Trade Induced Technical Change?

The Impact of Chinese Imports on Innovation, Diffusion and Productivity

Nick Bloom, Mirko Draca and John Van Reenen

Austrian Central Bank, October 2012

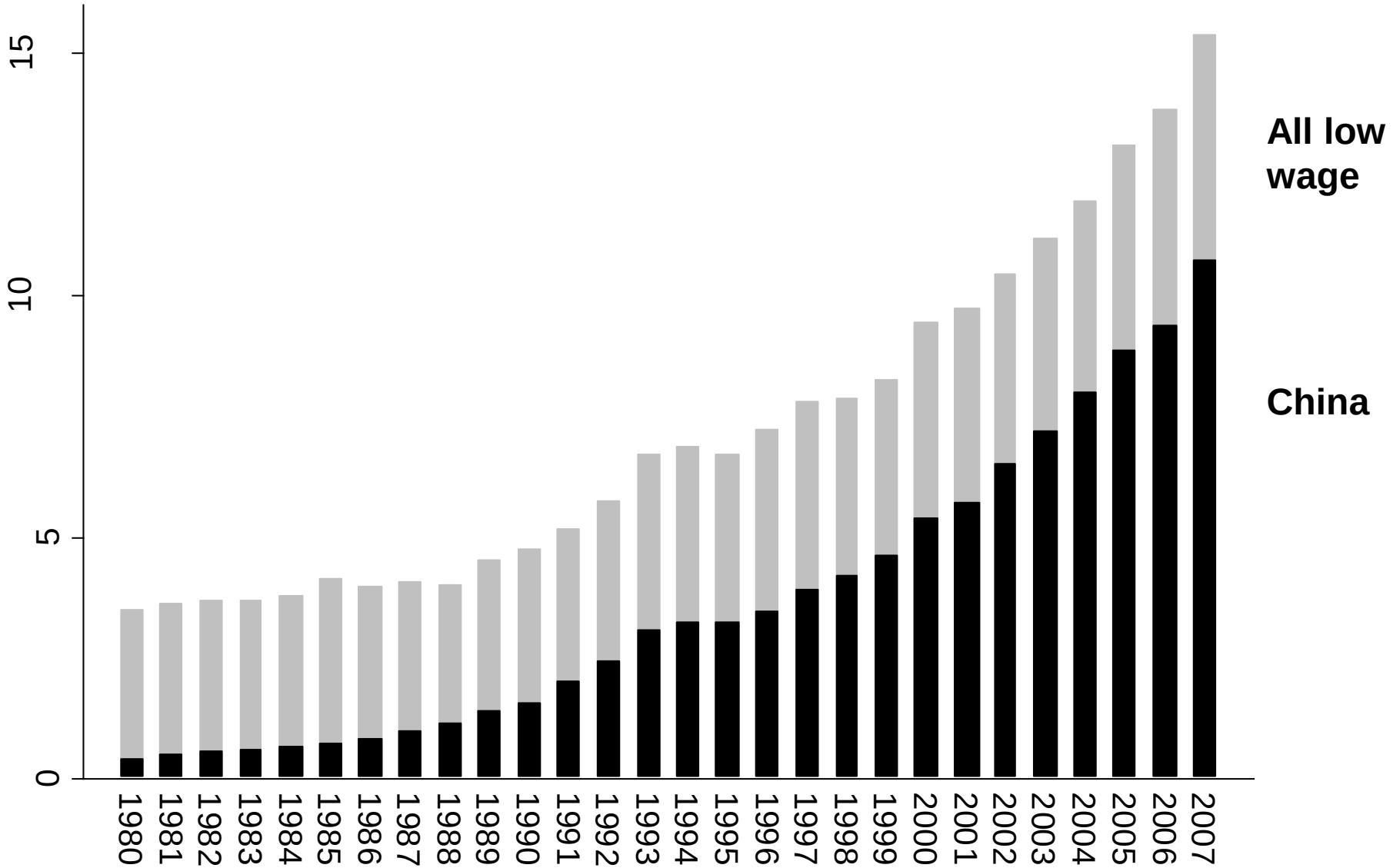
What is the impact of Southern trade on Northern technical change?

- Little empirical evidence, partly from limited micro data and partly due to a lack of North-South trade natural experiments

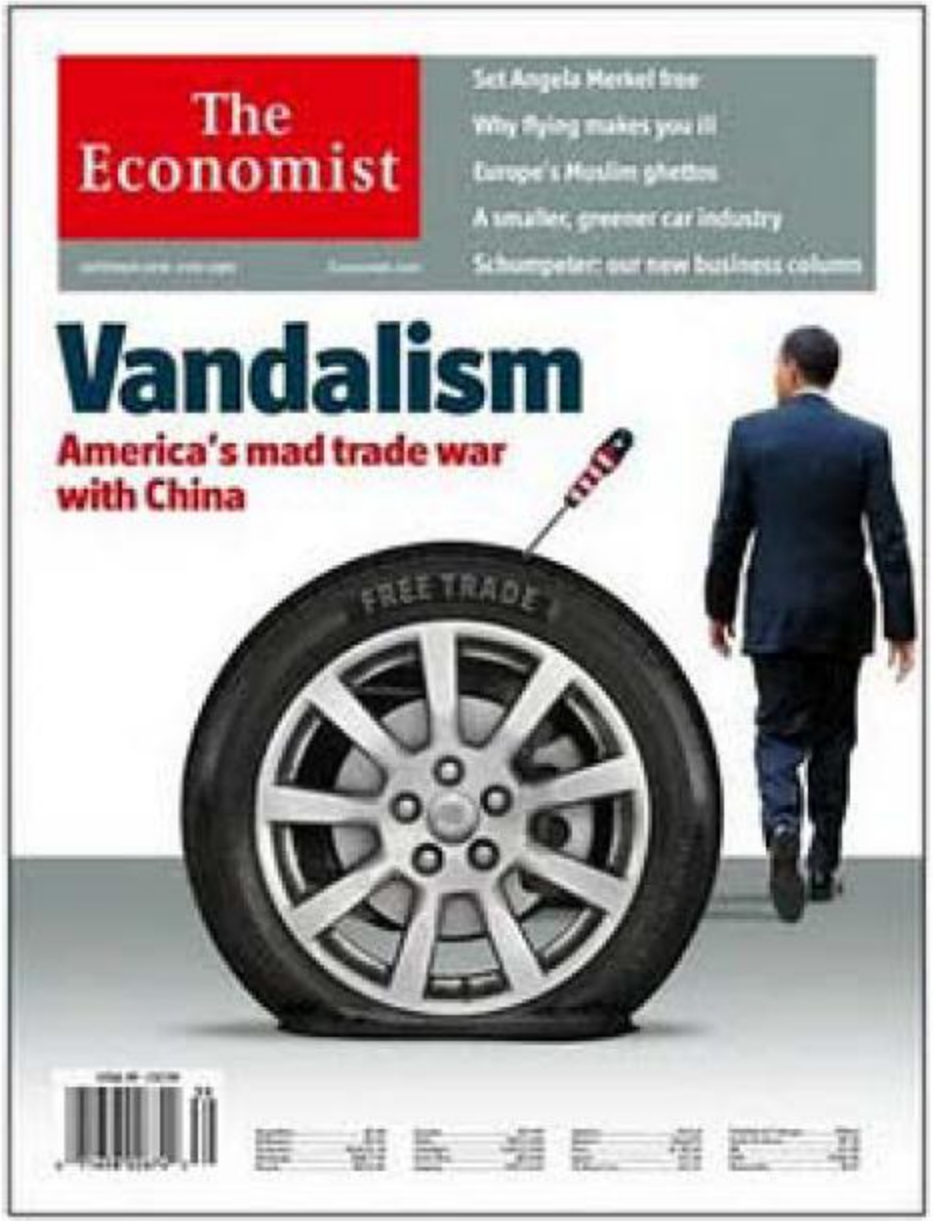
- Theoretical literature also ambiguous because of the ambiguous effects of competition on innovation and adoption

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

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.



Clear political importance – for example tires trade war in 2010

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Trade and the campaign

Chasing the anti-China vote

Sep 19th 2012, 20:33 by The Economist online

THERE was nothing subtle about the American government's lodging of a trade complaint on September 17th, alleging that China unfairly subsidises car-part exports on the same day that Barack Obama was campaigning in the crucial swing state of Ohio—home to many car-part suppliers. But then subtlety does not win many elections.

The president duly trumpeted the lodging of the complaint with the World Trade

China trade complaint last month

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 and R&D), IT and productivity (TFP and management scores)

B) Reallocation of jobs to higher tech/TFP establishments

So aggregate technological and TFP 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% of increase in IT, patents & productivity 2000-2007

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

Caveat: Our analysis is partial equilibrium

Recent ‘case-studies’ illustrate our results

Freeman and Kleiner (2005) look at a large US shoe maker’s response to increasing low wage country competition

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

Bugamelli, Schivardi & Zizza (2008) Italian manufacturers

All find very similar changes:

- Increased innovation to develop new product ranges
- Investment in IT, worker skills and management practices

Quick theory overview: 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, Khandewal, Pavcnik and Topalova (2008) & offshoring (e.g. Feenstra and Hanson, 1999)

Innovation – e.g. brand new products

- Market size and competition: e.g. Grossman & Helpman, 1992; Aghion, Bloom, Blundell, Griffith and Howitt 2005
- Directed innovation: e.g. Wood, 1994, Acemoglu, 1999, 2002; Thoenig and Verdier, 2003.

‘Trapped-Factor’ Innovation after low wage country trade (Bloom, Romer, Terry & Van Reenen, 2012)

- **Idea**: Chinese imports replace domestic products and therefore reduces opportunity cost of innovating
- Trapped factors (e.g. firm-specific skilled) 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
  - 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

- Focus on computers per worker as consistent across time and countries, but robustness to other measures like ERP

Innovation and Productivity data: firm panel

- European Patent Office data (**patents** and citations) matched to AMADEUS population of public and private firms (living & dead). Use 12 European nations (including **Austria**)

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

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

- Have 1,576 firms with **management** data, 2004 to 2010

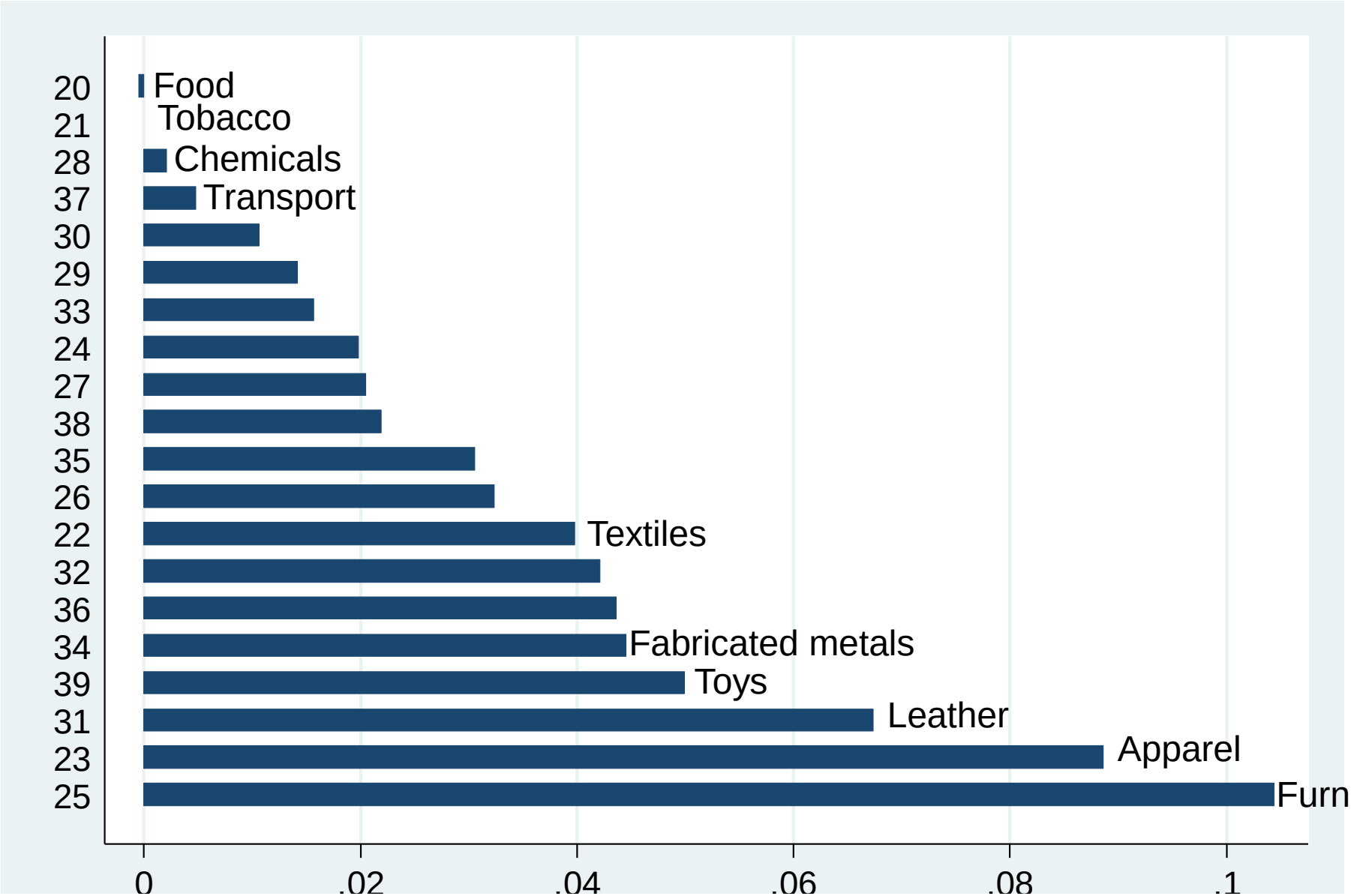
Trade data: UN Comtrade

- Trade data at 6-digit level product matched to 4-digit SIC 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
  - Chinese imports/apparent consumption
  - Chinese imports/production

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

Extensions & Robustness

Basic Technology Equation

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

patents, IT, R&D, TFP, management

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

Cluster at industry-by-country (jk)

Some econometric Issues

- 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 in 2002 and 2005
  - **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: worst case lower bounds & OP selection equations

Tab 1: Within Firm OLS Results

	(1) Δln(Patents)	(2) Δln(IT/N)	(3) Δln(R&D)	(4) ΔTFP	(5) Δmanagement
Method	5 year diffs	5 year diffs	5 year diffs	5 year diffs	3 year diffs
Change in Chinese Imports	0.321*** (0.102)	0.361** (0.076)	1.213** (0.549)	0.257*** (0.072)	0.814*** (0.314)
Sample period	2005-1996	2007-2000	2007-1996	2005-1996	2002-2010
# units	8,480	22,957	459	89,369	1,576
# industry clusters	1,578	2,816	196	1,210	579
Obs	30,277	37,500	1,626	292,167	3,607

Notes: SE clustered by industry-country, Country-year dummies included. Estimate TFP separately by industry (on 1.4m obs). Use Olley-Pakes (1996)/de Loecker (2007). Management data from Bloom and Van Reenen (2010), management mean (std dev.) is 3.09 (0.59). Because of short-panel run regressions in 3-year diffs.

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 in 2005 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

Example of SIC4 industry coding 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

Share of SIC4 on quota under MFA –almost random variation making this a great instrument)

ussic 4-digit	% industry covered by quotas (all stages) Mean	Freq.	
2211	.77447796	210	(BROADWOWEN FABRIC, COTTON)
2221	.23278008	63	(BROADWOWEN FABRIC, SILK)
2231	.02347782	134	(BROADWOWEN FABRIC, WOOL)
2321	.86472106	32	(MEN'S AND BOYS' SHIRTS)
2322	1	22	(MEN'S AND BOYS' UNDERWEAR)
2323	.78554922	26	(MEN'S AND BOYS' NECKWEAR)
2325	.05432023	10	(MEN'S AND BOYS' TROUSERS)
2329	.74802500	12	(MEN'S AND BOYS' CLOTHING NEC)
2337	.48232245	137	(WOMEN'S AND GIRLS SKIRTS)
2339	0	22	(WOMEN'S AND GIRLS CLOTHING NEC)

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

	ΔIn(IT/N)	**ΔChinese Imports**	**ΔIn(IT/N)**
Method	**OLS**	**First Stage**	**IV**
ΔChinese Imports	1.284*** (0.172)		1.851*** (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.
All columns using just textiles and apparel sample

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

	ΔPATENTS	ΔPATENTS	Δln(TFP)	Δln(TFP)
Method	**OLS**	**IV**	**OLS**	**IV**
ΔChinese Imports			0.620***	1.897**
			(0.100)	(0.806)
ΔChinese Imports	1.160***	1.864*		
	(0.377)	(1.001)		
Sample period	2005-1996	2005-1996	2005-1999	2005-1999
Units	1,866	1,866	55,791	55,791
Industry clusters	149	149	187	187
Observations	3,443	3,443	55,791	55,791

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

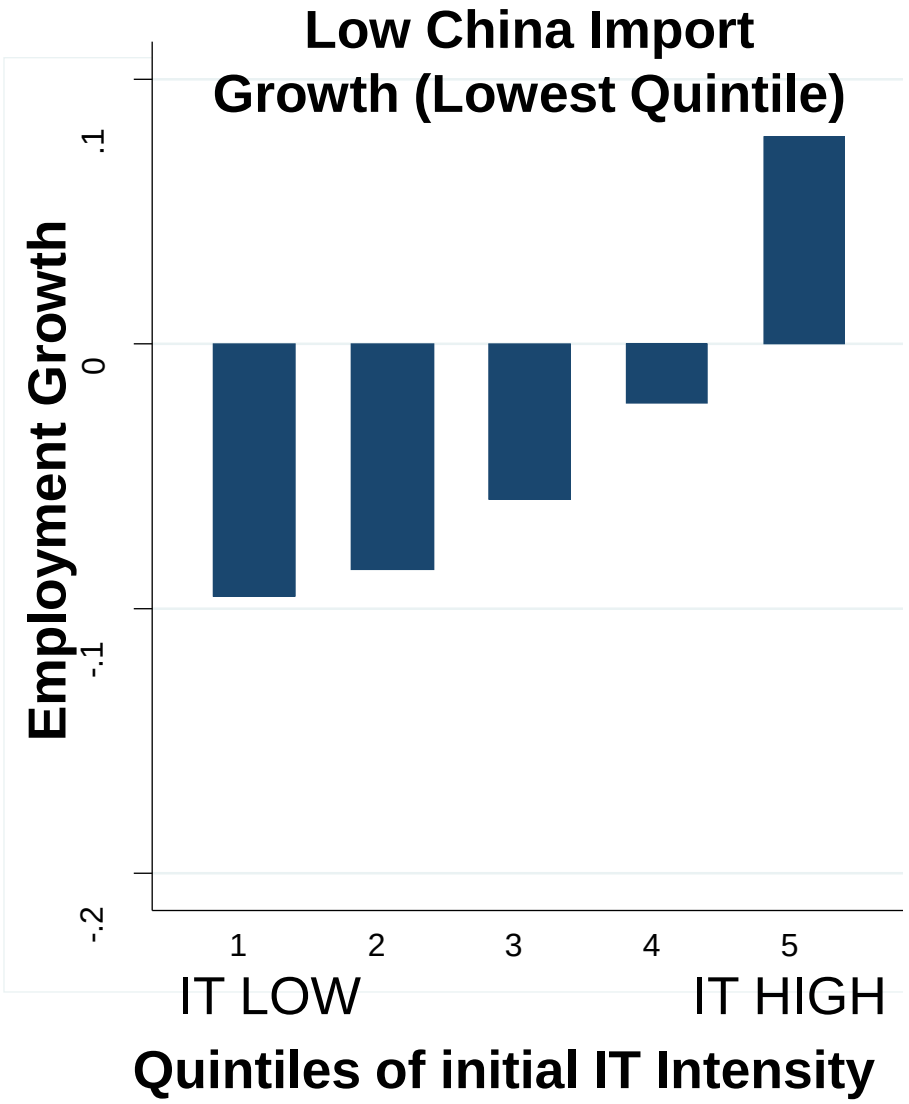


Table 3A: Innovating firms shed less jobs when faced with rising Chinese imports

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 $\gamma^s > 0$

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

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

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 within, between and exit effects

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

So how big are these magnitudes?

Aggregate effect of trade on technology, 2000-2007, % 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

Industry level Regressions: coefficients are about double firm coefficients (consistent with combining firm-level within, between & exit effects)

Dependent Variable:	**ΔIn(PATENTS)**	**ΔIn(IT/N)**	**ΔIn(R&D)**	**ΔIn(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

Note: 5 year differences. Industry by country regressions

Data

Within plant/firm effects

Reallocation effects between plants/firms

Extensions & Robustness

Extensions & Robustness

- **Extensions**
  - Dynamic selection issues
  - Other low wage countries (yes, similar to China)
  - Lawyer effects on patents (find no evidence for this)
  - Offshoring (find some effect on IT and TFP)
  - “I-Pod” story (firms innovate here to produce in China)

Dynamic Selection: Worst Case Lower Bounds

	(1)	(2)	(3)	(4)
Dependent Variable:	**PATENTS**	**PATENTS**	**Δ(IT/N)**	**Δ(IT/N)**
Estimating Method:	**FE NEGBIN**	**FE NEGBIN**	**OLS**	**OLS**
	Baseline	**Worst case Lower Bound**	**Baseline**	**Worst case Lower Bound**
Change in Chinese Imports	0.321***	0.271***	0.397***	0.389***
	(0.102)	(0.098)	(0.168)	(0.165)
Number of units	8,480	8,732	8,480	8,732
Number of clusters	1,578	1,662	1,578	1,662
Observations	30,277	31,272	74,038	75,463

Is there something about China?
No, similar to all low-wage countries

Dependent variable:	ΔIn(IT Intensity)			
Change in Chinese Imports	0.129*** (0.028)	0.126*** (0.029)		0.128*** (0.028)
Change in Non-China Low Wage Imports		0.018 (0.051)		
Change in All Low Wage country Imports			0.127*** (0.025)	
Change in High Wage Country Imports				0.002 (0.009)
Change in World Imports				
Observations	29,062	29,062	29,062	29,062

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

The lawyer effect?

Maybe firms just patenting more after Chinese import surge 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. We find the opposite
- 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 (which is what we find)

What about offshoring instead?

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

Table 9: OFFSHORING

Dependent Variable	ΔPATENTS	Δln(IT/N)	ΔTFP
Change in Chinese Imports	0.313***	0.279***	0.189***
	(0.100)	(0.080)	(0.082)
Change in Chinese Imports	0.173	1.685***	1.396***
in source industries	(0.822)	(0.517)	(0.504)
Observations	30,277	37,500	30,608

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

All the "IPod effect"?
No, imports seem to reduce industry profits

Dependent Variable:	**ΔIn(Employment)**	**ΔIn(EU Producer Prices)**	**ΔIn(Profits /Sales)**
Change in Chinese Imports	-0.411*** (0.133)	-0.453** (0.217)	-0.112** (0.052)
Observations	8,788	259	5,372
Industry-country pairs	1,913	131	2,295
Aggregation	SIC4	SIC2	SIC4
Years	2005-1996	2006-1996	2007-2000

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

Table 8 Heterogeneity: Chinese Import effects larger when more "trapped factors"

	ΔPATENT	ΔPATENT
Change in Chinese imports	0.202**	-2.466***
	(0.092)	(0.848)
Change in Chinese imports*TFP intensity (t-5)		1.464***
		(0.462)
Change in Chinese imports*Industry Wage premia	2.467**	
	(1.171)	
Number of Observations	14,500	14,500

Notes: Regression includes all standard controls including level of lagged TFP. TFP calculated using the de Loecker (2007) version of Olley-Pakes

Conclusions

Empirics

- Find trade-induced increases in innovation, IT and TFP
- Occurs *within* and *between* plants and firms
- Relatively large and growing: China “accounts” for ~15% of increase in aggregate European IT, patents and TFP
- Other low-wage countries trade similar effect, but high-wage countries trade appears to have no effect

Story/Model

- Trapped-factors seems to be best fit
  - firms have trapped factors, so innovate new products to escape competition from China
  - Another argument in favour of free-trade with emerging nations

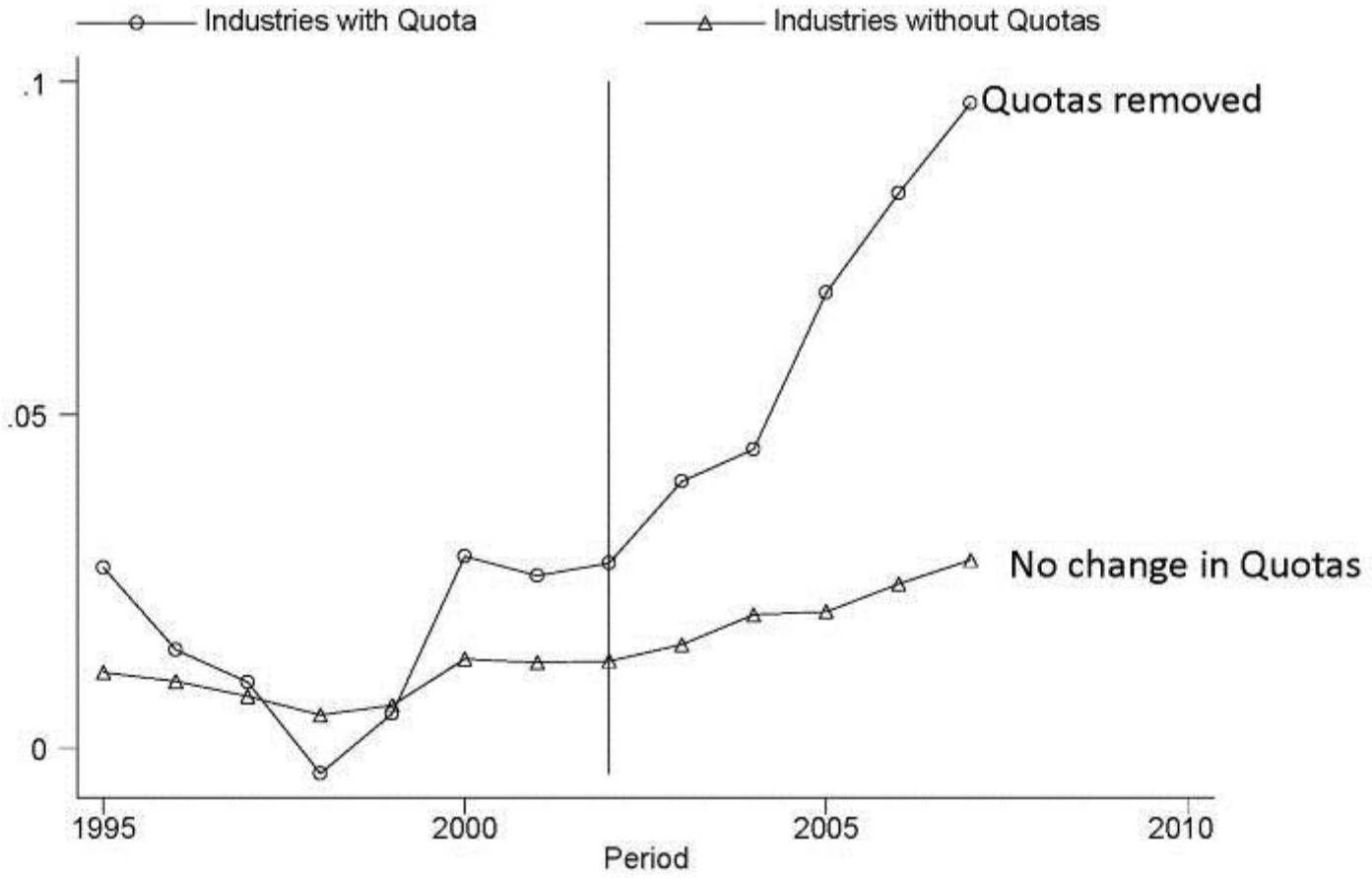
Back Up

Tab A9 The quota IV is uncorrelated with the growth in Chinese Imports prior to WTO accession

Dependent Variable	5 year Growth in Share of Chinese imports		
Quota Removal*Post WTO		0.042***	0.039***
		(0.010)	(0.010)
Quota Removal	0.036***	0.009	
	(0.008)	(0.008)	
Country by Year Effects	Yes	Yes	Yes
Country by industry trends	No	No	Yes
Number of clusters	84	84	84
Observations	11,138	11,138	11,138

Notes: SIC4 * country panel 1990 - 2007. Textiles and clothing industries only. Quota removal = height of the quota in the four digit industry in 2000. “Post WTO” = 1 after 2001 Estimation by OLS with standard errors clustered by four digit industry in parentheses.

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

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 10: INDUSTRY SWITCHING

Dependent variable	Plant Switches Industry	Plant Switches Industry	ΔIn(IT/N)	ΔIn(IT/N)
ΔChinese Imports	0.138*** (0.050)	0.131*** (0.050)		0.466*** (0.083)
IT intensity (t-5)		-0.018** (0.008)		
Switched Industry			0.025** (0.012)	0.023* (0.012)
Employment growth		-0.002 (0.006)		
Observations	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.

Table A5 Results on IT appear broadly robust to using other ICT diffusion measures

	Databases		ERP		Groupware	
Growth in Chinese Import Share	0.072		0.040		0.249***	
	(0.070)		(0.034)		(0.083)	
Highest Quintile Growth in Chinese Import Share		0.020**		0.013***		0.034**
		(0.010)		(0.005)		(0.014)
Quintile 4		0.030**		0.006		0.021
		(0.010)		(0.005)		(0.013)
Quintile 3		0.043***		0.014***		-0.008
		(0.010)		(0.005)		(0.013)
Quintile 2		0.024***		0.010**		-0.018
		(0.011)		(0.005)		(0.013)
Obs.	24,741	24,741	24,741	24,741	24,741	24,741

Note: All changes in long (5-year) differences. Includes country, year and site-type controls. All standard-errors clustered by country and SIC-4 cell

Summary Statistics: 12 Country Panel

	Computer Intensity	Employment	Number of Sites
Austria	0.50	352	1067
Denmark	0.69	148	510
Finland	0.59	173	677
France	0.55	243	2911
Germany	0.52	435	3679
Ireland	0.63	196	350
Italy	0.55	222	2630
Norway	0.72	131	362
Spain	0.49	175	1018
Sweden	0.60	161	1168
Switzerland	0.60	179	1346
United Kingdom	0.64	270	3567

Output Quotas rather than Input Quotas matter most

Dependent Var.	Δln(IT/N)	Δln(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.

List of low wage countries

Albania	**Egypt**	**Madagascar**	**Rwanda**
Angola	**Equatorial Guinea**	**Malawi**	**Senegal**
Bangladesh	**Ethiopia**	**Mali**	**Sierra Leone**
Benin	**Gambia**	**Mauritania**	**Sri Lanka**
Bolivia	**Ghana**	**Mongolia**	**Sudan**
Burkina Faso	**Guinea**	**Morocco**	**Suriname**
Burundi	**Guinea-Bissau**	**Mozambique**	**Syria**
Cambodia	**Guyana**	**Nepal**	**Tanzania**
Cameroon	**Haiti**	**Nicaragua**	**Togo**
Central African Rep	**Honduras**	**Niger**	**Uganda**
Chad	**India**	**Nigeria**	**Viet Nam**
China	**Indonesia**	**Pakistan**	**Yemen**
Comoros	**Ivory Coast**	**Papua New Guinea**	**Zambia**
Congo	**Lao People's Dem. Rep.**	**Philippines**	**Zimbabwe**
Djibouti			

Low wage countries list taken from Bernard, Jensen and Schott (2006). They defined these as countries with less than 5% average per capita GDP relative to the Unites States in the period between 1972-2001.

Table A2: China's Share of Global Imports - Top 10 Industries in 1999 (8/10 subsequently had faster than average growth in imports)

Industry Description	Industry	1999	2006	Change
1. Dolls and Stuffed Toys	3942	0.801	0.859	0.058
2. Drapery Hardware and Window Blinds and Shades	2591	0.526	0.545	0.019
3. Leather Gloves and Mittens	3151	0.505	0.593	0.088
4. Rubber and Plastics Footwear	3021	0.500	0.602	0.103
5. Women's Handbags and Purses	3171	0.456	0.515	0.059
6. Manufacturing Industries, NEC	3999	0.438	0.535	0.097
7. Luggage	3161	0.428	0.686	0.259
8. Personal Leather Goods	3172	0.406	0.451	0.045
9. Leather and Sheep-Lined Clothing	2386	0.399	0.490	0.092
10. Games, Toys, and Children's Vehicles, Exc. Dolls & bikes	3944	0.398	0.710	0.312
All Industries		0.054	0.108	0.054

Table 3C Include Industry time trends

Dependent Variable	Δln(PATENTS)		Δln(IT/N)		ΔTFP	
Change in Chinese Imports	0.321** (0.102)	0.145 (0.111)	0.195** (0.068)	0.177** (0.080)	0.262** (0.074)	0.232** (0.064)
SIC4 trends?	No	Yes	No	Yes	No	Yes
Sample period	2005-1996	2005-1996	2007-2000	2007-2000	2005-1996	2005-1996
#clusters	1,578	1,578	2,816	2,816	1,210	1,210
Observations	30,277	30,277	37,500	37,500	292,167	292,167

TAB A7: IV estimates of TFP using China joining WTO, pre-sample trends

Dependent Variable	ΔTFP	ΔTFP	ΔTFP	ΔTFP
	IV	**IV**	**IV**	**IV**
Δ Chinese Imports	1.897***	1.491***	1.608**	1.635***
	(0.806)	(0.264)	(0.410)	(0.313)
ΔTFP(t-5)			-0.211***	0.378***
			(0.024)	(0.063)
ΔChinese Imports(t-5)			-0.531	-0.450
			(0.602)	(0.423)
Endogenous RHS variables	Chinese Imports	Chinese Imports	Chinese Imports	Chinese Imports, ΔTFP(t-5)
Number of clusters	187	126	126	126
Observations	55,791	3,107	3,107	3,107

SE clustered by industry. Period is1996-2006.

Tab A3: Cites/Patents do not fall with Chinese imports –no evidence patent quality falling

Dependent variable	**ΔlnCITES** **OLS**	**Δln(CITES/ PATENT)** **OLS**
Growth in Chinese Imports	0.118 (0.081)	0.009 (0.029)
Observations	30,277	30,277

SE are clustered by 1578 industry-country pair, country-year dummies included

Tab 8 China also associated with skill upgrading (wage bill share of college educated in UK)

Sample	**All**	**All**	**All**	**Textiles & Apparel**	**Textiles & Apparel**
Method	**OLS**	**OLS**	**OLS**	**OLS**	**IV**
Change in Chinese Imports	0.144** (0.035)		0.099** (0.043)	0.166** (0.030)	0.277*** (0.053)
Change in IT intensity		0.081** (0.024)	0.050* (0.026)		
F-test of excluded IVs					9.21
Observations	204	204	204	48	48

SE are clustered by 74 SIC3 industries; 2006-1999, UK LFS data, IV is height of quota pre-WTO; all columns control for year dummies, regressions weighted by industry employment in 1999

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

Share of SIC4 on quota under MFA –almost random variation making this a great instrument)

ussic 4-digit	% industry covered by quotas (all stages) Mean	Freq.	
2211	.77447796	210	(BROADWOWEN FABRIC, COTTON)
2221	.23278008	63	(BROADWOWEN FABRIC, SILK)
2231	.02347782	134	(BROADWOWEN FABRIC, WOOL)
2321	.86472106	32	(MEN'S AND BOYS' SHIRTS)
2322	1	22	(MEN'S AND BOYS' UNDERWEAR)
2323	.78554922	26	(MEN'S AND BOYS' NECKWEAR)
2325	.05432023	10	(MEN'S AND BOYS' TROUSERS)
2329	.74802500	12	(MEN'S AND BOYS' CLOTHING NEC)
2337	.48232245	137	(WOMEN’S AND GIRLS SKIRTS)
2339	0	22	(WOMEN’S AND GIRLS CLOTHING NEC)

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:
   - Early exporting industries grew fastest as export growth 1989-05 mostly (94%) intensive margin (Schott, 2008)

3) 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	**ΔIn(PATS)**	**ΔIMP^{CH}**	**ΔIn(PATS)**	**ΔIn(IT/N)**	**ΔIn(IT/N)**
Method:	**OLS**	**1st Stage**	**IV**	**OLS**	**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***			
		(0.017)			
Sample period	2005-1996	2005-1996	2005-1996	2007-2000	2007-2000
Number of Units	8,480	8,480	8,480	22,957	22,957
Number of industry clusters	304	304	304	371	371
Observations	30,277	30,277	30,277	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**	**ΔTFP**
Method:	**OLS**	**IV**
Change in Chinese Imports	0.257***	0.507*
	(0.087)	(0.283)
Initial Chinese imports* US&EU Chinese import growth		
Sample period	2005-1996	2005-1996
Number of Units	89,369	89,369
Number of industry clusters	354	354
Observations	292,167	292,167

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

Dynamics: Patent effect largest at long lags

Dependent Variable	$\Delta \ln(1+PAT)$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-5}$ 5-year lag of Change in Chinese Imports	0.418*** (0.119)					
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-4}$ 4-year lag		0.375*** (0.099)				
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-3}$ 3-year lag			0.349*** (0.088)			
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-2}$ 2-year lag				0.243*** (0.075)		
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)_{t-1}$ 1-year lag					0.176*** (0.065)	
$\Delta\left(M_{jk}^{China} / M_{jk}^{World}\right)$ Contemporaneous change						0.138* (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

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

Is this just exporting to China?
No exporting does not seem to have strong effect

Dependent Variable	ΔIn(IT/N)	ΔPATENTS	ΔIn(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