# Export Market Penetration Dynamics

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# Intro: motivation

Heterogeneity + micro dynamics key drivers of aggregate trade

- Long run: new goods and least-traded products respond most
- Short run: persistence in export participation, "new exporter dynamics" slow adjustment

Cross-section of exporters varies systematically across destinations

- "Harder" markets: less concentration, fewer small exporters
- Aggregate implication: greater LR responses to trade shocks in harder markets

**This paper:**

- How—and why—do exporter dynamics vary across markets?
- What are the consequences for aggregate trade dynamics?

# Intro: contributions

> *[T]he literature has largely avoided the treatment of a firm's dynamic decisions across multiple destinations. The literature on (static) quantitative trade and firm heterogeneity has focused on the impact of geography on [exporting] costs. Merging these two approaches is a relatively unexplored, but promising, avenue of future research.* —Alessandria et al. (2020)

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**Data:** Brazilian exporters' life cycles vary systematically across destinations

- Harder markets: higher turnover, entrants larger and exit less often

**Theory:** Parsimonious model of customer accumulation across multiple destinations

- Synthesize market pen. costs (Arkolakis, 2010) + sunk costs (Das et al., 2007)
- One mechanism generates cross-sectional + dynamic facts, variation across markets
- Tractable in DSGE (Steinberg, 2019)

**Quantitative:** Larger, more prolonged responses to shocks in harder markets

- Consistent with evidence from Brazil's 1999 depreciation

# Data

# Data: overview

**Source:** Brazilian customs data during 1996–2008

**Variables:** destination, value, year, product, firm ID

**Processing:**

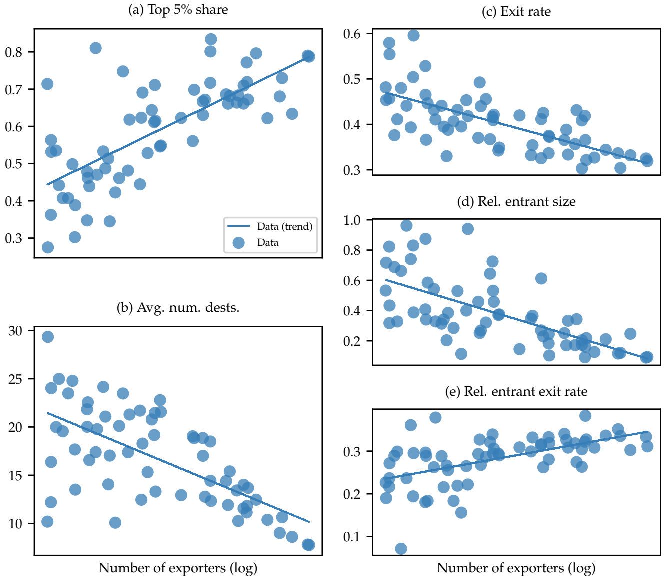
- Keep mfg. and 63 destinations with 20+ exporters/year
- Aggregate across products to firm-destination-year panel

**Definitions:**

- Entrant: firm $i$ that exports to destination $j$ in year $t$ but not in $t-1$
- Incumbent: firm $i$ that exports to destination $j$ in $t$ and $t-1$
- Exit: firm $i$ that exports to destination $j$ in $t$ but not in $t+1$

**Analysis:** how do distribution + dynamics of exporters vary across destinations?

# Data: distribution + dynamics of exporters across markets



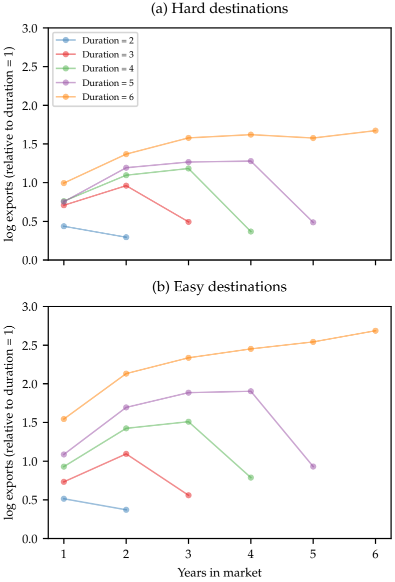

"Harder" markets have

- Greater concentration
- Exporters that serve many other markets
- Lower overall turnover
- Entrants that are smaller and exit more often

What makes a harder market?

- Smaller population
- Lower income per capita
- Higher trade costs

# Data: exporter-level sales trajectories across markets




- Estimate sales trajectories for exporters with different spell durations (Fitzgerald et al., 2020)

$$\log ex_{i,j,t} = \alpha + \sum_{m,n} \beta_{m,n} \mathbb{1}_{\{\text{duration}_{i,j}=m\}} \mathbb{1}_{\{\text{yrs. in mkt.}_{i,j,t}=n\}} + f_j + f_t + \epsilon_{i,j,t}$$

- Separate sample into two groups:
  - Hard markets: bottom 50% in num. exporters
  - Easy markets: top 50%
- Compared to easy markets, hard markets have
  - Smaller differences in entrants' sales
  - Less growth over spells

# Model

# Model: overview

Importing countries indexed by $j = 1, \ldots, J$ with three traits:

- Population, $L_j$
- GDP per capita, $Y_j$
- Trade barrier, $\tau_j$

Exporting country populated by unit measure of firms

- Cost of exporting depends on level of + change to customer base
- Endogenous entry + exit, expansion + contraction

Partial equilibrium

- Small open economy: exogenous importing-country characteristics
- Small export sector: exogenous exporting-country wage $= 1$

# Model: firms

Heterogeneity:

- Productivity, $x \sim \text{lognormal}(0, \sigma_x^2)$, redraw w/ prob. $\rho_x$
- Demand, $\mathbf{z} = (z_1, z_2, \ldots, z_J)$, $\log z_j' = \rho_z z_j + \sigma_z \epsilon_j$
- Customer base, $\mathbf{m} = (m_1, m_2, \ldots, m_J) \in [0, 1]^J$

Exogenous creation + destruction

- Die with probability $1 - \delta(x) = \max(0, \min(e^{\delta_0 x} + \delta_1))$
- Dying firms replaced by new ones with $\mathbf{m} = 0$

Standard CRS production + monopolistic competition

# Model: demand, pricing, and profits

Market $j$'s demand for a firm's product depends on

- Price, $p$
- Demand, $z$
- Customer base, $m \in [0, 1]$

Individual consumer's demand: $c_j(z, p) = L_j Y_j z^{\theta-1} p^{-\theta}$

Total demand: $y_j(z, m, p) = m c_j(z, p)$

CRS implies profit-max problem separable across markets:

$$\pi_j(x, z, m) = \max_p \left\{ p y_j(z, m, p) - \frac{\tau_j y_j(z, m, p)}{x} \right\} = \left( \frac{1}{1 - \theta} \right) m L_j Y_j \left( \frac{xz}{\tau_j} \right)^{\theta - 1}$$

## Model: market penetration dynamics

Firm's 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 depend on advertising as in Arkolakis (2010):

$$\partial n / \partial a_n = \psi_n L_j^{-\alpha_n} (1-m)^{-\beta_n} \left( \frac{1-m-n}{1-m} \right)^{\gamma_n}$$

$$\partial o / \partial a_o = \psi_o L_j^{-\alpha_o} m^{-\beta_o} \left( \frac{m-o}{m} \right)^{\gamma_o}$$

- $a_n, a_o$: advertising to attract new customers, retain old ones
- $\psi_n, \psi_o$: efficiency level
- $\alpha_n, \alpha_o$: macro return to market size
- $\beta_n, \beta_o$: micro return to market size
- $\gamma_n, \gamma_o$: convexity/diminishing returns

# Model: market penetration costs

Attraction/retention costs depend on current customer base and mass of new customers attracted/old customers retained:

$$a_{n,j}(m,n) = \frac{L_j^{\alpha_n}(1-m)^{\beta_n}}{\psi_n(1-\gamma_n)}\left[1-\left(\frac{1-m-n}{1-m}\right)^{1-\gamma_n}\right]$$
$$a_{o,j}(m,o) = \frac{L_j^{\alpha_o}m^{\beta_o}}{\psi_o(1-\gamma_o)}\left[1-\left(\frac{m-o}{m}\right)^{1-\gamma_o}\right]$$

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

$$f_j(m,m') = \min_{n,o}\ \left\{a_{n,j}(m,n) + a_{o,j}(m,o)\right\}$$
$$\text{s.t.}\quad 0 \le n \le 1-m, \quad 0 \le o \le m, \quad m' = n+o$$

# Model: equilibrium market penetration

Dynamic program also separable across markets:

$$V_j(x,z,m) = \max_{m'} \left\{ \pi(x,z,m') - f_j(m,m') + \delta(x) Q \mathbb{E}\left[V_j(x',z',m') | x,z\right] \right\}$$

Solution: $\underbrace{f_{j,m'}(m,m')}_{\text{marginal cost}} \geq \underbrace{\tilde{\pi}_j (xz)^{\theta-1}}_{\text{marginal profit}} - \underbrace{\beta\delta(x) Q \mathbb{E}\left[f_{j,m}(m',m'') | x,z\right]}_{\mathbb{E}[\downarrow] \text{ in future exporting cost}}$

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

$$f_{j,m'}(0,0) = \tilde{\pi}_j (x \underline{z}_j(x))^{\theta-1} - \delta(x) Q \mathbb{E}\left[f_{j,m}(0,m'') | x,z\right]$$

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

$$f_{j,m'}(\underline{m}_j(x,z),0) = \tilde{\pi}_j (xz)^{\theta-1} - \delta(x) Q \mathbb{E}\left[f_{j,m}(0,m'') | x,z\right]$$

# Model: key properties + relationship to other theories

Export participation driven by exporting cost, $f$

- Melitz (2003): fixed cost $f > 0$
- Arkolakis (2010): $f(m)$ to reach $m \in [0,1]$ customers, $f'' > 0$
- Sunk cost: $f(s)$ depends on export status $s \in \{0,1\}$
- **This paper:** $f(m, m')$ to reach $m'$ customers given current $m$

Key properties:

- $f_2(m, 0) > 0 \Rightarrow$ entry + exit
- $f_{22}(m, m') > 0 \Rightarrow$ concentration
- $f_{21}(m, m') < 0 \Rightarrow$ new exporter dynamics
  - $f_2(0, m') > f_2(m, m') \Rightarrow$ entrants start small then grow
  - $f_2(0, 0) > f_2(m, 0) \Rightarrow$ exit rate $\downarrow$ in $m$
- $f_2(m, m')/(L_j Y_j) \downarrow$ in $L_j, Y_j \Rightarrow$ variation in exporter dynamics across markets

# Calibration

# Calibration: strategy

**Assignments:** direct data analogues + standard values

- Destination characteristics $(Y_j, L_j, \tau_j)$ from CEPII Gravity database
- Demand elasticity $(\theta) = 5$
- Interest rate $(1/Q - 1) = 10\%$

**Indirect inference:** choose all other parameters so that simulated data reproduce

- Correlations between export participation and market characteristics
- Scatter plots of distribution + dynamics against export participation

**Validation:** compare simulated life-cycle sales trajectories against data

**Exploration:** how do exporting costs vary across firms + markets in equilibrium?

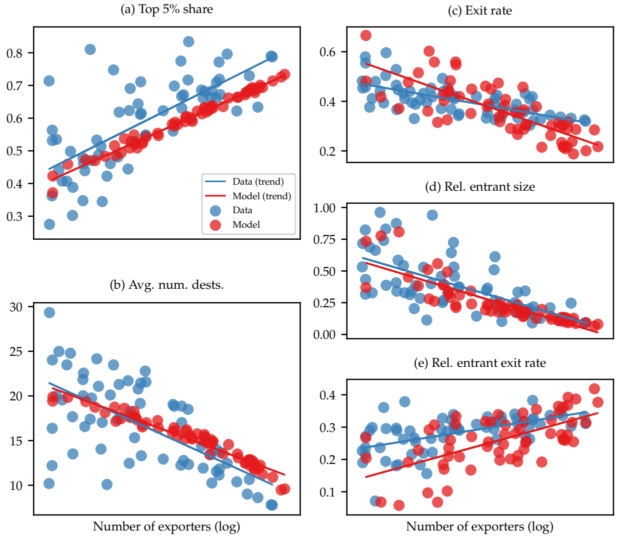
# Calibration: parameter values

| Parameter | Meaning | Value |
|---|---|---|
| *(a) Distribution of firm types* | | |
| $\sigma_x$ | Prod. variance | 1.02 |
| $\rho_x$ | Prod. persistence | 0.98 |
| $\sigma_z$ | Demand variance | 0.44 |
| $\rho_z$ | Demand persistence | 0.60 |
| $\delta_0$ | Corr(survival,prod.) | 34.7 |
| $\delta_1$ | Min. death prob. | 0.03 |
| *(c) New customer attraction costs* | | |
| $\alpha_n$ | Macro return to mkt. size | 0.51 |
| $\beta_n$ | Micro return to mkt. size | 0.94 |
| $\gamma_n$ | Convexity | 6.50 |
| $\psi_n$ | Level | 0.10 |
| *(d) Old customer retention costs* | | |
| $\alpha_o$ | Macro return to mkt. size | 0.96 |
| $\beta_o$ | Micro return to mkt. size | 0.79 |
| $\gamma_o$ | Convexity | 1.75 |
| $\psi_o$ | Level | 0.06 |

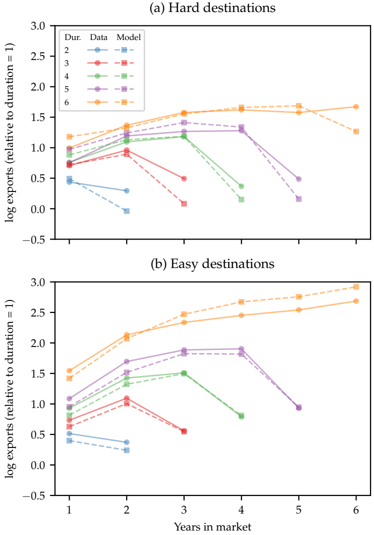
- Productivity more dispersed + more persistent than demand
- $\psi_n \approx \psi_o$: mirrors exog. new exporter dynamics models with similar startup and continuation costs
- $\alpha_n < \alpha_o$: larger macro returns to market size in attracting new customers
- $\beta_n > \beta_o$: larger micro returns to market size in retaining old customers
- $\gamma_n > \gamma_o$: attracting new customers gets harder more rapidly than retaining old ones

# Calibration: fit with data

## Targeted moments




## Non-targeted moments



# Aggregate implications

# Aggregate implications: overview

For each destination, analyze transition dynamics following:

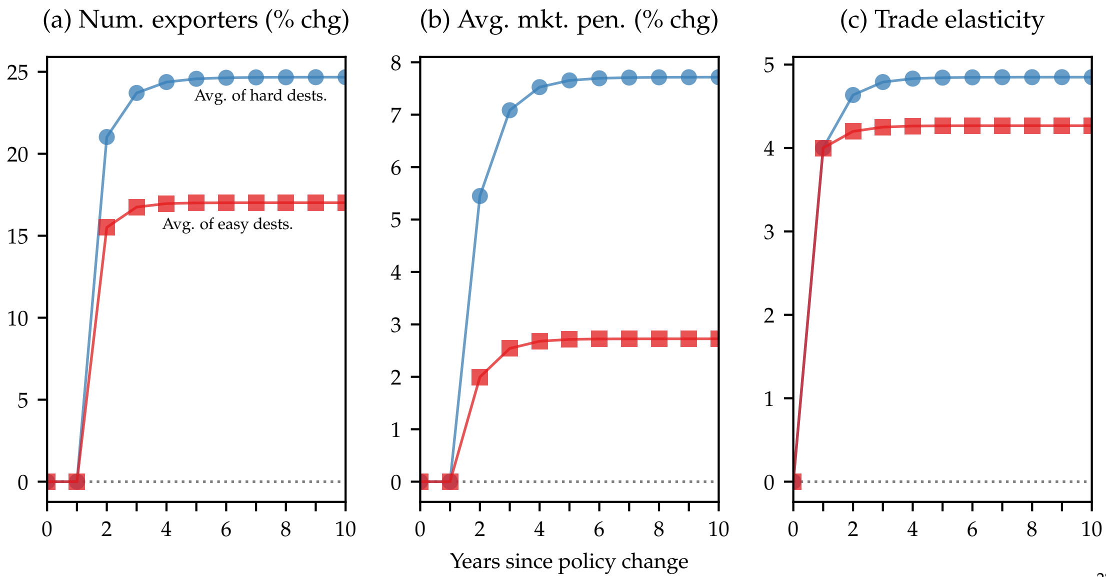
- Permanent 10% reduction in trade cost $\tau_j$
- Temporary 10% RER depreciation ($\log RER_j' = 0.9 \log RER_j + \epsilon_j$)

Compute average responses for easy destinations (top 50% in num. exporters) and hard destinations (bottom 50%)

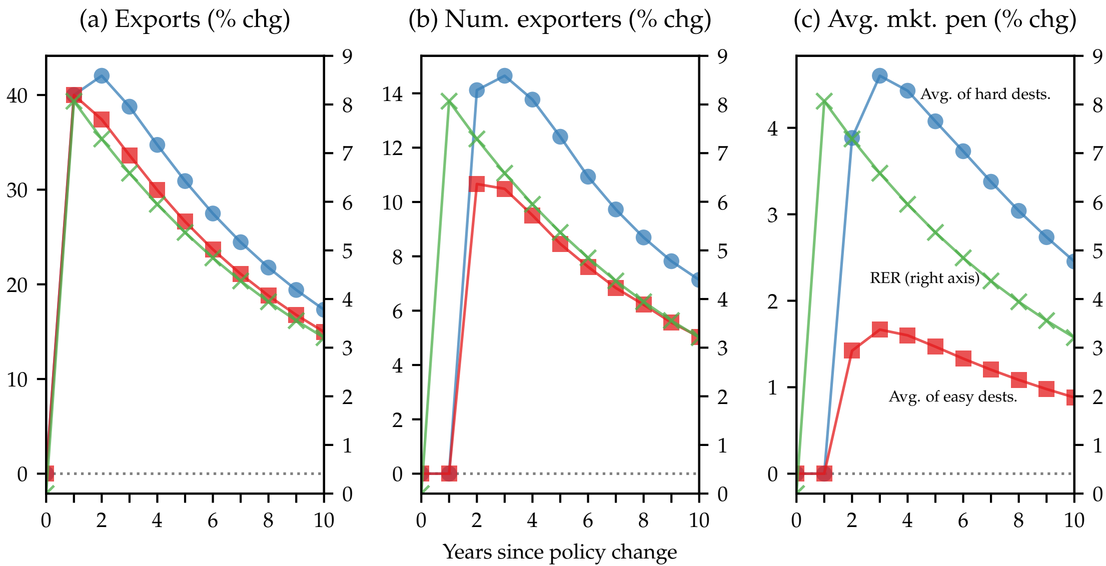
- Overall response: trade elasticity
- Extensive margin: number of exporters
- Firm-level intensive margin: number of customers

Compare to evidence in customs data from Brazil's 1999 RER depreciation

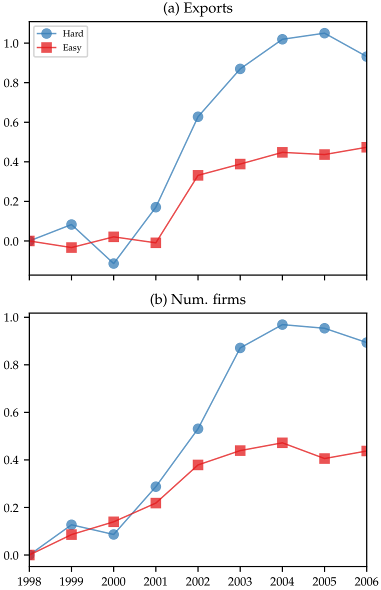
# Agg. implications: permanent trade reform



# Agg. implications: temp. RER shock



# Agg. implications: evidence from Brazil's 1999 depreciation




- Brazil's RER depreciated by 200% between 1998–2003
- Exports to hard markets grew more, even after accounting for changes in multilateral import demand

$$\log Y_{j,t} = \alpha + \sum_{s=1998}^{2006} \mathbb{1}_{\{t=s\}} \left[ \beta_{s,\text{easy}} \mathbb{1}_{\{j \in \text{easy}\}} + \beta_{s,\text{hard}} \mathbb{1}_{\{j \in \text{hard}\}} \right]$$
$$+ \delta_1 \log NER_{j,t} + \delta_2 \log CPI_{j,t} + \delta_3 \log RGDP_{j,t} + \delta_4 \log IM_{j,t} + f_j + \epsilon_{j,t}$$

- Greater growth in harder markets in other contexts:
  - Mix (2021): following creation of FTA
  - Boehm et al. (2020): following change in MFN tariffs

# Conclusion

# Summary

Brazilian microdata show that microeconomic dynamics of exporting firms differ systematically across markets

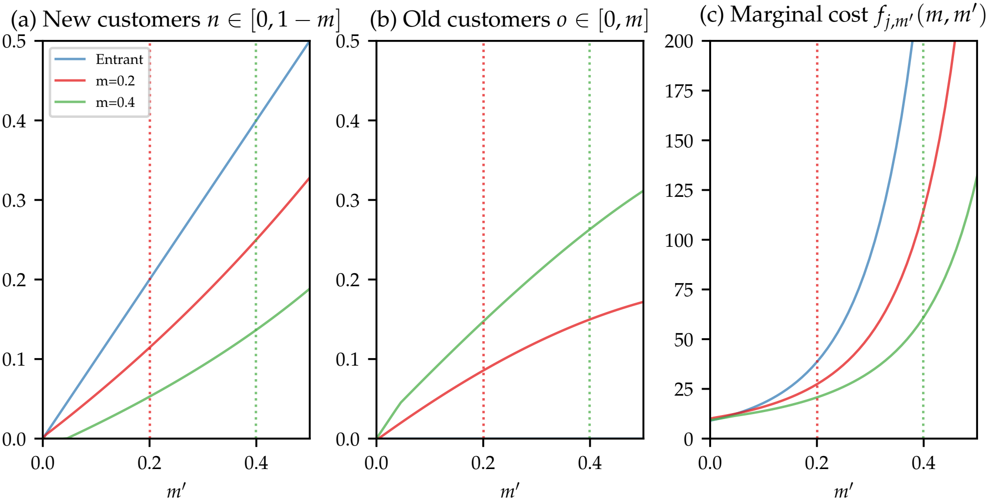
- Lower exit rate, more pronounced new exporter dynamics in easier markets
- Less sales growth with time in a market in easier markets

Simple theory of exporter selection and expansion accounts for these facts

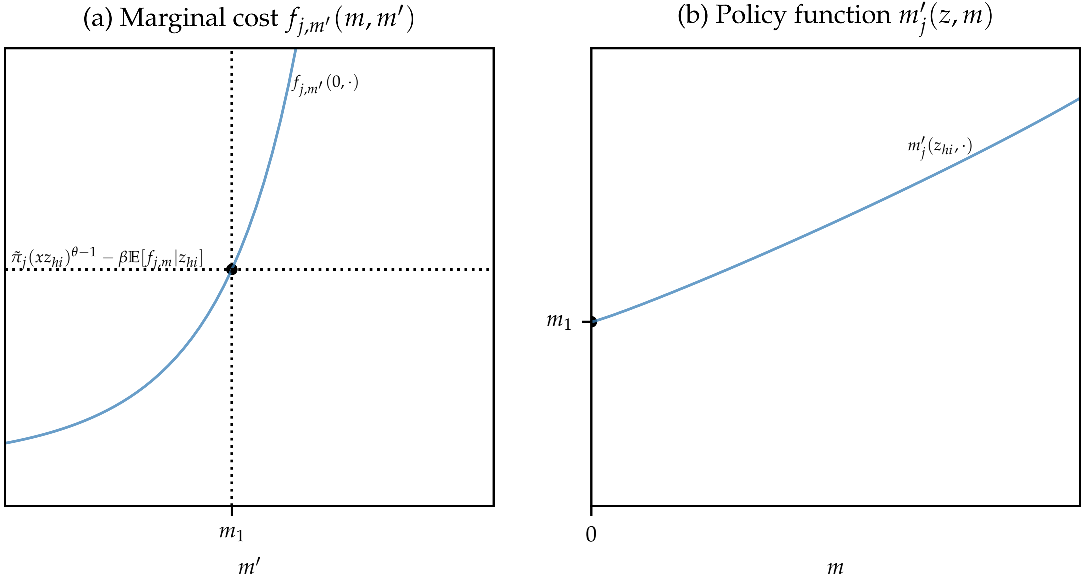
- Synthesizes static models of endogenous market penetration costs with dynamic sunk-cost models
- Predicts larger, more prolonged responses to trade shocks in “harder” destinations, consistent with empirical evidence

# Extras

# Model: solution to export-cost minimization problem



# Model: mechanism visualization



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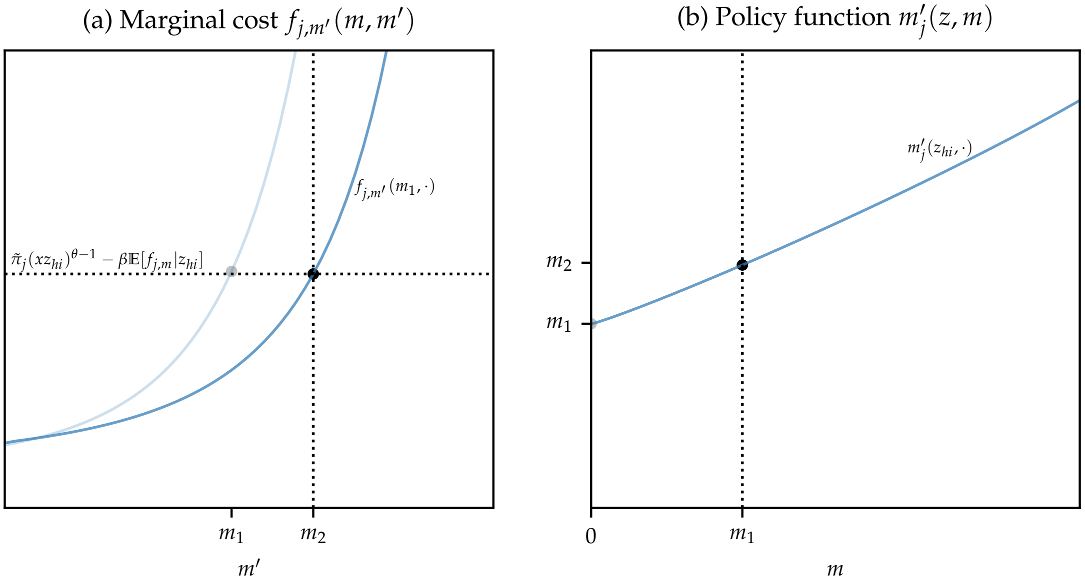

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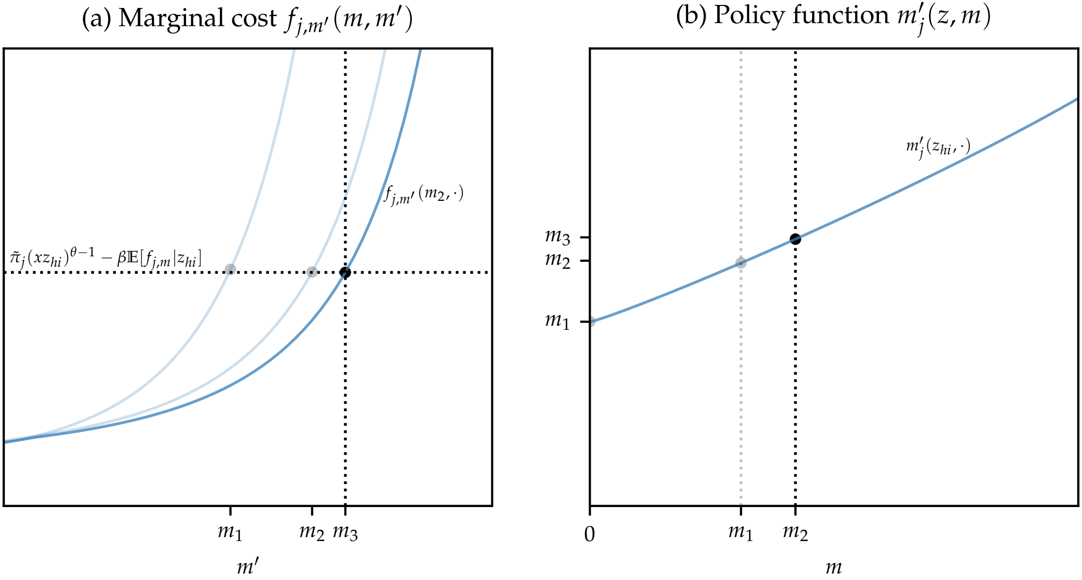

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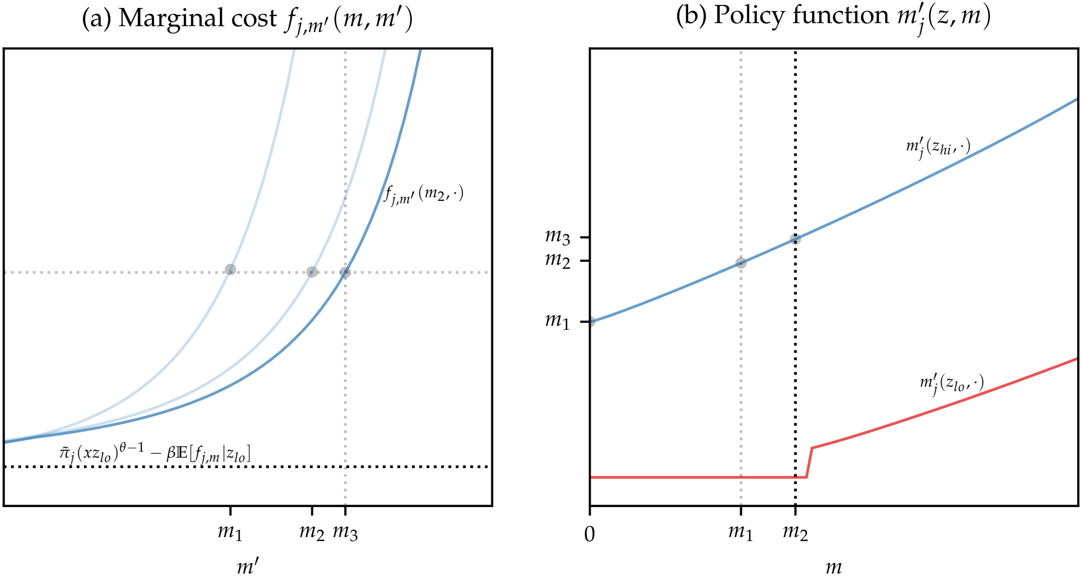

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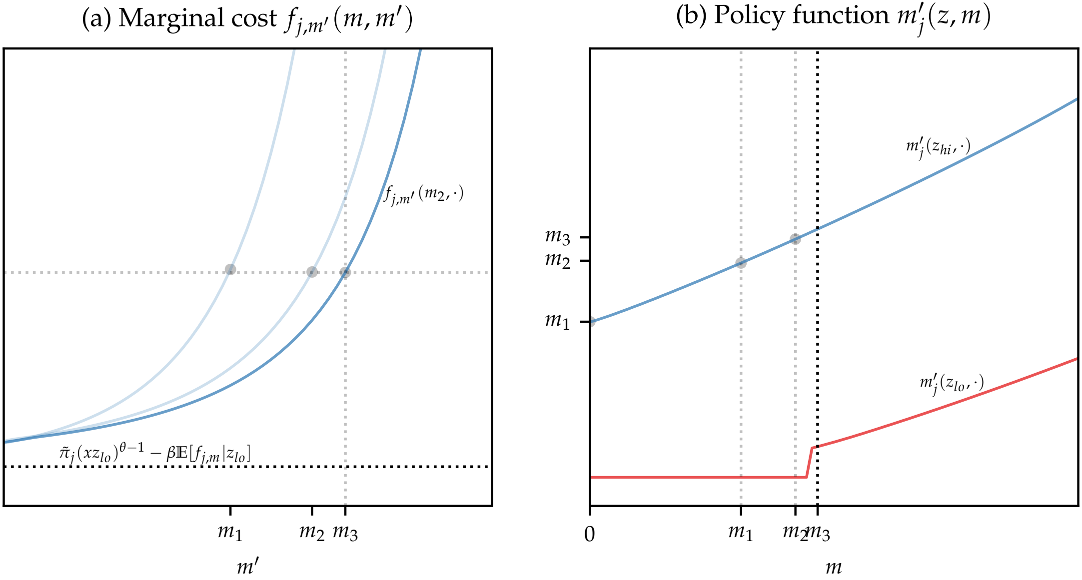


## Calibration: endogenous variation in export costs

Sunk cost models: startup cost $\sim 10\times$ continuation cost required to match high persistence of export status

- Das et al. (2007), Alessandria-Choi (2007, 2014)

New exporter dynamics models: similar startup + continuation costs, but former higher when measured relative to profits

- Ruhl-Willis (2017), Alessandria + al. (2020)

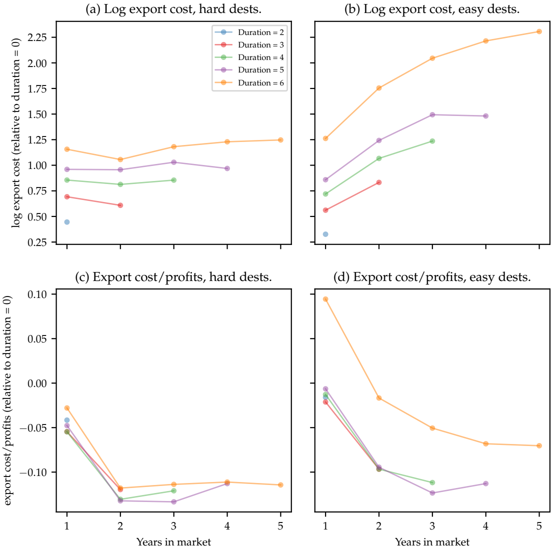
Exog. variation across firms, dests. required to match cross section, even in models with firm-level intensive margin growth

- Piveteau (2016), Fitzgerald + (2020)

How do export costs vary endogenously across firms + markets in this model?

$$\begin{bmatrix} \log f_{i,j,t} \\ \\ \frac{f_{i,j,t}}{\pi_{i,j,t}} \end{bmatrix} = \alpha + \sum_{m=1}^{6} \sum_{n=1}^{m} \beta_{m,n} \mathbb{1}_{\{\text{duration}_{i,j}=m\}} \mathbb{1}_{\{\text{yrs in mkt}_{i,j,t}=n\}} + f_j + f_t + \epsilon_{i,j,t}$$

# Calibration: endogenous variation in export costs




## Levels:

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

## Relative to profits:

- ↓ w/ time in a market
- More pronounced ↓ in easy dests.