International Trade and Macro: Sunk-cost models in practice

Putting the model to work

- Sunk-cost models models have been used
  - To recover trade costs across time, industries, and countries
  - To study the response of exports, entry, etc. to changes in policy, shocks,...
- Today: Das et al. (2007)
  - A "structural IO" approach
  - Lots of heterogeneity
  - High-powered econometrics

Export profits

- Firm i, potential export profit

$$\log(\pi^*_{it}) = \psi_0 z_i + \psi_1 e_t + \nu_{it}$$

- z_i = firm-specific, time-invariant characteristics
- e_t = log real exchange rate, follow AR(1) process
- ν_{it} = shocks to factor prices, productivity, demand,...
  - Model this as sum of m AR(1) processes
  - Let x be the components

- No data on export profit (no export production costs, just total)
- Cannot directly estimate the parameters

Some profit function math

- Assume monopolistic competition, $\eta_1 > 1$ is the elasticity

$$\pi^*_{it} = \eta_i^{-1} \times R^{f*}_{it}$$

- Take logs, substitute into LHS of profit function,

$$\log(R^{f*}_{it}) = \log(\eta_i) + \psi_0 z_i + \psi_1 e_t + \nu_{it}$$

- Notice the extra heterogeneity in η_i

- This also introduces a "incidental parameters problem"
  - Assume that $\eta_i = (1 + v)\eta_i^d$, a bit more math...

$$1 - \frac{C_{it}}{R_{it}} = \eta_i^{-1} \left(1 + v \frac{R^d_{it}}{R_{it}} \right) + \xi_{it}$$

  - Adds data on domestic revenue and costs, introduces *n* more equations and three (v, σ_ξ, λ_ξ) new parameters

Fixed costs

- The "continuation cost:" $\gamma_F - \epsilon_{1it}$
  - γ_F common across firms, ϵ_{1it} idiosyncratic
- The start-up cost: $\gamma_s z_i + \epsilon_{1it} - \epsilon_{2it}$
  - γ_s vector of coefficients, z_i same characteristics in π
- Fixed cost shocks (ϵ) are
  - Normal, serially uncorrelated
  - Orthogonal to e and ν
- Let $y \in 0, 1$ be the export indicator

$$
\begin{aligned}
u() &= \pi^*(e_t, x_{it}, z_i) - \gamma_F + \epsilon_{1it} && \text{if } y_{it} = 1 \text{ and } y_{it-1} = 1 \\
u() &= \pi^*(e_t, x_{it}, z_i) - \gamma_F - \gamma_s z_i + \epsilon_{2it} && \text{if } y_{it} = 1 \text{ and } y_{it-1} = 0 \\
u() &= 0 && \text{if } y_{it} = 0
\end{aligned}
$$

The export decision

- The recursive problem is

$$V_{it} = \max_{y_{it}} u(e_t, x_{it}, z_i, \epsilon_{it}, y_{it}, y_{i,t-1|\theta}) + \delta E_t V_{it+1}$$

- Where θ is the parameter vector, δ is the discount rate, and

$$E_t V_{it+1} = \int_{e'} \int_{x'} \int_{\epsilon'} V_{it+1} \times f_e(e'|e_t, \theta) f_x(x'|x_{it}, \theta) f_\epsilon(\epsilon'|\epsilon_t, \theta) d\epsilon' dx' de'$$

- Which generates the usual discrete-choice exporting rule

$$y_{it} = 1 \text{ if } u(e_t, x_{it}, z_i, \epsilon_{it}, 1, y_{i,t-1|\theta}) + \delta \Delta E_t V_{it+1} > 0$$

where

$$\Delta E_t V_{it+1} = E_t[V_{it+1}|y_{it} = 1] - E_t[V_{it+1}|y_{it} = 0]$$

Data

- Colombian firm-level data 1981–1991
  - $R^f_{it}, R^d_{it}, C_{it}, e_t, z_i$
- Focus on three industries: leather, knitted fabrics, basic chemicals
- Colombian export boom over this period (RER depreciation)
  - RER depreciates 33 percent
  - Exports grow: 26, 16, 19 percent per year
  - Export participation: 12$\rightarrow$18, 50$\rightarrow$58, 42$\rightarrow$50

Identification

- η_i, v: variation in R_{it}/C_{it}, R^f_{it}/R_{it}
- ψ and x process params: variation in export revenue across plants and time
- Sunk cost params: export behavior of firms with similar potential export profits, but different export history
- fixed cost params: exit behavior of firms (given a sunk cost value)

- Estimation: MCMC
- Number of x = 2; $\delta = 0.9$,
- z_i = big and small by 1981 domestic revenues
- Exchange rate estimated directly from data

TABLE I

POSTERIOR PARAMETER DISTRIBUTIONS (MEANS AND STANDARD DEVIATIONS)

	Leather Products	Basic Chemicals	Knitted Fabrics	Priors
		Profit Function Parameters		
ψ_{01} (intercept)	−13.645 (4.505)	1.143 (3.642)	−12.965 (3.058)	$\psi_{01} \sim N(0, 500)$
ψ_{02} (domestic size dummy)	1.544 (0.789)	1.862 (0.813)	1.362 (0.449)	$\psi_{02} \sim N(0, 500)$
ψ_1 (exchange rate coefficient)	4.323 (0.957)	0.975 (0.745)	4.047 (0.640)	$\psi_1 \sim N(0, 500)$
λ_x^1 (root, first AR process)	0.787 (0.180)	−0.383 (0.186)	0.458 (0.258)	$\lambda_x^1 \sim U(-1, 1)$
λ_x^2 (root, second AR process)	0.952 (0.018)	0.951 (0.022)	0.709 (0.103)	$\lambda_x^2 \sim U(-1, 1)$
$\sigma_{\omega 1}^2$ (variance, first AR process)	0.282 (0.144)	0.320 (0.109)	0.469 (0.250)	$\ln(\sigma_{\omega 1}^2) \sim N(0, 20)$
$\sigma_{\omega 2}^2$ (variance, second AR process)	0.422 (0.146)	0.491 (0.137)	0.809 (0.264)	$\ln(\sigma_{\omega 2}^2) \sim N(0, 20)$
v (foreign elasticity premium)	−0.016 (0.022)	0.849 (0.126)	0.950 (0.047)	$v \sim U(-1, 1)$
λ_ξ (root, measurement error)	0.336 (0.070)	0.962 (0.011)	0.935 (0.013)	$\lambda_\xi \sim U(-1, 1)$
σ_ξ (std. error, ξ innovations)	0.011 (0.001)	1.277 (0.389)	1.312 (0.264)	$\ln(\sigma_\xi) \sim N(0, 20)$
		Foreign Demand Elasticities (quintiles only)		
η_{Q1} (demand elasticity, quintile 1)	8.020 (2.907)	12.098 (13.881)	10.289 (12.032)	$\ln(\eta - 1) \sim N(2, 1)$
η_{Q2} (demand elasticity, quintile 2)	12.282 (13.351)	12.974 (18.682)	12.314 (8.330)	$\ln(\eta - 1) \sim N(2, 1)$
η_{Q3} (demand elasticity, quintile 3)	17.866 (11.089)	14.139 (13.363)	13.780 (16.725)	$\ln(\eta - 1) \sim N(2, 1)$
η_{Q4} (demand elasticity, quintile 4)	37.189 (25.331)	24.604 (27.253)	36.279 (32.844)	$\ln(\eta - 1) \sim N(2, 1)$
		Dynamic Discrete Choice Parameters		
γ_{S_1} (sunk cost, size class 1)	63.690 (1.934)	62.223 (3.345)	61.064 (2.628)	$\gamma_{S_1} \sim N(0, 500)$
γ_{S_2} (sunk cost, size class 2)	52.615 (4.398)	50.561 (5.043)	59.484 (2.361)	$\gamma_{S_2} \sim N(0, 500)$
γ_F (fixed cost)	−0.610 (1.042)	1.635 (0.983)	1.372 (1.340)	$\gamma_F \sim N(0, 500)$
$\sigma_{\varepsilon 1}$ (std. error, ε_1)	12.854 (6.171)	7.517 (4.109)	32.240 (8.382)	$\ln(\sigma_{\varepsilon 1}) \sim N(0, 20)$
$\sigma_{\varepsilon 2}$ (std. error, ε_2)	30.627 (7.831)	32.432 (3.196)	17.630 (4.737)	$\ln(\sigma_{\varepsilon 2}) \sim N(0, 20)$
		Initial Conditions Parameters		
α_0 (intercept)	−3.559 (6.523)	−13.693 (7.069)	−40.811 (21.379)	$\alpha_0 \sim N(0, 500)$
α_1 (domestic size dummy)	16.484 (9.965)	25.868 (11.959)	23.397 (14.762)	$\alpha_1 \sim N(0, 500)$
$\alpha_2(x_1)$	29.388 (11.675)	−18.028 (11.658)	31.603 (18.165)	$\alpha_2 \sim N(0, 500)$
$\alpha_3(x_2)$	3.451 (4.861)	8.908 (5.710)	16.561 (15.519)	$\alpha_3 \sim N(0, 500)$

Profit function parameter estimates

- Big firms earn bigger export profits
- Leather and knitted have big RER elasticity
- Strong serial correlation in plant shocks (λ_x)
- Average elasticities: 14.2, 13.0, 12.7
- $\eta = \eta^d(1 + v)$; for chem and knits, foreign markets are tougher

Fixed cost estimates

- Entry costs
  - Small producers \$412k–430k
  - Large producers \$344k–402k
  - These are big!
  - Actual entry costs paid are lower: Enter when ϵ draws are favorable
- Fixed costs
  - Close to zero
  - Large standard deviation—fixed cost matter sometimes

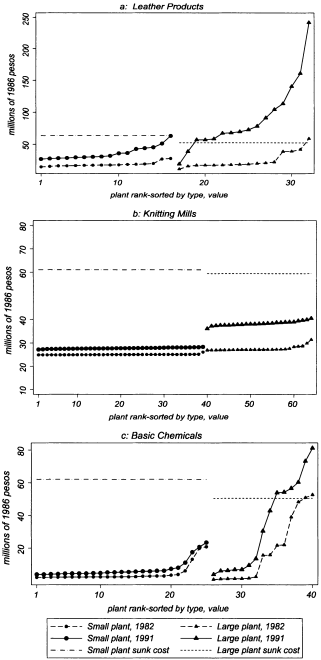


FIGURE 1.—Plant export value and sunk entry costs.

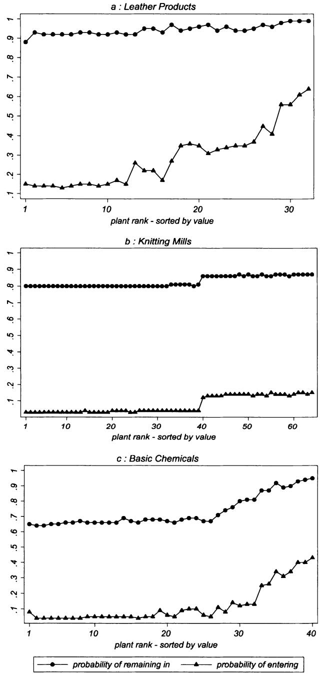


FIGURE 2.—Probability of exporting conditional on plant history.

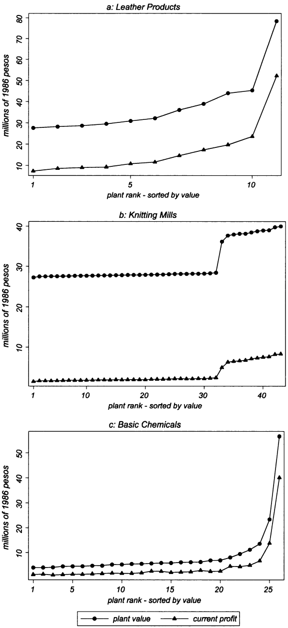
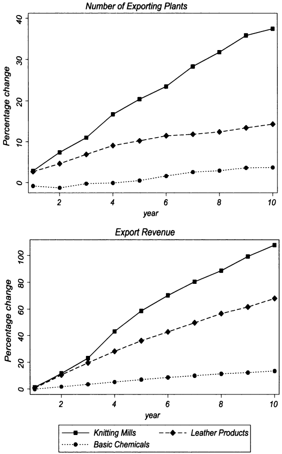


FIGURE 3.—Value of exporting and current profit for nonexporting plants.



IGURE 4.—Export response to a correctly perceived 20 percent devaluation.

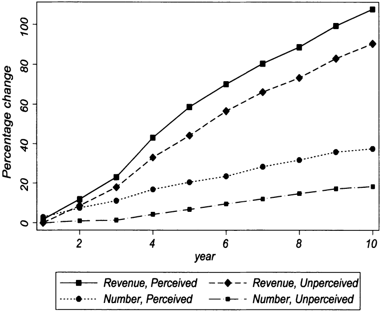


FIGURE 5.—Response to a perceived versus unperceived regime shift: 20 percent steady state devaluation, knitting mills.

References

Das, Sanghamitra, Mark J. Roberts, and James R. Tybout (2007). "Market entry costs, producer heterogeneity, and export dynamics." *Econometrica* 75 (3), pp. 837–873.