Endogenous Trade Participation with Incomplete Exchange Rate Pass-Through

Yuko Imura

Bank of Canada

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Disclaimer

The views expressed in this presentation, or in my remarks, are my own, and do not necessarily represent those of the Bank of Canada.

Exporter Characteristics and Dynamics

- Exporter characteristics
  - Only 21% of US manufacturing plants exported in 1992. (Bernard, Eaton, Jensen & Kortum 2003)
  - 12-18% more productive, 48% higher capital/worker, 20-45% more employment than non-exporters (Bernard & Jensen 1999)
- Significant export costs
  - 7-17% of a shipment's value (Alessandria et al. 2010)
- Time-varying extensive margin of trade figure
  - Entry rate = 13.9%, exit rate = 12.6% (Bernard & Jensen 2004)
- Incomplete exchange rate pass-through
  - 23% in short run, 42% in long run (Campa & Goldberg 2005)

Objective

This paper studies implications of endogenous trade participation for

- international business cycles,
- dynamics of trade participation, and
- exchange rate pass-through

in an environment with nominal rigidities.

Main Findings

- With price rigidities, limited adjustments along intensive margin of trade lead to procyclical movements in the number of exporters, resulting in larger responses of export price and trade balance, in contrast to existing studies under flexible prices.

- Quantitative effect of extensive margin of trade on exchange rate pass-through is negligible, preserving incomplete pass-through in the presence of nominal rigidity.

- Entry and exit lead relatively more productive firms to dominate the export market.

- The model explains delayed response of trade balance and terms of trade to currency depreciation, with substantial adjustments along intensive and extensive margins.

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Related Literature

Exporter entry and exit

- Export hysteresis in partial equilibrium
  Baldwin (1988), Baldwin and Krugman (1989), Dixit (1989)
- DSGE for business cycles
  Ghironi and Melitz (2005), Alessandria and Choi (2007)

Incomplete exchange rate pass-through

- Demand curvature and market structure
  Atkeson and Burstein (2008), Gust, Leduc and Vigfusson (2010)
- Local costs
  Burstein, Neves and Rebelo (2003), Corsetti and Dedola (2004)
- Price rigidities
  Devereux and Engel (2002), Bacchetta and van Wincoop (2003)

Model Overview: Two-country DSGE model

- Representative household

- Competitive final-good producers

$$D_t = \left\{ \omega \left[\int_0^1 y_t^H(i)^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1}\frac{\rho-1}{\rho}} + (1-\omega) \left[\int_{i \in \Theta_t} y_t^F(i)^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1}\frac{\rho-1}{\rho}} \right\}^{\frac{\rho}{\rho-1}}$$

- Monopolistically competitive intermediate-good firms
  - Each producing a differentiated product
  - Heterogeneous in prices, productivity, entry costs and continuation costs for exporting

$\Rightarrow$ These features drive individual firms' state-dependent export decisions.

Model Overview

- All intermediate-good producers sell in their own country.

$$y_t(i) = z_t(i) A_t K_t(i)^{\nu} L_t(i)^{1-\nu}$$

$z_t(i)$ = current firm-specific productivity

A_t = aggregate productivity

- To enter the export market, a firm pays entry cost, $\eta \sim G^E(\eta)$.
- Upon entering the export market, an entrant sets a new price for its exports.
- To continue exporting, a firm pays a continuation cost, $\xi \sim G(\xi)$.
- Price-adjustment hazard increasing in the age of a price

Potential Entrant

Potential entrant with productivity z_c drawing entry cost η solves:

$$V_t^E(z_c,\eta) = \max\left\{ \max_{P_{0,t}^X(z_c)} \left[Q_t \frac{P_{0,t}^X(z_c)}{P_t^*} \tau y_{0,t}^X(z_c) - w_t L_{0,t}^X(z_c) - r_t K_{0,t}^X(z_c) - \boldsymbol{\eta} w_t + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}\left(z_{\tilde{c}}, z_c, \xi'\right) \right], \quad \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V_{t+1}^E(z_{\tilde{c}}, \eta') \right\}$$

Maximum entry cost $\eta_t^E(z_c)$ this firm will pay to enter export market:

$$\beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V_{t+1}^E(z_{\tilde{c}}, \eta') = Q_t \frac{P_{0,t}^X(z_c)}{P_t^X} \tau y_{0,t}^X(z_c) - w_t L_{0,t}^X(z_c) - r_t K_{0,t}^X(z_c) - \boldsymbol{\eta_t^E(z_c)} w_t + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}\left(z_{\tilde{c}}, z_c, \xi'\right)$$

where $H_{1,t}\left(z_c, z_s, \xi\right) = \alpha_1 V_{0,t}(z_c, \xi) + (1-\alpha_1) V_{1,t}\left(z_c, z_s, \xi\right)$.

Price-adjusting Incumbent

Price-adjusting incumbent exporter with current productivity z_c drawing export cost ξ solves:

$$V_{0,t}(z_c,\xi) = \max\left\{ \max_{P^X_{0,t}(z_c)} \left[Q_t \frac{P^X_{0,t}(z_c)}{P^*_t} \tau y^X_{0,t}(z_c) - w_t L^X_{0,t}(z_c) - r_t K^X_{0,t}(z_c) - \boldsymbol{\xi} w_t + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}\left(z_{\tilde{c}}, z_c, \xi'\right) \right], \quad \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^E_{t+1}(z_{\tilde{c}}, \eta') \right\}$$

Max. continuation cost $\xi^0_t(z_c)$ the firm will pay to continue exporting:

$$\beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^E_{t+1}(z_{\tilde{c}}, \eta') = Q_t \frac{P^X_{0,t}(z_c)}{P^X_t} \tau y^X_{0,t}(z_c) - w_t L^X_{0,t}(z_c) - r_t K^X_{0,t}(z_c) - \boldsymbol{\xi^0_t(z_c)} w_t + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}\left(z_{\tilde{c}}, z_c, \xi'\right)$$

Non-price-adjusting Incumbent

Value of non-price-adjusting incumbent of type (z_c, j, z_s) drawing continuation cost ξ:

$$V_{j,t}(z_c, z_s, \xi) = \max\left[Q_t \frac{P^X_{j,t}(z_s)}{P^X_t} \tau y^X_{j,t}(z_c, z_s) - w_t L^X_{j,t}(z_c, z_s) - r_t K^X_{j,t}(z_c, z_s) - \boldsymbol{\xi} w_t \right.$$
$$\left. + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{j+1,t+1}\left(z_{\tilde{c}}, z_s, \xi'\right), \quad \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^E_{t+1}(z_{\tilde{c}}, \eta') \right]$$

Maximum cost $\xi^j_t(z_c, z_s)$ the firm will pay to continue exporting:

$$\beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^E_{t+1}(z_{\tilde{c}}, \eta') = Q_t \frac{P^X_{j,t}(z_s)}{P^X_t} \tau y^X_{j,t}(z_c, z_s) - w_t L^X_{j,t}(z_c, z_s) - r_t K^X_{j,t}(z_c, z_s)$$
$$- \boldsymbol{\xi^j_t(z_c, z_s)} w_t + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{j+1,t+1}\left(z_{\tilde{c}}, z_s, \xi'\right)$$

Probabilities of Export Participation

- Probabilities of entering export market:

$$\zeta_t^E(z_c) = G^E\left(\eta_t^E(z_c)\right) \quad \text{for} \quad c = 1, \cdots, n_z$$

- Probabilities of remaining in the export market:

  a) if adjusting prices

$$\zeta_t^0(z_c) = G\left(\xi_t^0(z_c)\right) \quad \text{for} \quad c = 1, \cdots, n_z$$

  b) if not adjusting prices

$$\zeta_t^j(z_c, z_s) = G\left(\xi_t^j(z_c, z_s)\right)$$

$$\text{for } c = 1, \cdots, n_z,\ s = 1, \cdots, n_z \text{ and } j = 1, \cdots, J-1$$

evolution

Household

Representative household chooses C_t, L_t, K_{t+1}, $B_{t+1}(s^{t+1})$, and M_t:

$$\max \mathbf{E}_t \sum_{t=0}^{\infty} \beta^t \left[\log C_t + \chi_1 \log\left(\frac{M_t}{P_t}\right) + \chi_2(1-L_t)\right]$$

subject to

$$P_tC_t+P_tI_t+\sum_{s^{t+1}} q(s^{t+1}|s^t)B(s^{t+1})+M_t \leq P_tw_tL_t+P_tr_tK_t+B(s^t)+M_{t-1}+P_td_t+T_t^M$$

$$K_{t+1} = (1-\delta)K_t + I_t - \phi\left(\frac{I_t}{K_t}\right)K_t$$

where

$B(s^{t+1})$ = holdings of state-contingent, home-denominated bond
$q(s^{t+1}|s^t)$ = price of $B(s^{t+1})$ in units of home currency in state s^t
T_t^M = lump-sum government transfer $= M_t^s - M_{t-1}^s$
M_t^s = money supply, $M_t^s = \mu_t M_{t-1}^s$, $\quad \log \mu_{t+1} = \rho_\mu \log \mu_t + \varepsilon_{t+1}^\mu$
$\phi(\cdot)$ = convex capital adjustment cost function, $\phi(\delta) = 0$, $\phi'(\delta) = 0$

Calibration

The model frequency is quarterly.

	Data	Model	Sources
Mass of exporters	0.21	0.21	Bernard et al. (2003)
Continuation rate	0.97	0.87	Bernard & Jensen (2004)
Entry rate	0.04	0.04	Bernard & Jensen (2004)
Imports/GDP ratio	0.12	0.12	Drozd & Nosal (2011)
Productivity relative to non-exporters	1.12-18	1.13	Bernard & Jensen (1999)
Mean price adjustment frequency	1.07-3.27	2.66	Bils & Klenow (2004) Nakamura & Steinsson (2008)

parameters

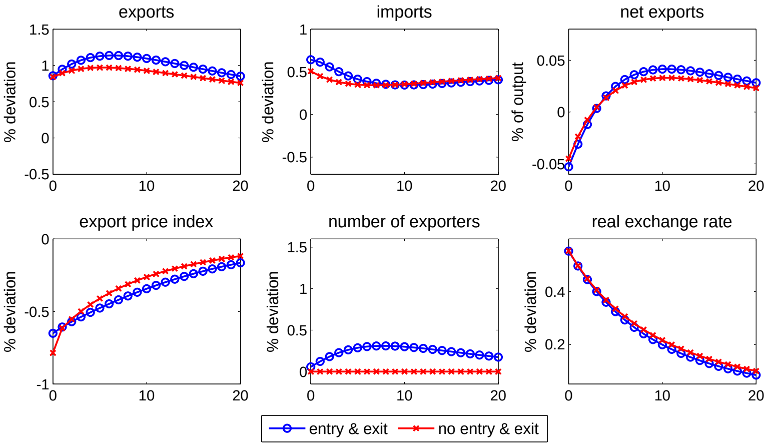
Business Cycle Moments

	Data	Model
Standard deviations relative to GDP		
Consumption	0.83	**0.43**
Investment	2.73	**4.88**
Labor	0.65	**1.26**
Net exports/GDP	0.15	**0.20**
Correlations with GDP		
Consumption	0.84	**0.87**
Investment	0.94	**0.94**
Labor	0.86	**0.79**
Net exports/GDP	-0.31	**-0.35**
Autocorrelations		
GDP	0.86	**0.66**
Consumption	0.88	**0.80**
Investment	0.88	**0.50**
Labor	0.90	**0.40**
International correlations		
GDP	0.41	**0.34**
Consumption	0.21	**0.56**
Investment	0.18	**0.17**
Labor	0.27	**0.46**

Business Cycle Moments

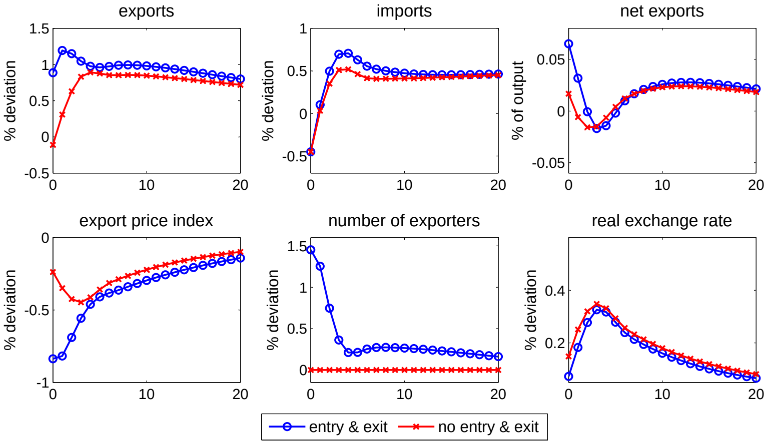
	Data	Model	Flex-price
Standard deviations relative to GDP			
Consumption	0.83	**0.43**	0.54
Investment	2.73	**4.88**	3.52
Labor	0.65	**1.26**	0.42
Net exports/GDP	0.15	**0.20**	0.15
Correlations with GDP			
Consumption	0.84	**0.87**	0.94
Investment	0.94	**0.94**	0.97
Labor	0.86	**0.79**	0.97
Net exports/GDP	-0.31	**-0.35**	-0.26
Autocorrelations			
GDP	0.86	**0.66**	0.69
Consumption	0.88	**0.80**	0.73
Investment	0.88	**0.50**	0.66
Labor	0.90	**0.40**	0.66
International correlations			
GDP	0.41	**0.34**	**0.06**
Consumption	0.21	**0.56**	**0.65**
Investment	0.18	**0.17**	**-0.32**
Labor	0.27	**0.46**	**-0.31**

Role of Entry and Exit: Flexible prices



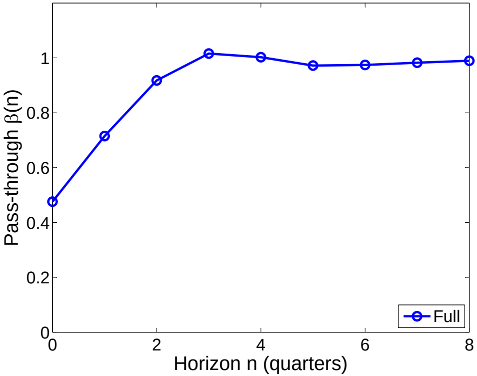
IRFs

Role of Entry and Exit: Nominal rigidities



Exchange Rate Pass-Through

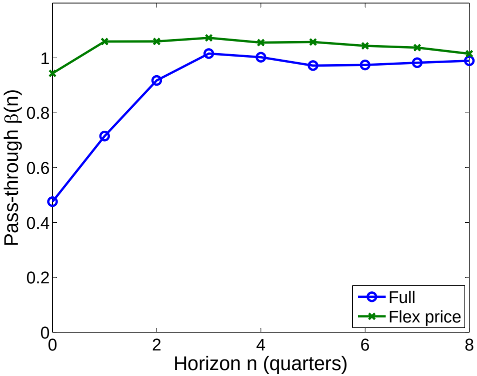
$$\Delta p_t^{X*} = \alpha + \sum_{n=0}^{8} \beta_n \Delta e_{t-n} + \sum_{n=0}^{8} \gamma_n \pi_{t-n}^* + \delta \Delta y_t + \epsilon_t$$



Full model generates short-run incomplete pass-through.

Exchange Rate Pass-Through

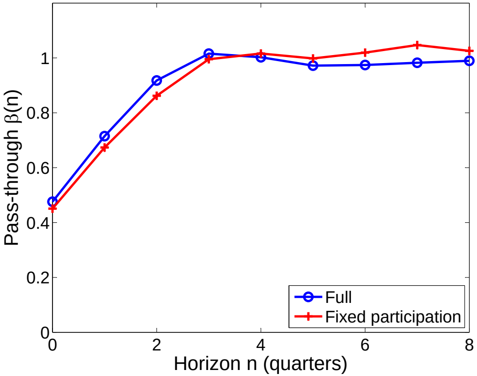
$$\Delta p_t^{X*} = \alpha + \sum_{n=0}^{8} \beta_n \Delta e_{t-n} + \sum_{n=0}^{8} \gamma_n \pi^*_{t-n} + \delta \Delta y_t + \epsilon_t$$



With flexible prices, pass-through is complete immediately.

Exchange Rate Pass-Through

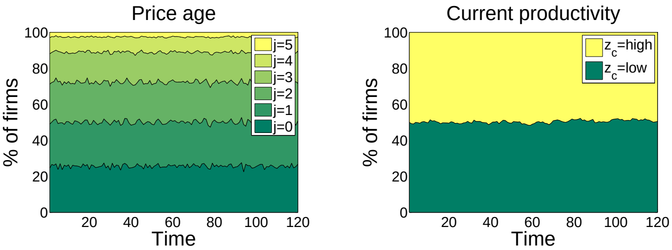
$$\Delta p_t^{X*} = \alpha + \sum_{n=0}^{8} \beta_n \Delta e_{t-n} + \sum_{n=0}^{8} \gamma_n \pi_{t-n}^* + \delta \Delta y_t + \epsilon_t$$



The added flexibility of endogenous trade participation does not overturn incomplete pass-through arising from nominal rigidity.

Pass-Through: Composition of exporters

Model without entry and exit



Pass-Through: Composition of exporters

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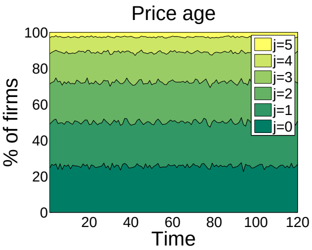
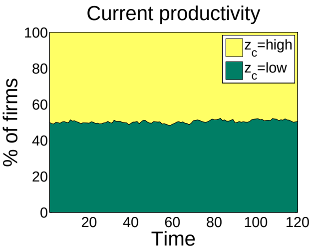
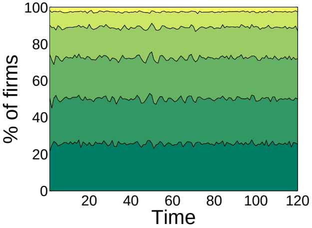
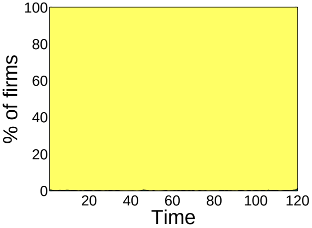


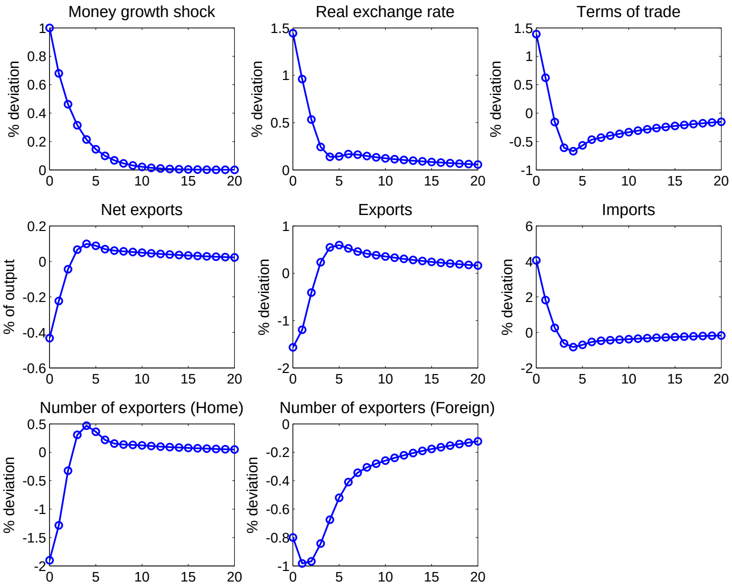


Model with entry and exit





Effects of monetary policy and currency movements



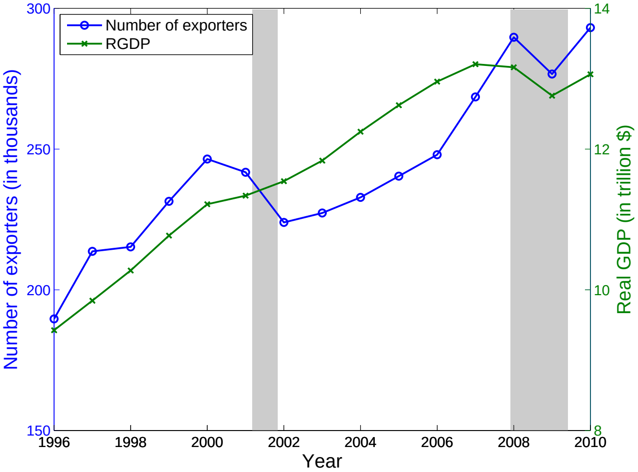
Conclusion

- In the presence of price rigidity, endogenous trade participation influences international business cycles, in contrast to earlier findings under flexible prices.

- This suggests that market structure and pricing conventions may be critical in analyzing the role of exporter entry and exit for aggregate dynamics and international transmission of shocks.

- Endogenous trade participation and incomplete exchange rate pass-through have important implications for the effects of currency movements and the conduct of monetary policy at both micro and macro levels.

Exporter Dynamics



Back

Final-Good Producer

Final-good producers combine home- and foreign-produced intermediate goods to produce final goods D_t.

$$\max_{y_t^H(i),\, y_t^F(i)} P_t D_t - \int_0^1 P_t^D(i) y_t^H(i) di - \int_{i \in \Theta_t} P_t^{X*}(i) y_t^F(i) di$$

subject to

$$D_t = \left\{ \omega \left[\int_0^1 y_t^H(i)^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1} \frac{\rho-1}{\rho}} + (1-\omega) \left[\int_{i \in \Theta_t} y_t^F(i)^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1} \frac{\rho-1}{\rho}} \right\}^{\frac{\rho}{\rho-1}}$$

$\gamma =$ elasticity of substitution b/w goods produced in the same country

$\rho =$ elasticity of substitution b/w home and foreign goods

$\Theta_t =$ time-varying set of foreign goods available in home country

$P_t =$ consumer price index

Price-adjusting firm with current productivity z_c chooses $P^D_{0,t}(z_c)$:

$$V^D_{0,t}(z_c) = \max_{P^D_{0,t}(z_c)} \left\{ \frac{P^D_{0,t}(z_c)}{P^D_t} y^D_{0,t}(z_c) - w_t L^D_{0,t}(z_c) - r_t K^D_{0,t}(z_c) \right.$$
$$\left. + \beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left[\alpha_1 \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^D_{0,t+1}(z_{\tilde{c}}) + (1-\alpha_1) \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V^D_{1,t+1}\left(z_{\tilde{c}}, z_c\right) \right] \right\}$$

α_j = probability of price adjustment for firms with j-period old price

$\pi_{c\tilde{c}}$ = probability of moving from $z = z_c$ to $z' = z_{\tilde{c}}$

Intermediate-Good Firm: Domestic market

Value of non-price-adjusting firm of type (z_c, j, z_s)

$$V_{j,t}^{D}(z_c, z_s) = \frac{P_{j,t}^{D}(z_s)}{P_t^{D}} y_{j,t}^{D}(z_c, z_s) - w_t L_{j,t}^{D}(z_c, z_s) - r_t K_{j,t}^{D}(z_c, z_s)$$

$$+\beta \mathbf{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left[\alpha_{j+1} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V_{0,t+1}^{D}(z_{\tilde{c}}) + (1 - \alpha_{j+1}) \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V_{j+1,t+1}^{D}(z_{\tilde{c}}, z_s) \right]$$

z_c = current productivity

j = number of periods since the price was last set

z_s = productivity at the time of last price adjustment

Evolution of the distribution of domestic firms

$\theta_{j,t}(z_c, z_s) =$ Number of firms starting date t as type (z_c, j, z_s)

Evolution for non-price adjusting firms:

$$\theta_{j+1,t+1}(z_{\tilde{c}}, z_{\tilde{s}}) = (1-\alpha_j)\sum_{c=1}^{n_z} \pi_{c\tilde{c}}\theta_{j,t}(z_c, z_{\tilde{s}})$$

Total number of firms starting $t+1$ as $(z_{\tilde{c}}, 1, z_{\tilde{s}})$:

$$\theta_{1,t+1}(z_{\tilde{c}}, z_{\tilde{s}}) = \pi_{\tilde{s}\tilde{c}}\sum_{j=1}^{J}\sum_{s=1}^{n_z} \alpha_j\theta_{j,t}(z_{\tilde{s}}, z_s).$$

Evolution of the distribution of exporters

$\psi_{j,t}(z_c, z_s) =$ Number of incumbents starting t as type (z_c, j, z_s)

Evolution for non-price-adjusting incumbents:

$$\psi_{j+1,t+1}(z_{\tilde{c}}, z_{\tilde{s}}) = (1-\alpha_j) \sum_{c=1}^{n_z} \zeta_t^j(z_c, z_{\tilde{s}}) \cdot \pi_{c\tilde{c}} \cdot \psi_{j,t}(z_c, z_{\tilde{s}})$$

Total number of exporters of type $(z_{\tilde{c}}, 1, z_{\tilde{s}})$:

$$\psi_{1,t+1}(z_{\tilde{c}}, z_{\tilde{s}}) = \underbrace{\pi_{\tilde{s}\tilde{c}} \cdot \zeta_t^0(z_{\tilde{s}}) \sum_{j=1}^{J} \sum_{s=1}^{n_z} \alpha_j \cdot \psi_{j,t}(z_{\tilde{s}}, z_s)}_{\text{adjusting incumbents surviving time } t} + \underbrace{\pi_{\tilde{s}\tilde{c}} \cdot N_t^E(z_{\tilde{s}})}_{\text{entrants at time } t}$$

Number of entrants with productivity z_c at t:

$$N_t^E(z_c) = \zeta_t^E(z_c) \left[\sum_{j=1}^{J} \sum_{s=1}^{n_z} \theta_{j,t}(z_c, z_s) - \sum_{j=1}^{J} \sum_{s=1}^{n_z} \psi_{j,t}(z_c, z_s) \right]$$

Back

Price Index

1. Price index for domestically-produced goods

$$P_t^D = \left[\sum_{j=1}^{J} \sum_{c=1}^{n_z} \sum_{s=1}^{n_z} \alpha_j \theta_{j,t}(z_c, z_s) P_{0,t}^D(z_c)^{1-\gamma} + \sum_{j=1}^{J-1} \sum_{c=1}^{n_z} \sum_{s=1}^{n_z} (1-\alpha_j) \theta_{j,t}(z_c, z_s) P_{j,t}^D(z_s)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$$

2. Price index for imported goods

$$P_t^{X*} = \left[\sum_{c=1}^{n_z} N_t^{E*}(z_c) P_{0,t}^{X*}(z_c)^{1-\gamma} + \sum_{j=1}^{J} \sum_{c=1}^{n_z} \sum_{s=1}^{n_z} \alpha_j \cdot \zeta_t^{0*}(z_c) \psi_{j,t}^*(z_c, z_s) P_{0,t}^{X*}(z_c)^{1-\gamma} + \sum_{j=1}^{J-1} \sum_{c=1}^{n_z} \sum_{s=1}^{n_z} (1-\alpha_j) \cdot \zeta_t^{j*}(z_c, z_s) \cdot \psi_{j,t}^*(z_c, z_s) \cdot P_{j,t}^{X*}(z_s)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$$

3. Price index for all the goods available in home country

$$P_t = \left[\omega_1^\rho \left(P_t^D \right)^{1-\rho} + \omega_2^\rho \left(P_t^{X*} \right)^{1-\rho} \right]^{\frac{1}{1-\rho}}$$

Parameter Values

Discount factor	β	0.99	
Weight on leisure in utility	χ_2	1.9	s.s. labor $=$ 0.33
Elasticity of substitution	γ	3.8	Ghironi & Melitz (2005)
Armington elasticity	ρ	1.5	BKK(1995)
Capital share in production	ν	0.3	
Depreciation rate of capital	δ	0.025	10% depreciation/year
Iceberg trade cost	τ	1.05	
# of firm-specific productivity levels	n_z	2	

Calibrated parameters

Home bias	ω	0.762
Entry costs $\sim U(0, \eta_U)$	η_U	2.8
Continuation costs $\sim U(0, \xi_U)$	ξ_U	0.17
Firm-specific productivity:	ρ_z	0.81
$\log z' = \rho_z \log z + \epsilon'$, $\epsilon \sim N(0, \sigma_\epsilon)$	σ_ϵ	0.085
Price adjustment probability	α_j	[0.05, 0.09, 0.25, 0.49, 0.70, 1.00]

Shock processes

- Productivity (Backus, Kehoe and Kydland, 1995)

$$\begin{bmatrix} A_t \\ A_t^* \end{bmatrix} = \begin{bmatrix} 0.906 & 0.088 \\ 0.088 & 0.906 \end{bmatrix} \begin{bmatrix} A_{t-1} \\ A_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^A \\ \varepsilon_t^{A^*} \end{bmatrix}$$

where $var(\varepsilon_t^A) = var(\varepsilon_t^{A^*}) = (0.007)^2$, $corr\left(\varepsilon_t^A, \varepsilon_t^{A^*}\right) = 0.258$

- Money growth (Chari, Kehoe and McGrattan, 2002)

$$\begin{bmatrix} \mu_t \\ \mu_t^* \end{bmatrix} = \begin{bmatrix} 0.68 & 0 \\ 0 & 0.68 \end{bmatrix} \begin{bmatrix} \mu_{t-1} \\ \mu_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^\mu \\ \varepsilon_t^{\mu^*} \end{bmatrix}$$

where $\bar{\mu} = 1.04^{1/4}$

- I choose $var(\varepsilon_t^\mu) = var(\varepsilon_t^{\mu^*})$ so that $\sigma_Y = 1.42$ in baseline model.

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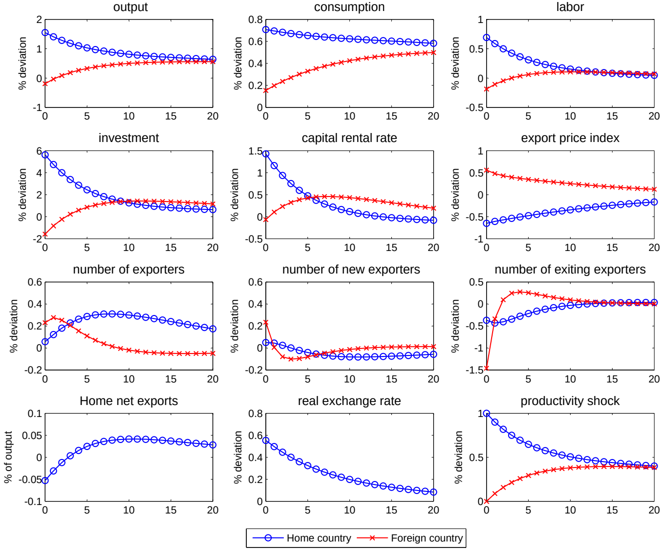
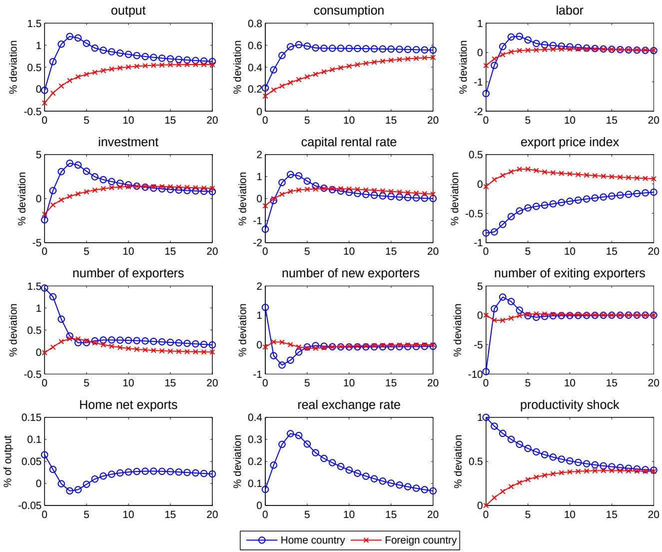
Steady state

		Sticky		Flexible	
	Data	**EE**	No EE	EE	No EE
Entry and exit					
Mass of exporters	0.21	**0.21**	0.21	0.21	0.21
Continuation rate	0.97/qtr	**0.87**	1	0.86	1
Entry rate	0.04/qtr	**0.04**	0	0.04	0
Exporter productivity relative to nonexporters	1.12-1.18	**1.13**	1	1.12	1
Imports/GDP ratio	0.12	**0.12**	0.11	0.12	0.11
Mean price duration	1.43-4.33qtrs	**2.66**	2.66	1	1

Impulse responses: Flexible-price model



Impulse responses: Sticky-price model



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Policy, exchange rate and trade