The Extensive Margin of Trade and Monetary Policy

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The views expressed in this presentation are our own, and do not represent those of the Bank of Canada.
Export persistence: long-run versus short-run

Persistence in long-run export participation

- Export continuation rate = 87.4%/yr
- Non-participation rate = 86.1%/yr


- Little evidence of growth in extensive margin of trade among advanced economies (Kehoe and Ruhl, 2013)

Different picture at the business cycle frequency (Naknoi, 2015)

- Extensive margin of exports is three times as volatile as output
The high volatility of the extensive margin over business cycles raises new questions for policy makers of open economies.

- What are the channels through which monetary policy might affect intensive and extensive margins of international trade?

- Does monetary policy affect the two margins in the same way?
This paper

- develop a two-country DSGE model with
  - nominal rigidities
  - state-dependent decisions on whether to enter/exit export market
  - firm heterogeneity in productivity, export costs, prices
- calibrate the model to match micro-level exporter characteristics
- examine the effects of monetary policy on the intensive and extensive margins of trade
Main Findings

- Exporter entry/exit is sensitive to firms’ price competitiveness relative to other exporters and firms in the destination market.

- Expansionary monetary policy shocks support the intensive margin of trade, but can deter export participation.
  - Currency depreciation and lower interest rates are favorable to export sales and export participation.
  - However, higher expected inflation discourages export participation.

- Monetary policy that is more aggressive toward inflation reduces fluctuations in export participation.
Related Literature

- Export hysteresis in partial equilibrium

- Firm heterogeneity and export decisions
  Melitz (2003), Bernard et al. (2003), Das et al. (2007), Chaney (2008)

- Business cycles and exporter entry/exit in general equilibrium

- Optimal monetary policy with exporter entry and exit
  Cooke (2015)
Model overview

Two symmetric countries, each with

- **Representative household**
  \[
  \max \mathbf{E}_t \sum_{t=0}^{\infty} \beta^t [\varepsilon_t^c \log C_t + \chi_2 (1 - L_t)]
  \]

- **Competitive final-good producers**
  \[
  \max_{y_t^H(i), y_t^F(i)} P_tD_t - \int_0^1 P_t^D(i) y_t^H(i) di - \int_{i \in \Theta_t} P_t^{X*}(i)y_t^F(i) di
  \]

- **Monopolistically competitive intermediate-good producers**
  - Probability of price adjustment increasing in the age of price
  - Entry and exit in the export market, subject to entry/continuation costs

- **Monetary authority**
  \[
  \hat{\nu}_t^p = \rho_i \hat{\nu}_{t-1}^p + (1 - \rho_i) \left[ \phi_{\pi} \hat{\pi}_t + \phi_Y \hat{Y}_t + \phi_Q \hat{Q}_t \right] + \mu_t
  \]
Intermediate-good firms

- Each producing a differentiated product
  \[ y_t(i) = z_t(i) A_t K_t(i)^\nu L_t(i)^{1-\nu} \]
  \[ z_t(i) = \text{firm-specific productivity, } A_t = \text{country-specific productivity} \]

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

Export participation

- To enter the export market, a firm pays entry cost, \( \eta \sim G^E(\eta) \).
- Upon entering, an entrant sets a new price for its exports.
- To continue exporting, a firm pays continuation cost, \( \xi \sim G(\xi) \).
- All export costs are paid in advance of production.

- Probability of price adjustment increases as price gets older
Potential entrant with productivity $z_c$ and entry cost $\eta$ solves

$$V_t^E(z_c, \eta) = \max \left\{ \max_{P_{0,t}(z_c)} \left[ Q_t \frac{P_{0,t}(z_c)}{P^*_t} y_{0,t}(z_c) - w_t L_{0,t}(z_c) - r_t K_{0,t}(z_c) - i_t^p \eta w_t \right. \right.$$

$$+ \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}(z_{\tilde{c}}, z_c, \xi') \left. \right] , \quad \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} V_{t+1}^E(z_{\tilde{c}}, \eta') \right\}$$

where

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

$\Rightarrow$ Maximum entry cost this firm would pay to start exporting, $\eta_t^E(z_c)$, equates the value of entry and the value of no entry.
Price-adjusting incumbent exporter with current productivity $z_c$

drawing export cost $\xi$ solves

$$V_{0,t}(z_c, \xi) = \max \left\{ \max_{P_{0,t}(z_c)} \left[ Q_t \frac{P_{0,t}^X(z_c)}{P_t^X} y_{0,t}(z_c) - w_t L_{0,t}(z_c) - r_t K_{0,t}(z_c) - i_t^p \xi w_t \\ + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\bar{c}=1}^{n_{\bar{c}}} \pi_{c\bar{c}} H_{1,t+1}(z_{\bar{c}}, z_c, \xi') \right] \right\}$$

$$= \max \left\{ \max_{P_{0,t}(z_c)} \left[ \frac{P_{0,t}^X(z_c)}{P_t^X} y_{0,t}(z_c) - w_t L_{0,t}(z_c) - r_t K_{0,t}(z_c) - i_t^p \xi w_t \\ + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\bar{c}=1}^{n_{\bar{c}}} \pi_{c\bar{c}} E_{t+1}(z_{\bar{c}}, \eta') \right] \right\}$$

$$\Rightarrow$$ Max export cost this firm would pay to continue exporting, $\xi^0_t(z_c)$, equates the value of continuation and the value of exit.
Value of non-price-adjusting incumbent of type \((z_c, j, z_s)\) drawing continuation cost \(\xi\)

\[
V_{j,t}(z_c, z_s, \xi) = \max \left[ Q_t \frac{P_{j,t}^X(z_s)}{P_t^X} y_{j,t}(z_c, z_s) - w_t L_{j,t}^X(z_c, z_s) - r_t K_{j,t}^X(z_c, z_s) - i_t \xi w_t + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}} \pi c \tilde{c} H_{j+1,t+1}(z_{\tilde{c}}, z_s, \xi') \right]
\]

\[
+ \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}} \pi c \tilde{c} V_{t+1}^E(z_{\tilde{c}}, \eta')
\]

\[\Rightarrow\] Maximum export cost for this firm to continue exporting, \(\xi_{j,t}(z_c, z_s)\), equates the value of continuation and the value of exit.
Export participation decisions

Export decisions depend directly on

\[ V_t^E(z_c, \eta) = \max \left\{ \max_{P_{0,t}^X(z_c)} \left[ Q_t \frac{P_{0,t}^X(z_c)}{P^*} y_{0,t}(z_c) - w_t L_{0,t}^X(z_c) - r_t K_{0,t}^X(z_c) - i_t^p \eta w_t \right] \right. \]

\[ + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}(z_{\tilde{c}}, z_c, \xi') \right\} \]

- Exchange rate
Export participation decisions

Export decisions depend directly on

\[ V_t^E(z_c, \eta) = \max \left\{ \max_{P^X_{0,t}(z_c)} \left[ Q_t \frac{P^X_{0,t}(z_c)}{P^*_t} y_{0,t}(z_c) - w_t L_{0,t}(z_c) - r_t K_{0,t}(z_c) - i_t^p \eta w_t \right] \right. \]

\[ + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}(z_{\tilde{c}}, z_c, \xi') \right] \right\} \]

- Exchange rate
- Relative export price
Export participation decisions

Export decisions depend directly on

\[ V_t^E(z_c, \eta) = \max \left\{ \max_{P_{0,t}^X(z_c)} \left[ Q_t \frac{P_{0,t}^X(z_c)}{P^*_t} y_{0,t}(z_c) - w_t L_{0,t}^X(z_c) - r_t K_{0,t}^X(z_c) - \nu t \eta w_t \right] \right\} \]

- Exchange rate
- Relative export price
- Production costs
Export participation decisions

Export decisions depend directly on

\[ V_t^E(z_c, \eta) = \max \left\{ \max_{P_{0,t}^X(z_c)} \left[ Q_t \frac{P_{0,t}^X(z_c)}{P_*^t} y_{0,t}(z_c) - w_t L_{0,t}^X(z_c) - r_t K_{0,t}^X(z_c) - i_t^p \eta w_t \right] \right\} 
\]

\[ + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi^{\tilde{c}} H_{1,t+1}(z_{\tilde{c}}, z_c, \xi') \right\}, \quad \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi^{\tilde{c}} V_{t+1}^E(z_{\tilde{c}}, \eta') \right\} \]

- Exchange rate
- Relative export price
- Production costs
- Interest rate (export cost)
Export participation decisions

Export decisions depend directly on

\[ V_t^E(z_c, \eta) = \max \left\{ \max_{P^X_{0,t}(z_c)} \left[ Q_t \frac{P^X_{0,t}(z_c)}{P^*_t} y^X_{0,t}(z_c) - w_t L^X_{0,t}(z_c) - r_t K^X_{0,t}(z_c) - i^p \eta w_t \right] \right\} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \sum_{\tilde{c}=1}^{n_z} \pi_{c\tilde{c}} H_{1,t+1}(z_{\tilde{c}}, z_c, \xi') \right\} \]

- Exchange rate
- Relative export price
- Production costs
- Interest rate (export cost)
- Demand for home exports, \( y^H_t(i) = (1 - \omega)^\rho \left( \frac{P^X_t(i)}{P^*_t} \right) -\gamma \left( \frac{P^X_t}{P^*_t} \right)^{-\rho} D^*_t \)
Calibration

- Home bias, $\omega$
- Entry costs, $U(0, \eta_U)$
- Continuation costs, $U(0, \xi_U)$
- Price adjustment probabilities, $\alpha_j$
- Firm-specific productivity process

$$\log z' = \rho_z \log z + \epsilon', \quad \epsilon \sim N(0, \sigma_\epsilon)$$

<table>
<thead>
<tr>
<th>Data</th>
<th>Model</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of exporters</td>
<td>0.21</td>
<td>0.23</td>
</tr>
<tr>
<td>Continuation rate</td>
<td>0.97</td>
<td>0.87</td>
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<tr>
<td>Entry rate</td>
<td>0.04</td>
<td>0.04</td>
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<tr>
<td>Imports/GDP</td>
<td>0.12</td>
<td>0.13</td>
</tr>
<tr>
<td>Productivity relative to</td>
<td>1.12-18</td>
<td>1.13</td>
</tr>
<tr>
<td>nonexporters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean price adjustment</td>
<td>1.07-3.27</td>
<td>2.66</td>
</tr>
<tr>
<td>frequency (qtr)</td>
<td></td>
<td></td>
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</tbody>
</table>
Monetary stimulus to counter negative TFP shock is effective on intensive margin, but worsens initial decline in extensive margin.
Response of extensive margin is dampened when monetary policy is more aggressive on inflation
Without extensive margin adjustment

Aggressive inflation stabilization increases volatility of exports
Monetary stimulus may have different implications for intensive margin and extensive margin of trade.

- Currency depreciation and lower interest rates are favorable to export sales and, to some extent, export participation.
- However, inflationary effects deter entry of new firms and erode competitiveness of some incumbent exporters.

Monetary policy that is more aggressive toward inflation stabilization reduces fluctuations in extensive margin.
Appendix
## Parameter Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>β</td>
<td>0.99  4% annual interest rate</td>
</tr>
<tr>
<td>Weight on leisure in utility</td>
<td>χ₂</td>
<td>1.8    s.s. labor = 0.33</td>
</tr>
<tr>
<td>Elasticity of substitution</td>
<td>γ</td>
<td>3.8    Ghironi &amp; Melitz (2005)</td>
</tr>
<tr>
<td>Armington elasticity</td>
<td>ρ</td>
<td>1.5    Backus et al. (1995)</td>
</tr>
<tr>
<td>Labor income share</td>
<td>1 − ν</td>
<td>0.6    Cooley &amp; Prescott (1995)</td>
</tr>
<tr>
<td>Depreciation rate of capital</td>
<td>δ</td>
<td>0.025  10% depreciation/year</td>
</tr>
<tr>
<td># of firm-specific productivity</td>
<td>n_z</td>
<td>2</td>
</tr>
<tr>
<td>Monetary policy rule (Clarida, Gali, Gertler, 1998)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inflation</td>
<td>φ_π</td>
<td>2</td>
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<tr>
<td>output</td>
<td>φ_Y</td>
<td>0.5</td>
</tr>
<tr>
<td>real exchange rate</td>
<td>φ_Q</td>
<td>0.1</td>
</tr>
<tr>
<td>persistence</td>
<td>ρ_i</td>
<td>0.8</td>
</tr>
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</table>
Representative household chooses $C_t$, $L_t$, $K_{t+1}$, $B_{t+1}(s^{t+1})$, $B^D_{t+1}$

$$\max_E \sum_{t=0}^{\infty} \beta^t [\varepsilon^c_t \log C_t + \chi_2(1 - L_t)]$$

subject to

$$C_t + I_t + \sum_{s^{t+1}} q(s^{t+1}|s^t) \frac{B(s^{t+1})}{P_t} + \frac{B^D_{t+1}}{P_t} \leq w_t L_t + r_t K_t + d_t + \frac{B(s^t)}{P_t} + i^p_t \frac{B^D_t}{P_t}$$

$$K_{t+1} = (1 - \delta)K_t + I_t - \frac{\kappa}{2} \left( \frac{I_t}{K_t} - \delta \right)^2 K_t$$

where

$B(s^{t+1}) = \text{state-contingent international bond}$

$q(s^{t+1}|s^t) = \text{price of } B(s^{t+1}) \text{ in units of home currency in state } s^t$

$B^D_t = \text{non-contingent domestic bonds}$

$\varepsilon^c_t = \text{demand shock}$