

# Trade Liberalization and Firm Dynamics

Ariel Burstein and Marc Melitz

## What We Do & Motivation

- Analyze how firm dynamics and endogenous innovation give rise to aggregate transition dynamics (consumption, trade volumes, productivity) in response to trade liberalization
- Firm and aggregate dynamics are shaped by the following elements:
  - Firm heterogeneity in both innovation and export decision
  - Endogenous entry and exit
  - Forward looking feedback loop between all those decisions
  - Anticipation effects regarding trade policy

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    - How key model “ingredients” interact to induce different firm responses over time
  - 3 Anticipation effects are especially important w.r.t. trade policy

## Broad Research Agenda

Consistent evidence from recent empirical work on producer-level responses to globalization:

- Changes in aggregate trading environment impact the decisions of heterogeneous firms (or plants) to
  - Export (and choice of export locations)
  - Enter and exit
  - Innovate and invest in R&D
  - Adapt technology and mode of operation
    - International supply chain
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    - Horizontal & vertical FDI
- Motivates the design of models explaining the heterogeneous response of firms to trade liberalizations
  - Capture the important composition effects for aggregate variables (trade flows, investment, ... , and ultimately welfare)
  - ... and endogenous source of comparative advantage



## Firm Dynamics Are Relevant for this Research Agenda

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  - No firm dynamics (life cycle or idiosyncratic uncertainty)
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    - Implies producers' choices regarding international market participation and technology do not change over time

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- In this paper, we focus on these dynamic interactions

## What We Do (Cont.)

- Focus on models that build on GE literature of firm productivity dynamics and add firm-level decisions regarding international market participation (typically an export decision)
- Specifically examine the predictions for the dynamic responses to trade liberalization involving the following firm decisions:
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  - How does timing of trade liberalization matter?
    - Permanent versus temporary
    - Unanticipated versus anticipated
- We develop theoretical and computational models of firm dynamics, innovation, and international trade to answer these questions

## Brief Survey of Related Theory

- Aggregate models of firm dynamics
  - Hopenhayn (1992), Atkeson & Kehoe (2005), Luttmer (2007)
- Firm dynamics and international trade
  - Alessandria & Choi (2007), Arkolakis (2009), Irarrazabal & Oromolla (2009), Ruhl (2008), Ruhl & Willis (2008)
- Models of innovation by incumbent firms
  - Griliches (1979), Erikson & Pakes (1995), Klette & Kortum (2004)
- Static models of innovation by incumbents and international trade
  - Bustos (2007), Yeaple (2005)
- Models of innovation, firm dynamics and international trade
  - Constantini & Melitz (2008), Atkeson & Burstein (2010)

## Key Results

- When is a sudden permanent change in trade costs likely to induce endogenous adjustment dynamics for key aggregate outcomes?
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  - 1 No export market selection
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  - 1 No export market selection
  - 2 Endogenous export market selection but no firm dynamics (even with endogenous innovation)
- Size of entrants and their likelihood of exporting (both relative to incumbents) key in shaping response of entry and transition dynamics

## Key Results (Cont.)

- Endogenous innovation amplifies differences in productivity between exporters and non-exporters
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- Innovation can precede anticipated reduction in trade costs, amplifies productivity differences underlying selection into exporting
- Firm dynamics and sunk costs generate option values ahead of actual changes in trade costs
- Note: the results regarding cumulative welfare gains from Atkeson & Burstein (2009) still hold

## Brief Survey of Empirical Work Highlighting These Interactions

- Hysteresis effects:
  - Roberts & Tybout (1997), Bernard & Jensen (2008)
- Reponse of productivity/innovation to trade liberalization
  - Lileeva & Trefler (2009) for Canada; Verhoogen (2009) for Mexico; and Bustos (2010) for Argentina; Aw, Robers & Xu (2010) for Taiwan; Bloom et al. (2009) for competition from Chinese imports
- Market demand dynamics
  - Eaton et al (2010)
- Anticipation effects ahead of changes in trade costs
  - Das et al. (2007): Effects of anticipated changes in exchange rates in some sectors
  - Bergin & Lin (2010): Entry into export markets ahead of EMU
  - Vanbeveren & Vandebussche (2010): Increased firm innovation ahead of entry into new export markets



Model

## Model Overview

- 2 country symmetric model (no terms of trade or current account dynamics)
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  - Entry subject to sunk cost
  - Firm productivity  $z$  then evolves stochastically
  - Firms can influence this evolution process via innovation
- Monopolistic competition: no strategic interactions
- Focus on entry and innovation (which determine distribution of firms) as only source of endogenous dynamics
- Perfect foresight: no aggregate uncertainty

## Preferences

- Consumption index  $C_t$  is CES aggregate of all available varieties (domestic and imported)
  - Symmetric elasticity of substitution  $\rho > 1$
  - In equilibrium, this is also the value of aggregate production  $Y_t$
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  - Let  $P_t$  denote the CES price index of consumption
- Inter-temporal preferences of representative household given by:

$$U = \sum_{t=0}^{\infty} \beta^t \log(C_t)$$

where  $\beta \in (0, 1)$  is standard discount factor

- Equilibrium interest rate is determined by these intertemporal preferences:

$$R_t = \frac{1}{\beta} \frac{C_{t+1}}{C_t}$$

(no aggregate uncertainty so perfect foresight)

## Production and Trade

- Labor is only factor of production (and numeraire)
- Each firm produces a separate differentiated variety
- Firm hires  $l_t(z)$  production workers (in addition to overhead labor  $f$ ) and produces output:

$$y_t(z) = \exp(z)^{1/(\rho-1)} l_t(z).$$

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- Increasing returns to scale driven by fixed costs
- A firm chooses to export to symmetric market subject to trade costs:
  - Per-unit “iceberg” cost  $\tau > 1$
  - Per-period fixed cost  $f_X$
  - Later on, will also add a sunk cost  $f_{EX}$



## Static profits

- Monopolistic competition: firms sets price in domestic market at constant markup over marginal cost:

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- Define the market demand index:

$$\Pi_{dt} \equiv \frac{P_t^\rho Y_t}{\rho^\rho (\rho - 1)^{1-\rho}}$$

- Then a firms total profits are given by:

$$\Pi_t(z) = \Pi_{dt} \exp(z) - f + x_t(z) [\Pi_{dt} \tau^{1-\rho} \exp(z) - f_X]$$

where  $x_t(z) \in \{0, 1\}$  represents an indicator variable for firm  $z$ 's export status

## Productivity dynamics

- Exogenous exit with probability  $\delta$  (independent of firm productivity  $z$ )
- Productivity evolution:
  - Conditional on survival, productivity  $z$  can go up or down by an exogenous amount  $\Delta_z$ 
    - It increases to  $z + \Delta_z$  with probability  $q$
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- If time period small, then binomial process approximates geometric Brownian motion in continuous time (as in Luttmer 2006)

# Innovation

- Firms can affect this productivity evolution process via innovation, which affects the probability  $q$
- The investment cost of a given probability  $q$  is  $\exp(z) c(q)$  (in units of labor)
  - where  $c(q)$  ( $c_q > 0$ ,  $c_{qq} > 0$ ) is the innovation cost function common across firms

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  - where  $c(q)$  ( $c_q > 0$ ,  $c_{qq} > 0$ ) is the innovation cost function common across firms
- For a given  $q$ , the investment cost is proportional to a firm's size in its *domestic* market
  - This implies size-independent growth for large firms, consistent with Gibrat's law
  - Same innovation decision by large firms:  $\bar{q}_t = \lim_{z \rightarrow \infty} q_t(z)$

## Innovation Choice

- A firm chooses its innovation level (indexed by the probability  $q$ ) to maximize its continuation value:

$$V_t^o(z) = \max_{q \in [0,1]} \Pi_t(z) - \exp(z) c(q) + (1 - \delta) \frac{1}{R_t} [qV_{t+1}(z + \Delta_z) + (1 - q)V_{t+1}(z - \Delta_z)]$$

which yields an optimal innovation level  $q_t(z)$  determined by the FOC:

$$\exp(z) c'(q) = (1 - \delta) \frac{1}{R_t} [V_{t+1}(z + \Delta_z) - V_{t+1}(z - \Delta_z)]$$

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- Exogenous innovation is obtained from very steep innovation cost function such that  $q_t(z) = \bar{q}, \forall z, t$



## Entry & Exit

### Exit

- The exit decision is determined by the maximization of overall firm value:

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which implies an exit cutoff  $\bar{z}_t$  such that  $V_t(\bar{z}_t) = 0$

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  - ... then draw their initial  $z$  from a common distribution  $G(z)$  (potentially degenerate)

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### Entry

- Firms pay sunk investment cost  $f_E$  to enter (in units of labor)
  - ... then draw their initial  $z$  from a common distribution  $G(z)$  (potentially degenerate)
- No other restrictions to entry, thus free-entry condition:

$$\frac{1}{R_t} \int V_{t+1}(z) G(z) dz \leq f_E$$

with equality if entry is strictly positive

## Aggregation

- CES price index:

$$P_t = \left[ \int p_t(z)^{1-\rho} M_t(z) dz + \int x_t^*(z) [\tau p_t^*(z)]^{1-\rho} M_t^*(z) dz \right]^{1/(1-\rho)}$$

where  $M_t(z)$  is measure of operating firms with productivity index  $z$

- Evolution of  $M_t(z)$  over time is implied by  $q_t(z)$ ,  $\delta$ , and  $\bar{z}_t$ , and the mass of entrants  $M_{Et}$ :

$$M_{t+1}(z') = \begin{cases} M_{Et} G(z') + (1-\delta)q_t(z' - \Delta_z)M_t(z' - \Delta_z) + \\ \quad (1-\delta)[1 - q_t(z' + \Delta_z)]M_t(z' + \Delta_z) & \text{if } z' \geq \bar{z}'_{t+1} \\ 0 & \text{if } z' < \bar{z}'_{t+1} \end{cases}$$

## Labor Market Aggregation

- Exogenous aggregate labor supply (normalized to 1) is used for production ( $L_{pt}$ ), innovation ( $L_{lt}$ ), and to cover the fixed costs for entry, export, and overhead production (we assume no sunk export costs for now):

$$L_{pt} + L_{lt} + M_{Et} f_E + \int [f + x_t(z) f_X] M_t(z) dz = 1$$

where

$$L_{pt} = \int l_t(z) M_t(z) dz$$

$$L_{lt} = \int [\exp(z) c(q_t(z))] M_t(z) dz$$

## Other Useful Aggregates (Reported in Computations)

- Domestic share of exporters:

$$\frac{\int x_t(z) \exp(z) M_t(z) dz}{\int \exp(z) M_t(z) dz}$$

- Export to GDP ( $Y_t$ ):

$$\frac{\tau^{1-\rho} \int x_t(z) \exp(z) M_t(z) dz}{\int \exp(z) M_t(z) dz + \tau^{1-\rho} \int x_t(z) \exp(z) M_t(z) dz}$$

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- Average firm productivity:

$$\bar{Z}_t = \frac{\int \exp(z) M_t(z) dz}{\int M_t(z) dz}$$

- This is proportional to the average firm size on the domestic market at any given level of market demand  $\Pi_{dt}$
- In other words,  $\bar{Z}_t / \Pi_{dt}$  is equal to average firm size (on the domestic market) in every period  $t$  (up to a normalization constant)

## Parameterization: Innovation Cost Function

$$c(q) = h \exp(bq)$$

- $b = c''(q) / c'(q) > 0$  indexes curvature of innovation cost function
- For exogenous innovation case, we pick high enough  $b$  that all firms choose same innovation level  $q_t(z) = \bar{q}$



## Parameterization: Remaining Calibration

- For all cases with productivity dynamics, we use degenerate distribution for entrants at  $z = 1$
- We calibrate  $(h, f_X, \Delta_z, \tau^{1-\rho}, \delta)$  to US data on (See Atkeson & Burstein 2010 for details):
  - Firm employment-based size distribution.
  - Variance of growth of large firms.
  - Death of large firms.
  - Exports / Gross Output.
  - Share of employment in exporting firms

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### With Sunk Export Costs:

- Firms must pay additional sunk export cost  $f_{EX}$  to become exporters
  - Lose this investment if stop exporting
- We assume that the majority of the fixed export costs are sunk, and calibrate  $f_{EX}$  to match the US data above

## Trade Liberalization Scenarios

- We consider the effects of a 3.5% reduction in international per-unit trade costs  $\tau$
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- We use this benchmark trade cost reduction throughout all scenarios
- We first consider the effects of a permanent unanticipated reduction
- We then contrast this to:
  - A temporary unanticipated reduction
  - An anticipated (2 years prior) reduction (thereafter permanent)
  - Similar anticipated reduction adding sunk export costs

## Results

## No Export Market Selection

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  - Offsetting effects of increased export opportunities and reductions in domestic sales from imports, same for all producers
  - Hence adjust immediately to new steady state: no transition dynamics
- Steady state consumption gain is limited to direct effect of change in trade cost from  $\tau'$  to  $\tau$ :

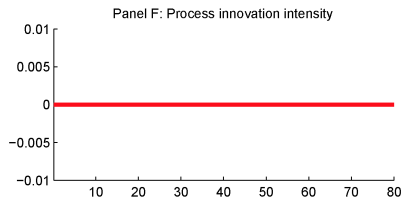
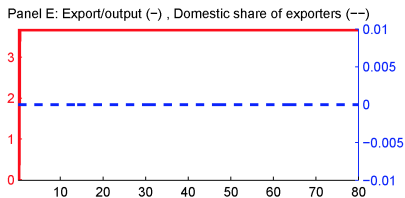
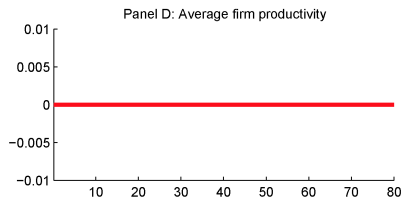
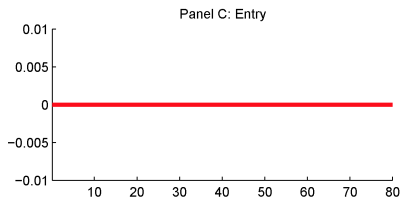
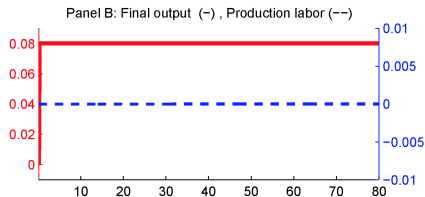
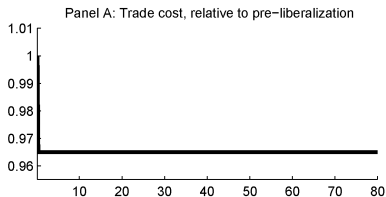
$$\left( \frac{1 + \tau'^{1-\rho}}{1 + \tau^{1-\rho}} \right)^{\frac{1}{\rho-1}}$$

- This is identical welfare gain as an Armington model (country produces a single good with exogenous unit labor requirement) and as in Krugman (1980)

## No Export Market Selection (Cont.)

- Illustrate analytic result in following figure
  - Panel A reports  $\tau_t/\tau_0$ , Panels B-F report  $\log(X_t/X_0) / \log(\tau_t/\tau_0)$  for each variable  $X$

# Permanent liberalization, with or without productivity dynamics, all firms export



## No Export Market Selection: Summary

- No change in average firm productivity
- No transition dynamics

## Export Market Selection but No Firm Productivity Dynamics

- No productivity dynamics,  $\Delta_z = 0$  (and hence no innovation)
- Entering productivity  $\exp(z)$  distributed Pareto with parameter  $\theta > \rho - 1$

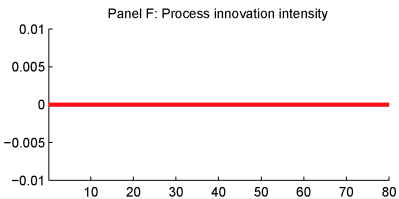
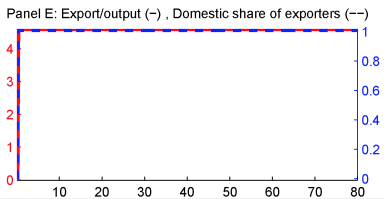
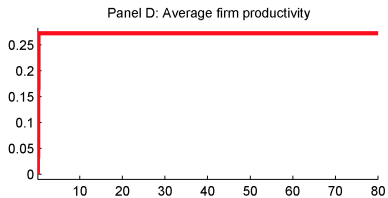
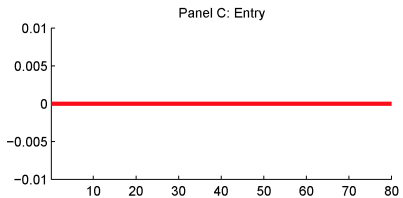
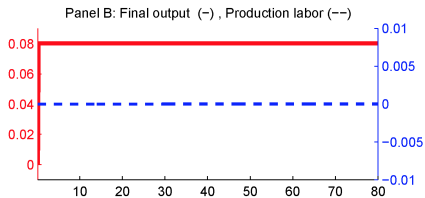
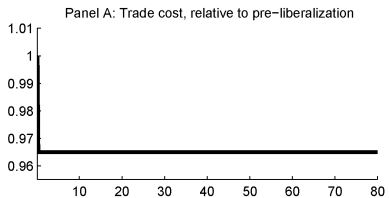
# Export Market Selection but No Firm Productivity Dynamics

- No productivity dynamics,  $\Delta_z = 0$  (and hence no innovation)
- Entering productivity  $\exp(z)$  distributed Pareto with parameter  $\theta > \rho - 1$

Analytic results:

- Number of entrants does not depend on the trade cost in steady state (dynamic model extension of Arkolakis et al 2009 )
- If trade costs fall, domestic cutoff rises, export cutoff falls
- Immediate transition to new steady state

# Permanent liberalization, no productivity dynamics



# Export Market Selection but No Firm Productivity Dynamics: Summary

- Bigger trade elasticity due to changes in cutoffs
- Rise in average firm productivity due to reallocation of production towards more productive producers
- No transition dynamics



## Export Market Selection and Firm Productivity Dynamics

- We now show how interaction of firm productivity dynamics and export market selection generates aggregate transition dynamics
- These transition dynamics are generated by the response of entry to the change in the trade cost
- In order to gain some intuition for the response of entry, we start with a simplified version of our model

## Response of Entry to Trade Liberalization: Building Intuition

Consider the following simplified version of our model:

- All firms have the same productivity level that is constant over time
- New entrants are non-exporters, exogenously become exporters when  $T + 1$  periods old (and remain exporters thereafter)

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- Let  $s_x$  represent the aggregate share of exports in total sales (in the cross-section)
- Let  $\tilde{s}_x$  represent an entrant's net present value of export sales relative to the net present value of total sales

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- Let  $s_x$  represent the aggregate share of exports in total sales (in the cross-section)
- Let  $\tilde{s}_x$  represent an entrant's net present value of export sales relative to the net present value of total sales
  - If  $T = 0$  (all firms export) or  $\beta = 1$  (no discounting), then  $s_x = \tilde{s}_x$
  - As  $T$  increases (it takes longer for an entrant to become an exporter) and  $\beta$  decreases (more discounting) then  $\tilde{s}_x$  decreases relative to  $s_x$ :
    - Profits from exporting become a less important component of a firm's value upon entry

# Response of Entry to Trade Liberalization: Building Intuition

Analytic results:

- When trade costs fall, entry falls (increases) in steady state if and only if  $\tilde{s}_x < s_x$  ( $\tilde{s}_x > s_x$ )
- For a given small change in trade costs, the percentage change in entry is proportional to  $\tilde{s}_x - s_x$

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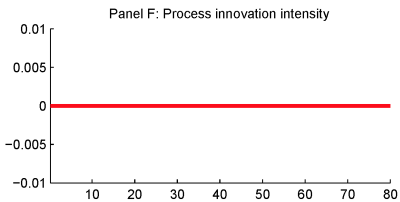
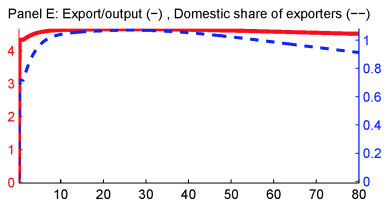
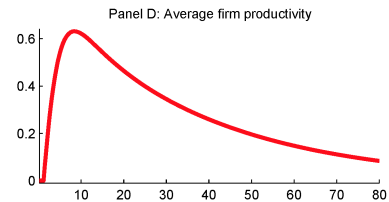
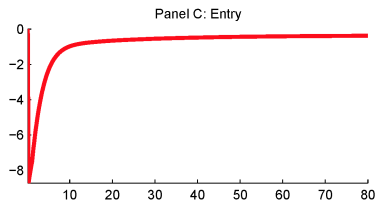
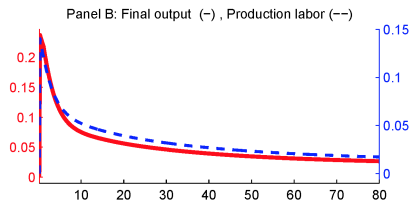
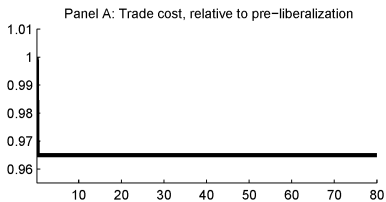
Intuition:

- When  $\tilde{s}_x < s_x$ , trade liberalization makes entry less profitable: Incumbent/exporters firms benefit proportionally more than entrants/non-exporters from lower trade costs
- This analytic results can be generalized to a richer structure of productivity and export participation dynamics (see Atkeson and Burstein 2010)

## Export Market Selection and Firm Productivity Dynamics

- This same intuition applies to our full model with productivity dynamics and export market selection
- Following figure considers a parameterization of the model with exogenous productivity dynamics, in which entrants are less likely to export than incumbent firms (i.e.  $\tilde{s}_x < s_x$ )

# Permanent liberalization, exogenous innovation





# Export Market Selection and Firm Productivity Dynamics: Summary

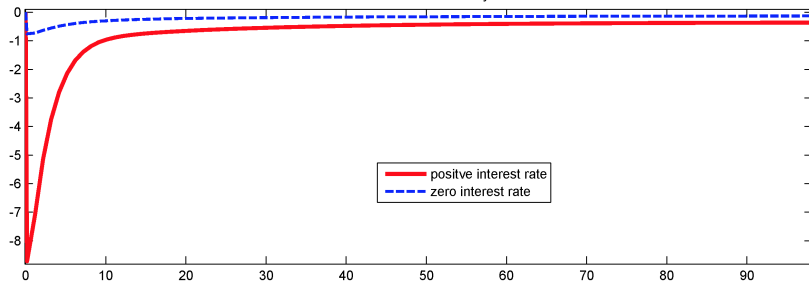
- Entry drops along transition and in new steady state
  - Trade liberalization makes entry less profitable: Incumbent/exporters firms benefit proportionally more than entrants/non-exporters
  - Mass of producing firms steadily decreases to its new steady state
- Consumption overshoots its steady state level because more labor can be used in production, mass of firms falls over time
  - Comparing consumption across steady states understates welfare gains from trade liberalization

## Export Market Selection and Firm Productivity Dynamics: Alternative Parametrizations

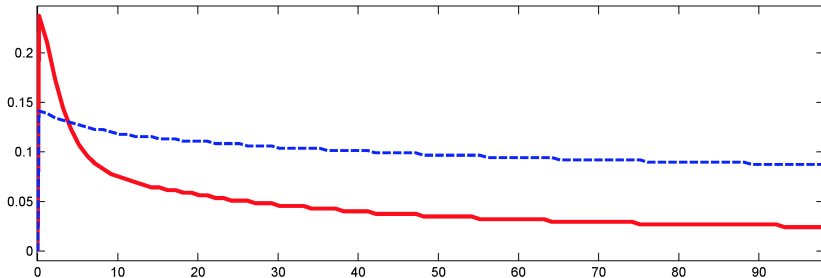
- Consider an alternative parametrization with no discounting ( $\beta = 1$ )
  - Wait for entrant to become an exporter is now inconsequential
- This increases the importance of the future expected exporting profits for an entrant
  - Entry responds less negatively to trade liberalization
  - Less overshooting of consumption
  - Transition dynamics look more similar to no productivity dynamics

Permanent liberalization, exogenous innovation, positive interest rate (-) and zero interest rate (-)

Panel C: Entry



Panel B: Final Output



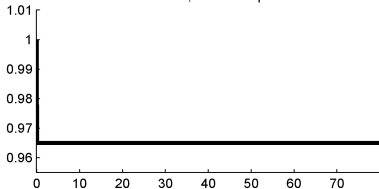
# Export Market Selection and Firm Productivity Dynamics

## Consequences of Endogenous Innovation

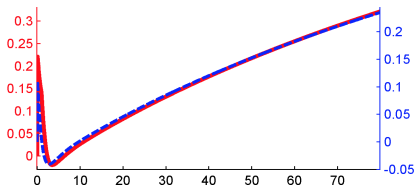
- Following figure considers a parameterization of the model with endogenous innovation

# Permanent Liberalization: Endogenous Innovation

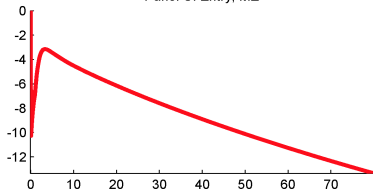
Panel A: Trade cost  $\tau$ , relative to pre-liberalization



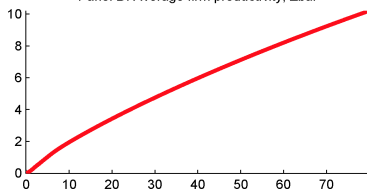
Panel B: Final output  $Y$  (-), Production labor  $LP$  (--)



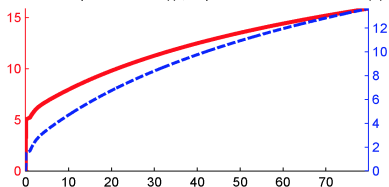
Panel C: Entry,  $ME$



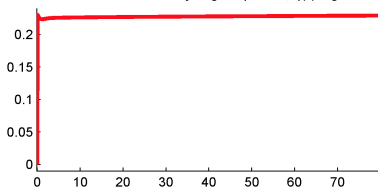
Panel D: Average firm productivity,  $Zbar$



Panel E: Export share  $sX$  (-), Exporters domestic share  $sD$  (--)



Panel F: Innovation by large exporters,  $q(z)$  high  $z$



# Export Market Selection and Firm Productivity Dynamics

## Consequences of Endogenous Innovation

- Innovation intensity by exporters rises
  - Lower trade costs increase the value of exporters relative to non-exporters, and the former respond by innovating relatively more
  - Average firm productivity increases, driven by the productivity increase of exporters
  - Increase in relative size and productivity of exporters takes a long time to unfold
- Trade volumes relative to output steadily increases as exporters become relatively more productive
  - Short run elasticity of trade with respect to trade costs is substantially smaller than the long run elasticity
- Consumption undershoots its steady state level
  - Comparing consumption across steady states overstates welfare gains from trade liberalization

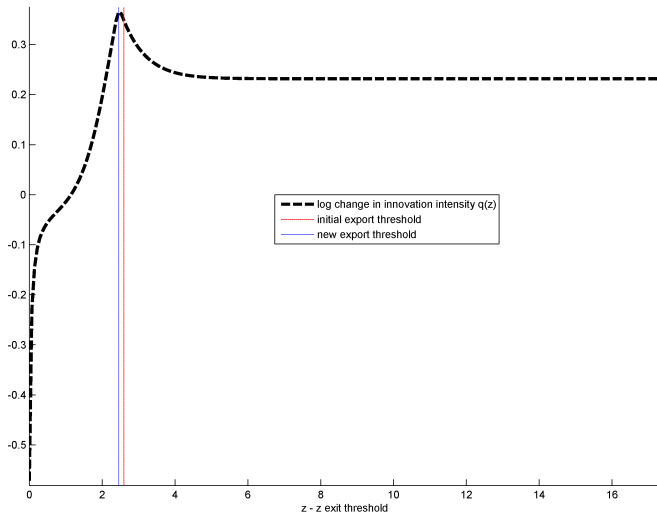
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  - Comparing consumption across steady states overstates welfare gains from trade liberalization
- Anticipation effects: Some non-exporters increase innovation in anticipation of future export status

# Export Market Selection and Firm Productivity Dynamics: Increased Innovation by Non-Exporters

Change in innovation intensity by firm across steady-states



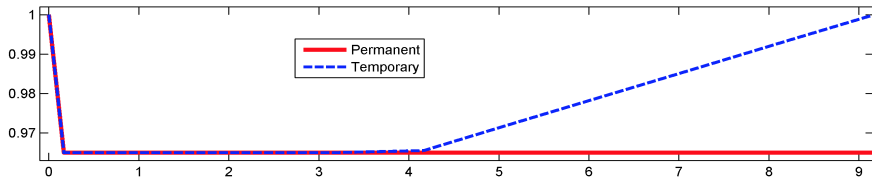


## Permanence of Trade Liberalization

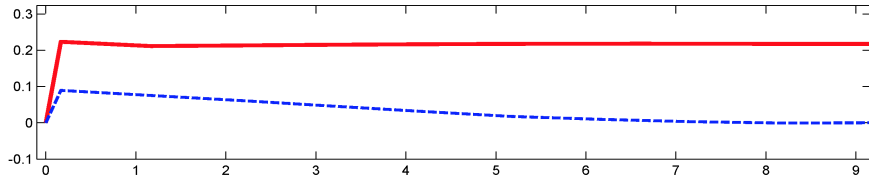
- For these endogenous changes in productivity and trade volumes (arising from changes in endogenous innovation) to be important, trade liberalization must be perceived to be long lasting
- The following figure considers a parameterization of the model with endogenous productivity dynamics
  - Temporary reduction in trade costs (see path of  $\tau$  in Panel A)

# Permanent (-) and Temporary (--) Liberalization, Endogenous Innovation

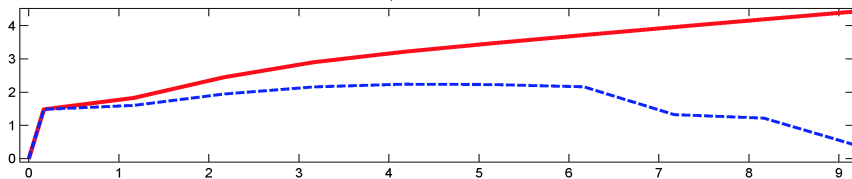
Panel A: Trade cost,  $\tau$



Panel B: Innovation by large exporters,  $q(z)$  high  $z$



Panel C: Exporters domestic share,  $sD$



# Permanence of Trade Liberalization

Two key effects:

- 1 Incentives: Entry and innovation responses are forward looking
  - Permanence of trade liberalization affects incentives for entry and innovation
  - Innovation intensity by exporters rises by less when reduction in trade costs is temporary

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  - Innovation intensity by exporters rises by less when reduction in trade costs is temporary
- 2 Transition dynamics are slow: given incentives, changes in entry and innovation take a long time to unfold

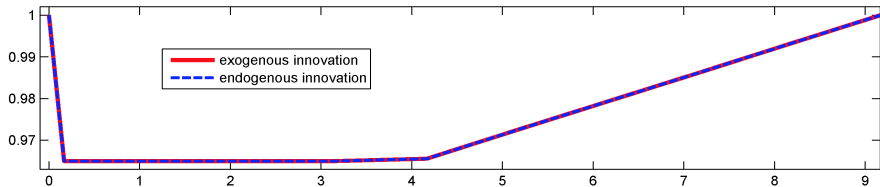
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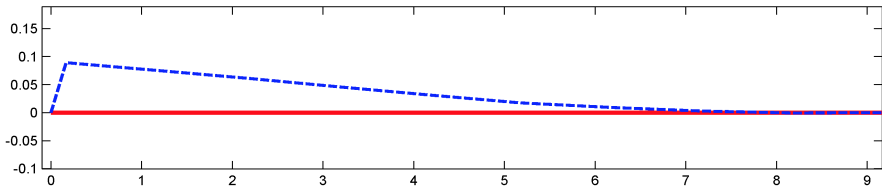
- 1 Incentives: Entry and innovation responses are forward looking
  - Permanence of trade liberalization affects incentives for entry and innovation
  - Innovation intensity by exporters rises by less when reduction in trade costs is temporary
- 2 Transition dynamics are slow: given incentives, changes in entry and innovation take a long time to unfold
  - As time window for lower trade costs is reduced, the role of endogenous innovation becomes increasingly muted
  - The following figure shows that the differences between endogenous and exogenous innovation are very muted when trade liberalization is temporary

# Temporary liberalization, exogenous (-) and endogenous (--) innovation

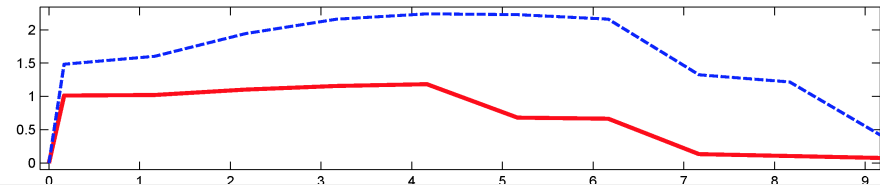
Panel A: Trade cost



Panel F: Innovation intensity by exporters



Panel E: Domestic share of exporters

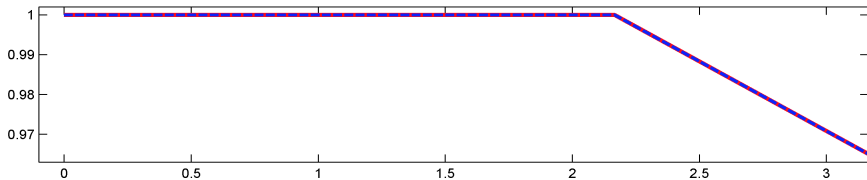


## Anticipation Effects: Response of Endogenous Innovation

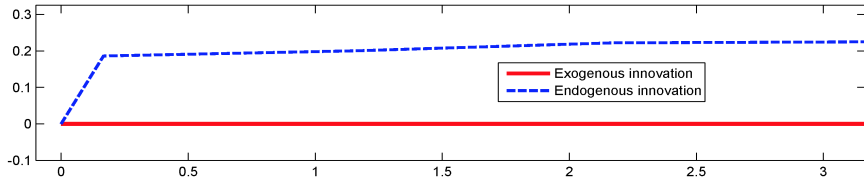
- The following figure considers an anticipated, permanent reduction in trade costs (see path of  $\tau$  in Panel A) in the parametrizations of the model with exogenous and endogenous innovation
- Anticipation effects for innovation: rise in innovation precedes reduction in trade costs if the latter is anticipated.

# Anticipated Liberalization: Exogenous (-) and Endogenous (--) Innovation

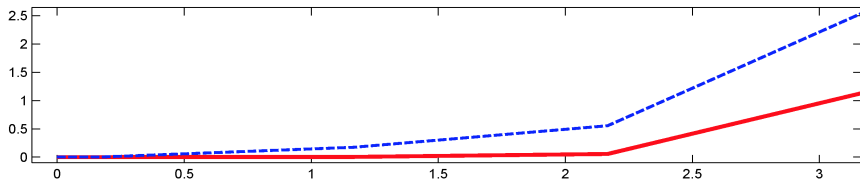
Panel A: Trade cost,  $\tau$



Panel B: Innovation by large exporters,  $q(z)$  high  $z$



Panel C: Exporters domestic share,  $sD$





# Anticipation Effects: Response of Endogenous Innovation

## Summary

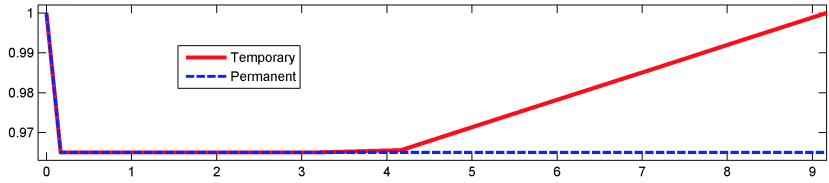
- Anticipation effects for innovation: rise in innovation precedes reduction in trade costs if the latter is anticipated.
  - Implies that the rise in share of exporters in domestic sales precedes the reduction in trade costs
  - What has been viewed as “exogenous” differences in productivity driving export market selection can also have an endogenous component

## Temporary Trade Liberalization and Sunk Export Costs

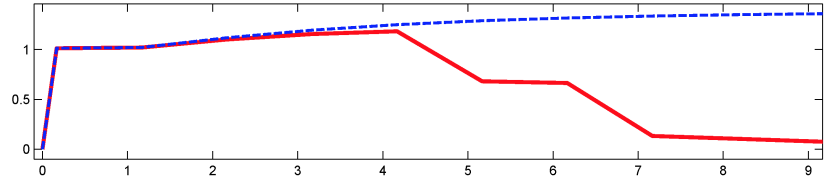
- We now introduce **sunk** costs of exporting, but stick to the case of **exogenous innovation**
- The following figure contrasts the permanent and temporary trade liberalization case for both our previous case with fixed export costs, and then with sunk export costs:

# Sunk versus Fixed Export Costs: Role of Permanence of Trade Liberalization

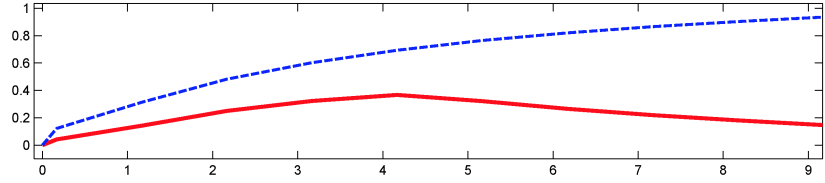
Panel A: Trade cost,  $\tau$



Panel B: Fixed Export Costs, Exporters domestic share,  $sD$



Panel C: Sunk Export Costs, Exporters domestic share,  $sD$



# Temporary Trade Liberalization and Sunk Export Costs

## Summary

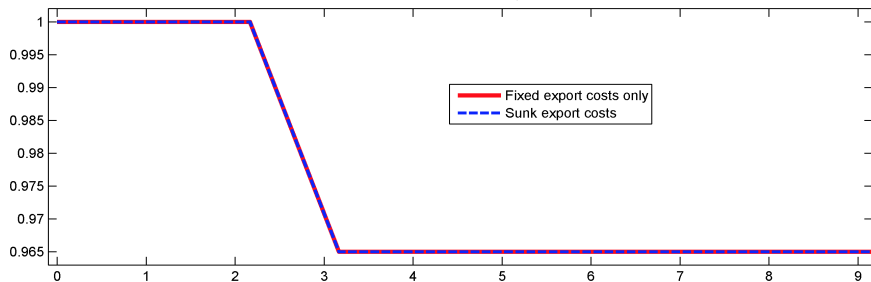
- With sunk costs, the initial response of trade volumes to the same decrease in trade costs is substantially larger when the reduction is perceived to be permanent
  - Note that this distinction is irrelevant without sunk costs (as shown in Panel B)

## Anticipation Effects: Sunk Costs and Option Values

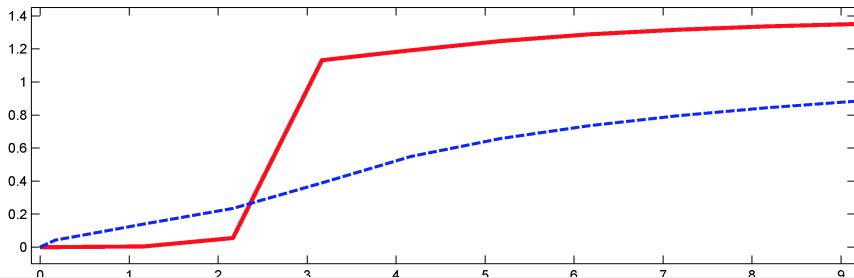
- The following figure considers an anticipated, permanent reduction in trade costs in the parametrizations of the model with **exogenous innovation**, with fixed costs of exporting and with **sunk** costs of exporting

# Anticipated Trade Liberalization, Exogenous Innovation, Fixed costs (-) and Sunk Export Costs (--)

Panel A: Trade cost,  $\tau$



Panel B: Exporters domestic share,  $s_D$



# Anticipation Effects: Sunk Costs and Option Values

## Summary

- Uncertainty and sunk export costs generate option values, and anticipation effects of trade liberalization affects these option values ahead of actual changes in trade costs.
- Implies that, with sunk export costs, the rise in share of exporters in domestic sales precedes the reduction in trade costs

## Conclusion

- We have characterized dynamic responses to trade liberalization in GE models of industry productivity dynamics with both endogenous innovation and trade
  - Can address recent evidence regarding firms' response to liberalization over time
    - Including: entry/exit, export, and innovation decisions
- These decisions generate endogenous dynamics for aggregate productivity, trade volumes, and consumption
  - Amplifies comparative advantage of exporters vs non-exporters
- Long lasting adjustment dynamics arise from combination of firm productivity dynamics and endogenous export market selection
- Timing of trade liberalization shape endogenous dynamics