

Trade, Technology Adoption and the Rise of the Skill Premium in Mexico

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Empirical Analysis of Firm Heterogeneity in International Trade
Workshop

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- In Mexico this increase reversed a two decade trend of reductions in inequality

The Case of Mexico

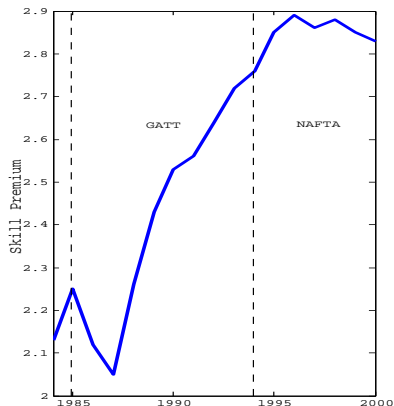
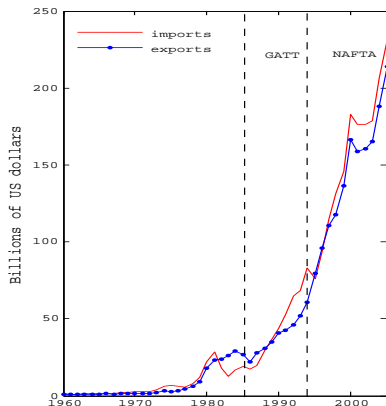
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- Quantify the impact of trade-induced skill-biased technology adoption on the skill premium
- **Findings:**
Trade-induced skill-biased technology adoption can explain about **one-sixth** of the increase in the skill premium observed in Mexico after its unilateral trade liberalization

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Reductions in trade barriers increase market size for potential exporters

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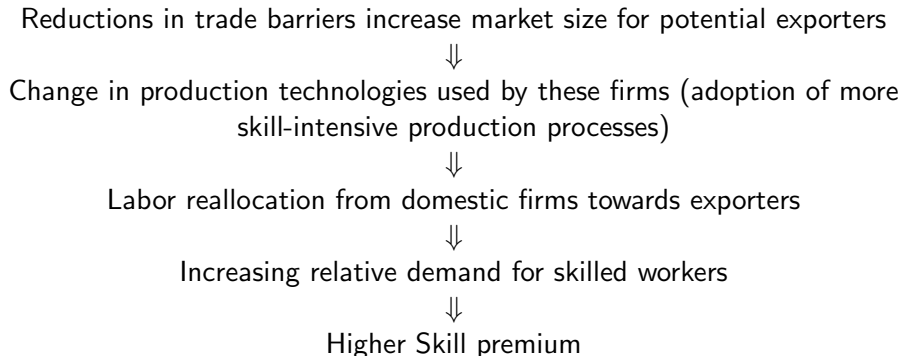


Labor reallocation from domestic firms towards exporters



Increasing relative demand for skilled workers

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Year	Share of plants			
	No Imported M&E No Exporting	Only Imported M&E	Only Exporting	Imported M&E & Exporting
1986	65.52	11.38	11.89	11.21
1987	60.59	11.27	15.46	12.68
1988	54.76	13.76	14.16	17.33
1989	48.64	17.50	13.08	20.78
1990	42.87	21.23	12.80	23.10

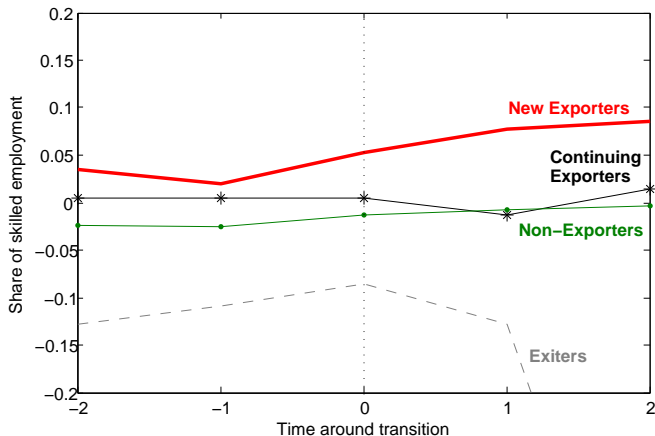
Price of Machinery & Equipment

- There is a dramatic fall in the relative price of machinery and equipment starting at the end of 1987, right after the trade liberalization reforms are consolidated



Trade, Technology Adoption and Skill Intensity

- New exporters are the plants that increase their skill intensity the most



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- **This is the first attempt to quantify the effect of trade-induced technology adoption on wage inequality**

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 - (vi) Exporting is costly: fixed participation costs and iceberg transportation costs

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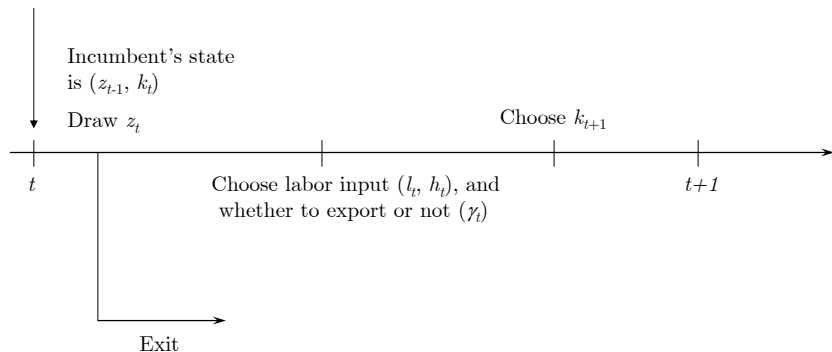
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- f_1, f_2, S_2 are denominated in units of output

Sequence of Actions

New entrants pay an entry fee
draw z from a distribution $G(z)$
using technology 1



Data

- Balanced panel of 1,913 large Mexican manufacturing plants for the period 1984-1990 from INEGI.
- Data on exports, imports of M&E is available after 1986.
- Assembly (*maquiladora*) plants are excluded from the survey.
- Data on entry/exit patterns comes from IDB's Job Flows in LAC database

Summary Statistics

	1984	1990	% change
Employment			
Production	201.8	228.9	13.4
Non-production	86.7	98.4	13.4
Hourly wages			
Production	28.7	26.7	-6.8
Non-production	56.1	67.5	20.2
Skill premium	2.10	2.76	31.4

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	1986	1990	% change
Fraction of exporting plants	22.8	35.9	57.4
Mean exports/sales	24.7	26.8	8.5
Fraction of plants importing M&E	22.6	37.3	64.9
Expenditure in imported M&E	5.3	9.9	85.5

Estimation Strategy

(i) We want to estimate the following vector of 12 parameters:

$$\theta \equiv \{\bar{z}_1, \bar{z}_2, \phi, \sigma_\varepsilon^2, f_1, f_2, S_2, A_x, f_x, \mu_E, S_E, \sigma_p\}.$$

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- (iii) Construct $S = 50$ simulated panels of plants $\{D_{it}^s(\theta)\}$. Calculate the mean of the vector of simulated moments:

$$\hat{\mathbf{m}}(\theta) = \frac{1}{S} \sum_{s=1}^S \mathbf{m}(D_{it}^s(\theta)).$$

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- (iv) The estimated vector of parameters $\hat{\theta}$, solves the following problem:

$$\min_{\theta \in \Theta} \Psi = (\log(\hat{\mathbf{m}}(\theta)) - \log(\mathbf{m}))' \left[\left(1 + \frac{1}{S}\right) \hat{\Sigma} \right]^{-1} (\log(\hat{\mathbf{m}}(\theta)) - \log(\mathbf{m})).$$

Calibrated Parameters

Parameter	Description	Value
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λ	Share of skilled workers	0.311
L	Size of Labor force	1,000

Moments Used in the Estimation

Post-Liberalization (1987-1990)	Value
Share of exporting plants	0.317
Mean exports/sales ratio	0.213
Mean total employment, exporters	504.93
Mean entry rate into exporting	0.039

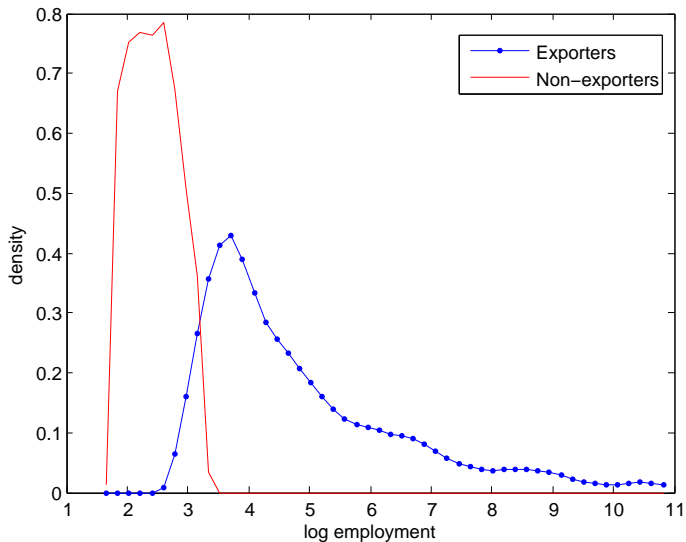
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Mean entry rate into exporting	0.039
Mean skill share, exporters	0.347
Std. skill share of employment	0.175
Mean total employment	311.76
Std. total employment	461.70
Share of firms using foreign technology	0.222
Mean adoption rate imported technology	0.053
Correlation($\text{export}_t, \text{export}_{t-1}$)	0.862
Correlation ($\text{skill share}_t, \text{skill share}_{t-1}$)	0.937
Share of plants with 0-30 employees	0.713
Share of plants with 30-100 employees	0.209
Share of plants with 100-500 employees	0.051
Mean entry rate	0.110
Mean total employment, entrants	17.85
Mean total employment, exiters	15.564

Goodness of Fit

Post-Liberalization (1987-1990)	Data	Simulated	log-difference
Share of exporting plants	0.317	0.327	0.014
Mean exports/sales ratio	0.213	0.223	0.018
Mean total employment, exporters	504.93	1,111.76	0.343
Mean entry rate into exporting	0.033	0.043	0.047
Mean skill share, exporters	0.347	0.345	0.002
Std. skill share of employment	0.175	0.120	0.164
Mean total employment	311.76	380.81	0.087
Std. total employment	461.70	2,548.45	0.742
Share of plants using imported M&E	0.222	0.327	0.169
Mean adoption rate imported M&E	0.039	0.043	0.084
Corr. ($\text{export}_t, \text{export}_{t-1}$)	0.862	0.785	0.046
Corr. ($\text{skill share}_t, \text{skill share}_{t-1}$)	0.937	0.908	0.041
Share of plants with 0-30 employees	0.713	0.708	0.003
Share of plants with 30-100 employees	0.209	0.140	0.172
Share of plants with 100-500 employees	0.051	0.086	0.229
Mean entry rate	0.110	0.005	1.280
Mean total employment, entrants	17.85	19.17	0.030
Mean total employment, exiters	15.564	21.54	0.141

Size Distribution by Exporting Status



Point Estimates

Parameter	Point Estimate	S. E.
Foreign market size (A_x)	910.23	0.892
Fixed cost of exporting (f_x)	48.726	0.045
Mean productivity tech. 1 (\bar{z}_1)	0.050	0.003
Mean productivity tech. 2 (\bar{z}_2)	0.109	0.005
Root productivity process (ϕ)	0.952	0.012
Variance productivity innovations (σ_ε^2)	0.278	0.073
Fixed cost of using tech. 1 (f_1)	91.409	2.354
Fixed cost of using tech. 2 (f_2)	568.53	30.242
Sunk cost of adopting tech. 2 (S_2)	65.093	14.881
Elasticity of substitution (σ_p)	1.410	0.952
Mean productivity, entrants (μ_E)	1.226	0.0187
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- Fixed cost of exporting accounts for 5% of average foreign revenues; 11% for new exporters
- Adoption costs are very large: two times the size of current revenues at the moment of switching

Trade Liberalization

Statistic	Benchmark	High tariff	High tariff
	$\tau_f = 1.05$	$\tau_f = 1.55$	affecting S_2
Aggregate income (Y)	100	116.10	118.02
Price index (P)	100	120.91	124.10
Price of foreign consumption good (τ_f)	105	155	155
Mass of incumbent firms (M)	100	101.23	102.50
Skill premium (w_h/w_l)	6.871	6.701	6.584
Share of plants using imported $M\&E$	0.329	0.319	0.274
Share of exporting plants	0.329	0.292	0.262

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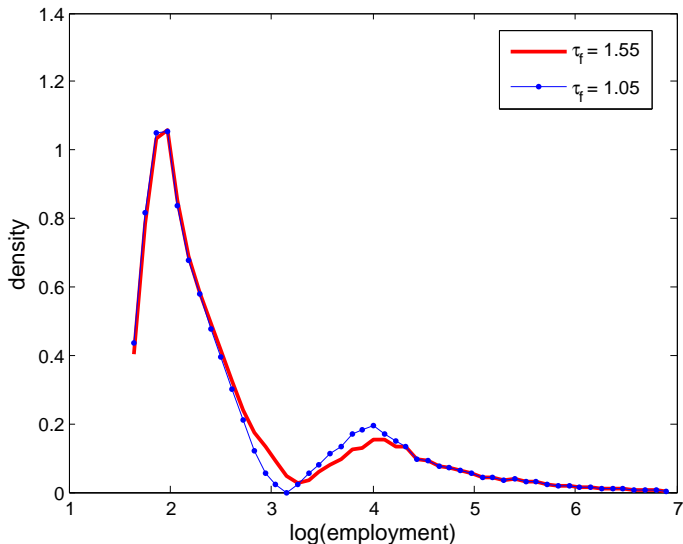
- Balanced trade results in a larger number of firms exporting. Overall, exporters are 12% smaller and 3% less skill-intensive
- About 27% of new exporters also switch technologies after trade liberalization. Skill premium increases by 2.46% after trade liberalization

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Share of plants using imported $M\&E$	0.329	0.319	0.274
Share of exporting plants	0.329	0.292	0.262

- Balanced trade results in a larger number of firms exporting. Overall, exporters are 12% smaller and 3% less skill-intensive
- About 27% of new exporters also switch technologies after trade liberalization. Skill premium increases by 2.46% after trade liberalization
- When technology adoption costs become $\tau_f S_2$, the skill premium increases by 4.2%

Size Distribution after Trade Liberalization



Concluding Remarks

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- Utilize data from ENESTYC to better identify the impact of adopting different manufacturing technologies on the workforce composition at the plant level
- Explore the transition dynamics of wage inequality after trade liberalization episodes in developing countries

Preferences & Demand

- Individuals are risk-neutral and have CES preferences over a continuum of domestically-produced goods $q_d(\omega)$ and one imported good q_f :

$$U = E_0 \sum_{t=0}^{\infty} \beta^t C_t,$$

$$C = \left(q_f^{\frac{\sigma_c-1}{\sigma_c}} + \int_{\omega \in \Omega} q_d(\omega)^{\frac{\sigma_c-1}{\sigma_c}} d\omega \right)^{\frac{\sigma_c}{\sigma_c-1}}, \quad \sigma_c > 1.$$

- Domestic demand:

$$q_d(\omega) = Y P^{\sigma_c-1} (p_d(\omega))^{-\sigma_c}.$$

- Foreign demand:

$$q_x(\omega) = A_x (p_x(\omega))^{-\sigma_c}.$$

with

$$P = \left[(p_f \tau_f)^{1-\sigma_c} + \int_{\omega \in \Omega} p_d(\omega)^{1-\sigma_c} d\omega \right]^{\frac{1}{(1-\sigma_c)}}.$$

Firm's Static Problem

An incumbent firm using technology k with productivity z solves the following static profit maximization problem:

$$\max_{h,l,q_d,q_x,p_d,p_x,\gamma \in \{0,1\}} p_d q_d + \gamma [p_x q_x - f_x mc] - w_h h - w_l l$$

s.t.:

$$q_d = Y P^{\sigma_c - 1} (p_d)^{-\sigma_c},$$

$$q_x = A_x (p_x)^{-\sigma_c},$$

$$q = q_d + \gamma \tau_x q_x.$$

taking as given Y, P, A_x, w_l, w_h .

Firm's Dynamic Problem

- At the beginning of each period, incumbent firms choose whether to remain in the market or exit:

$$V(k, z) = \max\{V^c(k, z), 0\}.$$

- A firm that stays in the market needs to choose what technology to operate next period:

$$V^c(k, z) = \max\{V^A(k, z), V^N(k, z)\}.$$



$$V^A(k, z) = \pi(k, z) - [f_k + S_{\tilde{k}}]mc(k, z) + \beta \int_{z'} Q_{\tilde{k}}(z'|z)V(\tilde{k}, z'),$$

$$V^N(k, z) = \pi(k, z) - f_k mc(k, z) + \beta \int_{z'} Q_k(z'|z)V(k, z').$$