

Nina Pavcnik (2002): "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants"

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November 17, 2009

1 Introduction

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- Data

2 Econometric Model

- Model
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Introduction

- During 1980s many developing countries liberalized trade
- What was the effect on plant's productivity?
 - Foreign competition reduces their market power \Rightarrow expand output
 - Gains from scale economies not likely in developing countries
 - May facilitate procurement of foreign technology (Eaton & Kortum, 96,97)

Introduction

- Heterogeneous plants
 - Not incorporated in most models
 - Evidence: Olley & Parks (96); Roberts and Tybout (96); Aw, Chen & Roberts (97)
 - Productivity improvements
 - Reshuffling of resources from less to more productive plants
 - Exit of unproductive firms
 - These gains come at a cost
- This paper evaluates gains vs costs in an empirical study of plant dynamics during adjustment to liberalized trade

Why Chile?

- From 1974 to 1979 Chile liberalized trade
- Lowered tariffs from $> 100\%$ to 10% ad valorem
- Short increase in 82-84 (35%), afterwards 20%
- Massive plant exit
⇒ Liquidation played an important role

Goals of the paper

- 1 Identification of trade effects
- 2 Measurement of plant-specific productivity
- 3 Incorporation of plant exit in the estimation

Data

- Chile 1979-1986
- Plants with 10 or more employees that stay in the market
- 90% are single plants
- 3 sectors
 - 1 Import-competing (imports/domestic output $> 15\%$)
 - 2 Export-oriented (exports $> 15\%$)
 - 3 Non-traded
- Robustness checked with other measures of trade-exposure
- 35% of 1979 plants exit
- No pre-liberalization data available

- 8 manufacturing industries (3 or 2 digit ISIC)
 - 1 Food manufacturing
 - 2 Textiles and apparel
 - 3 Manufacture of wood and wood products
 - 4 Manufacture of paper and paper products
 - 5 Chemical industry
 - 6 Glass
 - 7 Basic metals
 - 8 Manufacture of machinery and equipment
- Descriptive statistics show that exit played an important role in adjustment

2-step approach

- Estimate production function \Rightarrow productivity measure
- Estimate impact of trade on productivity

Assume a Cobb-Douglas production function:

$$y_{it} = \beta_0 + \beta_x x_{it} + \beta_k k_{it} + e_{it} \quad (1)$$

$$e_{it} = \omega_{it} + \mu_{it} \quad (2)$$

Plant's value function:

$$V_t(\omega_t, k_t) = \max \{L_t; \sup \Pi_t(\omega_t, k_t) - c(i_t) + dE[V_{t+1}(\omega_{t+1}, k_{t+1} | \Omega_{it})]\}$$

$$\begin{aligned} k_{t+1} &= (1 - \delta)k_t + i_t \\ i_t &= i_t(\omega_t, k_t) \end{aligned} \quad (3)$$

Production function - Problem

Problem: Plant-specific effect ω_{it}

- Affects exit decision
- Information asymmetry introduces 2 biases
 - Simultaneity bias
 - Selection bias
- 1st has been addressed by previous studies, 2nd not
 - Time-invariance
 - Quadratic function
 - GMM

Production function - Solution

Pravcnik consistently estimates production function semi-parametrically:

- Ignore plant-index i
- Invert investment rule 3
- Modify production function 1 and 2

$$\begin{aligned}\omega_t &= i_t^{-1}(i_t, k_t) = \theta_t(i_t, k_t) \\ \lambda_t(k_t, i_t) &= \beta_0 + \beta_k k_t + \theta_t(i_t, k_t) \\ y_t &= \beta x_t + \lambda_t(k_t, i_t) + \mu_t\end{aligned}\tag{4}$$

Production function - Estimation

- λ_t modeled as polynomial expansion of i_t and k_t
 - μ_t and x_t not correlated
⇒ β estimates consistent
- ⇒ Plant specific, time varying productivity measure!

Now: Separate effects of capital on output and investment.

$$E[\omega_{t+1}|\omega_t, k_{t+1}] = g(\theta_t(i_t, k_t)) - \beta_0 = g(\lambda_t - \beta_k k_t) - \beta_0 \quad (5)$$

Substitute this in 1:

$$\begin{aligned} y_{t+1} - \beta x_{t+1} &= \beta_0 + \beta_k k_{t+1} + E[\omega_{t+1}|\omega_t, k_{t+1}] + \xi_{t+1} + \mu_{t+1} \\ &= \beta_k k_{t+1} + g(\lambda_t - \beta_k k_t) + \xi_{t+1} + \mu_{t+1} \end{aligned} \quad (6)$$

But only firms that stay in the market are observed, so we need:

$$E[\omega_{t+1}|\omega_t, \omega_{t+1} > \underline{\omega}_{t+1}(k_{t+1})] = \Phi(\omega_t, \underline{\omega}_{t+1}) - \beta_0 \quad (7)$$

Let $X_t = 1$ if the plant produces at t .

$$\begin{aligned} P(X_{t+1} = 1) &= P(\omega_{t+1} > \underline{\omega}_{t+1}(k_{t+1}) | \underline{\omega}_{t+1}(k_{t+1}), \omega_t) \\ &= p_t(\underline{\omega}_{t+1}(k_{t+1}), \omega_t) \\ &= p_t(\underline{\omega}_{t+1}(k_t, i_t), \omega_t) \\ &= p_t(k_t, i_t) \equiv P_t \end{aligned}$$

So Φ can be written as $\Phi(\omega_t, P_t)$

Substitute $\Phi(\omega_t, P_t)$ for $g(\lambda_t - \beta_k k_t)$ in 6

$$y_{t+1} - \beta x_{t+1} = \beta_k k_{t+1} + \Phi(\lambda_t - \beta_k k_t, P_t) + \xi_{t+1} + \mu_{t+1} \quad (8)$$

- 4 estimated using 4th order expansion of k and i
 \Rightarrow Consistent estimates of β and $\lambda_t, \hat{\beta}, \hat{\lambda}_t$
- \hat{P}_t estimated by Probit with 4th order expansion of k and i
- Use these to estimate 8 by NLS with 3rd order expansion of \hat{P}_t and $\hat{\omega}_t = (\hat{\lambda}_t - \beta_k k_t)$

$$\Phi(\omega_t, P_t) = \sum_{j=0}^{3-m} \sum_{m=0}^3 \beta_{mj} (\hat{\lambda}_t - \beta_k k_t)^m \hat{P}_t^j$$

Estimation results

Calculate a productivity measure w.r.t. a reference plant r (mean output and input level in 79):

$$pr_{it} = y_{it} - \hat{\beta}_{ls}l_{it}^s - \hat{\beta}_{lu}l_{it}^u - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it} - (y_r - \hat{y}_r)$$

$$y_r = \bar{y}_{it}, \hat{y}_r = \hat{\beta}_{ls}\bar{l}_{it}^s + \hat{\beta}_{lu}\bar{l}_{it}^u + \hat{\beta}_m\bar{m}_{it} + \hat{\beta}_k\bar{k}_{it}$$

Decompose weighted productivity measure in

- 1 Unweighted productivity measure
- 2 Total covariance of productivity and plant's share of industry output

$$W_t = \sum_i s_{it} pr_{it} = \bar{p}r_t + \sum_i (s_{it} - \bar{s}_t)(pr_{it} - \bar{p}r_t)$$

- Covariance measure's contribution to the aggregate weighted productivity resulting from reallocation of market share and resources
- Should be increasing over time if liberalization induces reallocation from less to more productive plants
- This implies exit of least productive plants

Decomposition of aggregate productivity growth

Industry	Year	Aggregate Productivity	Unweighted Productivity	Covariance	Industry	Year	Aggregate Productivity	Unweighted Productivity	Covariance
Food	79	0.000	0.000	0.000	Chemicals	79	0.000	0.000	0.000
	80	0.005	0.008	-0.003		80	0.014	0.046	-0.032
	81	0.008	0.058	-0.049		81	0.126	0.076	0.050
	82	0.209	0.099	0.110		82	0.312	0.039	0.274
	83	0.144	0.049	0.095		83	0.238	-0.050	0.288
	84	0.116	0.044	0.072		84	0.156	-0.040	0.196
	85	0.092	0.014	0.078		85	0.229	-0.033	0.262
	86	0.179	0.129	0.050		86	0.432	-0.056	0.488
Textiles	79	0.000	0.000	0.000	Glass	79	0.000	0.000	0.000
	80	0.064	0.063	0.001		80	0.137	-0.036	0.174
	81	0.148	0.119	0.029		81	0.109	-0.073	0.182
	82	0.147	0.090	0.057		82	0.155	-0.044	0.200
	83	0.075	0.063	0.012		83	0.231	-0.052	0.283
	84	0.130	0.082	0.048		84	0.257	-0.071	0.328
	85	0.136	0.095	0.041		85	0.193	-0.095	0.287
	86	0.184	0.171	0.013		86	0.329	-0.011	0.340
Wood	79	0.000	0.000	0.000	Basic metals	79	0.000	0.000	0.000
	80	-0.052	-0.030	-0.022		80	-0.136	-0.022	-0.114
	81	-0.125	-0.071	-0.054		81	-0.002	0.050	-0.052
	82	0.070	-0.076	0.145		82	0.711	0.215	0.496
	83	0.148	-0.051	0.198		83	0.343	0.030	0.312
	84	0.169	0.038	0.131		84	0.153	-0.037	0.190
	85	0.019	-0.038	0.058		85	0.228	-0.153	0.380
	86	-0.035	0.045	-0.081		86	0.183	-0.076	0.259

Paper	79	0.000	0.000	0.000	Machinery	79	0.000	0.000	0.000
	80	-0.111	-0.035	-0.076		80	0.031	-0.025	0.005
	81	-0.127	0.038	-0.165		81	0.125	0.070	0.055
	82	-0.127	-0.079	-0.048		82	0.131	0.027	0.105
	83	-0.084	-0.221	0.137		83	0.077	0.025	0.053
	84	-0.073	-0.266	0.192		84	0.137	0.072	0.064
	85	-0.252	-0.362	0.110		85	0.083	0.032	0.051
	86	-0.131	-0.326	0.195		86	0.076	0.040	0.036
All	79	0.000	0.000	0.000	Import competing	79	0.000	0.000	0.000
	80	-0.010	0.018	-0.027		80	-0.063	0.027	-0.090
	81	0.051	0.054	-0.003		81	0.032	0.092	-0.061
	82	0.329	0.048	0.281		82	0.088	0.066	0.022
	83	0.174	0.010	0.164		83	0.077	0.034	0.043
	84	0.117	0.025	0.092		84	0.089	0.059	0.030
	85	0.120	-0.003	0.123		85	0.095	0.061	0.034
	86	0.193	0.066	0.127		86	0.319	0.107	0.213
Export oriented	79	0.000	0.000	0.000	Nontraded	79	0.000	0.000	0.000
	80	-0.059	-0.038	-0.021		80	0.044	0.021	0.024
	81	-0.048	-0.054	0.006		81	0.101	0.047	0.054
	82	0.591	0.040	0.551		82	0.228	0.038	0.190
	83	0.326	0.015	0.311		83	0.127	-0.004	0.131
	84	0.178	0.049	0.129		84	0.114	0.000	0.114
	85	0.203	-0.011	0.214		85	0.101	-0.040	0.142
	86	0.254	0.087	0.166		86	0.062	0.038	0.024

Note: The reported growth figures are relative to 1979.

Results

- Aggregate weighted productivity increased in 6/8 sectors
- Food & textile: growth driven by unweighted productivity
- Other sectors: growth driven by reallocation
- Overall: 66.8% of growth driven by reallocation
- Most growth in income competing sector
- Least growth in non-traded sector

Identification of effect of trade on plant's productivity over time:

$$pr_{it} = \alpha_0 + \alpha_1(\text{Time})_{it} + \alpha_2(\text{Trade})_{it} + \alpha_3(\text{Trade} * \text{Time})_{it} + \alpha_4 Z_{it} + v_{it} \quad (9)$$

Estimates of equation 12

	(1)		(2)		(3)		(4)		(5)		(6)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Export-oriented	0.106	0.030**	0.106	0.030**	0.112	0.031**	0.098	0.048**	0.095	0.048**	0.100	0.046**
Import-competing	0.105	0.021**	0.105	0.021**	0.103	0.021**	-0.024	0.040	-0.025	0.040	-0.007	0.039
ex_80	-0.054	0.025**	-0.053	0.025**	-0.055	0.025**	-0.071	0.026**	-0.068	0.026**	-0.071	0.026**
ex_81	-0.099	0.028**	-0.097	0.028**	-0.100	0.028**	-0.117	0.027**	-0.110	0.027**	-0.119	0.027**
ex_82	0.005	0.032	0.007	0.032	0.003	0.032	-0.054	0.028*	-0.042	0.028	-0.055	0.028*
ex_83	0.021	0.032	0.023	0.032	0.021	0.032	-0.036	0.029	-0.025	0.030	-0.038	0.029
ex_84	0.050	0.031	0.051	0.031	0.050	0.031	0.007	0.028	0.017	0.028	0.007	0.028
ex_85	0.030	0.030	0.032	0.031	0.028	0.030	-0.001	0.029	0.013	0.030	-0.003	0.029
ex_86					0.043	0.036					-0.008	0.034
im_80	0.011	0.014	0.011	0.014	0.010	0.014	0.013	0.014	0.013	0.014	0.013	0.014
im_81	0.047	0.015**	0.047	0.015**	0.046	0.015**	0.044	0.014**	0.044	0.014**	0.044	0.014**
im_82	0.033	0.016**	0.034	0.017**	0.030	0.016*	0.024	0.015*	0.024	0.015*	0.025	0.015*
im_83	0.042	0.017**	0.043	0.017**	0.043	0.017**	0.040	0.015**	0.041	0.015**	0.042	0.015**
im_84	0.062	0.017**	0.062	0.017**	0.063	0.017**	0.059	0.015**	0.059	0.015**	0.061	0.015**
im_85	0.103	0.017**	0.104	0.017**	0.104	0.017**	0.101	0.015**	0.102	0.016**	0.101	0.015**
im_86					0.071	0.019**					0.073	0.017**
Exit indicator	-0.081	0.011**	-0.076	0.014**			-0.019	0.010**	-0.010	0.013		
Exit_export indicator			-0.021	0.036					-0.069	0.035*		
Exit_import indicator			-0.007	0.023					-0.005	0.021		
Industry indicators	yes		yes		yes		yes		yes		yes	
Plant indicators	no		no		no		yes		yes		yes	
Year indicators	yes		yes		yes		yes		yes		yes	
R ² (adjusted)	0.057		0.058		0.062		0.498		0.498		0.488	
N	22983		22983		25491		22983		22983		25491	

Note: ** and * indicate significance at a 5% and 10% level, respectively. Standard errors are corrected for heteroscedasticity. Standard errors in columns 1–3 are also adjusted for repeated observations on the same plant. Columns 1, 2, 4, and 5 do not include observations in 1986 because one cannot define exit for the last year of a panel.

Results

- On average exiting plants 8.1% less productive
- Exit effects do not differ between sectors
- Import competing plants become more productive 81-86
Robust to inclusion of exit indicator
- Export oriented sector does not improve due to liberalization
They had to be productive previously

Conclusion

- Productivity measure based on consistent estimates of production function coefficients
- Identification of trade effects
- Role of plant exit
- Adjustment for self selection and simultaneity important
- "Import-competing" companies improve productivity
⇒ Firms innovate more when they face more competition
- Exit contributes to productivity gains

Criticism

- Consistency does not imply unbiasedness (FE estimation of 9)
- Does different necessarily mean better?
- Pre-liberalization data (Is liberalization causal?)
- Insufficient information about estimation and variables
- Conclusions based on $R^2 = .057$
- Actual tests instead of "close to"

Reference

Pavcnik, N. (2002), "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants", *Review of Economic Studies* 69, 245–276