Quality Differentiation and International Trade

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Topics in International Trade

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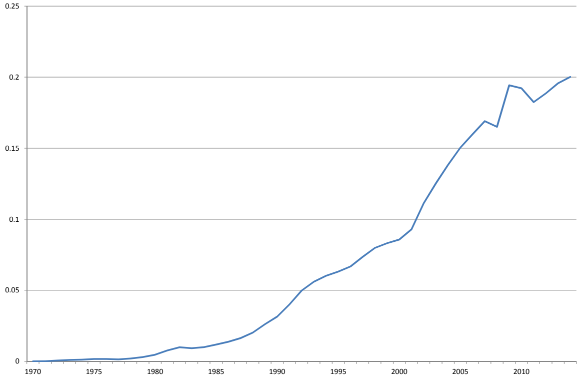
Motivation : The sophistication of Chinese exports

- China's (and other LWCs) exports have grown dramatically over the last three decades in large part due to its rapid penetration of new product markets
- China's exports overlap with the OECD is much greater than one would predict given its low wages
- China exports the same goods as other OECD countries to the same destinations, but at lower prices

$\Rightarrow$ Competition between China and the world's most developed economies may be less direct than their product-mix overlap implies, eg due to vertical differentiation

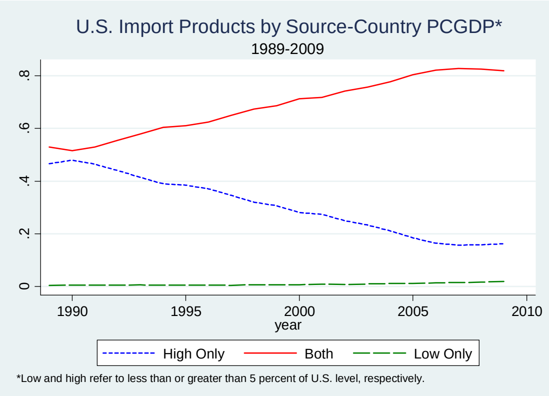
Motivation : Chinese penetration of the US market



Source : ComTrade. Share of China in US total imports

- Neo-classical interpretation : Specialization according to comparative advantages

Motivation : China's export overlap with developed countries



Source : Schott (2004)

- Contradicts the neoclassical view of international trade

Motivation : China's export overlap with developed countries

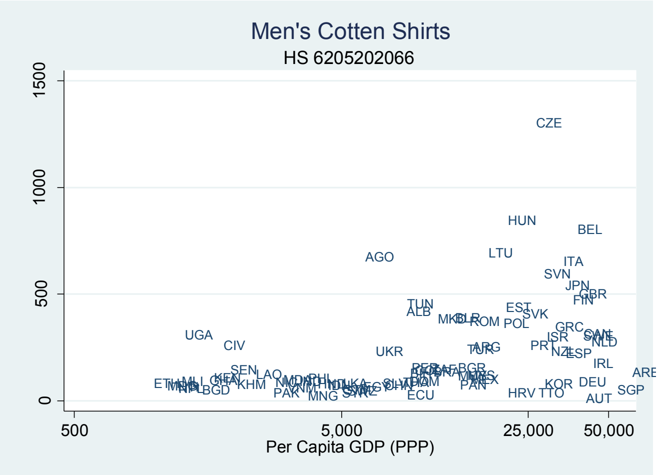
Countries' Export Similarity Index with the OECD

1972		1983		1994		2005	
Mexico	0.18	Mexico	0.20	Mexico	0.28	Korea	0.33
Brazil	0.15	Korea	0.18	Korea	0.25	Mexico	0.33
Taiwan	0.14	Taiwan	0.17	Taiwan	0.22	Taiwan	0.22
Israel	0.11	Israel	0.16	Brazil	0.19	China	0.21
Korea	0.11	Brazil	0.16	Hong Kong	0.17	Brazil	0.20
Argentina	0.11	Hong Kong	0.13	Singapore	0.16	Poland	0.17
Hong Kong	0.11	Singapore	0.13	China	0.15	Israel	0.17
Czech Rep	0.10	Argentina	0.09	Malaysia	0.15	India	0.16
Poland	0.10	Yugoslavia	0.09	Israel	0.14	Singapore	0.15
Yugoslavia	0.10	Hungary	0.08	Thailand	0.14	Hong Kong	0.15
Colombia	0.07	Poland	0.08	Argentina	0.09	Thailand	0.15
South Africa	0.07	Saudi Arabia	0.08	Poland	0.09	Argentina	0.13
Venezuela	0.06	China	0.08	India	0.09	Hungary	0.13
Singapore	0.06	South Africa	0.07	Philippines	0.08	Malaysia	0.11
Hungary	0.05	Neth Antilles	0.07	Venezuela	0.08	Indonesia	0.11
Romania	0.05	India	0.07	Hungary	0.07	Philippines	0.10
Cyprus	0.05	Philippines	0.07	Indonesia	0.07	South Africa	0.10
Gibraltar	0.05	Panama	0.06	South Africa	0.07	Panama	0.09
China	0.05	Thailand	0.06	Bermuda	0.06	Romania	0.08
India	0.05	Colombia	0.06	Colombia	0.06	Colombia	0.08

Source: Schott (2008). The ESI is from Finger and Kreinin (1979): $ESI_{cd} = \Sigma_p \min(s_{pc}, s_{pd})$, where s is the export share of product p in country c.

Notes : $ESI_{cd} = \sum_p min(share_{pc}, share_{pd})$ where $share_{pc}$ is the share of product p in country c's exports.

Motivation : Within-product relative prices



Source : Schott (2004)

Motivation : Within-product relative prices

TABLE V
Unit Values and Exporter Characteristics

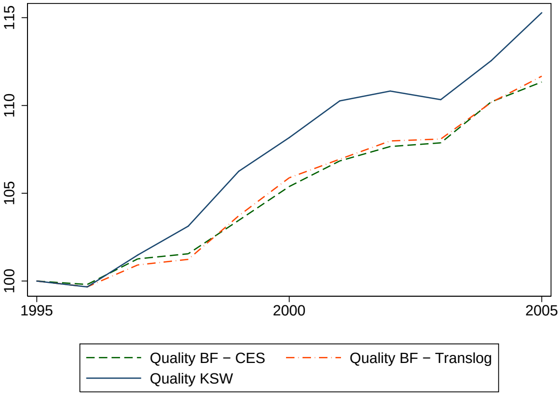
Regressor	Log Unit Value	Log Unit Value	Log Unit Value
Log PCGDP	0.134 ***		
	0.037		
Log Capital per Labor ($000)		0.435 ***	
		0.065	
Log Skill per Labor			0.501 **
			0.089
Product-Year Dummies	Yes	Yes	Yes
Product-Country-Year Observations	214,852	214,852	214,852
Number of Unique Products	12,024	12,024	12,024
Number of Unique Countries	48	48	48
R^2	0.77	0.78	0.77

Notes: This table reports OLS regression results of exporter unit value on real exporter PCGDP, real exporter capital per worker and exporter skill abundance across LMH products (see text). Sample restricted to available data across independent variables. GDP data are from the World Bank [2000]. Capital per labor ratios are from Penn World Tables 5.6; 1992 values are used for 1994. Education attainment data are from Barro and Lee [2000]; 1970 and 1995 data are used for 1972 and 1994, respectively. Robust standard errors adjusted for exporter clustering are noted below coefficients. Results for fixed effects are suppressed. ***, ** and * refer to statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Source : Schott (2004)

- Quality differentiation ?

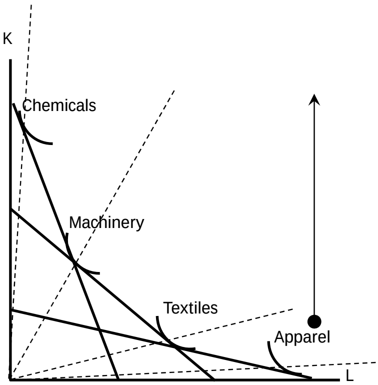
Motivation : Chinese competition and the quality of French exports



Source : Martin & Mejean (2014)

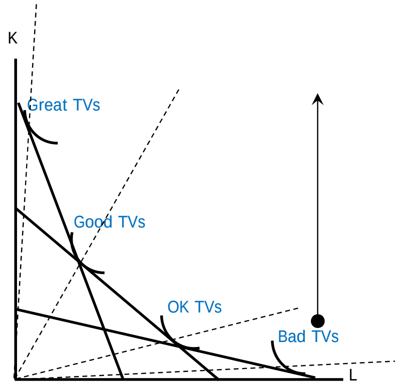
- Within-industry specialization along the quality dimension ?

Motivation : Across-industry specialization



Source : Schott (2004)

Motivation : Within-industry specialization



Source : Schott (2004)

Why Study Trade and Quality ?

Implications for :

- **Trade patterns**
  - Germany exports the same trade bundle as China to the US
  - Schott (QJE 2004), Hallak and Schott (QJE 2011) : systematic cross-country differences in exports quality
- **Labor market outcomes**
  - Quality upgrading and skill-biased technical change
  - Vertical differentiation influences the degree to which workers in developed economies are insulated from workers in developing countries
- **Sensitivity to price shocks**
  - Different effects of tariffs or exchange rate changes depending on the quality of products
  - Quality differences dampen price competition
- **Long term growth**
  - Export basket composition affects growth prospects (Hausmann, Hwang and Rodrik, JEG 2007)

How to measure quality ?

- Quality captures tangible and intangible product attributes valued by *all* consumers (vertical differentiation).
- How to measure it in trade data :
  - unit values (UV) in currency/ton or currency/unit $\frac{X_{pt}}{Q_{pt}}$, usually at HS10 level
  - Top down : inference from prices and market shares (Khandelwal RES 2010, Martin and Méjean JIE 2014), trade balances (Hallak and Schott 2011)
  - Bottom up : ISO certification (Verhoogen QJE 2008), industry quality ratings (Crozet et al. RES 2012)

Macro Evidence on Trade and Quality

- Schott (QJE 2004) : HOS trade patterns hold *within* products
  - Increases in capital-, skill-abundance and income/capita across countries and over time are associated with higher UVs.
  - Higher industry capital intensity is associated with higher UVs.
- Hummels and Skiba (AER 2004) : 'shipping good apples out'
  - Alchian and Allen (1964) : with per-unit transport costs, high-quality goods are more likely to be exported
  - average UVs are positively correlated with transport costs and distance
- Hallak (JIE 2006) : high-quality imports and importer GDP/capita
  - Linder (1961) : rich countries import more from other rich countries, because of comparative advantage in high-quality products due to greater local demand
  - rich countries import more from country-sectors with high UV indices, controlling for gravity factors.

Micro Evidence on Trade and Quality

- Manova and Zhang (QJE 2012) :
    - more successful Chinese exporters sell higher-quality outputs produced out of high-quality inputs
    - exporters vary the quality of their exports across destinations by varying input quality
- Hallak and Sivadasan (JIE 2013), Kugler and Verhoogen (RES 2012) : plant size and quality in Colombia, US, India
    - positive correlation between plant size and both input and output prices
    - *conditional on size*, exporters have higher quality, prices, input prices, wages, capital intensity

A Reinterpretation of Melitz' model

A Reappraisal of Melitz' model

- **Utility in country j**

$$U_j = \left[\int_{\omega \in \Omega_j} \left(b_j[\lambda(\omega)] q_j(\omega) \right)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

with $\lambda(\omega)$: quality ; $q_j(\omega)$: quantity ; $b_j'(\cdot) > 0$, $\sigma > 1$.
Horizontal *and* vertical differentiation

- **Demand**

$$q_j(\omega) = \frac{1}{b_j[\lambda(\omega)]} \left(\frac{\tilde{p}_j(\omega)}{P_j} \right)^{-\sigma} \frac{R_j}{P_j}$$

where $$\tilde{p}_j(\omega) = \frac{p_j(\omega)}{b_j[\lambda(\omega)]}$$

$$P_j = \left[\int_{\omega \in \Omega_j} \left(\frac{p_j(\omega)}{b_j[\lambda(\omega)]} \right)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$$

Conditional on prices, consumers demand more of varieties which they perceive as better quality

A Reappraisal of Melitz' model

- **Price**

$$p_{ij}(\omega) = \tau_{ij}\frac{\sigma}{\sigma-1}c_i[\lambda(\omega)]$$

$c_i[\lambda(\omega)]$: unit cost at quality λ, with $c_i'[\cdot] > 1$

- **Profits**

$$\pi_{ij}(\omega) = \frac{1}{\sigma}\left[\tau_{ij}^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\frac{c_i[\lambda(\omega)]}{b_j[\lambda(\omega)]}\right)^{1-\sigma}P_j^{\sigma-1}R_j\right] - f_{ij}$$

- **Bilateral exports**

$$p_{ij}(\omega)q_{ij}(\omega) = \frac{\left(\tau_{ij}\frac{c_i[\lambda(\omega)]}{b_j[\lambda(\omega)]}\right)^{1-\sigma}}{\sum_i \int_{\omega\in\Omega_{ij}}\left(\tau_{ij}\frac{c_i[\lambda(\omega)]}{b_j[\lambda(\omega)]}\right)^{1-\sigma}}R_j$$

- **Export probability**

$$P[Exp_{ij}(\omega) = 1] = P\left[\left(\frac{b_j[\lambda(\omega)]}{c_i[\lambda(\omega)]}\right)^{\sigma-1} > \sigma\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1} f_{ij}\tau_{ij}^{\sigma-1}P_j^{1-\sigma}\frac{1}{R_j}\right]$$

A Reappraisal of Melitz' model

	Melitz
Heterogeneity	Productivity (φ)
Price	$\frac{d \ln p_{ij}(\omega)}{d \ln \varphi} < 0$
Export proba	$\frac{d \ln P[Exp_{ij}(\omega)=1]}{d \ln \varphi} > 0$
Export value (cond. on exporting)	$\frac{d \ln p_{ij}(\omega) q_{ij}(\omega)}{d \ln \varphi} > 0$

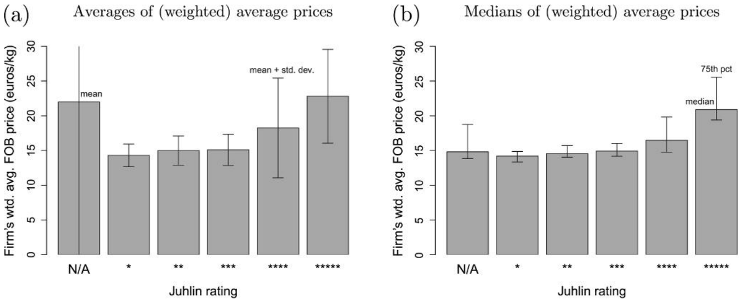
A Reinterpretation of Melitz' model

	Melitz	Here
Heterogeneity	Productivity (φ)	Quality (λ)
Price	$\frac{d \ln p_{ij}(\omega)}{d \ln \varphi} < 0$	$\frac{d \ln p_{ij}(\omega)}{d \ln \lambda} > 0$
Export proba	$\frac{d \ln P[Exp_{ij}(\omega)=1]}{d \ln \varphi} > 0$	$\frac{d \ln P[Exp_{ij}(\omega)=1]}{d \ln \lambda} > 0$ if $\frac{d \ln b_j[\lambda(\omega)]}{d \ln \lambda} > \frac{d \ln c_i[\lambda(\omega)]}{d \ln \lambda}$
Export value (cond. on exporting)	$\frac{d \ln p_{ij}(\omega) q_{ij}(\omega)}{d \ln \varphi} > 0$	$\frac{d \ln p_{ij}(\omega) q_{ij}(\omega)}{d \ln \lambda} > 0$ if $\frac{d \ln b_j[\lambda(\omega)]}{d \ln \lambda} > \frac{d \ln c_i[\lambda(\omega)]}{d \ln \lambda}$

Does quality "pay" ?

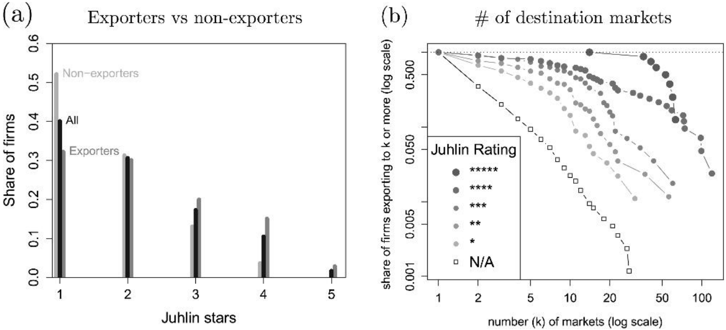
- Crozet, Head and Mayer (2012) estimate the model using French data on Champagne exports
- Quality is measured by ratings (Juhlin's rating, 1 to 5 stars)
- Results :
  - 'Quality pays', ie their estimate of $\frac{b[\lambda(\omega)]}{c[\lambda(\omega)]}$ is increasing in λ.
  - Higher quality exporters export more at both margins and charge higher prices.
- Model is consistent with the positive correlation between average UVs and distance (composition effect)

Quality and Prices



Source : Crozet et al (2012)

Quality and Trade



Source : Crozet et al (2012)

Structural estimation

	(1)	(2)	(3)	(4)	(5)
Dependent variable	$\ln p_d^{fob}(j)$	$\mathcal{E}_d(j)$	$\mathcal{E}_d(j)$	$\ln x_d^{fob}(j)$	$\ln x_d^{fob}(j)$
Method	OLS	LPM	Probit	OLS	Tobit
Observations	3205	44,586	44,586	3205	44,586
Parametric					
ln stars	0·22[a]	0·09[a]	0·09[a]	1·31[a]	4·58[a]
	(0·04)	(0·01)	(0·01)	(0·19)	(0·54)
ψ, S.D. of $\ln \alpha_d(j)$					4·30[a]
					(0·16)
R^2	0·24	0·27	0·32	0·23	0·62/0·15
Non-parametric					
Two stars	0·05[a]	0·02[a]	0·02[b]	0·32	1·25[b]
	(0·02)	(0·01)	(0·01)	(0·23)	(0·52)
Three stars	0·07[a]	0·04[a]	0·05[a]	0·63[a]	2·68[a]
	(0·03)	(0·01)	(0·01)	(0·23)	(0·55)
Four stars	0·20[a]	0·13[a]	0·11[a]	1·99[a]	5·80[a]
	(0·03)	(0·03)	(0·02)	(0·34)	(0·79)
Five stars	0·52[a]	0·26[a]	0·16[a]	1·67[a]	7·70[a]
	(0·14)	(0·03)	(0·02)	(0·23)	(0·59)
ψ, S.D. of $\ln \alpha_d(j)$					4·19[a]
					(0·16)
R^2	0·32	0·29	0·33	0·26	0·63/0·17

Notes: Destination (d) fixed effects for all columns. Column (3) reports marginal effects of the probit estimation. R^2 include country dummies. For Columns (3) and (5), R^2 are computed as the squared correlation between the predicted and actual values of the dependent variable. Second R^2 in Column (5) uses the same sample as Column (4). Standard errors clustered at the firm level in parentheses. Significance levels: [c] $p < 0{\cdot}1$, [b] $p < 0{\cdot}05$, [a] $p < 0{\cdot}01$.

Source : Crozet et al (2012). LPM=Linear Probability Model

Structural estimation

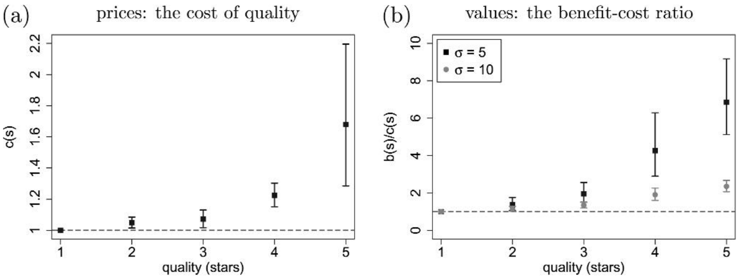


FIGURE 4
Structural interpretation of coefficients

Source : Crozet et al (2012). Parameters normalized to one for $\lambda = 1$

Quality Upgrading

Quality Upgrading

- In the previous model, quality is exogenously given
- Models with endogenous quality rely output quality to the 'quality' of inputs and labor
- Verhoogen (QJE 2008) introduces 3 fundamental elements :
  - firm heterogeneity in TFP
  - vertical differentiation
  - input quality/skills enter the 'quality production function'
- Results
  - A fall in trade costs (here, a large devaluation) leads exporters to increase the quality of their output, more so for high-TFP firms
  - This matters for within-sector wage inequality.

A sketch of the model

- Two countries : d=N, S. N_d identical consumers. 1 differentiated good.
- Consumers of d buy one unit of the variety ω that maximizes :

$$V(\omega) = \theta_d q(\omega) - \tilde{p}_d(\omega) + \varepsilon$$

  q : quality. $\tilde{p}$: price relative to price index. θ_d : willingness to pay (WTP) for quality.
- ε iid and distributed Gumbel (type I extreme value).

$$F(x) = Prob[\varepsilon \leq x] = \exp\left\{-\exp\left[-\left(\frac{x}{\mu} + \gamma\right)\right]\right\}$$

  μ a dispersion parameter that captures the degree of (horizontal) differentiation, $\gamma = .5772$ (Euler's constant).
- N consumers have a higher WTP $\theta_N > \theta_S$
- δ_d is the ratio of price index in d relative to South.
  $\delta_S = 1, \delta_N = RER$.
- Price $p(\omega)$ expressed in units of Southern price index :

$$p_d(\omega) = \delta_d \tilde{p}_d(\omega)$$

A sketch of the model : Demand

- Demand for variety $\omega \in \Omega_d$ has a multinomial logit form (Anderson et al. 1992, section 2.6.) :

$$x_d(\omega) = N_d \frac{exp\left[\frac{1}{\mu}\left(\theta_d q(\omega) - \frac{p_d(\omega)}{\delta_d}\right)\right]}{\int_{\Omega_d} exp\left[\frac{1}{\mu}\left(\theta_d q(\omega) - \frac{p_d(\omega)}{\delta_d}\right)\right] d\omega}$$

demand

- If all prices are equal, higher-quality products have greater demand.
- Monopolistic competition : firms treat the denominator as a constant.

A sketch of the model : Supply

- Each unit of output requires one skilled worker, one unskilled worker and one machine
- Firm has one production line for each market d
- Quality depends on the quality of both workers, the sophistication of the machine and the managerial ability (TFP) :

$$q_d(k_d, e_d^h, e_d^l; \lambda) = \lambda(k_d)^{\alpha^k}(e_d^h)^{\alpha^h}(e_d^l)^{\alpha^l}$$

with $\alpha \equiv \alpha^k + \alpha^h + \alpha^l$, $0 < \alpha < 1$.

- Firms are heterogeneous in λ, distributed Pareto over $[0; \lambda_m]$.
- Workers' quality depends on wages (imperfect screening, efficiency wages, firm-specific skills) :

$$e_d^l = z^l(w_d^l - \underline{w}^l)$$
$$e_d^h = z^h(w_d^h - \underline{w}^h)$$

z^l and z^h positive constants, w_d^l and w_d^h wages in production line d, $\underline{w}^l$ and $\underline{w}^h$ wages in the outside labor market

A sketch of the model : Implications

- Firms choose $\{p_d, w_d^l, w_d^h, k_d\}$ to maximize profits on each production line / to each destination, $(p_d - w_d^h - w_d^l - \rho k_d)x_d - F_d$:

$$p_d^* = \underline{w}^l + \underline{w}^h + \mu\delta_d + \alpha\delta_d\theta_d q_d^*(\lambda)$$

$$q_d^*(\lambda) = \left(\lambda(\delta_d)^\alpha(\theta_d)^\alpha(z^h\alpha^h)^{\alpha^h}(z^l\alpha^l)^{\alpha^l}(\frac{\alpha}{\rho})^{\alpha^k}\right)^{\frac{1}{1-\alpha}}$$

profit maximization

- Profits, output, quality, wages, prices, input demands, export status increase in λ.
- Quality is higher on N production lines, since $\theta_N > \theta_S$.
- If quality is sufficiently sensitive to high-skilled labor, as in $\frac{\alpha^h}{\alpha^l} > \frac{\underline{w}^h}{\underline{w}^l}$, then the skill premium $\frac{w^h}{w^l}$ is increasing in λ.
- Due to fixed entry costs, there is a λ_d^{min} export cutoff.

Exogenous price shocks

- A devaluation in S acts as a rise in δ_N
- A firm's average quality can be defined as a sum of each line's quality weighted by that line's share of production
- After a devaluation, the model predicts in South :
    - a rise in exporters' quality on the N production line, export shares, and therefore in exporters' average quality
    - a jump in quality for some firms that start exporting
    - similar patterns for low-, high-skilled wages, capital intensity
    - an increase in skill premia if $\frac{\alpha^h}{\alpha^l} > \frac{w^h}{w^l}$

Exogenous price shocks

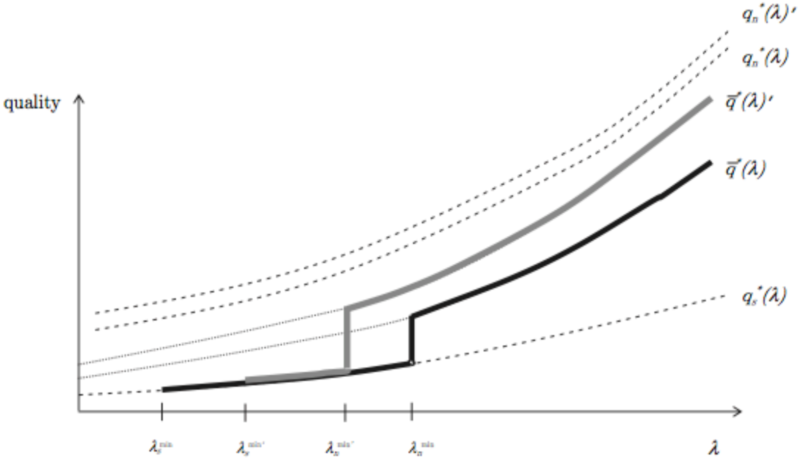


FIGURE VII
Response to Exchange-Rate Devaluation

Testing the predictions

- Data :
  - Mexican plant-level data, with two panels : 1984-2001 (1,114 firms) and 1993-2001 (3,263 firms)
  - ISO certification observed in 1995, 1999 and 2001.
  - TFP proxied by the deviation of log domestic sales to the industry mean.
- Estimation equation

$$\Delta y_{ijr} = \alpha + \beta \tilde{\lambda}_{ijr} + \psi_j + \xi_r + u_{ijr}$$

i : plant ; j : industry ; r : region ; $\tilde{\lambda}_{ijr}$: initial relative log sales. y_{ijr} : export share, blue-collar wages, white-collar wages, skill premium, capital/labor ratio, white-collar share.

- 'Triple difference' estimation : across abilities, before and after devaluation, relative to 1997-2001 control period.

TABLE II
Baseline Estimates, EIA 1993–2001 Panel

		A. Cross-sectional regressions, 1993					
		Export share of sales (1)	log(white-collar wage) (2)	log(blue-collar wage) (3)	log(wage ratio) (4)	log(K/L ratio) (5)	White-collar emp. share (6)
	log domestic sales, 1993	−0.001	0.209***	0.133***	0.075***	0.343***	0.010***
		[0.003]	[0.008]	[0.006]	[0.008]	[0.017]	[0.002]
	R^2	0.220	0.391	0.358	0.185	0.370	0.343
		B. Differential changes, 1993–1997 and 1997–2001					
		Δ (export share of sales) (1)	Δ log(white-collar wage) (2)	Δ log(blue-collar wage) (3)	Δ log(wage ratio) (4)	Δ log(K/L ratio) (5)	Δ (white-coll. emp. share) (6)
OLS regressions							
1993–1997	log domestic sales, 1993	0.020***	0.072***	0.036***	0.036***	0.083***	−0.002
		[0.002]	[0.008]	[0.006]	[0.009]	[0.011]	[0.002]
	R^2	0.173	0.15	0.129	0.09	0.134	0.111
1997–2001	log domestic sales, 1997	0.007***	0.016**	0.008	0.008	0.026***	−0.001
		[0.002]	[0.007]	[0.005]	[0.007]	[0.009]	[0.001]
	R^2	0.123	0.088	0.092	0.075	0.107	0.102
Difference (1993–1997 vs. 1997–2001)		0.014***	0.056***	0.028***	0.028**	0.057***	−0.002
		[0.003]	[0.010]	[0.007]	[0.011]	[0.014]	[0.002]
IV regressions							
1994–1997	log domestic sales, 1994	0.014***	0.058***	0.033***	0.026***	0.058***	0.000
		[0.002]	[0.007]	[0.005]	[0.008]	[0.009]	[0.002]
	R^2	0.161	0.148	0.118	0.093	0.119	0.092
1998–2001	log domestic sales, 1998	0.004**	0.005	0.004	0.001	0.016**	−0.001
		[0.002]	[0.006]	[0.004]	[0.007]	[0.008]	[0.001]
	R^2	0.111	0.082	0.097	0.077	0.102	0.099
Difference (1993–1997 vs. 1997–2001)		0.010***	0.053***	0.029***	0.024**	0.042***	0.001
		[0.003]	[0.009]	[0.007]	[0.010]	[0.012]	0.002

Notes. Table reports coefficients on log domestic sales for 30 separate regressions. (Covariate at left; dependent variables at top, with changes in Panel B over period at left.) All regressions include 205 industry (six-digit) and 32 state dummies. IV regressions instrument log domestic sales in 1994 and 1998 with values from previous year. $N = 3,263$ for all regressions. Variable definitions in Appendix I. Further details on data set in Section IV of the text and Appendix II (online). Robust standard errors in brackets. Standard errors on differences allow for cross-equation correlation. *** indicates significance at 1% level, ** at 5% level, * at 10% level.

TABLE IV
Estimates from EIA-ENESTyC Panel

		ISO 9000 certification (1)	White-collar avg. schooling (2)	Blue-collar avg. schooling (3)	Has formal training (4)	Turnover rate (5)	Accident rate (6)	Absentee rate (7)
A. Cross-sectional regressions, 1993								
	Log domestic sales, 1993	0.023**	0.286***	0.156***	0.049***	−20.239***	−0.802***	−0.250***
		[0.011]	[0.067]	[0.058]	[0.017]	[2.995]	[0.216]	[0.044]
	N	844	590	590	843	751	828	515
	R^2	0.154	0.258	0.240	0.117	0.168	0.*206	0.245
B. Differential Responses, 1993–1997 and 1997–2001								
		Δ ISO 9000 certification (1)	Δ white-collar avg. schooling (2)	Δ blue-collar avg. schooling (3)	Δ has formal training (4)	Δ turnover rate (5)	Δ accident rate (6)	Δ absentee rate (7)
1993–1997	Log domestic sales, 1993	0.079***	−0.105	0.204***	0.008	1.067	0.219	−0.025
		[0.018]	[0.104]	[0.078]	[0.020]	[4.224]	[0.247]	[0.093]
	R^2	0.171	0.164	0.194	0.1	0.184	0.141	0.243
1997–2001	Log domestic sales, 1997	0.036***	0.058	−0.023	−0.024	−4.294	0.045	−0.140
		[0.015]	[0.088]	[0.075]	[0.017]	[4.655]	[0.222]	[0.093]
	R^2	0.127	0.151	0.173	0.082	0.161	0.134	0.138
Difference (1993–1997 vs. 1997–2001)		0.042*	−0.163	0.228**	0.032	5.361	0.174	0.115
		[0.024]	[0.136]	[0.109]	[0.026]	[6.286]	[0.332]	[0.131]
	N	844	484	484	836	513	713	354

Notes. Table reports coefficients on log domestic sales for 21 separate regressions. (Covariate at left; dependent variables at top, with changes in Panel B over period at left.) All regressions include dummies for 50 industries (four-digit) and 32 states. Data on ISO 9000, training, turnover rate, accident rate, absentee rate from 1994, 1998, 2000; on schooling from 1991, 1998, 2000. Since requiring plants to have complete data on all variables would have reduced the panel prohibitively, I allow the sample size to change across columns. Variable definitions in Appendix I. Further details on data set in Section IV of the text and Appendix II (online). Robust standard errors in brackets. Standard errors on differences allow for cross-equation correlation. *** indicates significance at 1% level, ** at 5% level, * at 10% level.

Empirical results

- Main result : After the devaluation, more 'able' plants increased exports, blue- and white-collar wages, skill premia, and ISO9000 certification, in relative terms with respect to less productive firms
- Robust to IV estimation, using other proxies for managerial ability, using a different time period, controlling for region and industry fixed effects
- Controlling for the cost of capital or excluding nontradables rules out non-trade alternative explanations
- Javorcik and Iacovone (wp 2012) : in Mexican tequila industry, evidence of quality ugrading *in preparation for* exports.

Quality Ladders and Contestable Jobs

Quality Ladders

- Quality differences affect the intensity of foreign competition with an end-effect on labor market outcomes
  - LWCs competition is more “painful” in sectors with a short quality ladder
  - Flight to quality to cope with competition
- Khandelwal (ReStud 2011)
  - contestable jobs model with vertical differentiation
  - industry ’quality ladders’ inferred from market shares
  - competition from low-wage countries destroys fewer jobs in long ’quality ladder’ industries.

A sketch of the model

- 2 countries : $c = N, S$, each with J identical firms (j).
- Assume N's unit costs reflect higher wages $w_N > w_S$, but a lower marginal cost of producing quality (λ) :

$$c_c(\lambda) = w_c + \frac{\lambda^2}{2Z_c}, c = N, S$$

  where $Z_N > Z_S$ reflects higher productivity in N.
- Random utility (discrete choice) model :

$$V_{nj} = \theta\lambda_j - \alpha p_j + \varepsilon_{nj} \equiv v_j + \varepsilon_{nj}$$

  where the ε_{nj} are iid and distributed Gumbel.

Firms' optimal decisions

$$\max_{p_{j(c)},\lambda_{j(c)}} \{(p_{j(c)} - w_c - \frac{\lambda^2}{2Z_c})\frac{e^{v_{j(c)}}}{\sum_j e^{v_j}}\}$$

$$\Rightarrow p_{j(c)} = \frac{1}{\alpha} + w_c + \frac{\theta^2 Z_c}{2\alpha^2}$$

$$\lambda_{j(c)} = \frac{\theta Z_c}{\alpha}$$

$$v_{j(c)} = \frac{\theta^2 Z_c}{2\alpha} - \alpha w_c - 1$$

$$S_c = J s_{j(c)} = J\frac{e^{v_{j(c)}}}{\sum_j e^{v_j}}$$

Theoretical implications

- Pricing rule : Mark-up over marginal cost, which is increasing in quality
- Quality produced by Northern firms is relatively high
- High quality firms have larger market shares if

  $$\frac{\theta^2}{2\alpha}(Z_N - Z_S) > \alpha(w_N - w_S)$$

  ie consumers' valuation for quality is sufficiently high / the North's technological advantage in producing quality is sufficiently high to overcome cost disadvantage
- 'Ladder length' = difference between highest and lowest quality (Grossman & Helpman, 1991)

  $$\theta(\lambda_N - \lambda_S) = \frac{\theta^2(Z_N - Z_S)}{\alpha}$$

  Quality ladder increases in consumers' valuation for quality (Taken as exogenous)

Theoretical implications

- North loses market share as Southern manufacturing wages decline :

$$\frac{\partial S_N}{\partial w_S} = \alpha S_N S_S > 0$$

Consistent with empirical evidence (eg Bernard et al, 2006 : US employment is negatively associated with import competition, more so when import competition comes from LWCs)

- Intensity of competition depends on the length of the quality ladder :

$$\frac{\partial^2 S_N}{\partial w_S \partial \theta} = -\theta S_N S_S (S_N - S_S)(Z_N - Z_S) < 0 \; if \; (S_N > S_S)$$

In long-ladder markets, the sensitivity of Northern market shares to Southern competition is reduced

Estimating quality ladders

- Nested logit : national (c) varieties of HS10 product nests (h), within an industry (5d SITC)
- Consumer n chooses variety ch to maximize indirect utility :

$$V_{ncht} = \lambda_{1,ch} + \lambda_{2,t} + \lambda_{3,cht} - \alpha p_{cht} + \sum_{h=1}^{N} \mu_{hnt} d_{ch} + (1-\sigma)\varepsilon_{ncht}$$

$\sum_{h=1}^{N} \mu_{hnt} d_{ch} + (1-\sigma)\varepsilon_{ncht}$ iid Gumbel. $d_{ch} = 1$ if variety ch belongs to nest h, zero otherwise. σ : within-nest correlation.

- Domestic variety : $0h$, with mean utility normalized to zero.
- Berry (AER 1994) derives the estimated demand function :

$$\ln(s_{cht}) - \ln(s_{0ht}) = \lambda_{1,ch} + \lambda_{2,t} - \alpha p_{cht} + \sigma \ln(ns_{cht}) + \lambda_{3,cht}$$

s_{cht}, ns_{cht} : overall and within-nest market shares, respectively.

Estimating quality ladders

- The goal is to estimate quality $\lambda_{cht} = \hat{\lambda_{1,ch}} + \hat{\lambda_{2,t}} + \hat{\lambda_{3,cht}}$
- Issues :
  - endogeneity of price $\rightarrow$ IV : transport costs. Exclusion restriction : do not affect $\lambda_{3,cht}$ ie deviations from average quality
  - endogeneity of ns_{ch} $\rightarrow$ IV : nb of varieties in h and nb of varieties exported by c. Exclusion restriction : Variety entries/exits take place prior to quality choices
  - aggregation bias in HS classification ('hidden varieties') $\rightarrow$ proxy : population used as control
- Estimation on US import data, dropping homogenous goods as defined by Rauch (1999)
- Each product h has ladder length (at initial period) :

$$length_h = \max_c \lambda_{ch0} - \min_c \lambda_{ch0}$$

Estimated quality ladders

- Richer countries, on average, export higher quality varieties, within products
- More capital-intensive countries also tend to export higher qualities
- Size of quality ladders is relatively persistent over time
- In sectors with long quality ladders, prices and estimated qualities tend to be positively correlated (ie use of prices as proxy for qualities is ok). This is less the case in short quality-ladder sectors
- Capital-intensive and high productivity industries are associated with longer quality ladders

Quality ladder and US employment

- Finally, map HS10 products into SITC4 industries.
- Estimate the impact of ladder length on US employment.

$$\begin{aligned}\ln(Emp_{st}) = & b_1 OthPen_{st} + b_2 LwPen_{st} \\ & + b_3 Length_{st} * LwPen_{st} + \varepsilon_{st}\end{aligned}$$

  where $LwPen_{st}$ and $OthPen_{st}$ are import penetration by low wage and other countries, respectively.
- Low wage countries are defined as having less than 5% of US GDP/capita.
- The model predicts $b_2 < b_1 < 0$ and $b_3 > 0$.

	Log (Employment$_{mt}$)							
	OLS				IV			
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OTHPEN$_{mt}$	-0.493 ***	-1.175 ***	-0.475 ***	-0.495 ***	-1.774	-1.094	-0.979 **	-0.745
	0.157	0.406	0.132	0.157	1.295	2.869	0.436	0.545
LWPEN$_{mt}$	-1.894 ***	-2.190 ***	-4.643 ***	-1.897 ***	-7.162 **	-8.495	-11.713 ***	-5.429 ***
	0.256	0.360	1.194	0.267	2.983	5.511	3.010	1.753
Log (IndLadder$_m$) x LWPEN$_{mt}$	0.609 **	0.716 ***	0.600 **	0.617 **	4.620 *	5.714	2.879 ***	3.033 **
	0.216	0.234	0.276	0.239	2.414	4.453	0.885	1.462
Log (IndLadder$_m$) x OTHPEN$_{mt}$		0.317 **				-0.535		
		0.136				1.772		
Log (K/L$_m$) x LWPEN$_{mt}$			0.918 **				2.223 **	
			0.361				0.932	
Log (TFP$_m$) x LWPEN$_{mt}$				0.329				7.003 *
				0.870				3.726
Overidentification p-value	-	-	-	-	0.48	0.43	0.38	0.40
Kleibergen-Paap F statistic	-	-	-	-	0.61	0.61	18.40	3.52
Industry Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.112	0.120	0.124	0.112	0.013	0.009	0.018	0.020
Observations	2,585	2,585	2,585	2,585	2,585	2,585	2,585	2,585

Notes: The dependent variable for each regression is the four-digit SIC industry (log) employment. The first column regresses employment on import penetration from the rest of the world (OTHPEN), low-wage import penetration (LWPEN) and the interaction of LWPEN with the industry quality ladder. Column 2 includes the OTHPEN-ladder interaction. Column 3 includes the interaction of LWPEN with initial industry capital intensity (in 1989) and column 4 includes the interaction of LWPEN with intial industry TFP (in 1989). Columns 5-8 present the IV results. The instruments are weighted average tariff rates, exchange rates and freight rates for low-wage countries and the rest of the world. Robust standard errors are clustered at the two-digit SIC. Significance levels: *** .01; ** .05; * .10.

Conclusions

- Heterogeneous firms trade models capture quality differences across firms too.
- Trade liberalization encourages quality upgrading, causing an increase in wage dispersion.
- Vertical differentiation dampens labor market consequences of trade liberalization with low-wage countries.
- Further reading :
    - models where demand for quality is endogenous, through non-homothetic preferences and income/capita changes (Fajgelbaum et al. JPE 2011)
    - empirical relationship between export 'sophistication' and growth (Hausmann, Hwang and Rodrik, 2007)

References

- Crozet, Head & Mayer, 2012. "Quality Sorting and Trade : Firm-level Evidence for French Wine," *Review of Economic Studies* 79(2) : 609-644.
- Hallak, 2006. "Product quality and the direction of trade," *Journal of International Economics* 68(1) : 238-265
- Hallak & Schott, 2011, "Estimating Cross-Country Differences in Product Quality", *Quarterly Journal of Economics* 126(1) :417-474
- Hallak & Sivadasan, 2013. "Product and process productivity : Implications for quality choice and conditional exporter premia," *Journal of International Economics* 91(1) : 53-67.
- Hausmann, Hwang & Rodrik, 2007. "What you export matters," *Journal of Economic Growth* 12(1), pages 1-25
- Hummels & Skiba, 2004. "Shipping the Good Apples Out ? An Empirical Confirmation of the Alchian-Allen Conjecture," *Journal of Political Economy* 112(6) : 1384-1402
- Khandelwal, 2010, "The Long and Short (of) Quality Ladders," *Review of Economic Studies*, 77(4), 1450-1476

References

- Kugler & Verhoogen, 2012. "Prices, Plant Size, and Product Quality," *Review of Economic Studies* 79(1) : 307-339.
- Manova & Zhang, 2012 "Export Prices across Firms and Destinations" *Quarterly Journal of Economics* 127 : 379-436
- Martin & Mejean, "Low-Wage Countries' Competition, Reallocation Across Firms and the Quality Content of Exports," 2014, *Journal of International Economics*, 93-1 : 140-152
- Schott, 2004, "Across-Product versus Within-Product Specialization in International Trade". *Quarterly Journal of Economics* 119(2) :647-678
- Verhoogen, 2008, "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector." *Quarterly Journal of Economics* 123(2) : 489-530

Demand function

- Proba that a consumer from d chooses variety ω is

$$\begin{aligned}
& P[V(\omega) \geq V(\omega')\forall \omega' \neq \omega] \\
= \; & P[\theta_d q(\omega) - \delta_d^{-1} p_d(\omega) + \varepsilon \geq \theta_d q(\omega') - \delta_d^{-1} p_d(\omega') + \varepsilon' \forall \omega' \neq \omega] \\
= \; & P[\theta_d q(\omega) - \delta_d^{-1} p_d(\omega) - \theta_d q(\omega') + \delta_d^{-1} p_d(\omega') \geq \varepsilon' - \varepsilon \forall \omega' \neq \omega] \\
= \; & \int_{-\infty}^{\infty} f(x) \prod_{\omega' \neq \omega} F(\theta_d q(\omega) - \delta_d^{-1} p_d(\omega) - \theta_d q(\omega') + \delta_d^{-1} p_d(\omega') + x) dx
\end{aligned}$$

Using the change of variable $\alpha = exp\left[-\left(\frac{x}{\mu} + \gamma\right)\right]$ and $y(\omega) = exp\left(\frac{\theta_d q(\omega) - \delta_d^{-1} p_d(\omega)}{\mu}\right)$, this implies :

$$\begin{aligned}
P[V(\omega) \geq V(\omega')\forall \omega' \neq \omega] &= \int_0^{\infty} exp(-\alpha) \prod_{\omega' \neq \omega} \left[exp\left(-\frac{\alpha y(\omega')}{y(\omega)}\right)\right] d\alpha \\
&= \int_0^{\infty} exp\left[-\alpha\left(\int_{\Omega_d} \frac{y(\omega')}{y(\omega)} d\omega'\right)\right] d\alpha \\
&= \frac{y(\omega)}{\int_{\Omega_d} y(\omega) d\omega}
\end{aligned}$$

Profit maximization

- The firm maximizes, for each production line

$$\pi_d(\omega) = (p_d(\omega) - w_d^h(\omega) - w_d^l(\omega) - \rho k_d(\omega))x_d(\omega) - F$$

s.t.

$$\begin{aligned}
x_d(\omega) &= N_d \frac{exp\left[\frac{1}{\mu}\left(\theta_d q_d(\omega) - \frac{p_d(\omega)}{\delta_d}\right)\right]}{\int_{\Omega_d} exp\left[\frac{1}{\mu}\left(\theta_d q_d(\omega) - \frac{p_d(\omega)}{\delta_d}\right)\right] d\omega} \\
q_d(\omega) &= \lambda k_d(\omega)^{\alpha^k} e_d^h(\omega)^{\alpha^h} e_d^l(\omega)^{\alpha^l} \\
e_d^l(\omega) &= z^l(w_d^l(\omega) - \underline{w}^l) \\
e_d^h(\omega) &= z^h(w_d^h(\omega) - \underline{w}^h)
\end{aligned}$$

- First order conditions :

$$\frac{\partial \pi_d(\omega)}{\partial p_d(\omega)} = 0 \quad \Rightarrow \quad p_d(\omega) = \mu\delta_d + w_d^h(\omega) + w_d^l(\omega) + \rho k_d(\omega)$$

$$\frac{\partial \pi_d(\omega)}{\partial w_d^h(\omega)} = 0 \quad \Rightarrow \quad w_d^h(\omega) = \underline{w}^h + \alpha^h \theta_d \delta_d q_d(\omega)$$

$$\frac{\partial \pi_d(\omega)}{\partial w_d^l(\omega)} = 0 \quad \Rightarrow \quad w_d^l(\omega) = \underline{w}^l + \alpha^l \theta_d \delta_d q_d(\omega)$$

$$\frac{\partial \pi_d(\omega)}{\partial k_d(\omega)} = 0 \quad \Rightarrow \quad k_d(\omega) = \frac{\alpha^k}{\rho} \theta_d \delta_d q_d(\omega)$$

- Which implies :

$$p_d(\omega) = \mu\delta_d + \underline{w}^h + \underline{w}^l + (\alpha^k + \alpha^l + \alpha^h)\theta_d \delta_d q_d(\omega)$$

$$q_d(\omega) = (\lambda \eta \delta_d^\alpha \theta_d^\alpha)^{\frac{1}{1-\alpha}}$$

$$\textit{with} \qquad \eta = (z^h \alpha^h)^{\alpha^h} (z^l \alpha^l)^{\alpha^l} \left(\frac{\alpha^k}{\rho}\right)^{\alpha^k}$$

Back to the model