

Notes about Bustos (AER 2011): “Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms”

Seminario Avanzado de Comercio

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# Main features

- Impact of trade agreement (MERCOSUR) on Argentina
- Look at firms's technology upgrading and export decision simultaneously
- Good setup because of large tariff drop: from 29% average in 1991 to zero in 1995
  - ▶ This is tariff faced by Argentinian exporters to Brazil
  - ▶ it varied across industries
- Advantage of data set: availability of data on tech spending: computers, patents, innovation, R&D
- Main result: sectors with larger tariff cuts see an increase in export probability and technology upgrading:
  - ▶ average reduction in tariff (24%) increases probability of exporting by 10-12 percentage points
  - ▶ increase in tech spending by 0.20-0.28 log points
  - ▶ effect is stronger in upper-middle range of distribution (different from Lileeva and Trefler)

# Model

- Two symmetric countries of size  $L$
- One industry Melitz-type
- Productivity is  $\varphi$  and distributed Pareto with shape parameter  $k$ :  
 $G(\varphi) = 1 - \varphi^{-k}$
- Entry cost of  $f_e$ , fixed export cost  $f_x$  and variable transport cost  $\tau$
- Fixed cost of production  $f$
- Choice of two technologies:  $h$  or  $l$ 
  - ▶ higher technology has a higher fixed cost  $\eta f$  and a lower marginal cost  $\frac{1}{\gamma\varphi}$
- Two cost functions:

$$TC_l(q, \varphi) = f + \frac{q}{\varphi}$$
$$TC_h(q, \varphi) = f\eta + \frac{q}{\varphi\gamma}$$

# Firm behavior

- Preferences are CES with elasticity of substitution  $\sigma$

$$q(\omega) = EP^{\sigma-1}p(\omega)^{-\sigma}$$

- Denote by  $\rho = \frac{\sigma-1}{\sigma}$  the mark-up
- Firms have 4 options with 4 profits associated:

- ▶ Produce for domestic market and tech  $l$

$$\pi_l^d(\varphi) = \frac{1}{\sigma} E(P\rho)^{\sigma-1} \varphi^{\sigma-1} - f$$

- ▶ Produce for domestic market and tech  $h$

$$\pi_h^d(\varphi) = \frac{1}{\sigma} E(P\rho)^{\sigma-1} \varphi^{\sigma-1} \gamma^{\sigma-1} - f\eta$$

## Firm behavior (cont.)

- Dom+Export and tech  $l$ :

$$\pi_l^x(\varphi) = \left(1 + \tau^{1-\sigma}\right) \frac{1}{\sigma} E(P\rho)^{\sigma-1} \varphi^{\sigma-1} - f - f_x$$

- Dom+export and tech  $h$

$$\pi_h^x(\varphi) = \left(1 + \tau^{1-\sigma}\right) \frac{1}{\sigma} E(P\rho)^{\sigma-1} \varphi^{\sigma-1} \gamma^{\sigma-1} - f\eta - f_x$$

- Notice complementarity between three objects:

$$\left(1 + \tau^{1-\sigma}\right) \varphi^{\sigma-1} \gamma^{\sigma-1}$$

- So we know that the least productive firm will choose dom+tech  $l$  and most productive firm will choose export+tech  $h$
- Bustos kills option Dom+tech  $h$  by choosing fixed costs
- Three cutoffs only:
  - ▶ exit  $\varphi^*$
  - ▶ exporting  $\varphi^x$
  - ▶ exporting+high tech  $\varphi^h$

# Cutoffs (graphically)

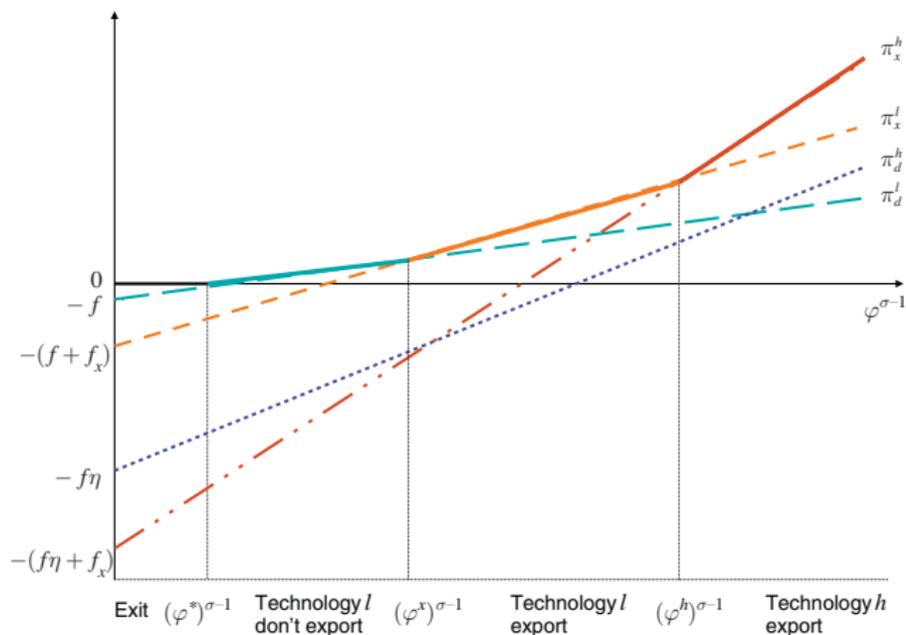


FIGURE 1. EXPORTING AND TECHNOLOGY CHOICES

# Cutoffs (algebra)

- Exit (as in Melitz):

$$\pi_l^d(\varphi^*) = 0$$

- Export:

$$\pi_l^x(\varphi^x) = \pi_l^d(\varphi^x)$$

- ▶ which implies:

$$\varphi^x = \varphi^* \tau \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}}$$

- Export + high tech

$$\pi_l^x(\varphi^h) = \pi_h^x(\varphi^h)$$

- ▶ which implies

$$\varphi^h = \varphi^* \frac{1}{(1 + \tau^{1-\sigma})^{\frac{1}{\sigma-1}}} \left( \frac{\eta - 1}{\gamma^{\sigma-1} - 1} \right)^{\frac{1}{\sigma-1}}$$

## Cutoffs (algebra) (cont.)

- Notice that low  $\tau$  implies high tech firms are a larger share of total active firms (complementarity between exporting and productivity)
- We can also find the share of high tech firms out of total exporters:

$$\frac{\varphi^h}{\varphi^x} = \left( \frac{\tau^{1-\sigma}}{1 + \tau^{1-\sigma}} \frac{\frac{\eta-1}{\gamma^{\sigma-1}-1}}{\frac{f_x}{f}} \right)^{\frac{1}{\sigma-1}}$$

- Condition for  $\frac{\varphi^h}{\varphi^x} > 1$  is that cost of high tech adoption  $\eta$  is large enough relative to  $f_x$
- We are skipping derivation of cutoff  $\varphi^*$  and other equilibrium variables like  $P$  and mass of firms  $M$

# Predictions of trade liberalization

- As  $\tau$  falls:
  - ▶ the fraction of surviving firms that export and use high tech increase
  - ▶ expected profits increase (like Melitz)
  - ▶ price index falls (like Melitz)
  - ▶ exit cutoff increases (like Melitz)
  - ▶ export cutoff decreases
  - ▶ cutoff for high tech decreases

# Trade liberalization in Mercosur

- Unexpected market-oriented reforms after Menem campaigned on populist platform (elected in 1989)
- Agreement in 1991, custom union in 1995
- Generalized, linear and automatic tariff cuts, instead of industry by industry
- Exports to Brazil quadrupled (rest of world export up by only 60%) between 1992 and 1996
- To avoid endogeneity of tariff change:  $\Delta\tau = \tau_{1991}$
- Industry is 4-digit ISIC code

TABLE 1—BRAZIL AND ARGENTINA'S M.F.N. TARIFFS

	Average	Standard deviation	Minimum	Maximum	Industries
Brazil's m.f.n. tariffs in 1991	0.29	0.17	0.00	0.84	101
Brazil's m.f.n. tariffs in 1992	0.24	0.13	0.00	0.63	104
Argentina's m.f.n. tariffs in 1992					
Outputs	0.13	0.06	0.00	0.22	102
Inputs	0.11	0.03	0.01	0.17	101
Change in Argentina's tariffs w.r.t. the world 1992–1996					
Outputs	0.01	0.05	–0.10	0.14	104
Inputs	0.01	0.02	–0.03	0.06	101

*Note:* Industries refer to 4-digit ISIC industries with available tariff data.

## Firm-level data

- Firm-level data from ENIT (Encuesta nacional de innovacion y conducta tecnologica de las empresas argentinas)
- Survey period 1992-1996 conducted in 1997
- Sample is 1639 industrial firms (representative of firms with more than 10 employees)
  - ▶ 15% of firms, 90% of output
  - ▶ use balanced panel of 1380 firms that exist both in 1992 and 1996
- Two variables:
  - ▶ spending on technology variable: computers+software, payments for tech transfer and patents, spending on equipment, material and labor related to innovation activities within the firm
  - ▶ index: out of 9 activities, how many the firm answered yes (process innovation, etc.)
- Employment by education group

# Fall in transport cost

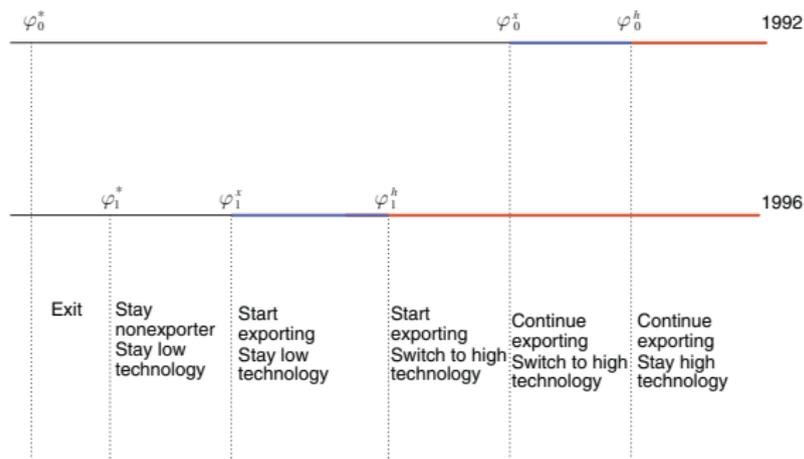


FIGURE 2. EFFECT OF FALLING VARIABLE TRADE COSTS

# Predictions

- Continuing exporters have higher spending on tech per worker than never-exporters (0.33 log points  $\approx 39\%$ )
  - ▶ they increase spending faster (0.28)
- New exporters not more technologically advanced than never exporters (not significant positive)
  - ▶ they increase spending faster (0.375)
- So far this only documents a correlation between export decision and technology upgrading decision, no causality
  - ▶ Use differential tariff change across industries to identify effect

# Difference between Exporters and Non-exporters

TABLE 2—DIFFERENCES BETWEEN EXPORTERS AND NONEXPORTERS

	Levels in 1992		Changes 1992–1996		Number of firms
	Continuing exporters	New exporters	Continuing exporters	New exporters	
Firm characteristic					
Sales	1.770 [0.089]***	1.032 [0.103]***	0.180 [0.040]***	0.254 [0.049]***	1,380
Employment	1.509 [0.074]***	0.870 [0.089]***	0.021 [0.026]	0.183 [0.035]***	1,380
Spending on technology per worker	0.335 [0.149]**	0.193 [0.175]	0.277 [0.106]***	0.375 [0.117]***	894
Skill intensity	5.147 [1.034]***	1.471 [1.104]	1.238 [0.377]***	1.252 [0.471]***	1,380

*Notes:* Robust standard errors in brackets. Exporter premia are estimated from a regression of the form: In  $Y_{ij} = \alpha_1 NE_{ij} + \alpha_2 EE_{ij} + \alpha_3 EN_{ij} + I_j + \varepsilon_{ij}$  where  $i$  indexes firms,  $j$  indexes four-digit ISIC industries;  $NE$  are new exporters (231 firms),  $EE$  are continuing exporters (556 firms),  $EN$  are firms that exported in 1992 but didn't in 1996 (27 firms) and the reference category relative to which differences are estimated is nonexporters (566 firms);  $I$  are industry dummies, and  $Y$  is the firm characteristic for which the differences are estimated.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

## Using tariff changes

- Since all tariffs are expected to go to zero in 1995:

$$\Delta\tau = \tau_{1995} - \tau_{1991} = -\tau_{1991}$$

- Correlation of initial tariff with other industry characteristics and different trends. To address this problem:
  - ▶ include two-digit industry dummies in the differenced equations (control for trends at the 2-digit level)
  - ▶ include controls for industry-level variables: elasticity of demand, capital and skill intensity
- Also control for Argentinian tariff change
- Important: effect of tariff cuts different by size of firm
  - ▶ divide firms into quartiles based on size of firm (sales) relative to industry mean

## Export Entry specification

- Entry in export market: estimate a linear probability model

$$EXP_{ijst} = \beta_{\tau^x} \tau_{jt} + \alpha_{st} + \mu_i + \varepsilon_{ijst}$$

where  $i$  is plant,  $j$  is 4-digit sector,  $s$  is 2-digit sector and  $t$  is time (1992 or 1996)

- Incidental parameter problem (Neyman and Scott, 1948) makes estimation with Probit and plant-level fixed effects inconsistent (can still do two-digit ISIC dummies)
  - ▶ problem arises in non-linear models when number of incidental parameters (e.g. fixed effect) rises with the number of observations
- If using linear probability model then can take first differences since panel is balanced

$$\Delta EXP_{ijs} = \beta_{\tau^x} \Delta \tau_j^x + \Delta \alpha_s + \Delta \varepsilon_{ijs}$$

# Entry in Export Market

TABLE 3—ENTRY IN THE EXPORT MARKET

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel A: Full sample. Dependent variable: change in export status 1996–1992</i>								
Δ Brazil's tariffs	-0.421 [0.084]***	-0.416 [0.080]***	-0.407 [0.081]***	-0.340 [0.106]***	-0.466 [0.097]***	-0.325 [0.091]***	-0.362 [0.093]***	-0.533 [0.141]***
Δ Argentina's tariffs w.r.t. world			0.207 [0.423]	0.176 [0.409]	-0.003 [0.340]			
Outputs				1.126 [0.886]	1.543 [0.693]**			
Inputs								
Δ Arg.'s tariffs w.r.t. Brazil						-0.507 [0.331]	-0.780 [0.300]**	-0.269 [0.344]
Outputs							1.215 [0.599]**	0.702 [0.524]
Inputs								
Industry-level controls					yes			yes
Firm-level controls		yes						
2-digit ISIC industry dummies	yes							
Observations	1,380	1,380	1,380	1,348	1,348	1,374	1,342	1,342
R <sup>2</sup>	0.03	0.04	0.04	0.04	0.05	0.04	0.04	0.05
<i>Panel B: Full sample. Dependent variable: export status in 1996</i>								
Δ Brazil's tariffs	-0.291 [0.071]***	-0.285 [0.077]***	-0.278 [0.074]***	-0.203 [0.084]**	-0.323 [0.101]***	-0.262 [0.101]**	-0.281 [0.111]**	-0.490 [0.144]**
Export status in 1992	0.642 [0.023]***	0.543 [0.028]***	0.543 [0.028]***	0.544 [0.028]***	0.546 [0.028]***	0.542 [0.028]***	0.545 [0.029]***	0.544 [0.028]***
R <sup>2</sup>	0.46	0.50	0.50	0.50	0.50	0.50	0.50	0.50
<i>Panel C: Sample of nonexporters in 1992. Dependent variable: export status in 1996</i>								
Δ Brazil's tariffs	-0.411 [0.108]***	-0.446 [0.124]***	-0.457 [0.122]***	-0.294 [0.123]**	-0.447 [0.138]***	-0.330 [0.150]**	-0.357 [0.175]**	-0.604 [0.202]**
Observations	797	797	797	781	781	797	781	781
R <sup>2</sup>	0.04	0.16	0.16	0.16	0.17	0.16	0.16	0.17

*Notes:* Standard errors are clustered at the 4-digit ISIC industry level. Δ denotes a change in a variable during the period 1992–1996. Firm-level controls include employment measured in efficiency units, sales per worker, and skill intensity, all measured in the initial year (1992). Industry-level controls include demand elasticity, skill intensity, and capital intensity of the 4-digit ISIC industry in the United States. In panel B remaining controls and number of observations are the same as in the corresponding column in panel A. In panel C controls are the same as in the corresponding column in panel A.

## Remarks

- Magnitude: average tariff cut of 24% leads to increased probability of exporting by 10 pp
- Robust to controlling for: change in Argentinian tariffs, initial employment, sales per worker, skill intensity and industry-level controls
- Potential problem: sunk costs in exporting make export decision in 1996 dependent on export in 1992
  - ▶ cannot control for initial export status because  $EXP_{1996}$  would enter both right and left-hand side
  - ▶ run specification in levels

$$EXP_{ijs1996} = \beta_{\tau^x} \Delta \tau_j^x + \delta EXP_{ij1992} + \alpha_s + \varepsilon_{ijs1996}$$

- ▶ result by Angrist and Pischke (2009): first-difference and lagged dependent value regression coefficients will bracket the true value of  $\beta$

# Entry in Export by Quartile

TABLE 4—ENTRY IN THE EXPORT MARKET BY QUARTILE OF THE FIRM SIZE DISTRIBUTION

Dependent variable indicated in columns	Full sample						Sample of nonexporters in 1992		
	Change in export status 1996–1992			Export status in 1996			Export status in 1996		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta$ Brazil's tariffs									
× first size quartile	-0.331 [0.185]*	-0.388 [0.188]**	-0.442 [0.198]**	-0.125 [0.170]	-0.159 [0.179]	-0.293 [0.190]	-0.358 [0.182]*	-0.372 [0.202]*	-0.436 [0.226]*
× second size quartile	-0.327 [0.146]**	-0.367 [0.195]*	-0.412 [0.219]*	-0.146 [0.175]	-0.170 [0.212]	-0.306 [0.228]	-0.261 [0.230]	-0.258 [0.260]	-0.318 [0.278]
× third size quartile	-0.722 [0.166]***	-0.784 [0.151]***	-0.832 [0.203]***	-0.541 [0.155]***	-0.576 [0.152]***	-0.702 [0.199]***	-0.774 [0.242]***	-0.720 [0.239]***	-0.782 [0.287]***
× fourth size quartile	-0.356 [0.175]**	-0.429 [0.179]**	-0.483 [0.204]**	-0.286 [0.119]**	-0.339 [0.146]**	-0.474 [0.162]***	-0.276 [0.342]	-0.323 [0.390]	-0.377 [0.379]
Controls									
Export status in 1992				0.553 [0.027]***	0.558 [0.027]***	0.557 [0.028]***			
$\Delta$ Arg.'s tariffs									
w.r.t. world		yes			yes			yes	
w.r.t. Brazil			yes			yes			yes
Industry-level controls		yes	yes		yes	yes		yes	yes
Firm-level controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
2-digit ISIC industry dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1,380	1,348	1,342	1,380	1,348	1,342	797	781	781
R <sup>2</sup>	0.03	0.05	0.04	0.50	0.50	0.50	0.15	0.16	0.16

Notes: Standard errors are clustered at the 4-digit ISIC industry level.  $\Delta$  denotes a change in a variable during the period 1992–1996. Controls for changes in Argentina's tariffs with respect to the world and Brazil include both output and input tariffs. Industry-level controls include demand elasticity, skill intensity, and capital intensity of the 4-digit ISIC industry in the United States. Firm-level controls include dummies for the second, third, and fourth quartile of the firm-size distribution in the initial year (1992).

\*\*\* Significant at the 1 percent level.

# Technology Adoption

- Data available for all years 1992-1996, but use only before and after information (otherwise need to cluster at the industry-post level)
- Estimating equation:

$$\Delta \log ST_{ijs} = \beta_{\tau^x} \Delta \tau_j^x + \beta_{\tau^m} \Delta \tau_j^m + \Delta \varepsilon_{ijs}$$

- Magnitude: average tariff reduction of tariff (24pp) induced increase in spending by 0.24 log points (1.079x0.24)
- Effect of Argentina's import tariffs on inputs and outputs go in the same direction, but are never significant
- Caveat: estimation done only on firms that report positive spending on technology (894 out of 1380) (why not use zeros?)
- Technology Index: average tariff reduction increases by 19pp the share of firms answering yes to questions about technology upgrading

# Technology Adoption: Spending

TABLE 5—TECHNOLOGY ADOPTION

Dependent variable: change in log (spending on technology)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta$ Brazil's tariffs	-1.079 [0.350]***	-1.077 [0.345]***	-1.051 [0.325]***	-1.079 [0.340]***	-0.939 [0.383]**	-1.437 [0.447]***	-1.435 [0.483]***	-1.449 [0.643]**
$\Delta$ Argentina's tariffs w.r.t. world								
Outputs			0.556 [1.116]	0.599 [1.147]	0.629 [1.186]			
Inputs				-0.762 [3.211]	-0.897 [3.040]			
$\Delta$ Argentina's tariffs w.r.t. Brazil								
Outputs						2.051 [1.322]	2.254 [1.367]	2.538 [1.881]
Inputs							-0.361 [2.785]	-0.739 [3.034]
Industry-level controls					yes			yes
Firm-level controls		yes	yes	yes	yes	yes	yes	yes
2-digit ISIC industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	894	894	894	872	872	892	870	870
R <sup>2</sup>	0.03	0.05	0.05	0.05	0.06	0.05	0.05	0.06

*Notes:* Standard errors are clustered at the 4-digit ISIC industry level.  $\Delta$  denotes a change in a variable during the period 1992–1996. Firm-level controls include employment measured in efficiency units, sales per worker, and skill intensity, all measured in the initial year (1992). Industry-level controls include demand elasticity, skill intensity, and capital intensity of the 4-digit ISIC industry in the United States.

# Technology Adoption: Index of Technology

TABLE 6—PRODUCT AND PROCESS INNOVATION

Dependent variable indicated in columns	Product and process innovation			Product innovation			Production process innovation		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta$ Brazil's tariffs	-0.236 [0.104]**	-0.299 [0.090]***	-0.400 [0.117]***	-0.293 [0.116]**	-0.346 [0.098]***	-0.438 [0.116]***	-0.183 [0.100]*	-0.261 [0.093]***	-0.357 [0.127]***
$\Delta$ Arg.'s tariffs w.r.t. world									
Outputs		-0.191 [0.271]			-0.184 [0.284]			-0.213 [0.295]	
Inputs		0.241 [0.618]			0.086 [0.740]			0.360 [0.574]	
$\Delta$ Arg.'s tariffs w.r.t. Brazil									
Outputs			0.530 [0.308]*			0.626 [0.335]*			0.341 [0.326]
Inputs			-0.263 [0.554]			-0.584 [0.578]			0.187 [0.586]
Industry-level controls		yes	yes		yes	yes		yes	yes
Firm-level controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
2-digit ISIC industry dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1,301	1,269	1,263	1,312	1,280	1,274	1,319	1,287	1,281
R <sup>2</sup>	0.24	0.25	0.26	0.22	0.24	0.24	0.22	0.23	0.23

*Notes:* Standard errors are clustered at the 4-digit ISIC industry level.  $\Delta$  denotes a change in a variable during the period 1992–1996. Firm-level controls include employment measured in efficiency units, sales per worker, and skill intensity, all measured in the initial year (1992). Industry-level controls include demand elasticity, skill intensity, and capital intensity of the 4-digit ISIC industry in the United States.

# Technology Adoption by Quartile

TABLE 7—TECHNOLOGY ADOPTION BY QUARTILE OF THE FIRM SIZE DISTRIBUTION

Dependent variable indicated in columns	Change in spending on technology			Product and process innovation		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta$ Brazil's tariffs						
× First size quartile	-0.872 [0.604]	-0.725 [0.570]	-1.235 [0.755]	-0.041 [0.116]	-0.076 [0.113]	-0.165 [0.143]
× Second size quartile	-0.846 [0.569]	-0.662 [0.629]	-1.171 [0.828]	-0.199 [0.149]	-0.227 [0.145]	-0.326 [0.163]**
× Third size quartile	-2.106 [0.609]***	-1.927 [0.627]***	-2.424 [0.886]***	-0.359 [0.133]***	-0.403 [0.146]***	-0.465 [0.171]***
× Fourth size quartile	-0.372 [0.534]	-0.146 [0.563]	-0.648 [0.773]	-0.190 [0.130]	-0.229 [0.132]*	-0.319 [0.154]**
Controls						
$\Delta$ Arg.'s tariffs w.r.t. world		yes			yes	
$\Delta$ Arg.'s tariffs w.r.t. Brazil			yes			yes
Industry-level controls		yes	yes		yes	yes
Firm-level controls	yes	yes	yes	yes	yes	yes
2-digit ISIC industry dummies	yes	yes	yes	yes	yes	yes
Observations	894	872	870	1,301	1,269	1,263
R <sup>2</sup>	0.05	0.06	0.06	0.20	0.20	0.20

Notes: Standard errors are clustered at the 4-digit ISIC industry level.  $\Delta$  denotes a change in a variable during the period 1992–1996. Controls for changes in Argentina's tariffs with respect to the world and Brazil include both output and input tariffs. Industry-level controls include demand elasticity, skill intensity, and capital intensity of the 4-digit ISIC industry in the United States. Firm-level controls include dummies for the second, third, and fourth quartile of the firm-size distribution in the initial year (1992).