International Trade and Macro: Exporter Dynamic models

Model and Trade Costs

1. Focus on how models have been used to recover trade costs across time, industries, and countries.

Model outline

1. **1.** Basic Model (Das et al., 2007; Alessandria and Choi, 2007; Alessandria and Choi, 2014b; Alessandria and Choi, 2014a)
2. **2.** Relaxing the trade cost assumptions (Ruhl and Willis, 2017; Alessandria et al., 2021; Alessandria and Avila, 2020)
3. **3.** Customer accumulation (Fitzgerald et al., 2016; Piveteau, 2021; Ruhl and Willis, 2017; Rodrigue and Tan, 2019; McCallum, 1995; Steinberg, 2021)

Das, Roberts & Tybout (2007)

1. Estimation of Sunk cost model for three Colombian industries in 1981-1991 period.
2. IO approach adds lots of heterogeneity and focus on the paths of individual firms.
3. Brings in uncertainty from exchange rate
4. Key output: Estimates of export fixed and sunk costs

- We cover the details in a separate set of slides…

Alessandria and Choi (2007)

1. Studies cyclical properties in RBC model from shocks to productivity
   - Uses perturbation methods to study cyclical movements in export behavior and net trade flows from shocks to aggregate productivity.
2. Sunk cost model with heterogeneous producers in GE
   - No firm entry creation/death.
   - IID idiosyncratic productivity shocks
   - Export decisions within same period
   - Firms make investments in capital prior to knowing idiosyncratic productivity.

- Much less heterogeneity than Das et al. (2007)
- Recover similar export costs

Exporter characteristics for calibration

- Bernard & Jensen (95, 99, 01) using Census LRD (84–92)

1. Not all firms export
   - Less than 50% of U.S. plants in LRD
   - Less than 20% in Census of Mfrs
2. Exporters are:
   - Bigger – 100% more shipments, 90% more employees
   - More Productive – 12 to 18% higher TFP
   - Larger exporter premia in Census of Mfrs (Bernard, et al. 02)
3. Change identity, annually
   - 14% of non-exporters STARTED exporting
   - 13% of exporters STOPPED exporting

Calibration: trade costs

Variables	BJ $(99,01)$	*Model*
Import share	**0.15**	**0.15**
Starters (n_0)	**0.036**	**0.035**
Stoppers $(1-n_1)$	**0.032**	**0.035**
$\ln \frac{A_X}{A_N}$	**0.12** to **0.18**	**0.154**
$\ln \frac{Y_X}{Y_N}$	0.952 to 1.139	0.902
$\ln \frac{L_X}{L_N}$	0.776 to 0.952	0.902

- $f_0/f_1 = 4.8$
- New exporter: entry costs $\approx$ 16.5% of sales
- Continuing exporter: trade cost $\approx$ 1.7% of sales
- Total trade costs $\approx$ 1.3% of GDP

Exporter premium: Gross output vs. value added

- Exporter premium is too dependant on foreign sales. Consider the extreme case where exporting is exogneous. Export intensity has to do all the work since there is no selection.
  - Suppose trade is 15% of GDP & 1/2 firms export exogenously.
  - Exporters and non-exporters both sell 42.5 of GDP. Export intensity is 15/(42.5 + 15) = 26%, which is too high.

- Can fix by allowing for an input-output set up

$$y(i) = e^{z} e^{\eta} \left(k^{\alpha} l^{1-\alpha}\right)^{1-\alpha_x} M^{\alpha_x}$$

$$Y = c + \int x(i)di + \int M(i)di$$

- If gross output to value added ($\frac{Y}{(c+\int x(i)di)}$) $= 3$, export intensity is 15/(142.5+15) = 9.5%.

Exporter premium: Export persistence

- With endogenous exporting, exporters premium from:
  - Supply: selection on productivity + capital (forward looking)
  - Demand: export more intensively (demand)

- Persistence of exporting influences exporter premium through offsetting selection & capital deepening effects.
- Very high export persistence.
  - Entry and exit thresholds are far apart. Selection is weak. Incentive to accumulate capital is strong.
- Very low export persistence. (iid)
  - Entry and exit thresholds are the same. Strict sorting on productivity. No incentive to make investments.

Alessandria and Choi (2014a)

1. Sunk cost model with heterogeneous producers in GE
   - Firm entry creation/death.
   - Persistent idiosyncratic productivity shocks
   - Shocks to fixed export costs σ_v
   - Capital and Materials in production
   - Lag between fixed costs and market access
2. Focus: aggregate implications of changes in trade policy in the presence of firm exporter dynamics (transitions & steady states).
   - Two sectors (tradable, non-tradable)
   - No aggregate shocks beyond trade costs.
3. Good example of calibrating to aggregate economy

Tradable Producer (z,v,m)

- For t, given markets, $m = \{0, 1\}$, $\max \Pi_{T,t}(z, m, v)$
- For $t + 1$, invest in exporting, $m' = \{0, 1\}$

  Current profits:

$$\Pi_{T,t}(\cdot) = \max \frac{P_{H,t}(\cdot)\, y_{H,t}(\cdot)}{P_t} + m\frac{e_t P^*_{H,t}(\cdot)\, y^*_{H,t}(\cdot)}{P_t} - W_t l_{T,t}(\cdot) - R_t k_{T,t}(\cdot) - P_{T,t} x(\cdot),$$

$$\text{s.t. } y_H + (1+\xi)\, y^*_H = e^z \left[k_T(\cdot)^{\alpha}\, l_T(\cdot)^{1-\alpha}\right]^{1-\alpha_x} x_T(\cdot)^{\alpha_x}$$

$$\Rightarrow P_{T,t}(z, m), P^*_{T,t}(z, m), k_{T,t}(z, m), l_{T,t}(z, m), x_{T,t}(z, m)$$

Tradable Producer (z,v,m): Export Decision

$$
\begin{aligned}
V_{T,t}(z,v,m) &= \Pi_{T,t}(z,m) + \max\left\{V_t^1(z,v,m), V_t^0(z,v,m)\right\} \\
V_t^1(z,v,m) &= -W_t f_m e^v + n_s(z) EQ_t V_{T,t+1}(z',v',1|z), \\
V_t^0(z,v,m) &= n_s(z) Q_t V_{T,t+1}(z',v',0|z)
\end{aligned}
$$

$\Rightarrow m_t'(z,v,m)$ depends on $z_{m,t}(v)$

Calibration: Aggregates

Parameter		Value
σ	IES	2
δ	Capital Depreciation	0.10
β	Disounting	0.96
θ	Elasticity of Subst. (Broda & Weinstein)	5
τ	Tariff (Anderson and van Wincoop)	0.08
ξ	Iceberg cost (export intensity $=$ 13.3%)	0.45
γ	MFR VA/(Private GDP) $=$ 21%	0.21
α_x	MFR Gross Output/MFR VA $=$ 2.8	0.804
α	Capital share of income $=$ 34%	0.286

Calibration: Establishment heterogeneity

$$\phi\left(z'|z\right) : z' = \rho z + \varepsilon, \varepsilon \sim N\left(0, \sigma_{\varepsilon}^2\right)$$

$$\phi_E\left(z\right) : z' = -\mu_E + \varepsilon, \varepsilon_E \sim N\left(0, \frac{\sigma_{\varepsilon}^2}{1-\rho^2}\right)$$

$$n_d\left(z\right) : 1 - n_s\left(z\right) = \max\left\{0, \min\left\{\lambda e^{-\lambda e^z} + n_{d0}, 1\right\}\right\}$$

$\Rightarrow$ 8 parameters $\left\{f_0, f_1, \sigma_v^2, \lambda, n_{d0}, \mu_E, \rho, \sigma_e^2\right\}$

Calibration: Establishments & exporters

- Exporter dynamics and characteristics:
  1. Overall participation rate = 22.3 % (92 Census of Mfrs.)
  2. Stopper rate = 17 % (ASM, 84 to 92)

- Establishment heterogeneity:
  3. Entrant 5-yr survival 37 % (Dunne et al. 89)
  4. Birth labor share =1.5 % (Davis, et al. 96)
  5. Exit labor share = 2.3 % (Davis, et al. 96)
  6. Establishment and employment distribution (92 Census)
  7. Establishment exporter distribution (92 Census)

Calibration

- Consider 4 variants
  1. Sunk-Cost
  2. No-Cost/Krugman ($f_1 = f_0 = 0$)
  3. Fixed-Cost ($f_0 = f_1$)
     - Identify role of sunk costs
  4. Permanent ($\rho = 1, \mu_E = 0, f_1 = f_0$)
     - Benchmark formulation in literature
     - Identify role of plant dynamics

Matching participation & churning

	Data	Sunk-Cost	Fixed-Cost	Perm.	No-Cost
5-year exit rate	37	37	37	11	37
Startups' labor share	1.5	1.5	1.5	2.1	1.5
Shutdowns' labor share	2.3	2.3	2.3	2.3	2.3
Stopper rate	17	17	**67**	**69**	**0**
Exporter ratio	22.3	22.3	22.3	22.3	**100**
Trade Share	3.9	3.9	3.9	3.9	3.9
Root Mean Squared Error (%)					
Overall fit	-	1.55	1.56	3.25	5.26
Establishments	-	0.37	0.37	0.92	1.07
Employment share	-	0.76	0.77	0.62	1.16
Export participation	-	2.49	2.51	5.16	8.46

How big are the fixed costs?

	ξ	$\frac{f_0}{f_1}$	σ_v	Costs Incurrred $\frac{mean(f_0 e^v)}{mean(f_1 e^v)}$	$\frac{median(f_0 e^v)}{median(f_1 e^v)}$
Sunk-Cost	0.451	19	1.1	3.7	4.5
Permanent	0.451	1	3.6	0.5	1
No Cost	0.757	-	-	-	-

- Tariff equivalent: raises export cost by about 30 percentage points ($\approx$40% of trade costs)
- Startup costs are 4 times profits of median starter
  - Das, Roberts, and Tybout (07) find 8-9 for Columbian plants
  - 750k ($1992)

How big are the fixed costs?

Costs as Share of Export Profits

Model	*Startup*	*Continuation*
Sunk-Cost	0.25	0.28
Permanent-Fixed	0	0.20
No-Cost	0	0

Sizeable share of export profits (trade) are ”organizational rents” to exporter decision not plant creation.

Micro-Dynamics: Successes, Failures, and Fixes

- Basic model captures exporter cross-section and dynamics, but what about other features?

1. Employment & Sales Growth w Changes in Export Status
   - Bernard & Jensen (99): growth rates vary w Δ in status.

2. Export Persistence at Longer Horizons
   - Frequent re-entry: Roberts & Tybout (97), Bernard & Jensen (04)

3. New Exporter Growth
   - Export intensity grows w time in market (Ruhl & Willis 08)

Resolution: Export intensity dynamics

- With CES

$$exs(z, \hat{\xi}) = \frac{(\tau\xi\hat{\xi})^{1-\sigma}}{1 + (\tau\xi\hat{\xi})^{1-\sigma}}$$

- Modify iceberg cost structure so that they fall with experience - reflects improvements in export distribution technology.
  - Ruhl and Willis (2017) assume firm enters at ξ_0 and then ξ_a is falling with a.
  - Alessandria et al. (2021) assume firm enters at $\xi_0 = \xi_H > \xi_L$ and then Markov transition between states
  - Both approaches have investments in improving market after entry, not just maintaining access
  - Back loads profits $=>$ lowers estimates of entry costs.
  - With uncertain growth this increases exit

Resolution: Export intensity dynamics

- Alternatively could accumulate customers or build habit (Drozd and Nosal, 2012; Fitzgerald et al., 2016; Piveteau, 2021; Rodrigue and Tan, 2019)

Customer-acquisition models of exporter dynamics

- Demand for firm's product depends on price (p), trade cost (τ), and customer base (m):

$$d(p, m; \tau) = (p\tau)^{-\theta} m^{\alpha}$$

  - α governs diminishing returns to having more customers
- Firms heterogeneous in productivity (z)
- Assume constant-markup pricing so that flow profits from exporting given by

$$\pi(z, m; \tau) \propto (z/\tau)^{1-\theta} m^{\alpha}$$

- Firm's problem: choose to export/not export to maximize PDV of profits—and possibly, choose how many customers to acquire
- Q: How to model customer aquisition?

Customer-acquisition models of exporter dynamics

- Fitzgerald et al. (2019, 2021): Quadratic adjustment cost
- Piveteau (2020): Word-of-mouth
- Steinberg (2021): Dynamic version of Arkolakis (2010)
- Customer acquisition in other contexts
  - Arkolakis (2010), EKK (2011): static models of how/why exporter distribution varies across bilateral trade relationships
  - Drozd-Nosal (2021): pricing to market, int'l macro puzzles
- Many other papers in which firms initially charge low prices to attract customers; focus on constant-markup models today
  - See Fitzgerald et al. (2019, 2021) for good review of both approaches

Fitzgerald et al. (2019, 2021)

- Pay sunk cost s to start exporting with $\underline{\text{m}}$ initial customers (exogenous)
- Pay fixed cost f to continue exporting; if not, lose all customers
- Customer base depreciates at rate δ, grows by investment a

$$m' = (1 - \delta)m + a$$

- Cost of investment:

$$c(m, a) = a + \phi a^2/m$$

- Dynamic program (V^0: potential exporter, V^1: incumbent):

$$V^0(z) = \max\left\{\mathbb{E}V^0(z'), \pi(z, \underline{\text{m}}; \tau) - f + \mathbb{E}V^1(z', \underline{m})\right\}$$
$$V^1(z) = \max\Big\{\mathbb{E}V^0(z'), \max_m \big[\pi(z, (1 - \delta)m + a; \tau) - s - c(m, a) + \mathbb{E}V^1(z', (1$$

Piveteau (2020)

- Pay sunk cost s to start exporting with $\underline{m}$ initial customers (exogenous)
- Pay fixed cost f to continue exporting; if not, lose all customers
- Customer base growth depends on sales and size of current customer base ("word of mouth")

$$m' = 1 - \{1 - \eta_1(1-\psi)pd(p, m; \tau) - \eta_2(1-\psi)m\}^{\frac{1}{1-\psi}} \in (0, 1)$$

- No cost of investment (in paper firm can also grow customer base by charging lower prices, and therefore selling more than under constant-markup pricing)

$$V^0(z) = \max\left\{\mathbb{E}V^0(z'), \pi(z, \underline{m}; \tau) - f + \mathbb{E}V^1(z', \underline{m})\right\}$$
$$V^1(z) = \max\left\{\mathbb{E}V^0(z'), \pi(z, m'; \tau) - s + \mathbb{E}V^1(z', m')\right\}$$

Steinberg (2021): market penetration dynamics

- No sunk or fixed costs, initial customer base endogenous
- Customer base evolves according to $m' = n + o$, where
  - $n \in [0, 1 - m]$: new customers attracted
  - $o \in [0, m]$ old customers retained
- Attraction/retention costs depend on current customer base:

$$a_n(m, n) = \frac{L^{\alpha_n}(1 - m)^{\beta_n}}{\psi_n(1 - \gamma_n)} \left[1 - \left(\frac{1 - m - n}{1 - m}\right)^{1-\gamma_n}\right]$$

$$a_o(m, o) = \frac{L^{\alpha_o} m^{\beta_o}}{\psi_o(1 - \gamma_o)} \left[1 - \left(\frac{m - o}{m}\right)^{1-\gamma_o}\right]$$

- Given current customer base m, cost of getting to m' given by

$$f(m, m') = \min_{n,o} \{a_n(m, n) + a_o(m, o)\} \quad \text{s.t.} \quad 0 \leq n \leq 1 - m, \quad 0 \leq o \leq m,$$

Steinberg (2021): dynamic program

Value function:

$$V(z, m) = \max_{m'} \left\{ \pi(z, m') - f(m, m') + \frac{\delta(z)}{1 + R} \mathbb{E}\left[V(z', m') | x, z\right] \right\}$$

Solution: $$\underbrace{f_2(m, m')}_{\text{marginal cost}} \geq \underbrace{\tilde{\pi} z^{\theta - 1}}_{\text{marginal profit}} - \underbrace{\frac{\delta(z)}{1 + R} \mathbb{E}\left[f_1(m', m'') | z\right]}_{\mathbb{E}[\downarrow] \text{ in future exporting cost}}$$

- If $m = 0$, enter if $z \geq \underline{z}$:

$$f_2(0, 0) = \tilde{\pi} \underline{z}^{\theta - 1} - \frac{\delta(z)}{1 + R} \mathbb{E}\left[f_1(0, m'') | z\right]$$

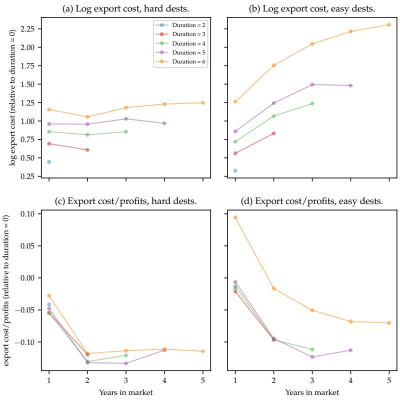
- If $m > 0$, exit if $m \leq \underline{m}(z)$:

$$f_2(\underline{m}(z), 0) = \tilde{\pi} z^{\theta - 1} - \frac{\delta(z)}{1 + R} \mathbb{E}\left[f_1(0, m'') | z\right]$$

Steinberg (2021): key properties

- $f_2(m, 0) > 0$: marginal cost of serving a single customer strictly positive $\Rightarrow$ entry + exit
- $f_{22}(m, m') > 0$: MC increasing in size of new customer base $\Rightarrow$ concentration
- $f_{21}(m, m') < 0$: MC decreasing in size of initial customer base $\Rightarrow$ new exporter dynamics
  - $f_2(0, m') > f_2(m, m')$: Entrant's MC curve entrants higher than incumbent's $\Rightarrow$ entrants start small then grow
  - $f_2(0, 0) > f_2(m, 0)$: Entrant's MC of acquiring single new customer higher than incumbent's MC of keeping single old customer $\Rightarrow$ exit rate $\downarrow$ in m

Steinberg (2021): Calibrated exporting costs



Levels:

- Easy dests: flat w/ time in a market
- Hard dests: $\uparrow$ w/ time in a market
- Higher for more successful exporters

Relative to profits:

- $\downarrow$ w/ time in a market
- More pronounced $\downarrow$ in easy dests.
- $f_2(m, m')/(LY) \downarrow$ in $L, Y \Rightarrow$ variation in exporter dynamics across markets

Complementary investments

1. Destinations (Albornoz et al., 2012; Albornoz et al., 2016; Morales et al., 2019)
2. Importing and Exporting (Kasahara and Lapham, 2013)

Trade Costs and Development

1. Developmpent(Fernandes et al., 2016)

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