Trade Induced Technical Change?

The Impact of Chinese Imports on Innovation, Diffusion and Productivity

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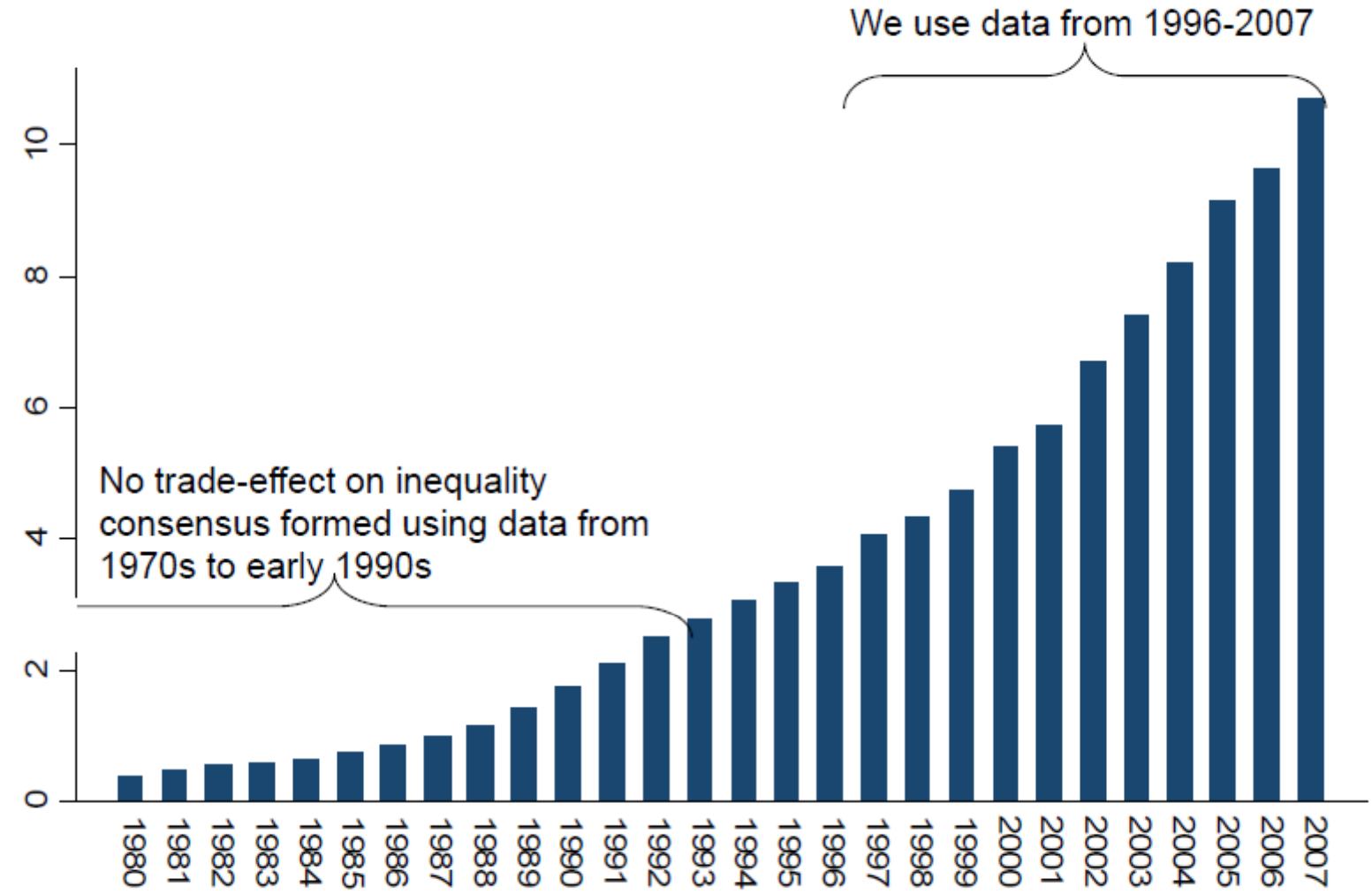
WHAT IS THE EFFECT OF REDUCING IMPORT BARRIERS AGAINST LOW WAGE COUNTRY IMPORTS (LIKE CHINA) ON TECHNICAL CHANGE IN RICH COUNTRIES (LIKE EU)?

- Little empirical evidence: more on developing countries
  - limited micro panel data on innovation
  - Fewer North-South trade “natural experiments”

- But this is a major economic and political issue because of the massive growth of Chinese imports & economic crisis

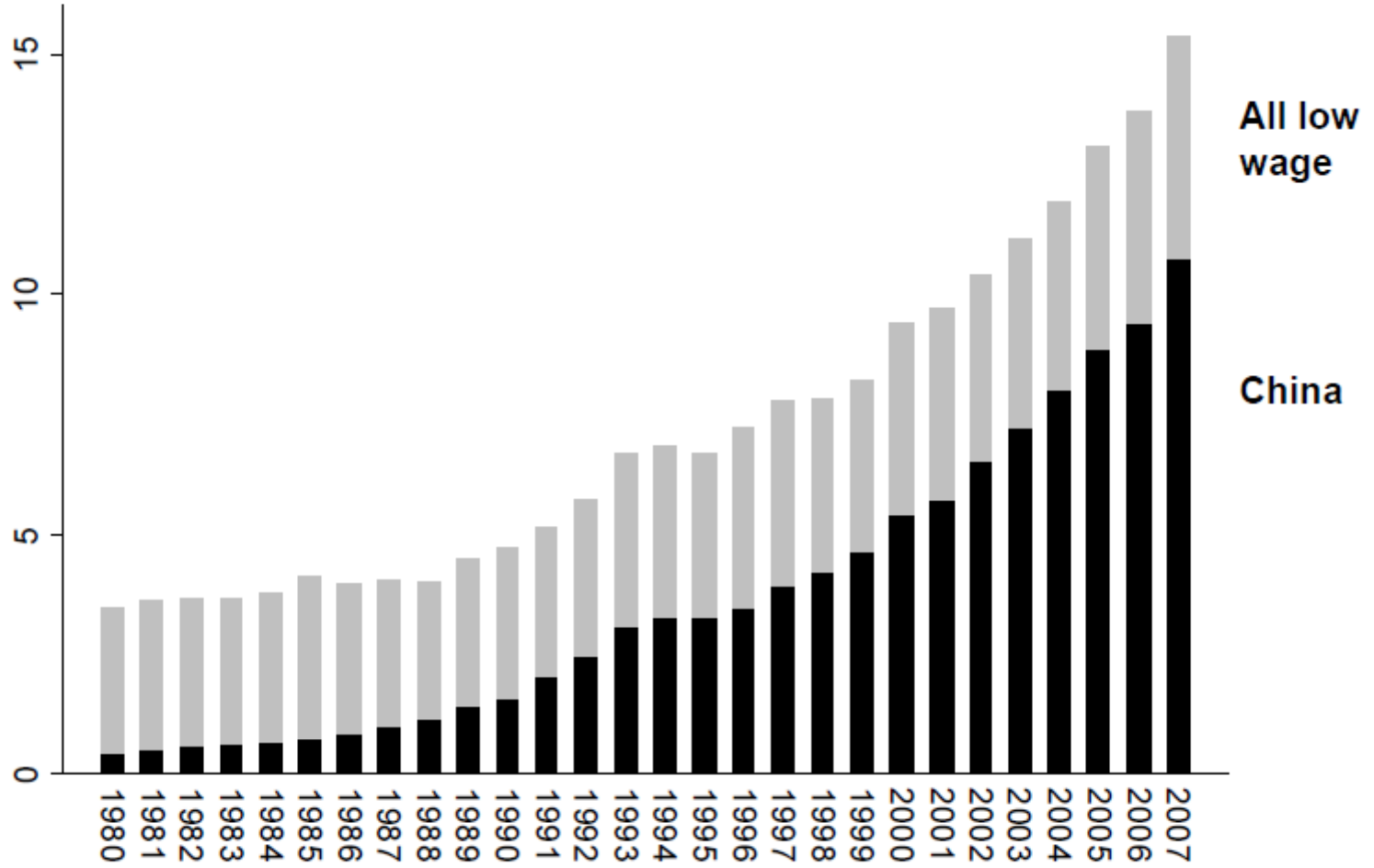
- Wage inequality literature: technology found to be more important than trade, but trade could induce technical change

Figure 1 China's % of imports in Europe and the US



Source: UN Comtrade data

China and all low-wage % of imports in Europe and the US



Low wage countries list from Bernard, Jensen and Schott (2006). Countries <5% GDP/capita of US 1972-2001.

This has clear political impact, such as the tires trade war

Summary: we study the impact of Chinese imports on technology in Europe (1/2)

Use new panel datasets on firms and establishments

We find that increased threat of Chinese imports leads to:

A) Within firm increase in innovation – patenting, R&D, IT intensity, and TFP

B) Reallocation of jobs to higher tech establishments/firms (cf. Tybout, 2003, on developing countries)

So aggregate technological upgrading in North from liberalization with low wage country like China

Summary: we study the impact of Chinese imports on technology in Europe (2/2)

China results robust to using 2 alternative IV strategies:

(i) China's entry into WTO relaxed quotas in textiles & clothing
(ii) initial conditions

Overall magnitudes moderate & rising: China "accounts" for:

- ≈ 15-20% of increase in IT, patents & productivity 2000-2007
- Grows larger over time

Suggests the impact on innovation is potentially another positive outcome (alongside cheaper prices) from low wage country trade

Caveat: Our analysis is partial equilibrium

Why might reducing import barriers matter for technology?

Compositional – shift towards existing high tech products

- Between firm: contraction/exit of low tech plants (e.g. Bernard, Jensen & Schott, 2006)
- Within firm: product mix (Bernard, Redding and Schott, 2007), Goldberg et al (2008) & offshoring (e.g. Feenstra and Hanson, 1999)

Innovation – e.g. brand new products

- Increased competition: e.g. Grossman & Helpman, 1992; Aghion et al., 2005
- Defensive innovation: e.g. Wood, 1994, Acemoglu, 1999, 2002; Thoenig and Verdier, 2003. Our model.....

Defensive Innovation in response to trade from low wage countries (Bloom, Romer & Van Reenen, 2010)

- **Idea**: Chinese imports replace domestic products and therefore reduces opportunity cost of innovating
- Skilled workers can produce or innovate.
  - Innovating loses a period of production but then obtain firm-specific skills from learning by doing
  - Innovation decision depends on opportunity costs
- *Pre-China*: skilled earn higher wages producing the old good than innovating (high op. cost of "trapped factor")
- *Post-China*: old lines unprofitable. Firm could close, but op. cost lower so resources redeployed on innovating
- Implications: (i) low wage country imports (e.g. China) competition increases innovation more than high wage country, (ii) bigger effect when more "trapped factors"

Data

Within plant/firm effects

Reallocation effects between plants/firms

Extensions & Robustness

IT data: European establishment panel

- Harte Hanks (HH) runs an annual establishment level survey on IT across Europe and the US
  - Consistent methodology since 1996
  - One European call centre in Ireland
  - HH sells data for commercial use so “market tested”

- Sampling frame is population of firms with >100 employees. Covers about 50% of all manufacturing employees

- We focus on number of computers per worker as consistent across time and countries, but do robustness on other measures like ERP

Innovation and Productivity data: European firm-level panel (AMAPAT)

- Population of European Patent Office data from 1978 (**patent** counts and citations)

- Name matched to AMADEUS company level data, population of public and private firms (Belenzon 2008), living and dead 1996-2006. Capital, labor, sales, etc.

- France, Italy, Spain and Sweden have good data on intermediates. Estimate industry-specific production functions for **TFP**

- Subset of AMADEUS quoted firms reporting **R&D** (459 firms with 5+ years) 1996-2007

Trade data: UN Comtrade

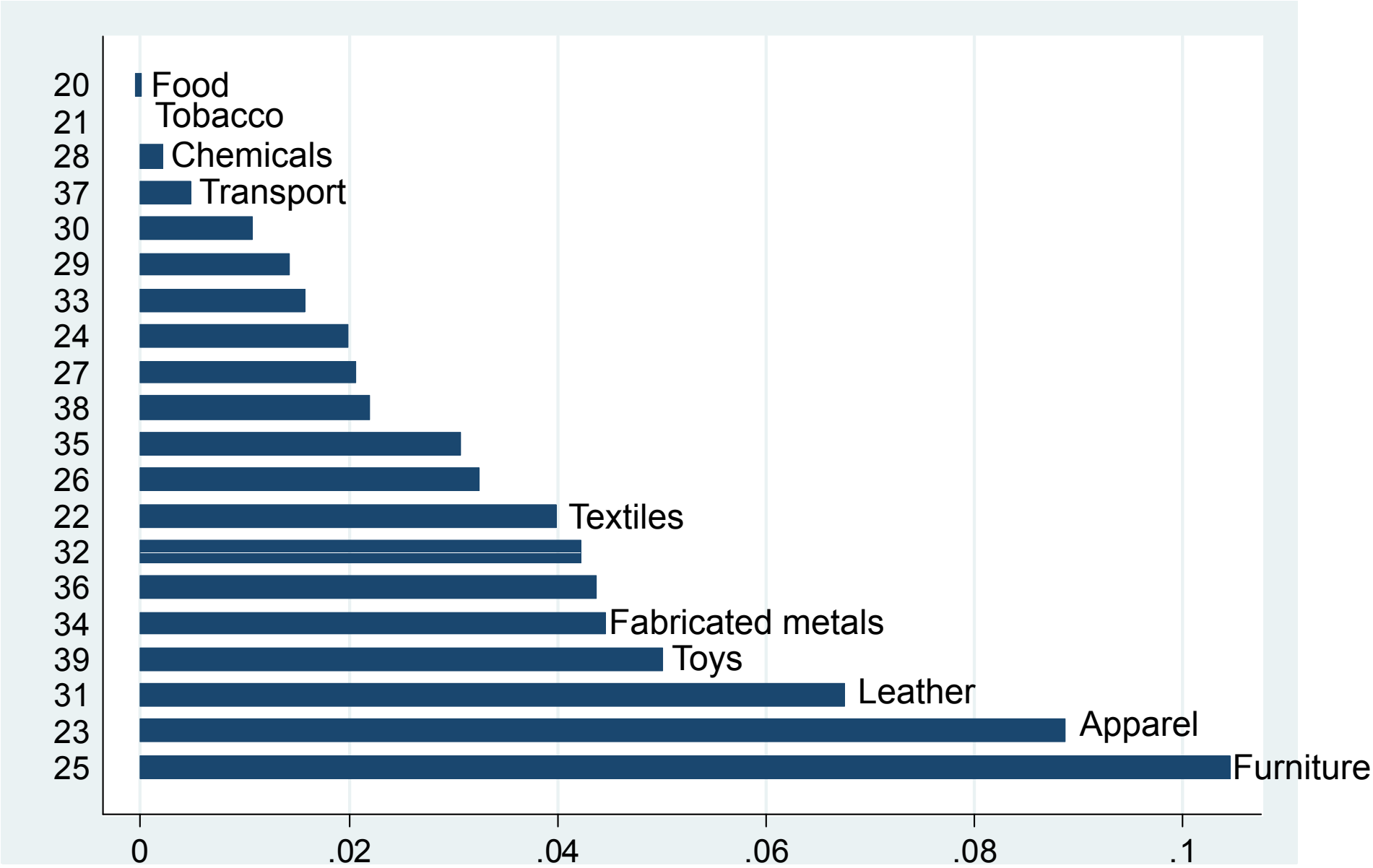
- Trade data collected at 6-digit level product level

- Matched to 4-digit SIC industries using Feenstra, Romalis, & Schott (2006) concordance

- Our main measure is IMP^{CH} = (Chinese Imports/All Imports):
    - Well measured annually at 4-digit SIC level

- Also use import penetration measures (from PRODCOM)
  - Chinese imports/apparent consumption
  - Chinese imports/production

Chinese export growth by SIC-2



TAB 5: At industry level, Chinese imports associated with lower prices & profitability

Dependent Variable:	**ΔIn(Producer Prices)**	**ΔIn(Profit Margin)**
Change in Chinese Imports	-0.447** (0.216)	-0.112** (0.052)
Observations	262	5,372
Industry-country pairs	131	2,295
Aggregation	SIC2	SIC4
Years	2006-1996	2007-2000

Notes: Estimation by OLS in 5 year long differences, SE clustered by industry-country pair, country-year dummies included,

Data

Within plant/firm effects

Reallocation effects between plants/firms

Extensions & Robustness

Basic Technology Equation

$$\ln Y_{ijkt} = \alpha IMP_{jkt}^{CH} + \beta x_{ijkt} + \lambda_i + u_{ijkt}$$

patents, IT, R&D, TFP

Chinese import share

Fixed Effects

Example: For IT
i = plants (22,957)
j = industries (366)
k = countries (12)
jk = 2,816 cells
t = 2000,…,2007

x : controls like country*time dummies

Robustness: Include imports from other low wage countries; from North; exports, skills, etc

Some econometric Issues

- Unobserved heterogeneity: Control for fixed effects – e.g. estimate in **5 year "long differences"**

- Endogeneity of Chinese imports (bias probably downwards).
  - Main IV: China's entry into WTO lead to quota increases in EU textile and clothing industry since Dec 2001.
  - Alternative IV: China's industry of comparative advantage in base year ("Initial conditions")

IV using MFA policy experiment

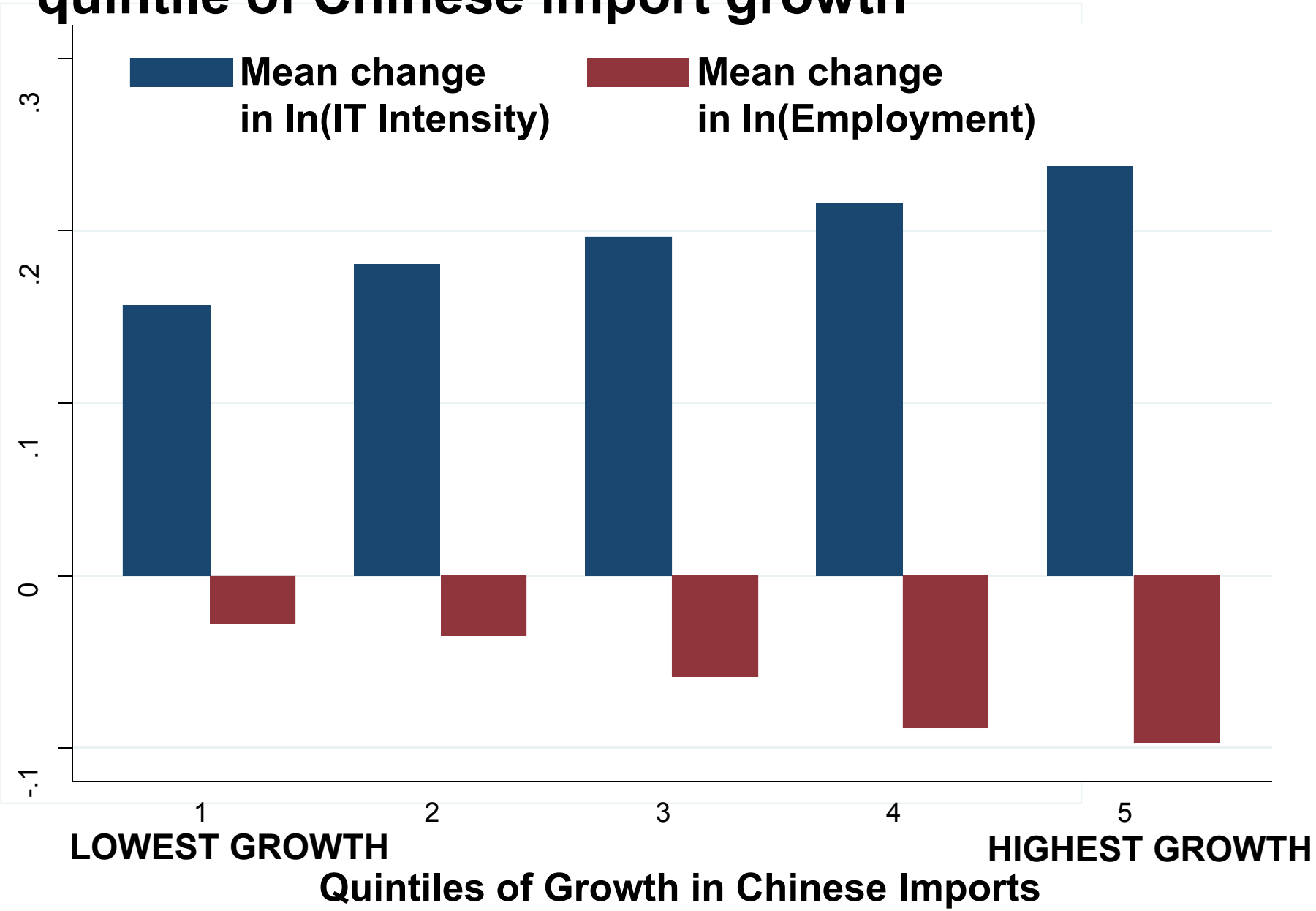
- The Multi Fiber Agreement (1974) restricted apparel and textile exports from developing countries
- The MFA was negotiated into GATT (WTO) as part of the Uruguay Round in 1994, with a 4 phase abolition 1995-2005
- When China entered the WTO in Dec 2001 it gained access to this phased abolition, occurring between 2001 and 2005
- When Chinese products came off quota there was huge surge of imports into EU and US
- Because there was some (endogenous) re-introduction of some quotas in 2006 we use baseline quotas in 2000

Some econometric Issues – cont.

- Endogeneity of Chinese imports (unobserved technology shocks positively correlated with Chinese imports)
  - **Main IV:** China's entry into WTO lead to quota increases in EU textile and clothing industry since Dec 2001.
  - **Alternative IV:** China's industry of comparative advantage in base year ("Initial conditions")
  - **Industry time trends**

- Selection
  - Examine "between" effects of survival and jobs
  - Examine industry level regressions
  - Dynamic selection: bounds approach; pre-policy trends

Fig 2 % Growth of IT intensity and employment by quintile of Chinese import growth



Tab 1: Within Firm Patents and IT Results

	(1) Δln(PATENTS)	(2) Δln(PATENTS)	(3) Δln(IT/N)	(4) Δln(IT/N)
Method	**5 year diffs**	**5 year diffs**	**5 year diffs**	**5 year diffs**
Change in Chinese Imports	0.321*** (0.102)	0.387*** (0.134)	0.361** (0.076)	0.195*** (0.067)
Change in Employment		0.015* (0.008)		-0.617*** (0.010)
Sample period	2005-1996	2005-1996	2007-2000	2007-2000
# Units	8,480	7,030	22,957	22,957
#industry clusters	1,578	1,464	2,816	2,816
Observations	30,277	22,938	37,500	37,500

Notes: SE clustered by industry-country, Country-year dummies included. Patents regressions robust to using count data FE models (e.g. Blundell, Griffith & Van Reenen,1999)

Tab 1 – cont.: Within Firm R&D &TFP Results

	(5) Δln(R&D)	(6) Δln(R&D)	(7) ΔTFP
method	**5 year diffs**	**5 year diffs**	**5 year diffs**
Change in Chinese Imports	1.213** (0.549)	1.545*** (0.330)	0.257*** (0.072)
Change in Employment		0.558*** (0.043)	
Sample period	2007-1996	2007-1996	2005-1996
# Units	459	459	89,369
# industry clusters	196	196	1,210
Observations	1,626	1,626	292,167

Notes: SE clustered by industry-country, Country-year dummies included.
In TFP only France, Italy, Spain & Sweden. Estimate TFP separately by industry (on 1.4m obs). Allow for endogenous factor inputs & selection using Olley-Pakes (1996)/de Loecker (2007)

Table 2A: IV estimates using changes in EU textile & clothing quotas - IT

	Δln(IT/N)	ΔChinese Imports	Δln(IT/N)
Method	**OLS**	**First Stage**	**IV**
ΔChinese Imports	1.284***		1.851***
	(0.172)		(0.400)
Quotas removal		0.088***	
		(0.019)	
Sample period	2005-2000	2005-2000	2005-2000
Number of units	2,891	2,891	2,891
industry clusters	83	83	83
Observations	2,891	2,891	2,891

SE clustered by 4 digit industries, Country-year and site type dummies included

Table 2A- Cont: IV estimates using changes in EU textile & clothing quotas – Patents and TFP

Method	ΔPATENTS OLS	Δ Chinese Imports First Stage	ΔPATENTS IV	Δln(TFP) OLS	Δ Chinese Imports First Stage	Δln(TFP) IV
ΔChinese Imports				0.620***		1.897**
				(0.100)		(0.806)
ΔChinese Imports	1.160***		1.864*			
	(0.377)		(1.001)			
Quotas removal		0.108***			0.068***	
		(0.022)			(0.026)	
Sample period	2005-1996	2005-1996	2005-1996	2005-1999	2005-1999	2005-1999
Units	1,866	1,866	1,866	55,791	55,791	55,791
Industry clusters	149	149	149	187	187	187
Observations	3,443	3,443	3,443	55,791	55,791	55,791

SE clustered by 4 digit industries, Country-year dummies included

IV using initial conditions

- Alternative IV makes 2 assumptions to use the whole sample

1) The aggregate increase in Chinese exports was exogenous (Chinese policy)

2) Initial exporting industries had a comparative advantage, consistent with:
   - Initial industries exports grew fastest (see slide over)
   - Increase in Chinese exports 1989-05 was almost all (94%) from the intensive margin (Schott, 2008)

- Define an instrument as aggregate Chinese export growth to EU times the industry level initial exports:

$$IV_{j,t} = (\text{Initial industry exports})_j * (\text{Macro exports growth})_t$$

Table 2B –cont.: IV estimates using initial conditions – patents and IT

Dependent Variable	**Δln(PATENTS)**	**ΔIMP^{CH}**	**Δln(PATENTS)**	**Δln(IT/N)**	**ΔIMP^{CH}**	**Δln (IT/N)**
Method:	**OLS**	**1st Stage**	**IV**	**OLS**	**1st Stage**	**IV**
Change Chinese Imports	0.321***		0.495**	0.361***		0.593**
	(0.117)		(0.224)	(0.106)		(0.252)
Initial Chinese imports* US&EU Chinese import growth		0.167***			0.124***	
		(0.017)			(0.002)	
Sample period	2005-1996	2005-1996	2005-1996	2007-2000	2007-2000	2007-2000
Number of Units	8,480	8,480	8,480	22,957	22,957	22,957
Number of industry clusters	304	304	304	371	371	371
Observations	30,277	30,277	30,277	37,500	37,500	37,500

SE clustered by 4 digit industries, Country-year dummies included

Table 2B –cont.: IV estimates using initial conditions –TFP

Dependent Variable	**ΔTFP**	**ΔIMP^{CH}**	**ΔTFP**
Method:	**OLS**	**1st Stage**	**IV**
Change in Chinese Imports	0.257***		0.507*
	(0.087)		(0.283)
Initial Chinese imports* US&EU Chinese import growth		0.078***	
		(0.021)	
Sample period	2005-1996	2005-1996	2005-1996
Number of Units	89,369	89,369	89,369
Number of industry clusters	354	354	354
Observations	292,167	292,167	292,167

SE clustered by 4 digit industries, Country-year dummies included

Data

Within plant/ firm effects

Reallocation effects between plants/firms

Extensions & Robustness

C) Employment Equation

Employment growth

If high TECH plants "protected" from Chinese imports then $\gamma^n > 0$

$$\Delta \ln N_{ijkt} = \gamma^n [TECH_{ijkt-5} * \Delta IMP^{CH}_{jkt}] +$$

$$\alpha^n \Delta IMP^{CH}_{jkt} + \delta^n TECH_{ijkt-5} + \beta^n \Delta x^n_{ijkt} + \nu^n_{ijkt}$$

expect $\alpha^n < 0$ **expect $\delta^n > 0$**

FIG 3: EMPLOYMENT GROWTH BY INITIAL IT INTENSITY

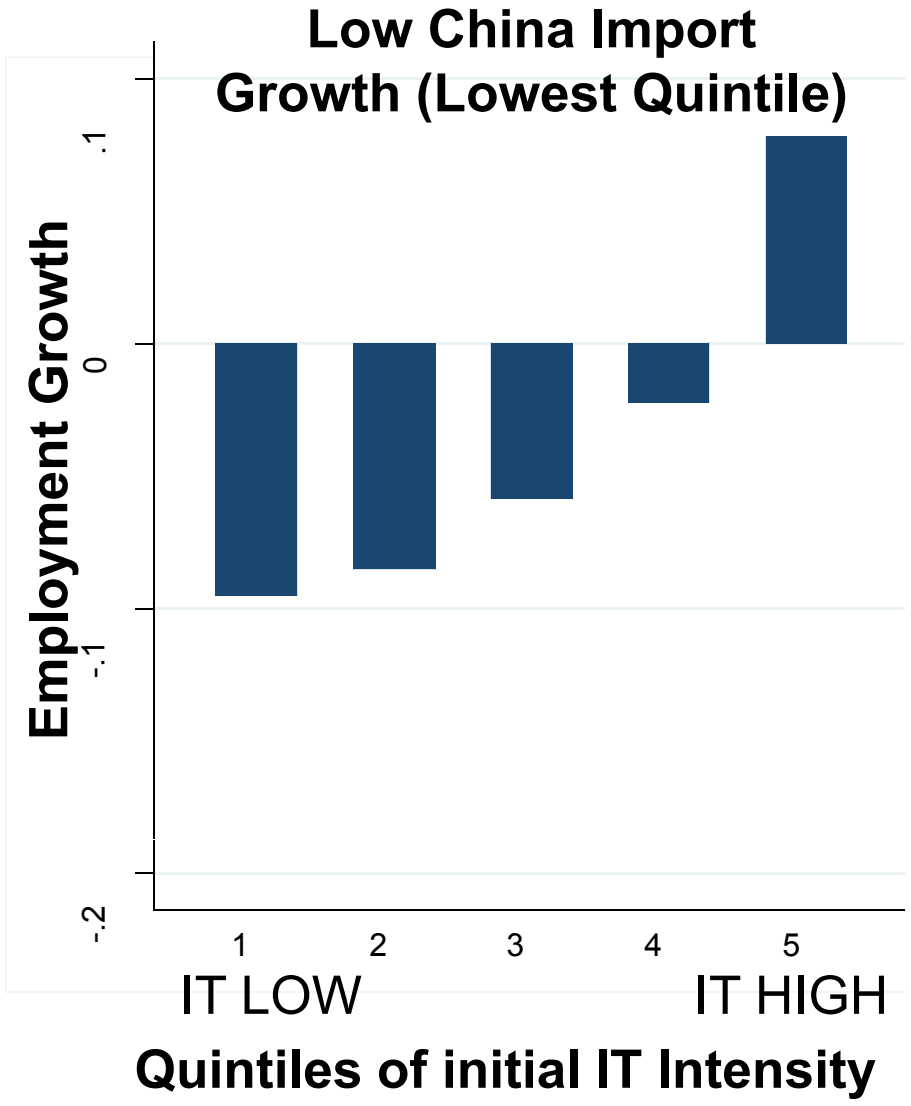


Table 3A: High tech firms less likely to shed jobs rink when faced by Chinese imports

Dependent Variable:	**ΔIn(N)**	**ΔIn(N)**	**ΔIn(N)**
TECH Measure:	**Patents**	**IT**	**TFP**
Chinese Import Growth	-0.352***	-0.379***	-0.382***
	(0.067)	(0.105)	(0.093)
Ln(pat stock/worker) at t-5	0.469***		
	(0.058)		
Ln(pat stock/worker) at t-5*	1.546**		
Chinese imports growth	(0.757)		
IT intensity (t-5)		0.230***	
		(0.010)	
(IT/N) (t-5)*Chinese Imp Growth		0.385**	
		(0.157)	
Ln(TFP) at t-5			0.256***
			(0.016)
Ln(TFP) at t-5*			0.956***
Chinese import growth			(0.424)
Clusters	3,123	2,816	1,210
Observations	581,474	37,500	292,167

SE clustered by country- industry, all standard additional controls included

C) Survival Equation

Survival

If high TECH plants partially "protected" from effect of Chinese imports then $\gamma^s > 0$

$$SURVIVAL_{ijkt} = \gamma^s [TECH_{ijkt-5} * \Delta IMP_{jkt}^{CH}] +$$

$$\alpha^s \Delta IMP_{jkt}^{CH} + \delta^s TECH_{ijkt-5} + \beta^s \Delta x_{ijkt}^s + \nu_{ijkt}^s$$

expect $\alpha^s < 0$ **expect $\delta^s > 0$**

Tab 3B: High tech firms more likely to survive Chinese imports

Dependent Variable	Survival	Survival	Survival	Survival
TECH measure:	patents	patents	IT	TFP
Change in Chinese Imports	-0.122**	-0.122**	-0.182**	-0.189***
	(0.036)	(0.036)	(0.072)	(0.056)
Ln(patent stock/worker$_{t-5}$) *Change in Chinese Imports		0.391***		
		(0.018)		
(IT/N) $_{t-5}$*Change in Chinese Imports			0.137	
			(0.112)	
ln(TFP$_{t-5}$) *Change in Chinese Imports				0.097
				(0.076)
IT Intensity (IT/N)$_{t-5}$			-0.002	
			(0.006)	
Ln(patent stock/worker$_{t-5}$)	0.052***	0.040**		
	(0.008)	(0.011)		
Ln(TFP$_{t-5}$)				-0.003
				(0.004)
Observations	490,095	490,095	28,624	268,335

SE clustered by up to 3.369 country- industry pairs, all standard additional controls included (and lagged Size)

So how big are these magnitudes?

• We use the regression coefficients multiplied by the change in Chinese imports to generate predicted impacts

• Combine both the within firm/plant effects and the between firm/plant effects

• Calculate this as a share of aggregate IT, patenting and TFP growth over the same period

• Compare to industry-level regressions that combine within, between (& net entry)

Tab 5 Industry level results are consistent with these within and between firm/plant magnitudes

	(1)	(2)	(3)	(4)
Dependent Variable:	**Δln(PATENTS)**	**Δln(IT/N)**	**Δln(R&D)**	**Δln(TFP)**
Change in Chinese Imports	0.368 *	0.399***	2.145*	0.326***
	(0.200)	(0.120)	(1.186)	(0.072)
Sample period	2005-1996	2007-2000	2007-2000	2005-1996
Country by industry clusters	1,646	2,902	151	1,140
Observations	6,888	7,409	322	5,660

Industry coefficients almost double the firm/plant coefficients, consistent with the between & net exit effect being about the same size as the within effect.

Note: 5 year differences. Industry by country regressions

Table 4: Back of the envelope magnitudes Decomposing aggregate effect of trade on technology, 2007-2000

% of Technology Measure that Chinese trade 'accounts for'

Measure	Within (%)	Between (%)	Exit (%)	Total (%)
Patents	5.8	6.3	2.5	14.7

Notes: calculated for the regression sample using OLS coefficients

Data

Within plant/firm effects

Reallocation effects between plants/firms

Extensions & Robustness

Extensions & Robustness

- **Trapped Factor Model implications**
  - Low wage and high wage country trade
  - Heterogeneity
- **Other theories**
  - Offshoring
  - Industry switching
  - Exports
- **Robustness**
  - Skills
  - GE/Welfare
  - Dynamic selection issues
  - Lawyer effects
  - Alternative ICT measures

Conclusions

- Find a trade-induced increase in IT, patents, TFP & R&D
- Occurs *within* and *between* plants and firms
- China “accounts” for 15-20% of increase in aggregate IT, patents and TFP and rising over time
- Other low-wage countries trade similar effect, but high-wage countries trade appears to have no effect

Next Steps

- Theory
- More on heterogeneity by industry
- FDI to China (from ORBIS data)

Back Up