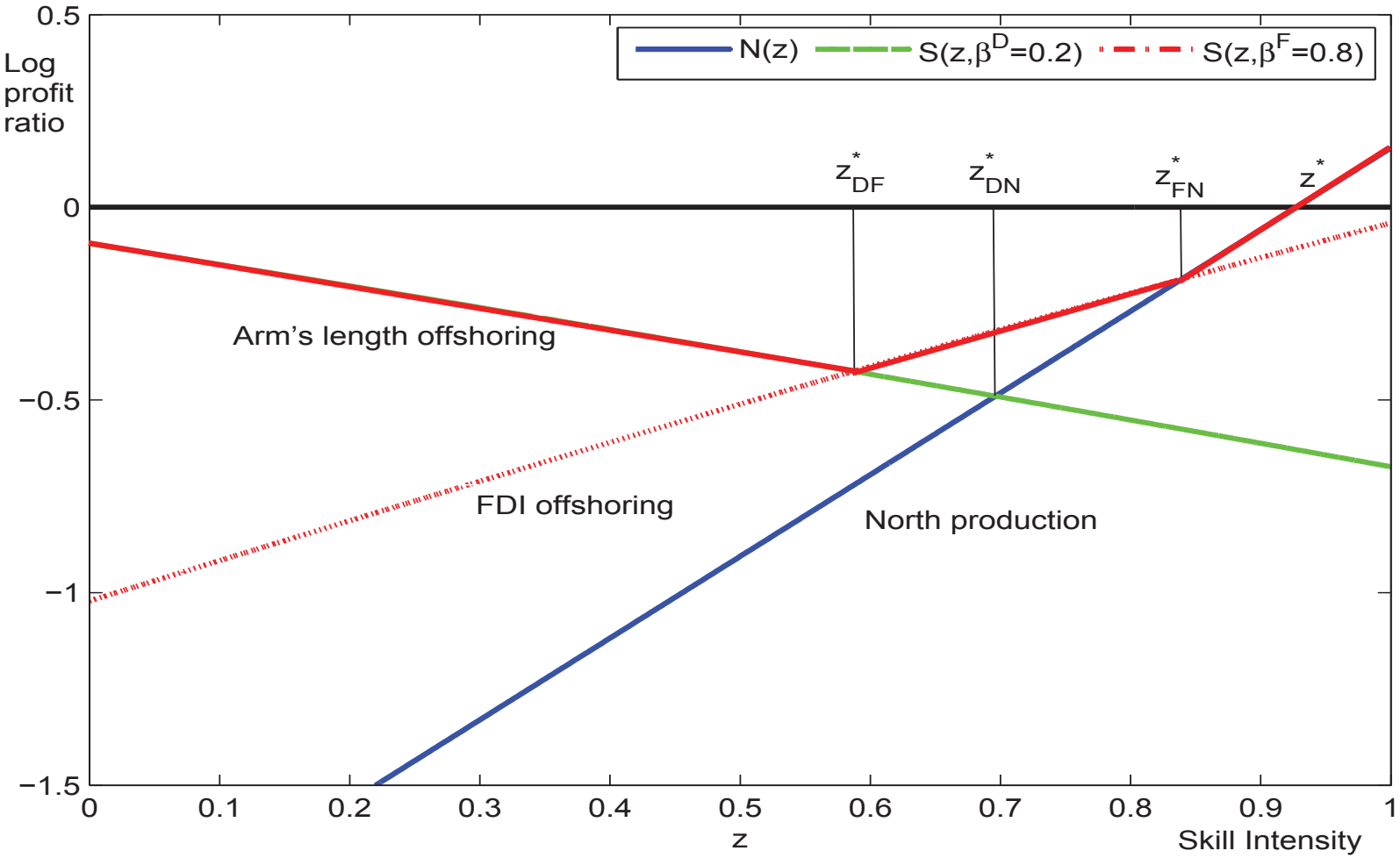


Figure 3: Offshoring, Optimal Ownership and Skill Intensity of Intermediate Goods

Main Implication

Under general conditions, the most-skill-intensive products are produced in the North, the next-most-skill-intensive products are offshored through FDI, and the least skill-intensive products are outsourced to the South domestic owned firms.

Trade Liberalization

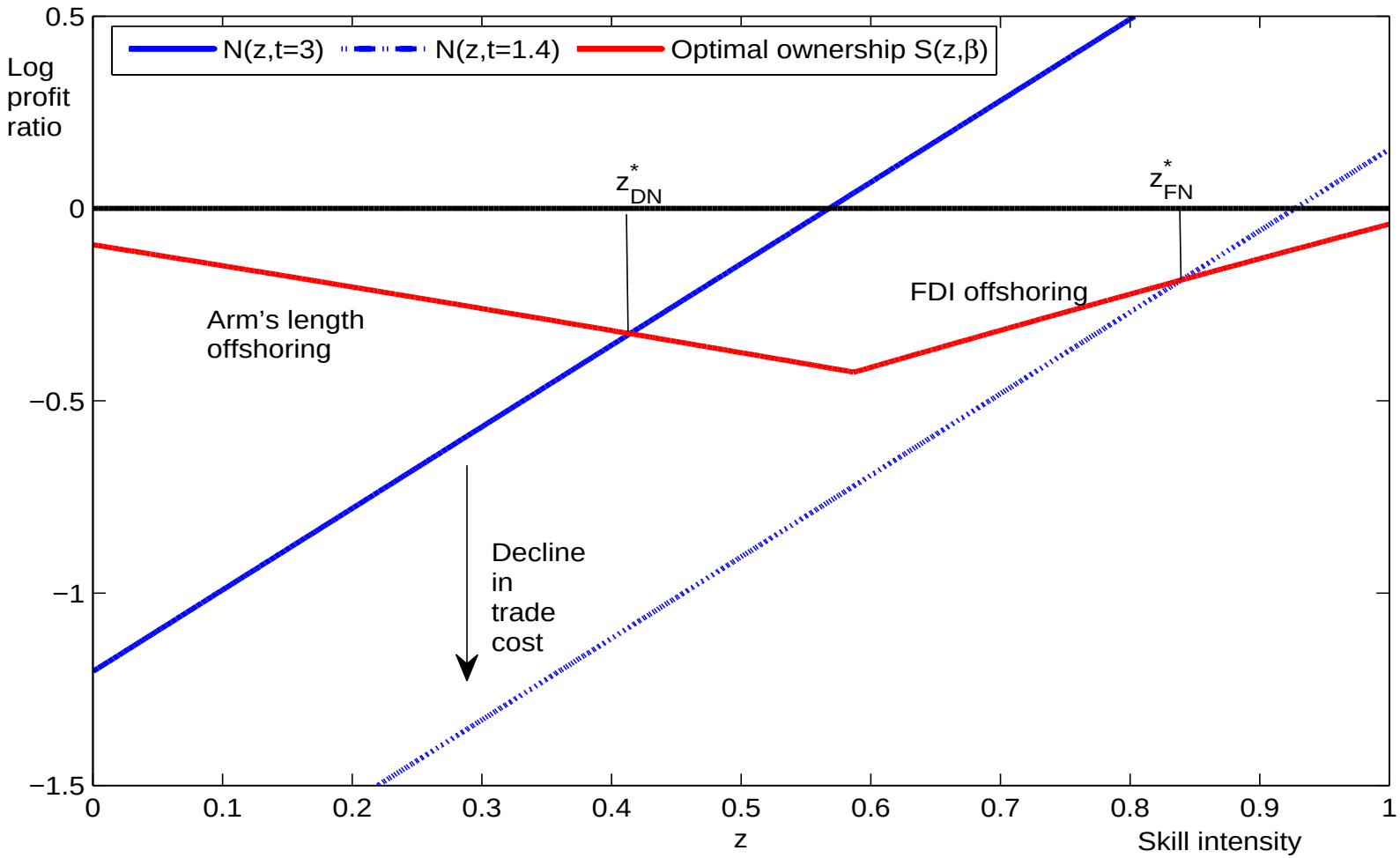


Figure 4: Trade liberalization, Offshoring and Skill Intensity of Intermediate Goods

Ownership Liberalization

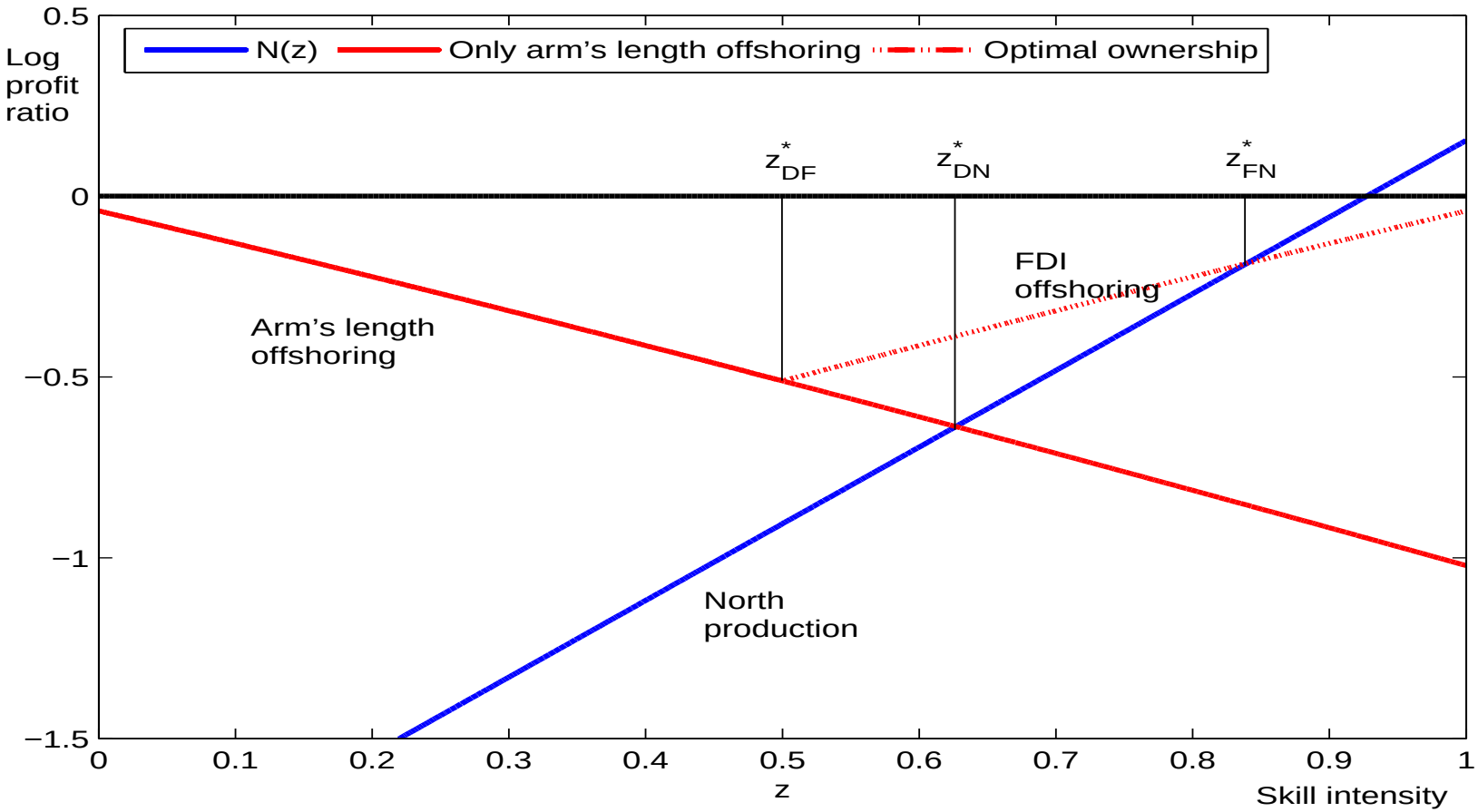


Figure 5: Ownership liberalization, Offshoring and Skill Intensity of Intermediate Goods

Effect of Trade and Ownership Liberalization on Offshoring

If the offshoring cost is relatively low, ownership liberalization and further reduction in offshoring cost both shift more skill-intensive products to the South through FDI, and thus the share of FDI offshoring increases.

College Premium in the South

- The relative demand of skilled workers for a given product z,

$$\frac{h(z,\beta)}{l(z,\beta)} = \frac{\beta z}{(1-\beta)(1-z)}\frac{w}{q}$$

increases in β and z, but decreases in relative price q/w.

- The aggregate relative demand of skilled labor $D(q/w, \overline{z})$, is given by

$$D(q/w, \overline{z}(t,\Psi)) = \frac{\int_0^{\overline{z}} h(z,\beta)dz}{\int_0^{\overline{z}} l(z,\beta)dz} \tag{9}$$

where Ψ denotes ownership choice set, β could be β^D and β^F for different range of z, and $\overline{z}$ is the cutoff between the South and the North.

Changes in Skill Premium

Feenstra-Hanson mechanism

The aggregate skill demand in the South increases in $\overline{z}$, i.e., $\frac{\partial D(q/w,\overline{z})}{\partial \overline{z}} > 0$. Thus, the aggregate skill demand increases as the offshoring cost declines.

Ownership liberalization mechanism

If offshoring cost is relatively low and $\alpha \leq 1/2$, ownership liberalization in foreign capital increases the aggregate skill demand in the South.

Effect on skill premium

Ownership liberalization and offshoring cost reduction increase the skill premium.

Formulation of An Augmented Mincer Wage Equation

- Inverse skill demand function

$$ln(q/w) = lnD^{-1}(t, \Psi)$$

- Mincer wage equation

$$ln(wage) = \alpha_0 + \alpha_1 college + \epsilon$$

where *college* is an indicator variable. It follows:

$$ln(q/w) = \alpha_1$$

- Augmented Mincer wage equation

$$ln(wage) = \alpha_0 + \alpha_1(t, \Psi)college + \epsilon$$

Identification Strategy

- Step 1: Estimate the effect of offshoring cost reduction and ownership liberalization on FDI offshoring (R^F) and arm's length offshoring (R^D)

$$lnR^O = lnR^O(t, \Psi)$$

where $O \in \{F, D\}$

- Step 2: Estimate the augmented Mincer regression

$$ln(wage) = \alpha_0 + \alpha_1(R, R^F/R)college + \epsilon$$

  - Use rich spatial variations in regional exposures to FDI and arm's length offshoring for estimation
  - Construct IV by using predicted values from the regional distribution regression in step 1

A Natural Experiment

- A nation-wide natural experiment in China upon it's accession to WTO in 2001
- Wholly foreign ownership was restricted in 1990s, but this restriction was lifted around 2001
- Government industrial policy specifies which industries are encouraged, restricted or prohibited for foreign ownership (released in 1995, revised in 1997, 2002, 2004 and 2007)
- Construct two indicator variables about ownership policy at industrial level, using key-word matching method: encouragement policy and restriction policy (Blonigen and Ma, 2010)

Ownership Liberalization

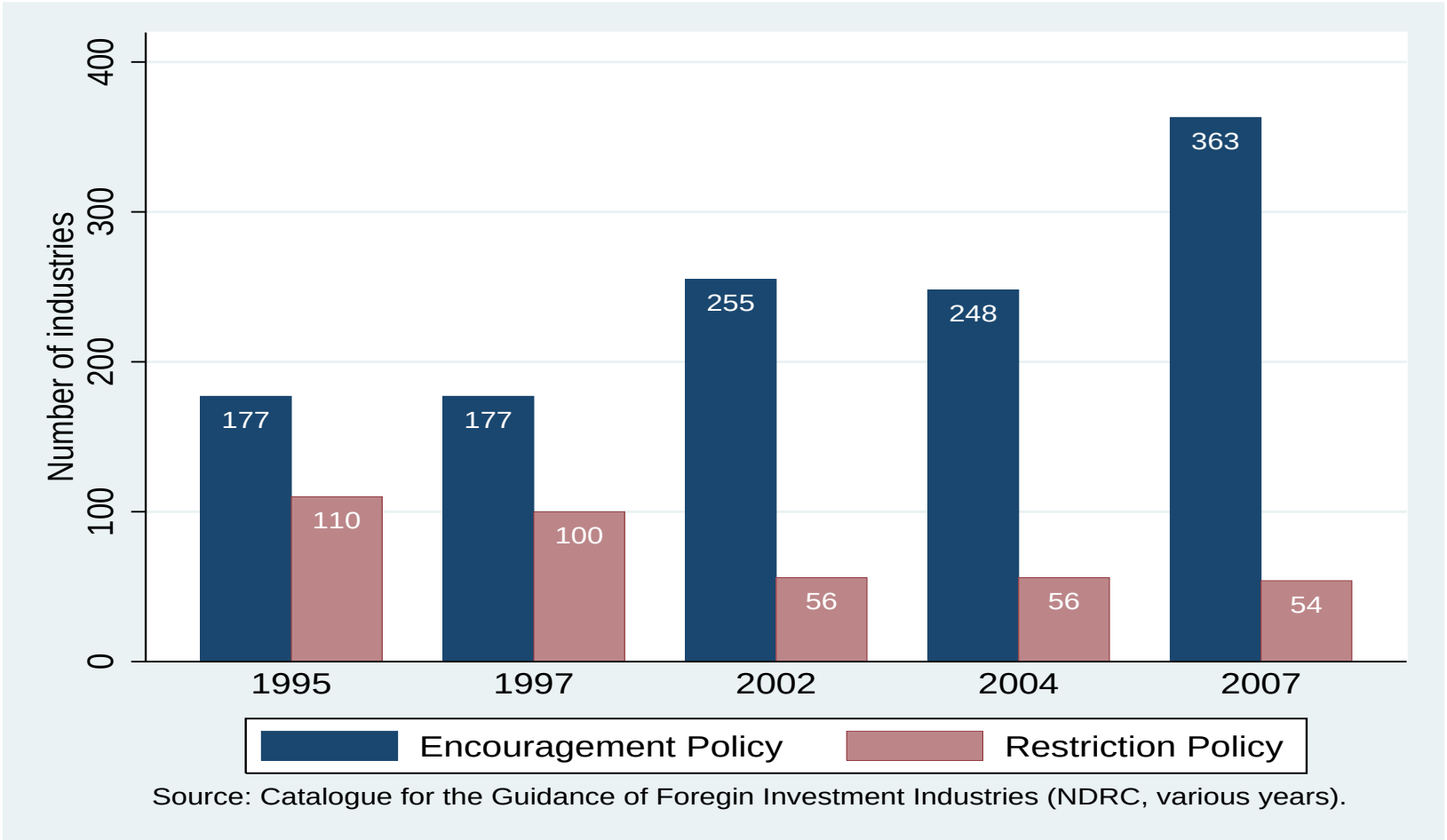


Figure 4: Measure of Ownership Liberalization 1995-2007

Data

- Chinese Custom Trade Data (1988-2008)
  - Three firm ownership types at product level (HS6)
  - Types of custom regimes: processing trade v.s ordinary trade
- Chinese Urban Household Survey (CUHS 1992-2006)
  - National representative sample, covers all provinces except Tibet
- Chinese National Industry Census 1995 (CNIC1995)
  - Measure of skill intensity: the industrial employment share of workers with college degrees or above
  - Cover 113 out of 127 classes in ISIC REV.3 at 4 digits level
- Chinese provincial panel (1992-2008) for control variables

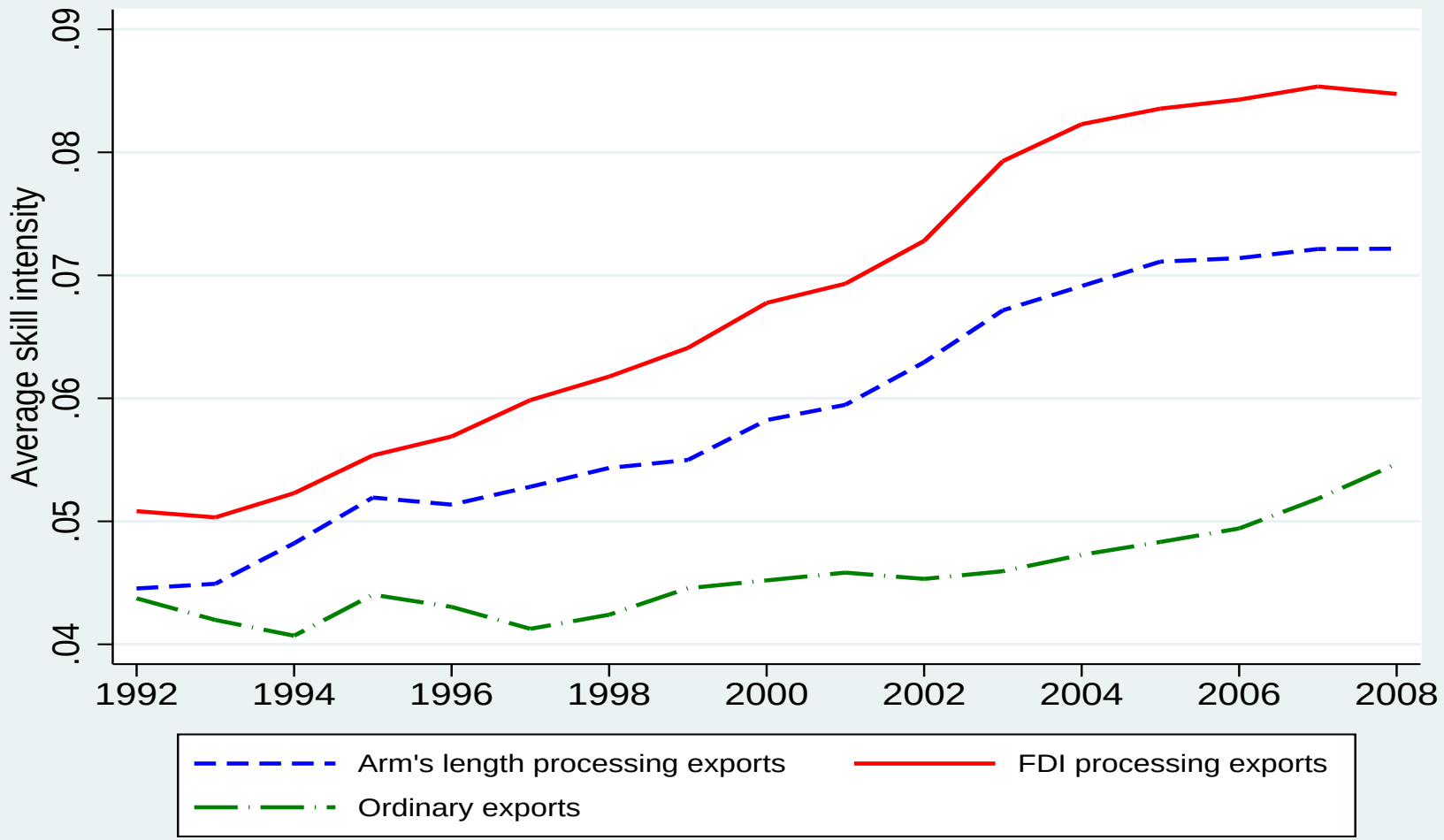
Summary Statistics

Table 1: Summary Statistics of China's Processing Exports

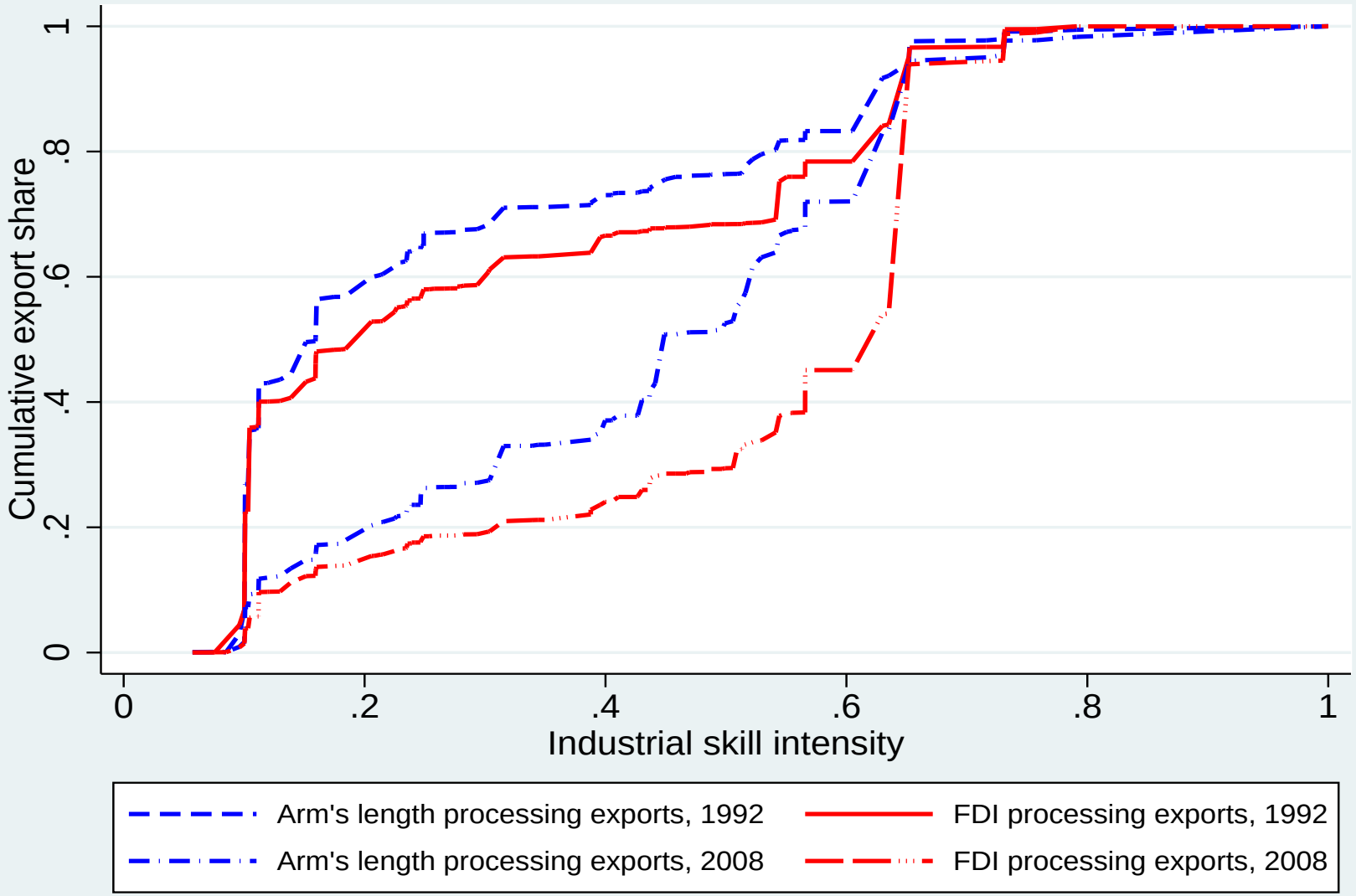
	Processing exports		Share in processing exports		FDI's share in		
Year	Value (Billion dollar)	Share in total exports	High-skill industries	High-income trade partners	All	Low-skill industries	High-skill industries
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1992	39	0.53	0.36	0.95	0.10	0.09	0.13
1993	44	0.54	0.36	0.94	0.15	0.14	0.18
1994	57	0.51	0.41	0.92	0.19	0.17	0.21
1995	73	0.53	0.47	0.90	0.22	0.21	0.23
1996	84	0.60	0.46	0.90	0.26	0.24	0.29
1997	99	0.58	0.49	0.89	0.29	0.26	0.32
1998	104	0.60	0.51	0.90	0.32	0.28	0.36
1999	111	0.59	0.54	0.90	0.36	0.31	0.40
2000	137	0.58	0.58	0.90	0.38	0.33	0.42
2001	147	0.58	0.60	0.91	0.41	0.35	0.44
2002	179	0.57	0.65	0.89	0.46	0.40	0.50
2003	241	0.57	0.71	0.91	0.52	0.43	0.56
2004	327	0.57	0.75	0.90	0.56	0.46	0.59
2005	415	0.56	0.77	0.89	0.60	0.51	0.62
2006	509	0.54	0.79	0.88	0.63	0.55	0.65
2007	616	0.51	0.80	0.87	0.64	0.56	0.65
2008	674	0.48	0.81	0.84	0.64	0.58	0.66

Note: We use the employment share of college workers in 1995 to measure skill intensity at the industrial level; and, high-skill industries denote skill intensity above the sample mean.

Average Skill Intensity of Processing and Ordinary Exports



Distribution of Processing Exports



The Kolmogorov-Smirnov Test

Panel A: Skill difference between FDI and Arm's length processing exports		
	Two-sided test	One-sided test
P-value	No difference between two distributions	FDI weakly dominates Arm's length
1992	0.06	1.00
1993	0.18	1.00
1994	0.26	1.00
1995	0.08	1.00
1996	0.07	1.00
1997	0.02	1.00
1998	0.01	1.00
1999	0.00	1.00
2000	0.00	1.00
2001	0.00	1.00
2002	0.00	1.00
2003	0.00	1.00
2004	0.00	1.00
2005	0.00	1.00
2006	0.00	1.00
2007	0.00	1.00
2008	0.00	1.00

The Kolmogorov-Smirnov Test (continue)

Panel B: Skill upgrading for FDI and Arm's length processing exports

		Two-sided test	One-sided test
	P-value	No difference between two distributions of t and (t+5)	The distribution in (t+5) weakly dominates the one in t
Arm's length processing exports	1992-1997	0.03	1.00
	1997-2002	0.01	1.00
	2002-2007	0.00	1.00
FDI processing exports	1992-1997	0.02	1.00
	1997-2002	0.00	1.00
	2002-2007	0.00	1.00

Note: P-value is computed based on the limiting distribution of the Kolmogorov-Smirnov test statistics..

Regional Distribution of Processing Exports

Econometric specification

$$\begin{aligned} ln(R_{oijt}) &= \theta_0 + \theta_1 FDI_{oijt} + \alpha_1 EP_{it} + \alpha_2 RP_{it} + \alpha_3 offcost_{jt} + (\beta_1 EP_{it} \\ &+ \beta_2 RP_{it} + \beta_3 offcost_{jt}) \times FDI_{oijt} + \gamma' X + \xi_i + \xi_j + \xi_t + \epsilon_{oijt} \end{aligned} \tag{10}$$

- $ln(R_{oijt})$: the log value of processing export of firm ownership o in industry i, province j and year t
- FDI_{ijt}: an indicator for FDI processing exports
- EP_{it}: encouragement policy; RP_{it}: restriction policy
- $offcost_{jt}$: offshoring cost reduction variable, infrastructure and national policy zones
- X: other controls including interactions of industrial factor intensities (i.e., skill intensity, capital intensity, contract dependent) and province-level factor endowments/institution (i.e., college share, capital output ratio, and court efficiency).

Determinants of Processing Exports

Table 3: Determinants of China's Processing Exports

	All industries			High-skill industries	Low-skill industries
VARIABLES	(1)	(2)[a]	(3)	(4)	(5)
FDI indicator	-1.174***	-1.214***	-1.219***	-1.769***	-1.148***
	(0.060)	(0.060)	(0.060)	(0.122)	(0.061)
Enc. policy	0.068	0.078	0.093	0.263**	-0.095
	(0.073)	(0.072)	(0.073)	(0.112)	(0.093)
Res. policy	-0.077	-0.056	-0.057	0.063	-0.383***
	(0.059)	(0.056)	(0.055)	(0.066)	(0.089)
Natl policy zones	0.025**	0.019			
	(0.011)	(0.012)			
Infrastructure	0.278**	0.319***			
	(0.111)	(0.111)			
FDI × Enc. policy	0.244***	0.244***	0.244***	0.751***	0.180***
	(0.055)	(0.055)	(0.055)	(0.115)	(0.059)
FDI × Res. policy	-0.448***	-0.441***	-0.435***	-0.520***	-0.156**
	(0.060)	(0.060)	(0.060)	(0.079)	(0.076)
FDI × Natl. zones	0.078***	0.082***	0.080***	0.088***	0.075***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)
FDI × Infrastructure	0.205**	0.186**	0.209**	0.301**	0.191*
	(0.089)	(0.091)	(0.093)	(0.118)	(0.098)
Skill intensity × college share		0.857***	0.862***	0.491***	0.569*
		(0.081)	(0.081)	(0.102)	(0.293)
Capital intensity × capital/output		0.006**	0.006**	0.004	0.004
		(0.003)	(0.003)	(0.004)	(0.003)
Contract dependent × institution		0.140***	0.141***	0.166***	0.152***
		(0.012)	(0.012)	(0.014)	(0.017)
Industrial fixed effect	+	+	+	+	+
Provincial and year fixed effect	+	+			
Province-year fixed effect			+	+	+
Observations	36,871	36,158	36,158	15,839	20,319
R-squared	0.512	0.521	0.532	0.521	0.564

Augmented Mincer Wage Regression

Econometric specification

$$\begin{aligned} ln(wage_{mjt}) &= \alpha_0 + [\beta_0 + \beta_1 proexratio_{jt} + \beta_2 feshr_{jt} + \beta_3 X_{jt}] \times coll_{mjt} \\ &+ \gamma_{jt} G_{mjt} + \delta_{jt} + \epsilon_{mjt} \end{aligned}$$

- $ln(wage_{mjt})$ is log annual real wage earning for person m in province j and year t
- $coll_{mjt}$ is the college indicator
- G_{mjt} are other personal control variables: gender, experience, state owned sector
- X_{jt} are other provincial control variables
- δ_{jt} is provincial-year pair fixed effect

IV Construction

- Generate predict values of offshoring by firm types using regional distribution regression
- Construct IV using the predicted values $\widehat{lnR}_{oijt}$

$$\widehat{proexratio}_{jt} = \sum_{i,o} exp(\widehat{lnR}_{oijt})/industrial\_out_{jt}$$

$$\widehat{feshr}_{jt} = \sum_{i,o=F} exp(\widehat{lnR}_{oijt}) / \sum_{i,o} exp(\widehat{lnR}_{oijt})$$

College Premium

Table 5: Determinants of Manufacturing College Premium in Urban China: 1992-2006

	OLS			IV[a]	
Independent variables	(1)	(2)	(3)	(4)	(5)
College	0.350***	0.244***	0.208***	0.252***	0.221***
	(0.009)	(0.014)	(0.029)	(0.008)	(0.022)
College indicator interaction terms					
College × Processing exports ratio		0.668***	0.723***	0.774***	0.789***
		(0.169)	(0.179)	(0.157)	(0.157)
College × Share of FDI processing exports		0.250***	0.242***	0.189***	0.196***
		(0.044)	(0.048)	(0.049)	(0.051)
College × Ordinary exports ratio		0.246	0.199	0.271	0.222
		(0.190)	(0.229)	(0.166)	(0.210)
College × R&D ratio			-0.164		0.091
			(0.779)		(0.523)
College $\times K/Y$			0.030		0.023
			(0.023)		(0.015)
Individual characteristics					
Experience	0.048***	0.048***	0.048***	0.047***	0.047***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience square	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sex	-0.202***	-0.202***	-0.202***	-0.208***	-0.208***
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)
State owned sector	0.195***	0.197***	0.196***	0.194***	0.194***
	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)
First stage F-stat				> 157.66	> 144.33
Endogeneity test (p-value)				0.0913	0.1508
Constant, Province-year pair dummy	+	+	+	+	+
N	156,658	156,658	155,905	143,010	143,010
R^2	0.366	0.368	0.369	0.298	0.304

Robust Analysis

Table 6: Robustness Analysis on the College Premium

	Cultural Revolution Cohort only	Male only	Quality of College Education	All Trade Partners
Independent variables	(1)	(2)	(3)	(4)
College indicator	0.129***	0.181***	0.238***	0.221***
	(0.034)	(0.027)	(0.021)	(0.022)
College indicator interaction terms				
College × Processing exports ratio	0.505**	0.597***	0.894***	0.744***
	(0.229)	(0.186)	(0.177)	(0.146)
College × Share of FDI processing exports	0.226***	0.257***	0.188***	0.179***
	(0.070)	(0.065)	(0.054)	(0.052)
College × Ordinary exports ratio	0.065	-0.023	0.162	0.295
	(0.334)	(0.229)	(0.215)	(0.204)
College × R&D ratio	-1.085	0.594	0.066	-0.247
	(0.971)	(0.584)	(0.525)	(0.540)
College $\times K/Y$	0.056**	0.034*	0.016	0.023
	(0.025)	(0.018)	(0.015)	(0.015)
College × Teacher-student ratio			-0.006***	
			(0.002)	
Individual characteristics				
Experience	0.040***	0.052***	0.047***	0.047***
	(0.005)	(0.001)	(0.001)	(0.001)
Experience square	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Sex	-0.217***		-0.208***	-0.208***
	(0.005)		(0.003)	(0.004)
State owned sector	0.243***	0.152***	0.192***	0.195***
	(0.006)	(0.006)	(0.004)	(0.004)
First stage F-stat	> 168.23	> 154.33	> 137.10	> 141.37
Constant, Province-year pair dummy	+	+	+	+
N	51,775	79,086	137,316	143,010
R^2	0.297	0.287	0.301	0.303

Note: the dependent variable is log annual wage income. Regressions are estimated by GMM using the predicted processing exports ratio and the share of FDI processing exports as instruments. The bootstrapped standard errors are in parentheses. *, **, and *** indicate significance at the 10,5, and 1 percent levels.

Conclusion

- The increase in processing exports can account for 63 percent of total increase in college premium between 2000 and 2006
- The increase in FDI processing exports alone can account for 55 percent of total increase in college premium during this period
- Conventional trade does not contribute significantly to skill demand
- Ownership structure of offshoring matters for skill upgrading in exports and skill premium in developing countries

Thank You !