Trade Induced Technical Change? The Impact of Chinese imports on IT and Innovation

Nick Bloom, Stanford, NBER & CEP
Mirko Draca, UCL & CEP
John Van Reenen, LSE, NBER & CEP

Minnesota Trade Conference, May 2009

CENTRE *for* ECONOMIC PERFORMANCE

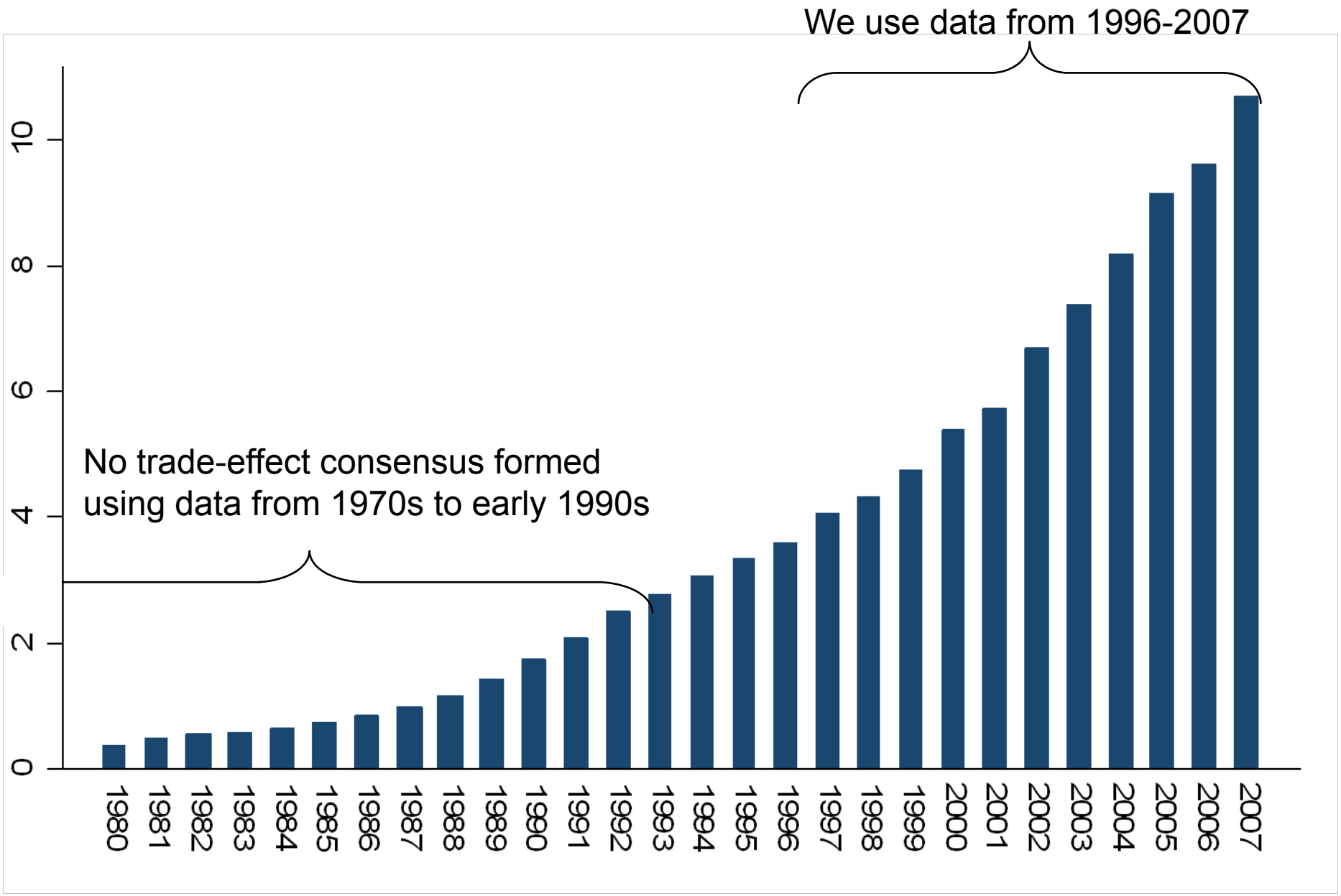
Economists and public view of Chinese trade tends to downplay technology impact

- (Labor) economists' view that low wage country trade relatively unimportant in explaining growth of wage inequality (skill-biased technical change more important)
- Public view that Chinese imports devastate manufacturing (albeit with some gains from lower consumer goods prices)

Problems with these views

- Both views tend to take technical change as exogenous. But range of theories suggest trade with "South" could induce technical change in "North"
- Most studies of effects of trade on wage inequality use data up to early 1990s

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



Source: UN Comtrade data

Why might trade matter for technology?

Compositional – shift towards existing products that use more high-tech inputs (like IT)

- Between firm: contraction/exit of low tech plants (e.g. Bernard, Jensen & Schott, 2006)
- Within firm: product mix (Bernard, Redding and Schott, 2007, 2009; Goldberg et al, 2008) & offshoring (e.g. Feenstra and Hanson, 1999)

Innovation – (e.g. new products)*:*

- Increased competition: e.g. Grossman & Helpman, 1992; Aghion et al. 2005; Holmes et al. 2008.
- Defensive innovation: e.g. Wood, 1994, Acemoglu, 1999, 2002; Thoenig and Verdier, 2003

Summary of results (1/2)

4 panel datasets on EU manufacturers: (1) 23,000 plants for IT, 2000-2007; (2) 15,000 firms for patents; 1996-2005; (3) 350,000 firms for TFP 1995-2006; (4) 500 firms for R&D 2000-2007

We find that increased Chinese imports appear to:

A) Generate a within establishment increase in IT intensity

B) Generate a within firm rise in patenting, TFP and R&D

C) Reallocate employment to higher tech establishments/firms
Low tech producers have larger employment falls (and exit rates) in response to Chinese imports

Summary of results (2/2)

Robust to endogeneity using as IVs: (i) China's entry into WTO relaxed quotas in textiles & clothing, (ii) initial conditions

Magnitudes small but rising rapidly. China "accounts" for:

- ≈ 15-20% of increase in IT, patents & productivity 2000-2007
- ≈ 20-30% of increase in IT, patents & productivity 2004-07

Appears trade becoming more important by influencing technical change.

Two recent ‘case-studies’ illustrate our results

Freeman and Kleiner (2005) look at a large US shoe factory’s response to increasing shoe imports

Bartel, Ichinowski and Shaw (2007) look at US valve manufacturers’ response to cheaper imports

Both find very similar changes:

- Shorter production runs with a wider variety of products
- Investment in IT and worker training
- Increased innovation to develop new product ranges

Results also help interpret evidence from the growing trade and productivity literature

- Trade liberalization associated with rise in aggregate productivity (e.g. Tybout, 2000; Pavcnik, 2002; Trefler, 2004; de Loecker, 2007; Amit and Konings, 2006, Dunne et al. 2009)

- Reallocation across plants & products can potentially explain everything (eg Melitz 2003; Bernard, Redding & Schott, 2009)

- So is there also a role for technical change as well?
  - Little evidence of effects of trade on observable measures of technology (e.g. Bustos, 2007)

- The results suggest yes, there is a technological route as well

Data

Within plant/firm effects

Reallocation effects between plants/firms

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 Dublin
  - HH sells data for commercial use so “market tested”

- Data includes hardware, software and personnel. We focus on PCs per worker (cf. Beaudry, Doms & Lewis, 2006)
  - Compare with other IT measures (Databases, ERP, etc.)

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

Innovation data: European firm-level panel

- Use patent counts (& citations) as innovation measure. European Patent Office data from 1978

- Name matched to BVD's AMADEUS: European company level data, covering public and private firms (see Belenzon 2008)

Productivity & R&D data: AMADEUS & OSIRIS

- Company accounts for about 10 million public and private firms across Europe in AMADEUS dataset
  - We use the 1/3 million firms in France, Italy, Spain and Sweden with panel sales, capital, labor and materials data

- ORSIRIS has data on all 10,000 publicly quoted firms in Europe, including 500 firms reporting R&D data

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):
    - Available annually at 4-digit SIC level
    - Well measured

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

Example of SIC4 detail

23 APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS

231 MEN'S AND BOYS' SUITS, COATS, AND OVERCOATS

2311 MEN'S AND BOYS' SUITS, COATS, AND OVERCOATS

232 MEN'S AND BOYS' FURNISHINGS, WORK CLOTHING, AND ALLIED GARMENTS

2321 MEN'S AND BOYS' SHIRTS, EXCEPT WORK SHIRTS

2322 MEN'S AND BOYS' UNDERWEAR AND NIGHTWEAR

2323 MEN'S AND BOYS' NECKWEAR

2325 MEN'S AND BOYS' SEPARATE TROUSERS AND SLACKS

2326 MEN'S AND BOYS' WORK CLOTHING

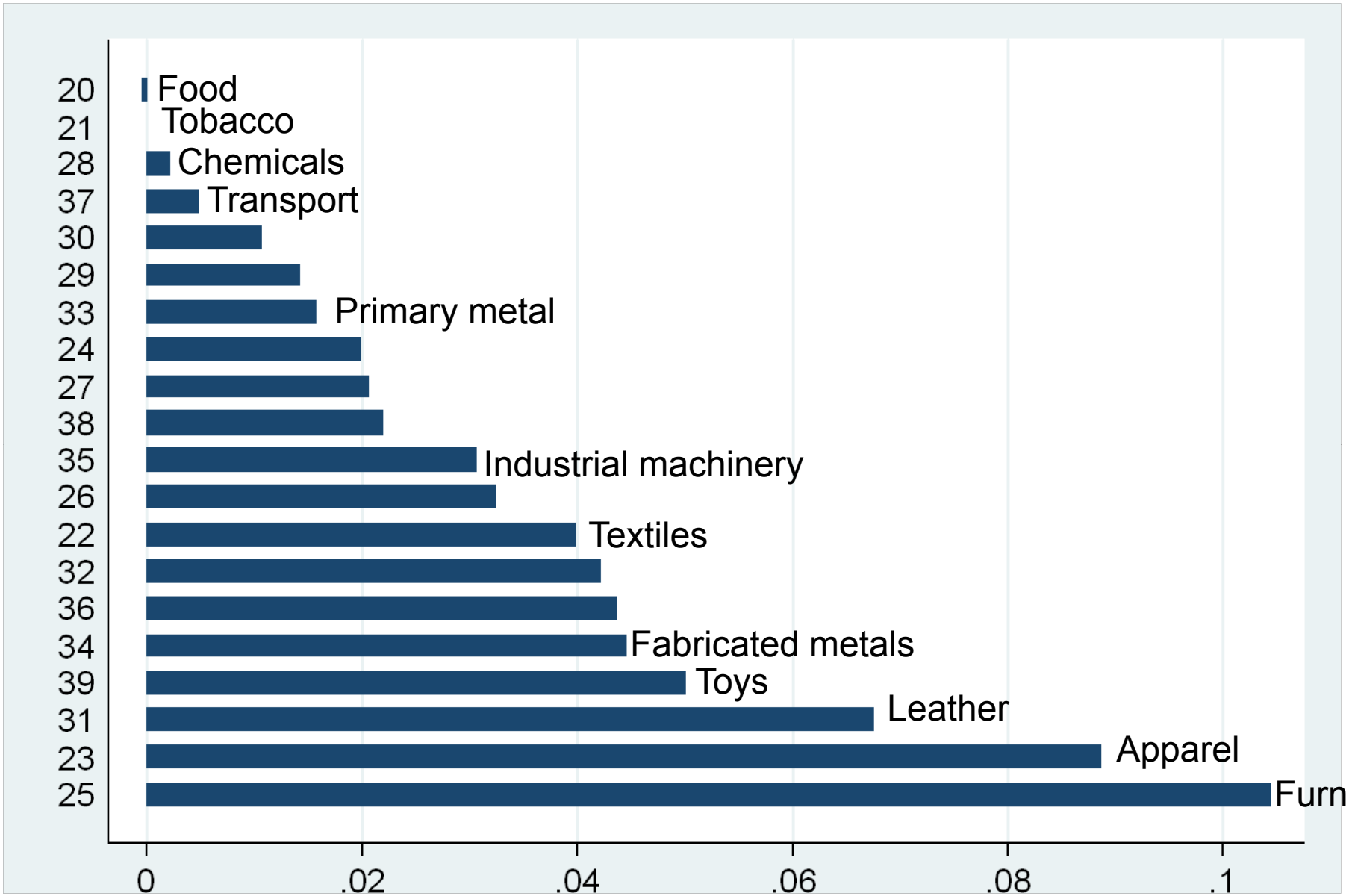
2329 MEN'S AND BOYS' CLOTHING, NOT ELSEWHERE CLASSIFIED

Example of HS6 detail

HS6 codes we match against SIC2321

610510 Men's or Boys' Shirts of Cotton, Knitted or Crocheted
610520 Men's or Boys' Shirts of Man-made Fibers, Knitted or Crocheted
610590 Men's or Boys' Shirts of Other Textile Materials, Knitted or Crocheted
620510 Men's or Boys' Shirts of Wool or Fine Animal Hair
620520 Men's or Boys' Shirts of Cotton
620530 Men's or Boys' Shirts of Man-made Fibers
620590 Men's or Boys' Shirts of Other Textile Materials

Chinese export growth by SIC-2



5-year change in export share, 2000 to 2005, for our sample

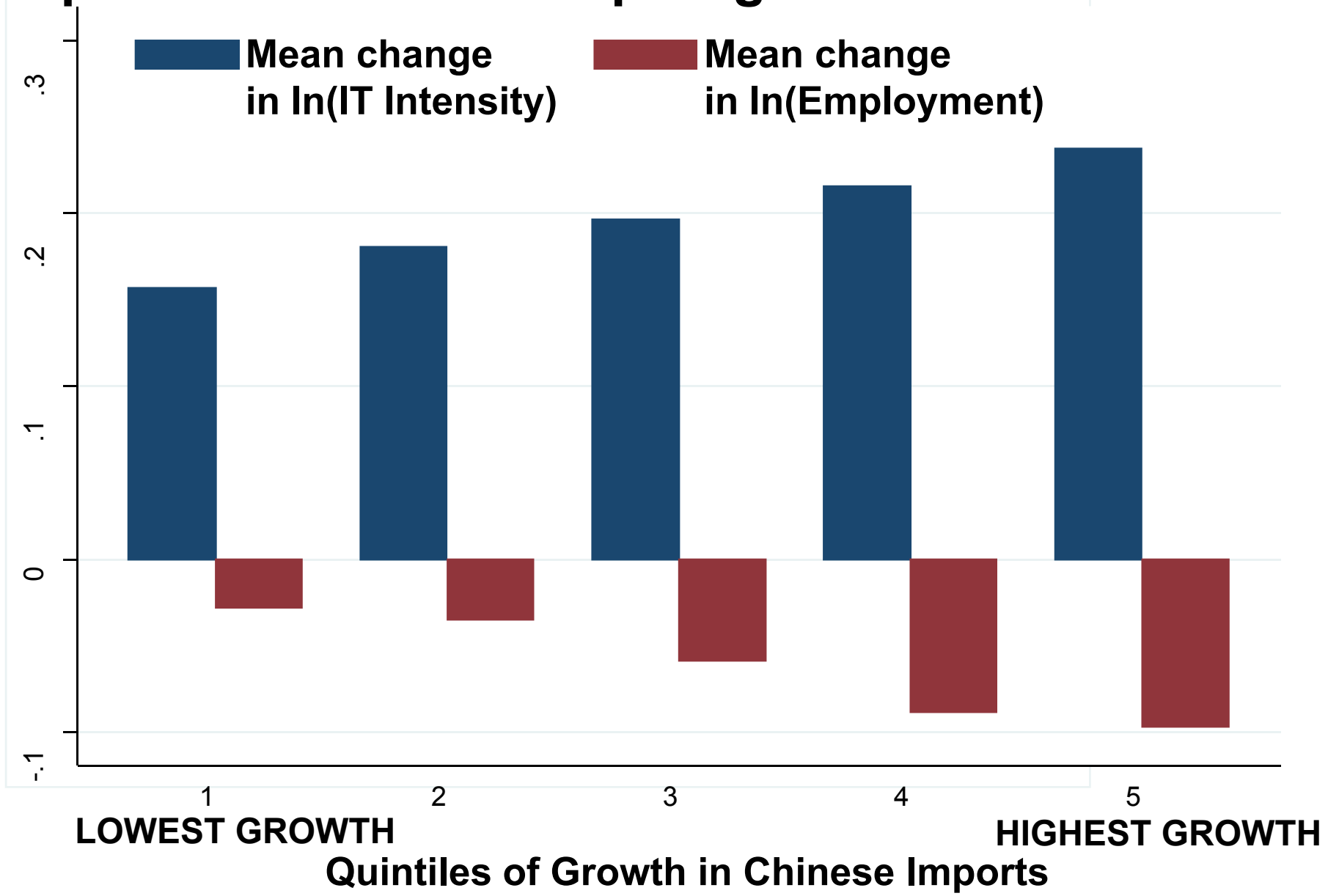
Data

Within plant/firm effects

Reallocation effects between plants/firms

Robustness

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



A) Information Technology Equation

$$\Delta \ln(IT / N)_{ijkt} = \alpha \Delta IMP^{CH}_{jkt} + \beta \Delta x_{ijkt} + \nu_{ijkt}$$

PCs (*IT*) per Worker (*N*)

Chinese import share in an industry-country pair

x –controls country*time dummies, site "types", employment growth.

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

Robustness: also include imports from other low wage countries, from North, North, output, exports, skills, etc

Some econometric Issues

- Unobserved heterogeneity: Generally estimate in **5 year "long differences"**

- Endogeneity of Chinese imports (note bias probably downwards).

- 2 strategies:
  - (A) China's entry into WTO lead to quota increases in EU textile and clothing industry since Dec 2001.
  - (B) China's industry of comparative advantage in base year ("Initial conditions")

- Show OLS first, then IV results (coefficients all larger)

Tab 2: Information Technology (5 year diff)

Dependent Variable:	ΔIn(IT/N)			
Change in Chinese imports share	0.429*** (0.080)	0.396*** (0.077)	0.361*** (0.076)	0.195*** (0.068)
Change in employment				-0.617*** (0.010)
Country Year Effects	No	Yes	Yes	Yes
Site-Type Controls	No	No	Yes	Yes
Observations	37,500	37,500	37,500	37,500

SE clustered by industry-country pair (2,816 cells), 22,957 plants, 2000-2007

B) Patenting Equation

$$INNOV_{ijkt} = \exp(\theta_1 IMP^{CH}_{jkt-5} + \theta_2 x_{ijkt} + \eta_i + e_{ijkt})$$

- *INNOV* measured by patent counts (also consider citations)
- Use 5-year lag to reflect delay in R&D to patents (we test dynamics)
- Use several approaches to deal with fixed effects in count-data models (e.g. Blundell, Griffith & Van Reenen, 1999), but find similar results across all specifications

Table 3 Innovation: Patents Equations

Method	SIC4*CTY FE	Firm FE	Long Dif
Dep. Variable	**PATENTS**	**PATENTS**	**ΔPATENTS**
Chinese Imports at (t-5)	0.303*** (0.105)	0.273*** (0.097)	
ln(Employment) at (t-1)			
ln(Capital/Sales) at (t-1)			
Δ Chinese Imports at (t-5)			0.354*** (0.098)
SIC4*country FE	Yes	-	-
Firm FE	No	Yes	No
No. Firms	15,119	15,119	8,991
Observations	92,910	92,910	30,608

SE clustered by industry-country pair (2,225), country*year effects included.

Endogeneity

- Endogeneity likely to bias coefficients down, as innovation and IT shocks should reduce imports

- Nevertheless, use two different IV strategies:

  A) China's entry into WTO in Dec 2001 led to large and varying quota increases/abolition in textiles and apparel (Brambilla, Khandelwal and Schott, 2008)

  B) Use $[\text{Global growth in Chinese imports}]_t$ interacted with $[\text{China's total import share in 4 digit sector in 1999}]_j$
     - China's trade liberalization exogenous. Largest impact in industries where China has comparative advantage – those that China already exporting in early on.
     - Consistent with this industries exporting heavily in 1999 subsequently also had much larger increase in exports

Table 4: IV estimates using changes in EU textile & clothing quotas

Dependent Var.	**Δln(IT/N)**	**ΔIMP^{CH}**	**Δln(IT/N)**	**ΔPAT**	**ΔIMP^{CH}**	**ΔPAT**
Method	**OLS**	**First Stage**	**IV**	**OLS**	**First Stage**	**IV**
Δ in Chinese Imports	1.284***		1.851***			
	(0.172)		(0.400)			
Δ in Chinese Imports at (t-3)				1.294***		3.933
				(0.478)		(2.405)
Quota Removal		0.088***			0.034***	
		(0.004)			(0.005)	
Observations	2,891	2,891	2,891	3,339	3,339	3,339

SE clustered by 4 digit industries (83), all standard additional controls included

Table 5: IV estimates using initial conditions

Dependent variable	ΔIn(IT/N)	ΔIMP^{CH}	ΔIn(IT/N)	ΔPATENTS	ΔIMP^{CH}	ΔPATENTS
Method:	OLS	First Stage	IV	OLS	First Stage	IV
Change in Chinese Imports	0.361***		0.727**			
	(0.106)		(0.220)			
Change in Chinese Imports (t-5)				0.342***		0.455*
				(0.095)		(0.251)
Initial Chinese imports *Aggregate growth China		0.254***			0.230***	
		(0.003)			(0.003)	
Number of Units	22,957	22,957	22,957	8,991	8,991	8,991
Observations	37,500	37,500	37,500	30,608	30,608	30,608

SE clustered by 4 digit industry (370), all standard additional controls included

Data

Within plant/ firm effects

Reallocation effects between plants/firms

Robustness

C) Employment Equation

$$\Delta \ln N_{ijkt} = \alpha^n \Delta IMP_{jkt}^{CH} + \beta^n \Delta x_{ijkt}^n + \nu_{ijkt}^n$$

Employment growth

expect $\alpha^n < 0$

If high TECH plants (measured by IT or patents) partially "protected" from effect of Chinese imports then $\gamma^n > 0$

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

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

FIG 3: EMPLOYMENT GROWTH BY INITIAL IT INTENSITY

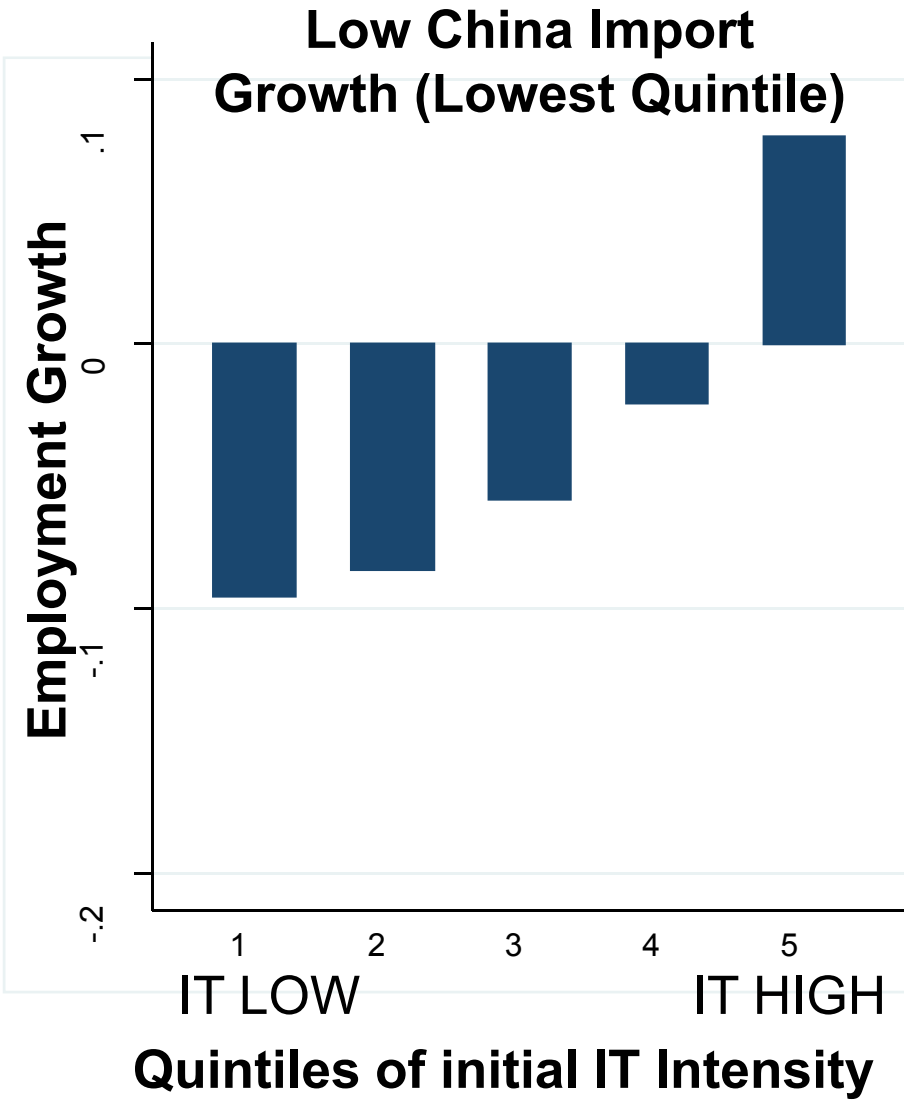


Table 6: Employment Growth

Sample	HH	HH	HH	HH	**Amadeus**
Dependent Variable	**ΔIn(N)**	**ΔIn(N)**	**ΔIn(N)**	**ΔIn(N)**	**ΔIn(N)**
Chinese Import Growth	-0.277***	-0.203***	-0.379***	-0.396***	-0.286***
	(0.074)	(0.072)	(0.105)	(0.120)	(0.069)
IT intensity (t-5)		0.241***	0.230***		
		(0.009)	(0.010)		
Chinese Imp Growth*IT (t-5)			0.385**		
			(0.157)		
Quintile2 of IT				0.165	
*Chinese Import Growth				(0.126)	
Quintile3 of IT				0.009	
*Chinese Import Growth				(0.174)	
Quintile4 of IT				0.362***	
*Chinese Import Growth				(0.139)	
Highest Quintile 5 of IT				0.514***	
*Chinese Import Growth				(0.159)	
Ln(pat stock/worker at t-5)					0.336***
					(0.060)
Ln(pat stock/worker at t-5)*					2.142***
Chinese imports growth					(0.824)
Observations	37,500	37,500	37,500	37,500	336,028

D) Survival Equation (for plants alive in 2000)

$$SURVIVAL_{ijkt} = \alpha^s \Delta IMP_{jkt}^{CH} + \beta^s \Delta x_{ijkt}^s + \nu_{ijkt}^s$$

=1 if plant alive in 2005

expect $\alpha^s < 0$

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

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

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

Tab 7: High tech plant more likely to survive Chinese imports

Change in Chinese Imports	-0.118**	-0.182**	-0.274***	-0.113**
	(0.047)	(0.072)	(0.098)	(0.025)
Change in Chinese Imports*(IT/N) $_{t-5}$		0.137		
		(0.112)		
Lowest Quintile *(IT/N) $_{t-5}$*Change in Chinese Imports				
Ln(patent stock/worker$_{t-5}$) *Change In Chinese Imports				0.194**
				(0.111)
Quintile2 of (IT/N) $_{t-5}$* Change in Chinese Imports			0.238**	
			(0.104)	
Quintile3 of (IT/N) $_{t-5}$* Change in Chinese Imports			0.135	
			(0.137)	
Quintile4 of (IT/N) $_{t-5}$ * Change in Chinese Imports			0.272**	
			(0.124)	
Highest Quintile (IT/N) $_{t-5}$ *Change Chinese Imports			0.201	
			(0.138)	
IT Intensity (IT/N)$_{t-5}$	0.001	-0.002		
	(0.006)	(0.006)		
Ln(patent stock/worker$_{t-5}$)				0.034***
				(0.009)
Observations	28,624	28,624	28,624	122,336

Tab 8A: IT Magnitudes - mainly from within establishment IT increases, rising over time

% increase in IT in data that Chinese trade 'accounts for', OLS

Period	Within (%)	Between (%)	Exit (%)	Total (%)
2000-07	11.1	3.1	1.2	15.4

Tab 8B: Patents magnitudes even split of between and within effects, also rising over time

% increase in Patents that Chinese trade 'accounts for', based on 2.8% average annual growth of all patents

Period	Within (%)	Between (%)	Exit (%)	Total (%)
2000-07	10.8	10.0	1.8	22.6

Notes: calculated for the regression sample using OLS coefficients

Tab 8C: Total Factor Productivity Magnitudes even split between and within, also rising over time

% increase in TFP that Chinese trade 'accounts for', based on aggregate 2% TFP growth rates

Period	Within	Between	Exit	Total
2000-07	10.4	6.7	1.3	18.4
2000-04	6.2	4.1	0.8	11.1
2004-07	16.0	10.2	2.0	28.2

Notes: within magnitude calculated for the regression sample using Olley Pakes (1996)/de Loecker (2007) method.

Data

Within plant/firm effects

Reallocation effects between plants/firms

Extensions/Robustness

Extensions

- Low wage and high wage country trade
- Offshoring
- Industry switching
- Productivity
- R&D
- Exports

Robustness

- Alternative normalizations for Chinese Trade
- Lawyer effects
- Dynamic selection
- Human and fixed capital,
- Alternative ICT measures

Results appear robust to using other Chinese import competition measures

Our baseline measure: (Chinese Imports/World Imports)

Also try:
(A) (Chinese Imports/Domestic Production)
(B) (Chinese Imports/Apparent Consumption)

Apparent Consumption = [Domestic Production + Imports - Exports]

Tab 9A: Results appear robust to using other Chinese import competition measures (/production)

Dependent Variable:	**ΔIn(IT/N)**	**ΔPATENTS**	**ΔIn(N)**	Survival
Change in Chinese Imports (over production)	0.053** (0.024)		-0.192*** (0.043)	-0.060*** (0.022)
Change in Chinese Imports (t-4)		0.364*** (0.114)		
Change Chinese Imports*IT (t-5)			0.138** (0.057)	
Change Chinese Imports* Lowest Quintile IT (t-5)				-0.128** (0.051)
$(IT/N)_{t-5}$			0.248*** (0.011)	
Lowest quintile of IT (t-5)				-0.014** (0.006)
Observations	31,820	7,130	31,820	25,130

Tab 9B: Results appear robust to using other Chinese import competition measures (/apparent consumption)

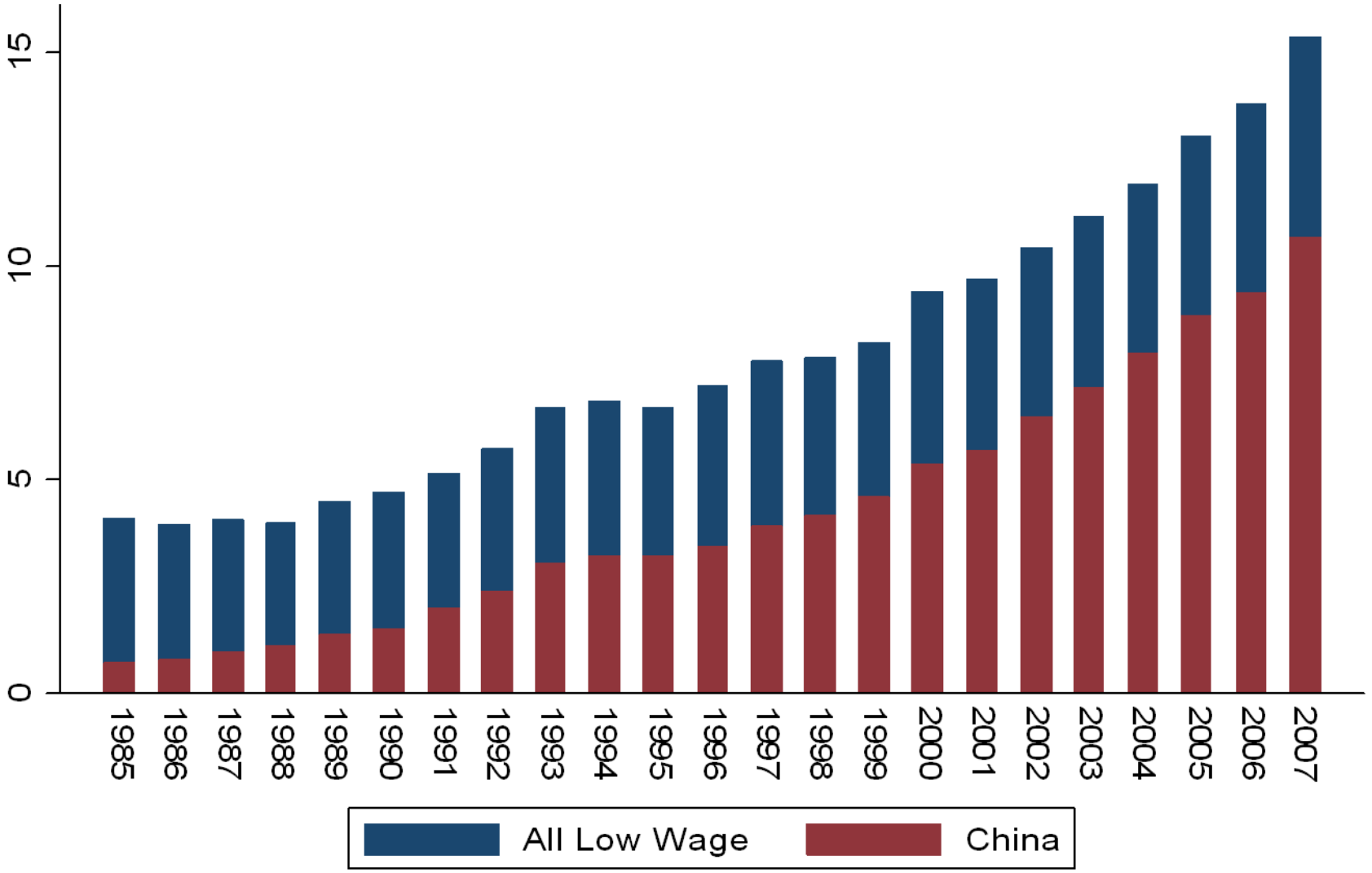
Dependent Variable:	**ΔIn(IT/N)**	**ΔPATENTS**	**ΔIn(N)**	Survival
Change in Chinese Imports (over apparent consumption)	0.169* (0.089)		-0.759*** (0.124)	-0.191*** (0.063)
Change Chinese Imports (t-4)		0.555*** (0.168)		
Change Chinese Imports*IT (t-5)			0.631*** (0.198)	
Change Chinese Imports* Lowest Quintile IT (t-5)				-0.333** (0.140)
$(IT/N)_{t-5}$			0.241*** (0.011)	
Lowest quintile of IT (t-5)				-0.013* (0.006)
Observations	31,225	7,130	31,225	24,495

China imports as an example of a low wage country import shock

What about imports from other low-wage countries – e.g. India, Vietnam or Indonesia?

What about imports from high-wage countries?

China accounts for most low-wage import growth in Europe and the US



Low wage countries list taken from Bernard, Jensen and Schott (2006).
Defined as countries <5% GDP/capita relative to the US 1972-2001.

Table 10A: Low wage imports similar effect to China, high wage imports appear to have no effect

Dependent var:	Δln(IT/N)				
Change in Chinese Imports	0.053**	0.048*		0.050*	0.047*
	(0.024)	(0.026)		(0.026)	(0.027)
Change in Non-China Low Wage Imports		0.028			
		(0.042)			
Change in All Low Wage country Imports			0.051**		
			(0.023)		
Change in High Wage Country Imports				0.004	
				(0.009)	
Change in World Imports					0.005
					(0.009)
Observations	31,820	31,820	31,820	31,820	31,820

Low wage countries list taken from Bernard et al (2006). Defined as countries <5% GDP/capita relative to the US 1972-2001.
Chinese imports normalized by domestic production

What about offshoring?

Is effect all driven by firms offshoring low value inputs to China?

Investigate this by generating a Chinese offshoring proxy (based on Feenstra-Hansen, 1999)

- Weight Chinese imports/apparent consumption by SIC 4-digit input-output tables (US 2002 tables)
- Proxies how much Chinese imports are increasing for each industry averaged across its sourcing industries

Find some offshoring effects for IT, nothing for patents

Table 11: OFFSHORING

Approach	**Long Differences**		
Dependent Variable	**ΔIn(IT/N)**	**ΔIn(IT/N)**	**ΔPATENTS**
Change in Chinese Imports	0.364***	0.220***	
	(0.090)	(0.082)	
Change in Chinese Imports	0.865	-0.021	
in source industries	(0.569)	(0.501)	
Change in employment		-0.617***	
		(0.010)	
Level of Chinese Imports (t-3)			0.371**
			(0.195)
Level of Chinese Imports			-0.760
in source industries (t-3)			(1.089)
Observations	28,231	28,231	30,608

Note: We also find bigger jobs shakeout for firms who have branches in China

Industry Switching

- Do trade effects we identify on IT operate through changing product mix (e.g. Dropping older varieties?)
- Bernard et al (2007, 2009) and Goldberg et al (2008a,b)
- Defined using Harte Hanks as primary four digit industry code changed (11% did so over 5 year period)
- Evidence for industry switching response to China which raises IT, but only a small fraction of trade effect

Table 12: INDUSTRY SWITCHING

Dependent variable	Plant Switches Industry	Plant Switches Industry	ΔIn(IT/N)	ΔIn(IT/N)	ΔIn(IT/N)
ΔChinese Imports	0.138*** (0.050)	0.131*** (0.050)		0.247*** (0.081)	0.244*** (0.081)
IT intensity (t-5)		-0.018** (0.008)			
Switched Industry			0.025*** (0.012)		0.018* (0.011)
Employment growth		-0.002 (0.006)		-0.619*** (0.011)	-0.619*** (0.011)
Observations	32,917	32,917	32,917	32,917	32,917

"Switched Industry" is a dummy if a plant switched its main four digit industry over a five Year period. SE clustered by country*industry pair. 2000-2007.

Productivity and Trade

- Use TFP growth instead of measures of technology
- Results consistent with technical change equations
- Magnitudes (similar within and between effect) like patents

Tab 13: Productivity and Trade

Estimation technique	**OLS**	**OLS**	**OLS**
Method of calculating TFP	**Olley Pakes**	**Olley Pakes**	**Olley Pakes**
Dependent Variable:	**TFP growth**	**Δln(N)**	**SURVIVAL**
Change in Chinese	0.280**	-0.485***	-0.206***
Imports share	(0.296)	(0.131)	(0.070)
lnTFP (t-5)* Change in		1.697***	
Chinese Imports share		(0.644)	
lnTFP(t-5)		0.232***	
		(0.023)	
Bottom quintile of TFP (t-5)*			-0.166**
Change Chinese Imports			(0.068)
Bottom quintile of TFP (t-5)*			-0.014***
			(0.004)
Observations	293,447	293,447	293,447

SE clustered by industry-country pair (405 cells), 1996-2006. 4 countries

R&D and Trade

- For publicly quoted firms can get R&D data (private firms do not usually report R&D)
- Use panel of all 459 European firms which report R&D over 5+ years
- Find similar positive effects of Chinese trade on R&D

R&D and Trade

Dependent Variable (in 5-year differences):	**dlog(R&D)**	**dlog(R&D/Sales)**	**dlog(Sales)**
Change in Chinese imports share	1.213**	1.808***	-0.955
	(0.549)	(0.304)	(0.726)
Change in Chinese imports * Log(R&D stock/sales)(t-5)			1.619
			(1.705)
Log(R&D stock/sales)(t-5)			0.150**
			(0.031)
Country by year controls	Yes	Yes	Yes
Observations	1,626	1,626	1,626

SE clustered by industry-country pair (71 cells), 2001-2007

Robustness: The lawyer effect? Is the increase in patents "defensive"?

Maybe firms just patenting more to protect intellectual property?

So investigate this in three ways:

- R&D – seem to be spending more on innovation
- Cites/patents – should drop if more marginal ideas patented
- Timing of patents – if this is simply a legal response should happen immediately (or in advance), while it is an innovation response more likely to be lagged

Tab A1: Cites/Patents unaffected by Chinese imports – so no evidence patent quality falling

Dependent variable	Cites/ Patent	Cites/ Patent	Cites/ Patent	Ln(1+Cites/ Patent)
	OLS	OLS	OLS	OLS
Growth in Chinese Imports	0.090	0.023	0.082	0.025
	(0.242)	(0.843)	(0.242)	(0.115)
Log (Patents)			0.021***	
			(0.007)	
4 digit industry controls	Yes	n/a	n/a	n/a
Firm fixed effects	No	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes
Observations	21,273	21,273	21,273	21,273

SE are clustered by industry-country pair

Table A2: Dynamics: Patent effect largest at long lags

Dependent Variable	$\Delta \ln(1+PAT)$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-5}$	0.418***					
5-year lag of Change in Chinese Imports	(0.119)					
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-4}$		0.375***				
4-year lag		(0.099)				
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-3}$			0.349***			
3-year lag			(0.088)			
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-2}$				0.243***		
2-year lag				(0.075)		
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-1}$					0.176***	
1-year lag					(0.065)	
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)$						0.138*
Contemporaneous change						(0.072)
Country Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Site-Type Controls	n/a	n/a	n/a	n/a	n/a	n/a
Observations	21,560	26,663	30,592	32,076	32,079	32,081

Table A2: Employment effects largest at short lags

Dependent Variable	$\Delta \ln N$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-5}$	0.137					
5-year lag of Change in Chinese Imports	(0.161)					
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-4}$		-0.011				
4-year lag		(0.125)				
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-3}$			-0.179			
3-year lag			(0.131)			
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-2}$				-0.242**		
2-year lag				(0.125)		
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-1}$					-0.215**	
1-year lag					(0.107)	
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)$						-0.211*
Contemporaneous change						(0.112)
Country Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Site-Type Controls	n/a	n/a	n/a	n/a	n/a	n/a
Observations	13,764	17,300	20,236	21,314	21,314	21,315

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, and rising over time
- Other low-wage countries trade similar effect, but high-wage countries trade appears to have no effect

Next Steps

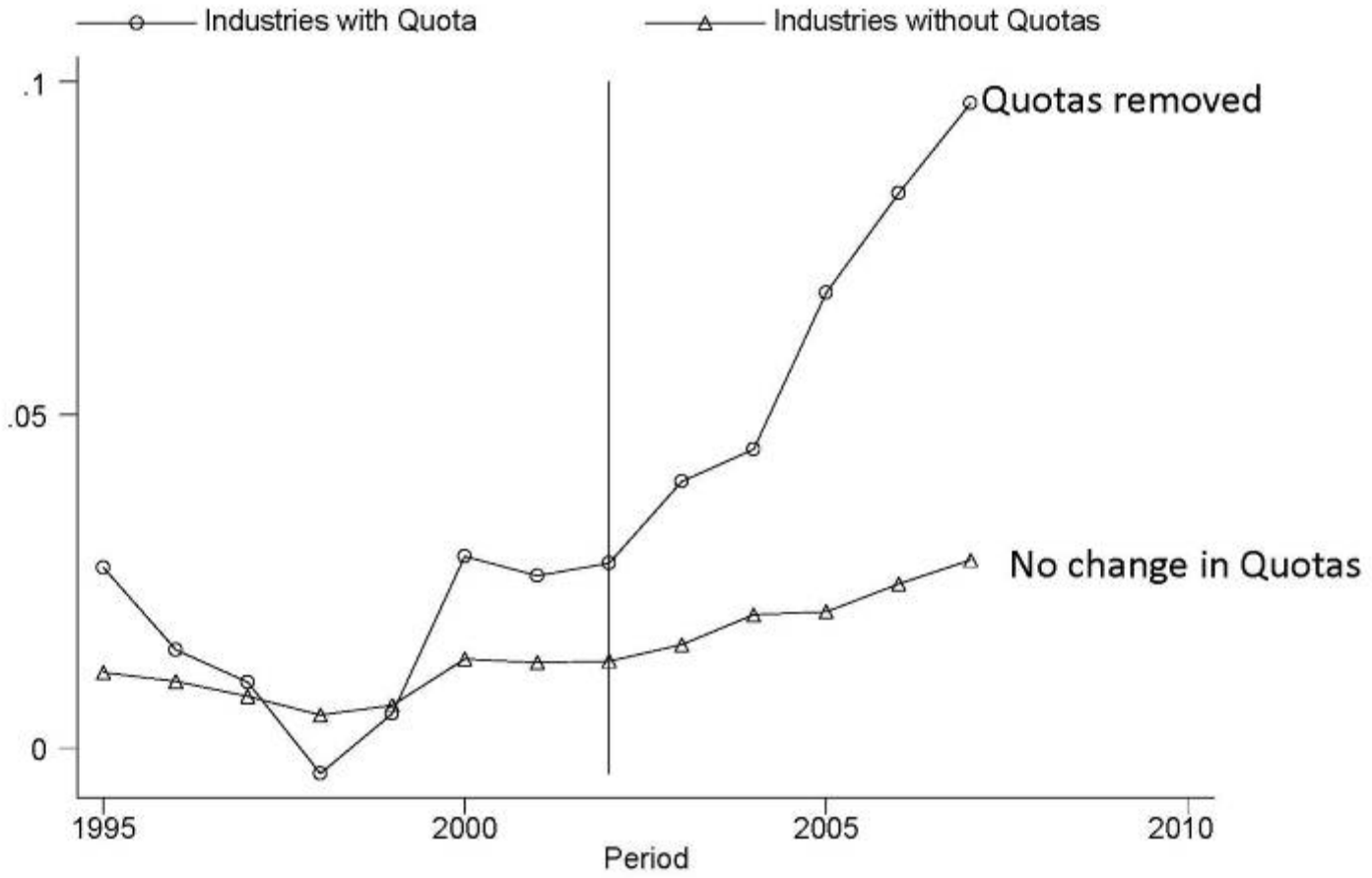
- Entry (use recent years when coverage best)
- Skills (from European Census data sets)
- FDI to China (from ORBIS data)
- Heterogeneity by industry

Back Up

Table A4: Controlling for skills and fixed capital

Dependent Variable	**Δln(IT/N)**			
Change in Chinese Imports	0.401***	0.222***	0.222**	0.235***
	(0.100)	(0.084)	(0.084)	(0.080)
Change in industry wages	0.194**	0.111		
	(0.099)	(0.084)		
Change in industry capital/employee				0.029
				(0.046)
Change in employment		-0.659***	-0.622***	-0.619***
		(0.031)	(0.016)	(0.035)
Observations	7,578	7,578	7,578	6,782

Growth of Chinese import share has been greater post WTO for industries that had Quotas against Chinese textiles and apparel imports



Notes: the lines show the five yearly growth in Chinese imports to EU as a proportion Of all imports for 4 digit industries with quotas (prior to China's entry to WTO) and Industries without quotas. Textile and Clothing industry only

Offshoring via FDI: job falls from Chinese imports more likely when firm has existing subsidiary in China

Dependent Variable	ΔIn(N)	ΔIn(N)
Change in Chinese imports	-0.330***	-0.329***
	(0.110)	(0.106)
% Global employment in China (t-5)* Change in Chinese imports	-2.679**	-2.421**
	(1.088)	(1.065)
Multinational * Change in Chinese Imports		-0.121
		(0.203)
IT intensity (t-5)* Change in Chinese imports	0.269	0.293*
	(0.164)	(0.171)
IT intensity (t-5)	0.240***	0.244***
	(0.011)	(0.011)
% Global employment in China (t-5)	0.079	0.121
	(0.073)	(0.072)
Multinational		-0.029**
		(0.009)
Observations	32,250	32,250

Notes: % global employment in China estimated from Amadeus ownership Structure. all standard controls included, SE clustered by SIC4*country

Output Quotas rather than Input Quotas matter most

Dependent Var.	ΔIn(IT/N)	ΔIn(IT/N)	Means
Method	Reduced Form	Reduced Form	(standard dev)
Output Quota	1.284***	0.133***	0.094
Removal	(0.172)	(0.045)	(0.232)
Input Quota		0.311	0.031
Removal		(0.342)	(0.041)
Observations	2,891	2,891	

Notes: Input quotas are calculated using the Feenstra-Hansen method but using quotas instead of import flows. 489 SIC4 clusters.

An example establishment: Rolls Royce Power Engineering

Survey Date: 24/08/04, Zip: L30 4UZ

Class Description	Manufacturer	Series	Group	Model	Quanity
PCs	DELL	PC	P3-DESK	P3-DESK	150
PCs	COMPAQ	PC	P3-DESK	P3-DESK	110
PCs	DELL	PC	P3-PORT	P3-PORT	30
SERVERS	IBM	RS/6000	RS/6000-5XX	RS/6000-5XX	1
SERVERS	COMPAQ	SERVER	SERVER	SERVER	1
SERVERS	COMPAQ	WORKSTATION	WORKSTATION	ALPHASTATION	8
NETWORKING	CABLE&WIRE	FRAME-RELAY	FRAME-RELAY	FRAME-RELAY	1
NETWORKING	WAN-CONNECT	WAN	WAN	INTERNATIONA	4
NETWORKING	WAN-CONNECT	WAN	WAN	TOTAL	6
PROGRAMMES	MICROSOFT	BROWSER	BROWSER	EXPLORER	3
PROGRAMMES	SAP	ERP	ERP	ERP	1
PROGRAMMES	MCAFEE	SYS-UTILITY	ANTI-VIRUS	TVD	1
PROGRAMMES	MICROSOFT	OFFICE	SUITES	OFFICE-97	1
PROGRAMMES	MACROMEDIA	APPL-DEVELOP	WEB-DESIGN	DREAMWEAVER	1
PROGRAMMES	ORACLE	DATA-MGMT	DBMS	ORACLE	1
PROGRAMMES	MICROSOFT	OFFICE	E-MAIL	OUTLOOK	1
PROGRAMMES	MICROSOFT	GEN-BUSINESS	PROJECT-MGMT	PROJECT	1
PROGRAMMES	MICROSOFT	DATA-MGMT	DBMS	ACCESS	1
PROGRAMMES	MICROSOFT	APPL-DEVELOP	INTG-APP/DEV	VISUALBASIC	1
PROGRAMMES	MICROSOFT	DATA-MGMT	DBMS	SQL-SERVER	1

Table A5: Exporting to China does not seem to have an effect

Dependent Variable	Δln(IT/N)	ΔPATENTS	Δln(N)	Survival
Change in Chinese Imports	0.196***		-0.380***	-0.179**
	(0.068)		(0.105)	(0.074)
Change in Chinese Imports (t-5)		0.349***		
		(0.100)		
Change Chinese Imports			0.385**	0.075
*(IT/N) at (t-5)			(0.157)	(0.116)
Change in Exports to China	0.028		-0.059	0.015
	(0.098)		(0.096)	(0.069)
Change in Exports to China, (t-5)		-0.085		
		(0.158)		
Number of Observations	37,500	21,560	37,500	28,624