Appendices for
Trade Liberalization, Exports and Technology Upgrading: Evidence in the Impact of MERCOSUR on Argentinean Firms

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This document contains Theory Appendices A, B and C and Data Appendices D and E.

Appendix A: Theoretical Model, Industry Equilibrium

A.1. Proof that the sorting of firms in technology and exporting choices are the ones described in Figure 1

To solve for the optimal exporting and technology choices as a function of productivity I split the productivity space in segments where exporting dominates non exporting regardless of technology choice and vice versa, based on the following propositions:

Proposition 1 If a firm finds exporting profitable under technology *l*, then that firm also finds exporting profitable under technology *h*:

$$\pi_l^x(\varphi) > \pi_l^d(\varphi) \Rightarrow \pi_h^x(\varphi) > \pi_h^d(\varphi)$$

Proof

$$\pi_l^x(\varphi) > \pi_l^d(\varphi) \Rightarrow \tau^{1-\sigma}\frac{1}{\sigma}E(P\rho)^{\sigma-1}\varphi^{\sigma-1} > f_x \Rightarrow$$

$$\tau^{1-\sigma}\frac{1}{\sigma}E(P\rho)^{\sigma-1}\varphi^{\sigma-1}\gamma^{\sigma-1} > f_x \Rightarrow \pi_h^x(\varphi) > \pi_h^d(\varphi)$$

Then, if φ^x is defined as the level of productivity above which a firm using technology *l* finds exporting profitable $[\pi_l^d(\varphi_x) = \pi_l^x(\varphi_x)]$, Proposition 1 implies that all firms with $\varphi > \varphi_x$ export, regardless of technology choice.

Proposition 2 If a firm finds does not find technology *h* profitable when exporting, that same firm does not find technology *h* profitable when only serving the domestic market:

$$\pi_l^x(\varphi) > \pi_h^x(\varphi) \Rightarrow \pi_l^d(\varphi) > \pi_h^d(\varphi)$$

Proof

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

$$\frac{1}{\sigma}E(P\rho)^{\sigma-1}\varphi^{\sigma-1}\left(\gamma^{\sigma-1}-1\right) < f(\eta-1) \Rightarrow \pi_l^d(\varphi) > \pi_h^d(\varphi)$$

Then, if φ^h is defined as the level of productivity above which an exporter finds adoption of technology h profitable [$\pi_h^x(\varphi_h) = \pi_l^x(\varphi_h)$], Proposition 2 implies that all firms with $\varphi < \varphi^h$ use technology *l*, regardless of export status.

There are two possible configurations for the technology and export status decisions:

1. $\varphi^x < \varphi^h$

In this case, propositions 1 and 2 imply that firms in the range

- $\varphi^* < \varphi < \varphi^x$ only serve the domestic market and use technology l
- $\varphi^x < \varphi < \varphi^h$ use technology l but also export
- $\varphi^h < \varphi$ both export and use technology h

2. $\varphi^h < \varphi^x$

In this case there are two possible situations:

2.a. The marginal firm using technology *h* is only serving the domestic market. Thus, in equilibrium there are firms only serving the domestic market and using technology *l*, firms only serving the domestic market and using technology *h*, and exporters using technology *h*. That is, there are no exporters using technology *l*.

2.b The marginal firm using technology *h* is an exporter. In equilibrium there are only domestic firms using the low technology and exporters using the high technology. That is, in this case there are no exporters using technology *l* either.

A.2. Solution for expected profits $\bar{\pi}$

To solve for expected profits, first note that they can be expressed as:

$$\bar{\pi} = \bar{\pi}_d(\tilde{\varphi}_d) + p_x \bar{\pi}_x(\tilde{\varphi}_x)$$

where $\bar{\pi}_d(\tilde{\varphi}_d)$ are expected profits from domestic sales:

$$\text{(A.1)} \qquad \bar{\pi}_d = \frac{1}{\sigma} E(P\rho)^{\sigma-1} \tilde{\varphi}_d^{\,\sigma-1} - f - f(\eta - 1)\frac{1-G(\varphi^h)}{1-G(\varphi^*)}$$

and $\tilde{\varphi}_d$ is the expected productivity level of home surviving firms:

$$\tilde{\varphi}_d = \left(\int_{\varphi^* < \varphi < \varphi_h} \varphi^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi^*)} d\varphi + \int_{\varphi_h < \varphi} \gamma^{\sigma-1} \varphi^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi^*)} d\varphi \right)^{\frac{1}{\sigma-1}}$$

$p_x = [1-G(\varphi^x)]/[1-G(\varphi^*)]$ is the probability of exporting, $\bar{\pi}_x(\tilde{\varphi}_x)$ are expected exporting profits:

$$\bar{\pi}_x(\tilde{\varphi}_x) = \frac{1}{\sigma} E(P\rho)^{\sigma-1} \tau^{1-\sigma} \left[\tilde{\varphi}_x(\varphi^*) \right]^{\sigma-1} - f_x$$

and $\tilde{\varphi}_x$ is the expected productivity level of home firms that export:

$$\tilde{\varphi}_x = \left[\int_{\varphi_x < \varphi < \varphi_h} \varphi^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi_x)} d\varphi + \int_{\varphi_h < \varphi} \gamma^{\sigma-1} \varphi^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi_x)} d\varphi \right]^{\frac{1}{\sigma-1}}$$

I first express $\bar{\pi}$ as a function of the exit cutoff. $\bar{\pi}_d(\tilde{\varphi}_d)$ can be written as a function of the exit cutoff substituting for the solution for $\varphi^h(\varphi^*)$ (eq. 3) in eq. (A.1) and using the zero profit condition for the marginal firm (eq. 1) to eliminate the aggregate variables (E and P) in eq. (A.1). $\bar{\pi}_x(\tilde{\varphi}_x)$ can also be written as a function of the exit cutoff by substituting for the solution for $\varphi^x(\varphi^*)$ and $\varphi^h(\varphi^*)$ (eqs. 2 and 3) in the definition of $\tilde{\varphi}_x$ to obtain $\tilde{\varphi}_x(\varphi^*)$ and also using the zero profit condition for the marginal firm in the foreign country (that is identical to the one at home, eq. 1, because of the symmetry assumption) to eliminate the aggregate variables (E and P). After some algebra, the solution for expected profits is given by equation (5).

Appendix B: Theoretical Model, Comparative Statics

B.1. $\partial \bar{\pi} / \partial \tau < 0$

$\partial \bar{\pi} / \partial \tau = \{(\sigma-1)/[k-(\sigma-1)]\} f \dfrac{\partial \Delta}{\partial \tau} < 0$ because $\sigma > 1$, $k > (\sigma-1)$ and

$$\frac{\partial \Delta}{\partial \tau} = -k\tau^{-k-1} \left(\frac{f_x}{f} \right)^{\frac{-k}{\sigma-1}} \frac{f_x}{f} - k(1+\tau^{1-\sigma})^{\frac{k}{\sigma-1}-1} \tau^{-\sigma} \left(\frac{\eta-1}{\gamma^{\sigma-1}-1} \right)^{-\frac{k}{\sigma-1}} (\eta-1) < 0 .$$

B.2 $\partial P / \partial \tau > 0$

This can be directly seen from equation (9) where the sign of $\partial P / \partial \tau$ is the opposite of the sign of $\partial \Delta / \partial \tau$.

B.3 $\partial\varphi^* / \partial\tau < 0$

This can be seen from equation (6) where the sign of $\partial\varphi^* / \partial\tau$ is the same as the sign of $\partial\Delta / \partial\tau$.

B.4 $\partial\varphi_x / \partial\tau > 0$

Differentiate equation (7) w.r.t. τ:

$$\frac{\partial\varphi^x}{\partial\tau} = \left[\frac{f}{\delta f_e}\left(\frac{\sigma-1}{k-(\sigma-1)}\right)\right]^{\frac{1}{k}}\left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}\frac{\partial\left(\Delta_t^{\frac{1}{k}}\tau\right)}{\partial\tau}$$

then, as $\sigma > 1$ and $k > (\sigma-1)$, it is sufficient to consider the sign of the last term. As

$$\Delta_t^{\frac{1}{k}}\tau = \left\{\tau^k + \left(\left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}\right)^{-k}\frac{f_x}{f} + \tau^k\left(1+\tau^{1-\sigma}\right)^{\frac{k}{\sigma-1}}\left[\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{-\frac{k}{\sigma-1}}(\eta-1)\right]\right\}^{\frac{1}{k}}$$

the last term is:

$$\text{(B.1)} \qquad \frac{\partial\left(\Delta_t^{\frac{1}{k}}\tau\right)}{\partial\tau} = \frac{1}{k}\left(\Delta_t^{\frac{1}{k}}\tau\right)^{\frac{1}{k}-1}\left\{k\tau^{k-1} + A\left[\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{-\frac{k}{\sigma-1}}(\eta-1)\right]\right\}$$

where $A = k\tau^{k-1}\left(1+\tau^{1-\sigma}\right)^{\frac{k}{\sigma-1}} - \tau^k k\left(1+\tau^{1-\sigma}\right)^{\frac{k}{\sigma-1}-1}\tau^{-\sigma} > 0$ because:

$$A > 0 \Leftrightarrow k\tau^{k-1}\left(1+\tau^{1-\sigma}\right)^{\frac{k}{\sigma-1}} > \tau^k k\left(1+\tau^{1-\sigma}\right)^{\frac{k}{\sigma-1}-1}\tau^{-\sigma} \Leftrightarrow 1 > \frac{\tau^{1-\sigma}}{(1+\tau^{1-\sigma})}$$

Then, as all terms in equation (B.1) are positive, $\partial(\Delta_t^{\frac{1}{k}}\tau)/\partial\tau > 0$, and then $\partial\varphi_x / \partial\tau > 0$.

B.5 $\partial\varphi_h / \partial\tau > 0$

First, note that as $k > 0$, $sign\,(\partial\varphi_h / \partial\tau) = sign\{\partial[(\varphi_h)^k] / \partial\tau\}$

$$(\varphi_h)^k = \left[\frac{f}{\delta f_e}\left(\frac{\sigma-1}{k-(\sigma-1)}\right)\right]\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{\frac{k}{\sigma-1}}\Delta_t\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}$$

$$\frac{\partial\left[(\varphi_h)^k\right]}{\partial\tau} = \left[\frac{f}{\delta f_e}\left(\frac{\sigma-1}{k-(\sigma-1)}\right)\right]\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{\frac{k}{\sigma-1}}\frac{\partial\left[\Delta_t\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}\right]}{\partial\tau}$$

Then, it is sufficient to consider the sign of the derivative of the last term w.r.t. τ , where the last term is:

$$\Delta_t\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}} = \left\{\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}} + \left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}\tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} + \left[\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{-\frac{k}{\sigma-1}}(\eta-1)\right]\right\}$$

Then,

$$\frac{\partial\left[\Delta_t\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}\right]}{\partial\tau} = k\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}\left[\left(1+\tau^{1-\sigma}\right)^{-1}\tau^{-\sigma}\left(1+\tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}}\right) - \tau^{-k-1}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}}\right]$$

As $k\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}} > 0$, then the sign of $\partial\left[\Delta_t\left(1+\tau^{1-\sigma}\right)^{-\frac{k}{\sigma-1}}\right]/\partial\tau$ is the same as the sign of the last term: which I show below is strictly positive as long as $\tau^{\sigma-1}f_x > f$ which will be the case if trade costs are such that not all firms export:

$$\left(1+\tau^{1-\sigma}\right)^{-1}\tau^{-\sigma}\left(1+\tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}}\right) - \tau^{-k-1}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} > 0 \Leftrightarrow 1+\tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} > \left(1+\tau^{1-\sigma}\right)\tau^{\sigma-k-1}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}}$$

$$\Leftrightarrow 1+\tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} > \tau^{\sigma-k-1}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} + \tau^{-k}\frac{f_x}{f}^{\frac{\sigma-1-k}{\sigma-1}} \Leftrightarrow 1 > \frac{1}{\tau^{k-(\sigma-1)}}\frac{f}{f_x}^{\frac{k-(\sigma-1)}{\sigma-1}} \Leftrightarrow \tau^{\sigma-1}f_x > f$$

Appendix C: Theoretical Model, The Case Where All Firms Export

Suppose the marginal firm is an exporter. In this case φ^* would be defined by:

(C.1) $$\pi_l^x(\varphi^*) = 0 \Leftrightarrow \left(1+\tau^{1-\sigma}\right)\frac{1}{\sigma}E(P\rho)^{\sigma-1}\left(\varphi^*\right)^{\sigma-1} - f - f_x = 0$$

Then, the technology adoption cutoff would be

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

and expected profits would be

$$\bar{\pi}_t = \left(\frac{\sigma-1}{k-(\sigma-1)}\right)\left[f + f_x + \left(\left(\frac{\eta-1}{\gamma^{\sigma-1}-1}\right)^{\frac{1}{\sigma-1}}\right)^{-k}(f_h - f)\right]$$

Then, a reduction in τ would not affect expected profits. Thus, the exit cutoff would also remain unaffected. As a result, as can be seen in eq. (C.1) the price level would fall in such a way to offset the increase in revenues produced by the fall in τ. Then, the benefit of technology adoption (that is proportional to revenues) would not increase. The reason why this does not happen when not all firms export is that the reduction in τ produces an advantage for the more productive firms relative to the marginal firm, thus its positive impact on revenues is not offset by free entry.

Appendix D: Data Description

D.1 Methodology used to compute input tariffs

I computed input tariffs for each 4-digit-ISIC industry in a similar way as Mary Amiti and Jozef Konings (2007). The Input tariff for each industry is computed as weighted average of the tariffs of all inputs used, where the weights are based on the cost share of each input, according to the following formula:

$$\text{(D.1)} \qquad input\ tariff_{jt} = \sum_i w_{ij} \times tariff_{it} \qquad \text{where} \qquad w_{ij} = \frac{a_{ij}}{\sum_i a_{ij}}$$

where j indexes the 4-digit-ISIC industry for which the input tariff is computed; i indexes the 4-digit-ISIC industry producing the input, and t indexes time. w_{ij} denote the cost share of each input i in the production of output j, and a_{ij} is total expenditure in input i by industry j. These expenditure shares include both domestic and imported inputs, as the objective is to assign the relevant input tariff to each industry based on the inputs used, irrespective of whether these are imported or not.

I obtained data on a_{ij} directly from the "Use Matrix at Buyer Prices" computed by INDEC (the Argentinean government statistical agency) for the year 1997.[1] This is the closest year to the period under study (1992-1996) with available data, as the previous matrix was elaborated in 1973. The columns of the matrix correspond to economic *activities* demanding inputs and the rows to the cost of the inputs (*products*) demanded. For the industrial sector there are a total of 79 activities and 115 products (inputs) classified according to an ad-hoc classification (MIPAr97) that follows very closely the 4-digit-ISIC industry classification.

To calculate input tariffs according to formula (D.1) I constructed a correspondence between the MIPAr97 classification for products and the 4-digit-ISIC classification.[2] The construction of the

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[1] The data and description of the methodology used to compute the matrices are available on INDEC's website: http://www.indec.mecon.ar/principal.asp?id_tema=621.

[2] The MIPAr97 classification is in Spanish and I matched it to the 4-digit-SIC classification in English. When in doubt about the translation of some product or activity I used the translations available in the United Nations Classifications Registry online http://unstats.un.org/unsd/cr/registry/default.asp.

correspondence was straightforward as most MIPAr97 products had a single match and a few matched to more than one 4-digit-ISIC industry. In those cases I computed the product tariff as a weighted average of the tariffs of each of the 4-digit-ISIC-industry tariffs where weights were given by imports. With this information I applied formula (D.1) to find the input tariff corresponding to each MIPAr97 activity.

Next, to match the input tariff corresponding to each MIPAr97 activity to the firm-level dataset I constructed a correspondence between the MIPAr97 activity classification and the 4-digit-ISIC classification. The construction of this correspondence was also straightforward as the majority of MIPAr97 activities had a single match and some matched to more than one 4-digit-ISIC industry, in which case I assigned the same input tariff to both.

D.2 Discrete Measures of Technology Adoption

The survey (ENIT) includes the following 9 YES/NO questions referring to improvements and innovations achieved between 1992 and 1996:

Improvements in Products

1. Technological improvement of existing products
2. New product because of advances in scientific-technological basis
3. New product because of new production process
4. New product because of employment of new raw materials or intermediates
5. Product differentiation

Improvements in Production Process

1. Technological improvement of existing process for the same product
2. New process associated to advances in scientific-technological basis
3. New production process for new product
4. Machinery and equipment associated to new processes

D.3 Measures of Employment in Primary School Equivalents and Skill Intensity

I aggregated workers into two skill categories. Skilled workers (*S*) are college graduates plus tertiary education graduates converted to college equivalents.[3] Unskilled workers (*U*) are high school graduates converted to primary school equivalents.[4] The conversion of workers to college and primary school equivalents was done using the 1992 industrial sector wage premia.[5] Employment in primary school equivalents is computed as: $L_t = S_t \ (w_s / w_u)_{1992} + U_t$ where t=1992, 1996.

Skill intensity is measured as the share of skilled labor in employment in primary school equivalents:

$$\left(\frac{L_s}{L} \right)_t = \frac{S_t \ (w_s / w_u)_{1992}}{S_t \ (w_s / w_u)_{1992} + U_t}$$

where $t = 1992$, 1996. As skilled labor is weighted by the skill premium in 1992, changes in this share only reflect changes in quantities of skilled and unskilled labor, and not changes in the skill premium.

D.4 Proxy for Initial Productivity

In the model heterogeneity is given by labor productivity holding technology constant (φ), which is not observable in the data. The information in the survey does not allow to estimate a measure of productivity by inference from the residual in the production function because it lacks

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[3] College graduates completed 5 to 6 years of education after high school, while tertiary graduates completed 3 years of education after high school.

[4] The survey classifies workers according to education but although it distinguishes between engineers, other college and tertiary degrees it does not distinguish within the categories of high school graduates and primary school graduates. These last two categories are pooled together for non-production and R&D workers and are divided into "skilled and specialized" and "unskilled" for production workers. As all the analysis in this paper is performed pooling high school and primary school workers into the unskilled labor category this does not present inconveniences, except that it affects the weighting of these types of workers to convert them in primary school equivalents. For this purpose workers have been assigned into one of these categories by assuming that the overall share of high school and primary school workers is the same as the one reported in the next wave of this survey (1998-2001) that does differentiate between these educational categories. Then, workers reported as high school or primary school workers in non-production and R&D are assigned in a fraction 0.46 to high school graduates. For production workers, "skilled and specialized" workers are also assigned in a fraction 0.46 to high school graduates while "unskilled" workers are assigned to primary school graduates. Alternative assignments or measures of the relative employment of skilled workers unweighted by skill premiums give similar results to the ones reported.

[5] Estimated by mincerian regressions from Household Survey data in Sebastian Galiani and Guido Porto (forthcoming) and Leonardo Gasparini, Mariana Marchionni and Walter Sosa Escudero (2005).

information on value added and a long-enough series of investment to construct a measure of the capital stock. As a proxy for initial productivity, I use initial firm size in terms of (log) employment in primary school equivalents relative to the 4-digit-industry average. Alternatively (log) domestic sales relative to the 4-digit-industry could be used as a proxy for initial productivity. I prefer the employment measure because it reflects value-added better than sales, as long as there are differences in the level of vertical integration across firms.

D.5 Sector-level measures of capital and skill intensity in the U.S. from the NBER productivity database.

Average capital and skill intensity in the industry in the U.S. in the 1980's obtained from the NBER productivity database. The measure of capital intensity is capital (real equipment plus real structures) per worker, although other measures like only real equipment capital per worker, or capital over value added provide similar results. The measure of skill intensity is the ratio of non-production to production workers in the industry, although the relative wage share of non-production workers was also used providing similar results.

Table D.1

Summary Statistics

ETIA Panel, Year 1992.

	Non-exporters	Exporters	All	Observations
Employment	122.571	376.237	229.736	1380
	[8.949]	[24.839]	[12.169]	
Employment in primary school equivalents	142.457	457.659	275.618	1380
	[19.981]	[30.882]	[14.860]	
Sales	9,609.766	40,385.239	22,611.288	1380
	[678.182]	[4,510.816]	[1,987.166]	
Skill intensity	11.923	19.302	15.041	1380
	[0.552]	[0.712]	[0.449]	
Spending in technology per worker	0.315	0.861	0.546	1380
	[0.036]	[0.111]	[0.052]	
Investment in capital goods per worker	3.308	3.497	3.388	1380
	[0.832]	[0.455]	[0.518]	
Spending in technology per worker / ST>0	0.579	1.048	0.825	913
	[0.063]	[0.133]	[0.076]	
Investment in capital goods per worker / I>0	5.129	4.152	4.652	1005
	[1.284]	[0.535]	[0.707]	
Index of product and process innovation	0.316	0.466	0.381	1301
	[0.011]	[0.013]	[0.008]	
Index of product innovation	0.306	0.449	0.368	1312
	[0.011]	[0.013]	[0.009]	
Index of production process innovation	0.327	0.482	0.394	1319
	[0.012]	[0.014]	[0.009]	
Export share of sales/ Exports >0		0.159		583
		[0.010]		

Notes: Standard errors of means in parentheses. Employment in number of workers, employment in primary school equivalents in number of primary school workers, sales in thousands of 1992 pesos (exchange rate: 1 peso / US$ 1), spending in technology per worker and investment in capital goods per worker in thousands of 1992 pesos per worker in efficiency units. Further detail on dataset and variable definitions in section 2.B of text and Appendix D.

Table D.2 : Firms per Quartile of the Firm Size Distribution in 1992

Quartile	Full Sample	Sample with data on innovation index	Simple with positive ST in 1992-1996
Panel A: Number of firms in the sample per size quartile			
1	345	328	127
2	345	323	211
3	345	326	262
4	345	324	294
Total	1380	1301	894
Panel B: Percent of total observations in the sample			
1	0.25	0.25	0.14
2	0.25	0.25	0.24
3	0.25	0.25	0.29
4	0.25	0.25	0.33
Total	1.00	1.00	1.00

Note: The measure of firm size used to define quartiles is (log) employment in primary school equivalents relative to the 4-digit-ISIC Industry mean in 1992.

Appendix E: Suplementary Tables

Table E.1: Spending in Technology per worker

Dependent variable: change in log (spending in technology per worker) 1996-1992

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Change in Brazil's tariffs	-1.066	-1.038	-0.957	-1.037	-0.870	-1.309	-1.270	-1.213
	[0.333]***	[0.334]***	[0.314]***	[0.299]***	[0.336]**	[0.448]***	[0.505]**	[0.658]*
Change in Arg.'s tariffs w.r.t. world								
Outputs			1.703	1.806	1.909			
			[1.057]	[1.091]	[1.113]*			
Inputs				-1.743	-2.125			
				[2.474]	[2.619]			
Change in Arg.'s tariffs w.r.t. Brazil								
Outputs						1.550	1.951	1.967
						[1.243]	[1.274]	[1.822]
Inputs							-1.298	-1.445
							[2.741]	[3.020]
Firm-level controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-level controls					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-squared	0.04	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Notes: standard errors are clustered at the 4-digit-ISIC industry level. * indicates significant at 10%; ** significant at 5%; *** significant at 1%. 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 U.S.

Table E.2: Technology Adoption by Quartile of the Firm Size Distribution, Alternative Measures of Technology

Dependent variable indicated in columns

	Change in Spending in Technology per worker 1996-1992			Product Innovation			Production Process Innovation		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Change in Brazil's tariffs									
× First Size Quartile	-0.706	-0.553	-0.834	-0.049	-0.083	-0.165	-0.029	-0.072	-0.155
	[0.649]	[0.600]	[0.816]	[0.105]	[0.109]	[0.130]	[0.140]	[0.134]	[0.169]
× Second Size Quartile	-0.857	-0.664	-0.886	-0.280	-0.287	-0.380	-0.138	-0.191	-0.282
	[0.546]	[0.589]	[0.834]	[0.170]	[0.161]*	[0.172]**	[0.140]	[0.139]	[0.164]*
× Third Size Quartile	-2.061	-1.861	-2.115	-0.440	-0.478	-0.535	-0.281	-0.336	-0.396
	[0.564]***	[0.594]***	[0.896]**	[0.130]***	[0.145]***	[0.167]***	[0.159]*	[0.166]**	[0.190]**
× Fourth Size Quartile	-0.352	-0.138	-0.354	-0.257	-0.288	-0.372	-0.124	-0.177	-0.262
	[0.523]	[0.548]	[0.803]	[0.153]*	[0.154]*	[0.163]**	[0.121]	[0.128]	[0.158]
Change in Arg.'s tariffs w.r.t. World		Yes			Yes			Yes	
Change in Arg.'s tariffs 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	894	872	870	1312	1280	1274	1319	1287	1281
R-squared	0.08	0.09	0.09	0.18	0.19	0.19	0.18	0.18	0.19

Notes: standard errors are clustered at the 4-digit-ISIC industry level. * indicates significant at 10%; ** significant at 5%; *** significant at 1%. Controls for changes in Argentina's tariffs w.r.t. 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 U.S. Firm-level controls include dummies for the second, third and fourth quartile of the firm-size distribution in the initial year (1992).

Table E.3: Spending in Technology per worker by initial Export Status
Dependent variable: change in log (spending in technology per worker) 1996-1992

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Sample of non-exporters in 1992								
Change in Brazil's tariffs	-0.912	-1.012	-0.909	-0.909	-0.808	-1.330	-1.517	-1.458
	[0.529]*	[0.493]**	[0.464]*	[0.410]**	[0.425]*	[0.664]**	[0.763]**	[0.933]
Panel B: Sample of exporters in 1992								
Change in Brazil's tariffs	-1.197	-1.093	-1.025	-1.207	-1.028	-1.271	-1.025	-1.009
	[0.351]***	[0.359]***	[0.378]***	[0.362]***	[0.449]**	[0.472]***	[0.587]*	[0.801]
Controls								
Change in Arg.'s tariffs w.r.t. world								
Outputs			Yes	Yes	Yes			
Inputs				Yes	Yes			
Change in Arg.'s tariffs w.r.t. Brazil								
Outputs						Yes	Yes	Yes
Inputs							Yes	Yes
Firm-level controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-level controls					Yes			Yes
2-digit-ISIC industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: standard errors are clustered at the 4-digit-ISIC industry level. * indicates significant at 10%; ** significant at 5%; *** significant at 1%. Number of observations in Panel A is 417 or 407 when input tariffs are included as controls. Number of observations in Panel B is 477 in columns 1 to 3, 465 in columns 4 and 6, 475 in column 6 and 463 in columns 7 and 8. 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 U.S.