Export Dynamics and Large Devaluations

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* These are my own views and do not reflect the views of the Federal Reserve Bank of Philadelphia or Board of Governors.

Two Main Questions

Trade responds slowly to changes $\Delta's$ in relative prices

- J-curve & short-run/long-run Armington elasticity

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Seek to understand:

- What explains sluggish export response following devaluations?
- How does sluggish export response affect aggregate fluctuations?

Summary

- Document dynamics of exports, real exchange rate, and interest rates in 11 emerging markets
  - Exports increase gradually following devaluations
  - Extensive margin important source of gradualness
  - High interest rates dampen export increase

Summary

- Document dynamics of exports, real exchange rate, and interest rates in 11 emerging markets
  - Exports increase gradually following devaluations
  - Extensive margin important source of gradualness
  - High interest rates dampen export increase

- SOE model with dynamic exporting decision from sunk costs (i.e starting to export costs more than continuing):
  - Captures most gradual export dynamics
  - Generates important role for interest rates
  - Magnifies Δ output (bigger drop & bounceback) dampens Δnx
  - TFP mismeasured from intangible investment in exporting

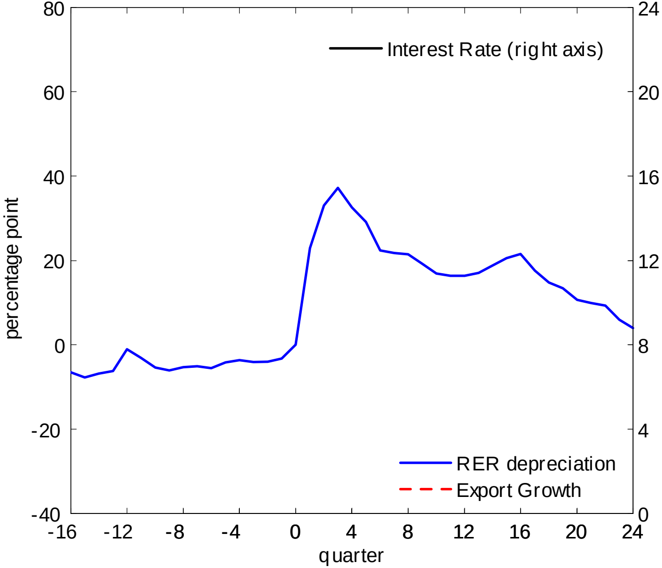
Salient Features of Large Devaluations

- Focus on large devaluations of emerging economies:
  - Big shocks
  - Sample: Argentina (01), Brazil (98), Colombia (98), Indonesia (97), Korea (97), Malaysia (97), Mexico (94), Russia (98), Thailand (97), Turkey (01), Uruguay (02)

Salient Features of Large Devaluations

- Five main characteristics
  - RER depreciation

Gradual Export Dynamics following Devaluations



Salient Features of Large Devaluations

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  - Interest rate increases (EMBI spreads)

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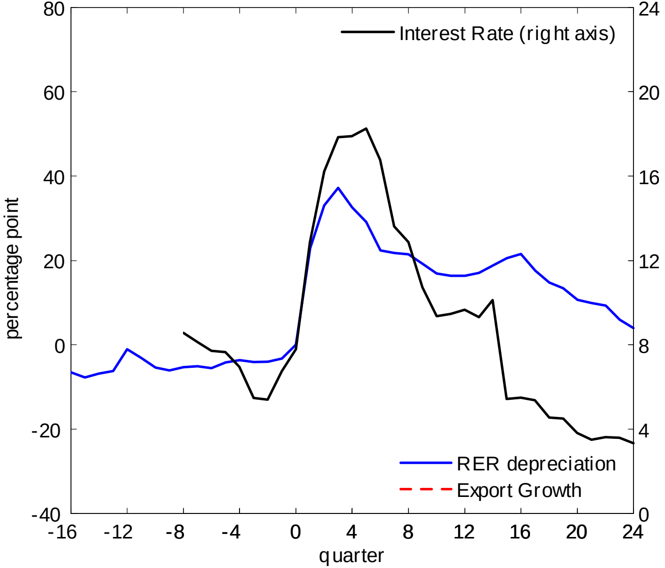

Salient Features of Large Devaluations

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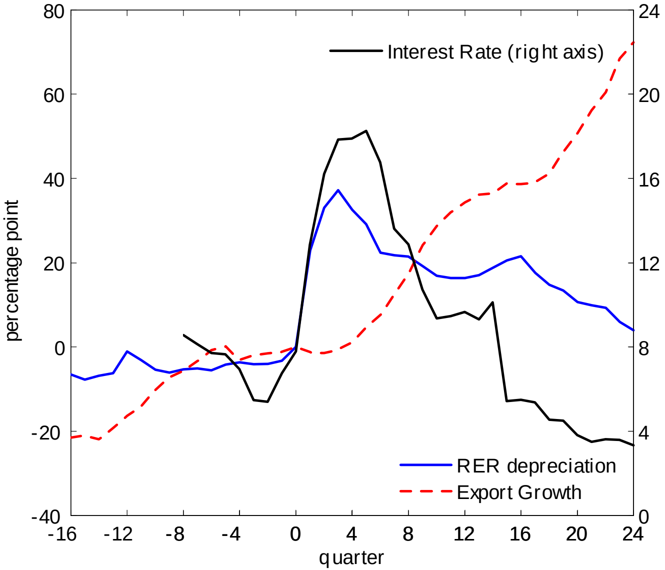
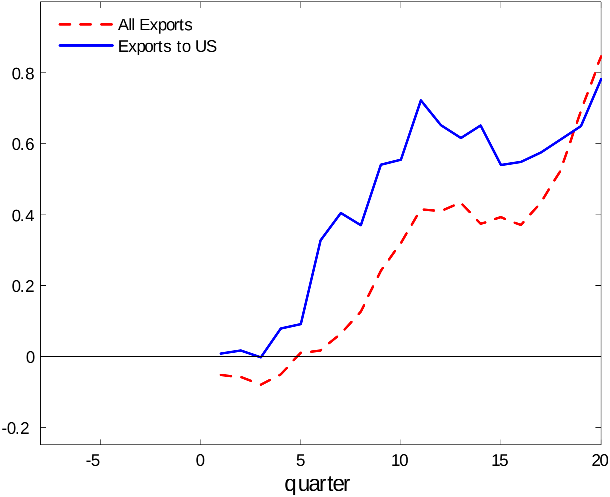
  - Gradual export expansion ($\varepsilon_t = \frac{\Delta EX_t - \Delta D_t^*}{\Delta RER_t}$ increases with t)

Gradual Export Dynamics following Devaluations



Mean Export elasticity $\left(\varepsilon_t^x = \frac{\Delta EX_t - \Delta D_t^*}{\Delta RER_t}\right)$



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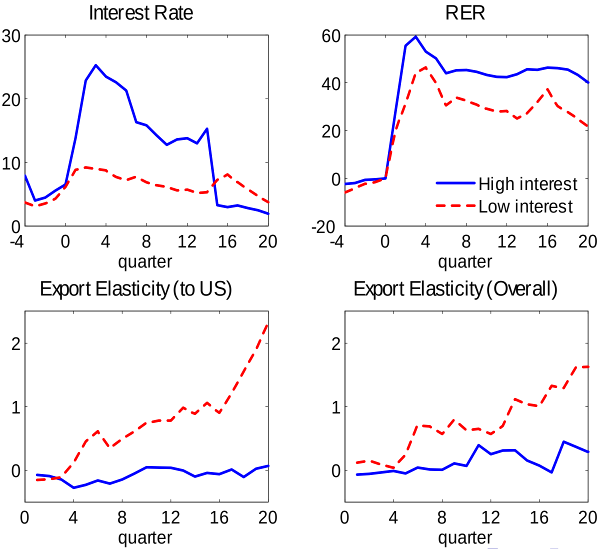
High Interest Rates Depress Exports



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  - Gradual export expansion ($\varepsilon_t = \frac{\Delta EX_t - \Delta D_t^*}{\Delta RER_t}$ increases with t)
  - High interest rates depress exports
  - Extensive (products/destinations/exporters) margin important

Exports ($ and #) Expand Gradually

- Consider two measures of US imports from 11 devaluations
  - Overall exports - Nominal exports deflated by US import price
  - Extensive margin - Count of 10-digit HS goods-districts

Exports ($ and #) Expand Gradually

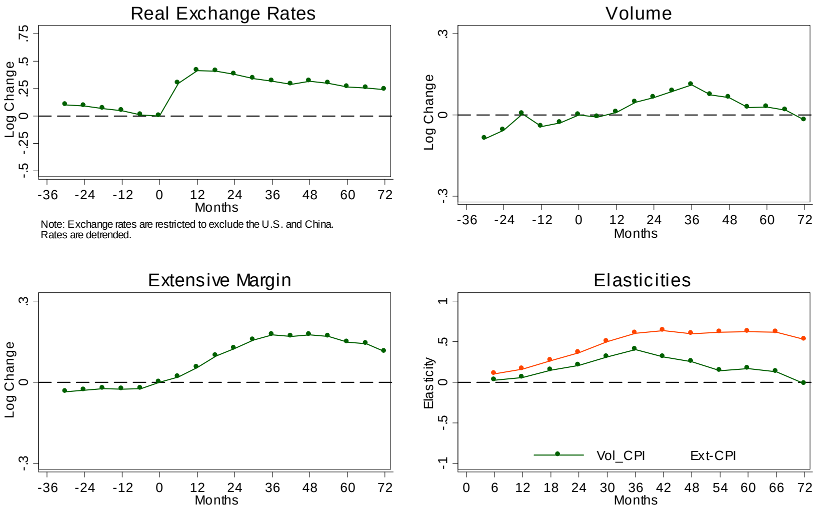
- Consider two measures of US imports from 11 devaluations
  - Overall exports - Nominal exports deflated by US import price
  - Extensive margin - Count of 10-digit HS goods-districts
- Remove linear trend (or scale by aggregate US imports)
- Calculate trade elasticity

$$\varepsilon_{ik}^{x} = \frac{\ln\left(x_{i,t_0+k} / x_{i,t_0}\right)}{\ln\left(RER_{i,t_0+k} / RER_{i,t_0}\right)}, x = \$ \text{ or } \#$$

- RER here is between country i and ROW ex US and PPI based.

Figure 3: Exports to U.S., Detrended Basis

11-Country Mean



Importance of Extensive Margins for Exports

- Extensive margin response 2x as strong as volume
- Slighter weaker if we condition on contribution of new products to growth
- Slighter stronger if we consider firm-level data.

Gradual Expansion & Interest rates effects

Iceberg & static fixed costs models.

- No sluggishness
- Interest rates have no direct role (opposite in GE)

Need to consider dynamic model of extensive margin

- Focus on a model with a sunk cost of starting to export (exporting is intangible investment)

Model

- SOE model with a non-constant trade elasticity
- Nominal bond ($) to smooth consumption of composite NT final good made from imports & domestic intermediates
- Export sector with stochastic fixed entry & continuation costs of exporting (Das, Roberts, Tybout 07)
  - Endogenous entry/exit of exporters and stock of exporters (N)

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  - Endogenous entry/exit of exporters and stock of exporters (N)
- Aggregate shocks to productivity, interest rate, and β (discounting) $S = (z, r, \beta)$
  - Endogenizes fluctuations in rer

Consumer's Problem

$$
\begin{aligned}
V(B, N, S) &= \max_{C, L, B'} u(C, L) + \beta E V(B', N', S') \\
\text{st} &: \quad PC + B = WL + \frac{B'}{1+R} + \Pi
\end{aligned}
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\frac{u_c}{P} &= \frac{u_l}{w} \\
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Standard FOC's

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For stationarity assume elastic interest rate on bonds

$$R = r + e^{\psi(\bar{B}-B)}$$

Final good sector

Competitive sector combines domestic & foreign inputs

$$\begin{aligned} P &= \min p_m M + p_d D \\ \text{st} &: \quad G(M, D) = \left(D^{\frac{\gamma-1}{\gamma}} + \omega^{\frac{1}{\gamma}} M^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \geq 1 \end{aligned}$$

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Armington structure implies:

$$\begin{aligned} P &= \left(p_d^{1-\gamma} + \omega p_m^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \\ p_m / p_d &= \omega^{\frac{1}{\gamma}} (M/D)^{-\frac{1}{\gamma}} = 1/RER \end{aligned}$$

For simplicity, assume $p_d = w/z$, normalize $\mathrm{p}_m = 1$

Export Sector and Extensive Export Margin

- Unit mass of intermediates available to export
  - Differ in export status $m \in \{0, 1\}$ & iid cost κ from $F_m(\kappa)$
  - $F_0(\kappa_0) \in [0, 1]$ nonexporters start to export
  - $F_1(\kappa_1) \in [0, 1]$ exporters continue to export
  - One period lag in changing exporting status

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  - N current exporters and $1 - N$ nonexporters

- Law of motion of stock of exporters

$$N' = F_1(\kappa_1) N + F_0(\kappa_0)(1 - N)$$

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- Production: exports, $EX = z l_1^{\alpha}$

Exporter's Problem

Study export decision seperate from pricing

Exporter's Problem

$$V_m(\kappa, S) = m\pi + \max\left\{-\frac{w}{z}\kappa + \frac{EV_1(\kappa', S')}{1+R}, \frac{EV_0(\kappa', S')}{1+R}\right\}$$

Exporter's Problem

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Marginal export cost satisfies

$$\frac{w\kappa_m}{z} = \frac{E\left[V_1(\kappa', S') - V_0(\kappa', S')\right]}{1+R}$$

IID shocks implies $\kappa_0 = \kappa_1 = \kappa^*$,

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Marginal export cost satisfies

$$\frac{w\kappa_m}{z} = \frac{E\left[V_1(\kappa', S') - V_0(\kappa', S')\right]}{1+R}$$

IID shocks implies $\kappa_0 = \kappa_1 = \kappa^*$, in steady state

$$\frac{w\kappa^*}{z} = \frac{\pi + \int_0^{\kappa^*} \left(F_1(\kappa) - F_0(\kappa)\right) d\kappa}{1+R}.$$

Pricing decision

$$\begin{aligned} \pi &= \max p_x EX\left(p_x, S\right) - wl_x \\ \text{st} &: EX\left(p_x, S\right) = \left(zl_x\right)^{\alpha} = \overline{EX}\left(S\right) p_x^{-\theta} \end{aligned}$$

where $\overline{EX}\left(S\right)$ is a demand shifter.

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Optimal price is a markup over marginal cost

$$p = \frac{\theta}{\theta - 1} mc = \frac{\theta}{\theta - 1} \frac{w}{\alpha z} y^{\frac{1}{\alpha} - 1}$$

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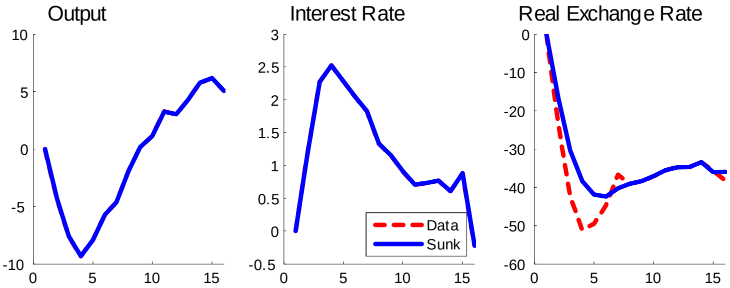
ROW demand shifter derived from ROW problem:

$$\overline{EX}\left(S\right) = N^{\frac{\gamma - \theta}{\theta - 1}} p_x^{-\gamma} Y$$

Calibration - Shocks

$$\begin{aligned}\log z' &= \rho_z \log z + \varepsilon^z \\ r &= \bar{r} + \rho_r \left(r - \bar{r}\right) + \varepsilon^r \\ \log a' &= \rho_\beta \log a + \varepsilon^a \\ \beta &= \bar{\beta} e^a\end{aligned}$$

Let $\rho_z = \rho_r = \rho_\beta = 0.95$ and choose shocks $\{z_t, r_t, a_t\}$ to fit $\{y_t, R_t, rer_t\}$



Model misses overshooting of real exchange rate.

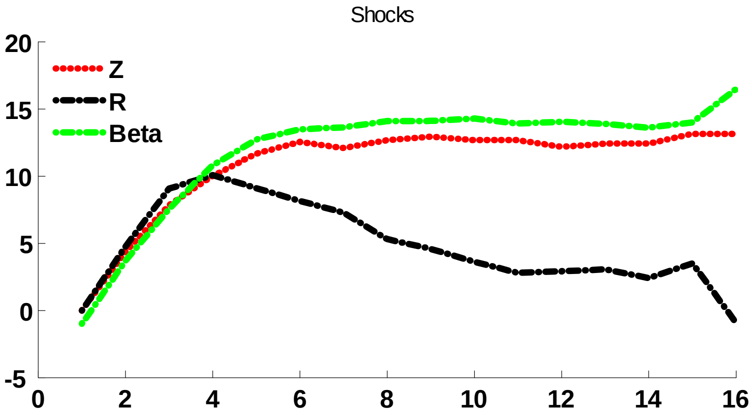


Figure 8: Productivity, Interest Rates, Discount factor, Labor Productivity

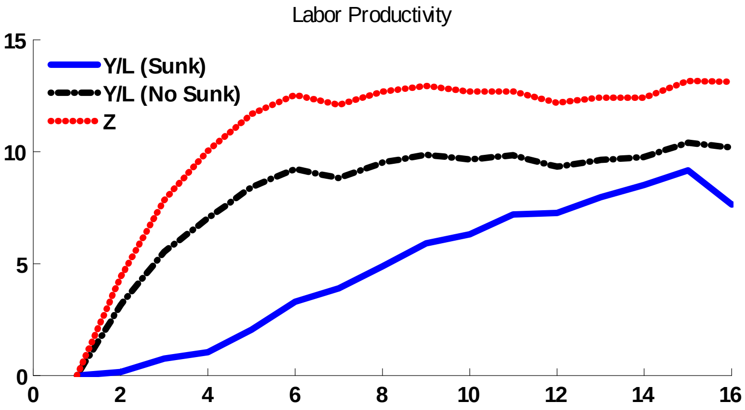


Figure 8: Productivity, Interest Rates, Discount factor, Labor Productivity

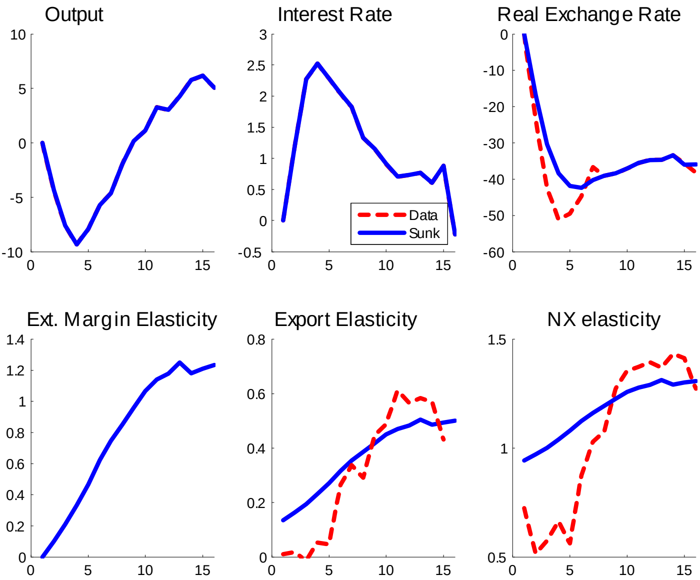
Net export elasticity

Useful to focus on elasticiyt of NX wrt to RER

$$\varepsilon_t^{nx} = \frac{\Delta \ln \left(P_x X_t \,/\, M_t \right) - \Delta \ln \left(D_t^* \,/\, D_t \right)}{\Delta \ln rer_t}$$

where D*, D are measures of ROW and local expenditures.

Unconventional NX measure, but recovers elasticity of substitution in Armington trade models.



Output
Interest Rate
Real Exchange Rate
Data
Sunk
Ext. Margin Elasticity
Export Elasticity
NX elasticity

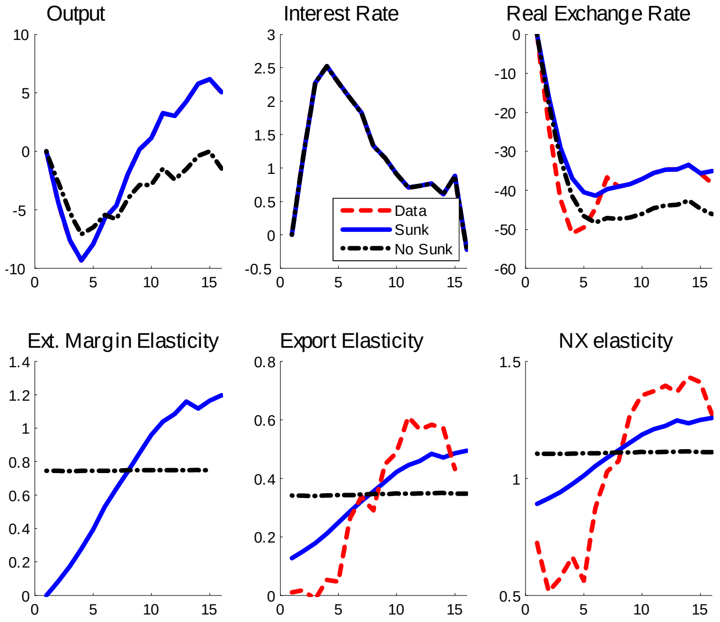
Do dynamics of export elasticity matter?

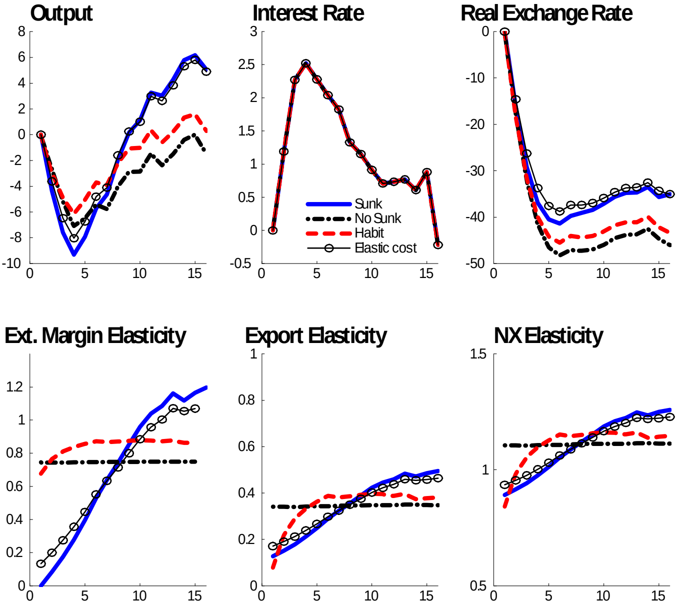
- Compare benchmark model with 3 versions of no sunk cost (i.e. $f_0 = f_1$)
  - No sunk
  - Export habit: $\hat{X}_t = X_t e^{-\xi_X \Delta X}$
  - Elastic entry costs: $f_t = e^{\xi_N \Delta N}$

- Same shocks but calibrate dispersion in export costs (v) to generate same avg. export elasticity & slope (ξ_x, ξ_N)

Plain-vanilla no sunk cost model

1. No sluggishness: exports or NXs
2. Smaller recession & minor recovery
3. Deeper depreciation


Output
Interest Rate
Real Exchange Rate
Ext. Margin Elasticity
Export Elasticity
NX elasticity
Data
Sunk
No Sunk


Output
Interest Rate
Real Exchange Rate
Sunk
No Sunk
Habit
Elastic cost
Ext. Margin Elasticity
Export Elasticity
NX Elasticity

Does source of sluggish exports? Yes!

- Export habit similar to model with no export dynamics.
- Elastic entry costs ($f_t = e^{\xi_N \Delta N}$) comes closest to sunk cost model
  - But requires $\xi_N = 77 \Rightarrow 1$ percent increase in exporters increases entry cost by 77%
  - Also response to interest rate shocks quite different

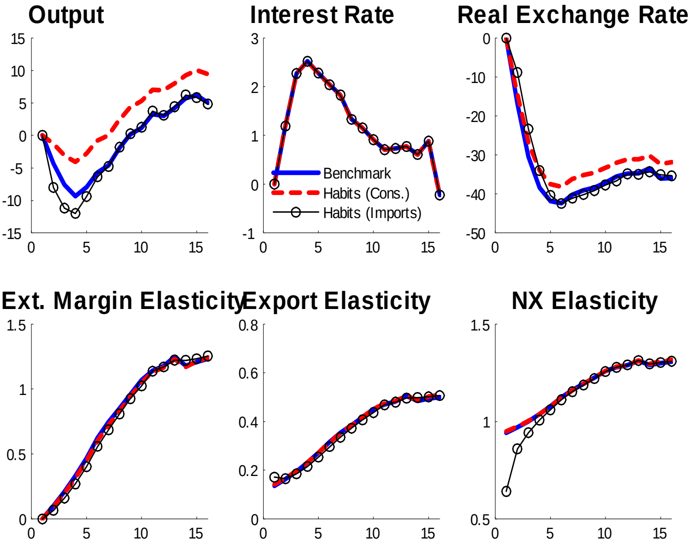
Does sluggish in NX matter?

Sluggish nx elasticity requires habit on imports (not consumption)

$$G\left(X, M, M_{-1}\right) = \left[D^{\frac{\gamma-1}{\gamma}} + \left[\omega e^{\xi_M \Delta M}\right]^{\frac{1}{\gamma}} M^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}$$

No impact on sluggish exports

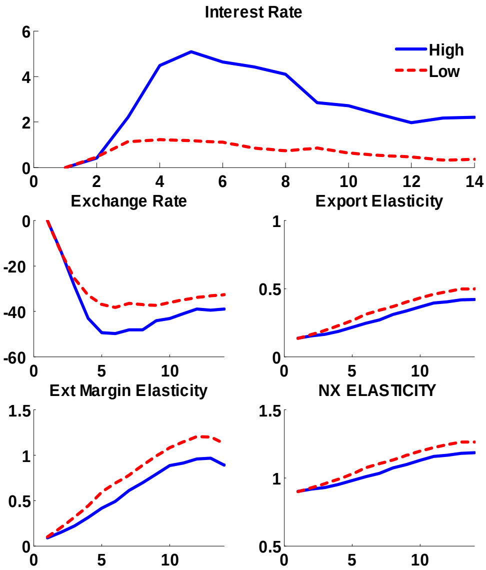
Bigger drop in output in SR



Output
Interest Rate
Real Exchange Rate
Benchmark
Habits (Cons.)
Habits (Imports)
Ext. Margin Elasticity
Export Elasticity
NX Elasticity

High and Low Interest Rate Shocks

- Reconsider differences in export response of high and low interest countries
- Consider response to $\{z, \beta\}$ with high or low interest rate path
- Find high interest rate path generates 80 percent of long-run response of low interest rate
  - 60 percent of the growth in export elasticity

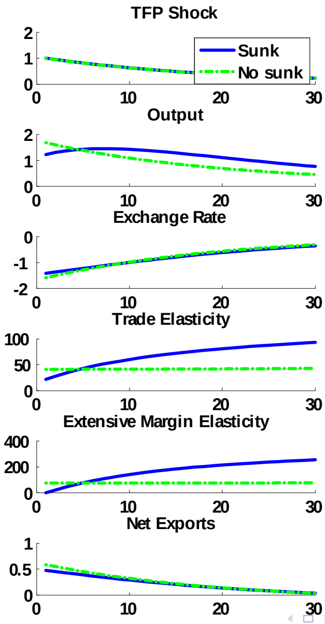

Interest Rate
High
Low
6
4
2
0
0
2
4
6
8
10
12
14
Exchange Rate
0
-20
-40
-60
0
5
10
Export Elasticity
1
0.5
0
0
5
10
Ext Margin Elasticity
1.5
1
0.5
0
0
5
10
NX ELASTICITY
1.5
1
0.5
0
5
10

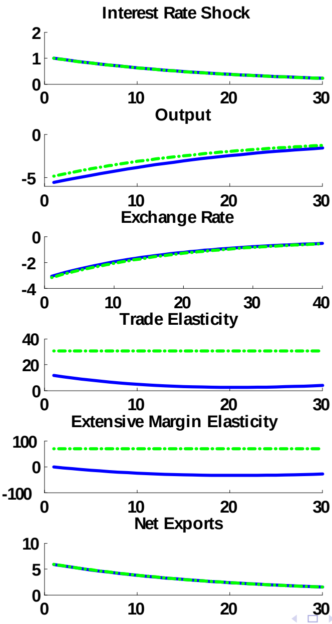
Conclusion

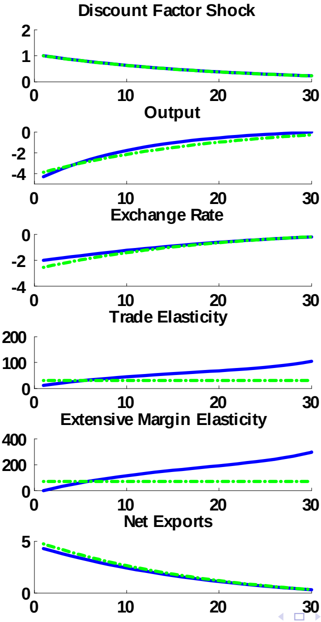
- Document key features of export dynamics following devaluations
  - Gradual export expansion
  - Interest rate dampens exports
- Find with a sunk cost of exporting we can generate
  - Some gradualness of exports
  - Most gradualness of extensive margin
  - Takes time to build up *intangible* exporter capital
  - Some sensitivity to interest rates
- Sluggishness matters for aggregates (y,nx,TFP)
  - Source of sluggishness matters.

Do dynamics of export elasticity matter?

- Different output dynamics across models primarily reflect differences in response to productivity & interest rates shocks
- For productivity shocks, without sunk cost output responds more in the short-run and less in the long-run.
  - With sunk costs, substantial resources used to build up stock of exporter
- Interest rate shocks more recessionary wth sunk cost since discourages investment in exporting
- Examine impulse response to shocks


TFP Shock
Sunk
No sunk
Output
Exchange Rate
Trade Elasticity
Extensive Margin Elasticity
Net Exports


Interest Rate Shock
2
1
0
0
10
20
30
Output
0
-5
0
10
20
30
Exchange Rate
0
-2
-4
0
10
20
30
40
Trade Elasticity
40
20
0
0
10
20
30
Extensive Margin Elasticity
100
0
-100
0
10
20
30
Net Exports
10
5
0
0
10
20
30


Discount Factor Shock
Output
Exchange Rate
Trade Elasticity
Extensive Margin Elasticity
Net Exports

Two Main Questions

Is there a better shock than the beta shock?

Outline

- Related Literature
- Evidence
- Model
- Results

Related Literature

- Sluggish trade - J-curve (Junz & Rhomberg, 73, Magee 73, Meade 88) - focus on contracting frictions for slow reversal of NX following devaluations.
- Sunk costs and exchange rates in partial equilibrium
  - Baldwin & Krugman (86) argue sunk costs affect NX dynamics.
  - Roberts & Tybout (97), Das, Roberts & Tybout (07) show sunk costs can generate some sluggishness.
- Sunk costs in GE
  - Alessandria & Choi (07) - sunk costs don't matter for NX
  - Alessandria & Choi (11) - sunk costs matter for output/trade dynamics following trade liberalization
  - Here consider more shocks, big shocks, & calibrate to sluggishness.

Importance of Extensive Margins for Exports

- Might suspect new exporters are relatively small & account for relatively little export growth
- Split products into continuing, new, and exitting from t_0 to t
- Disaggregate export growth into the intensive margin and extensive margins of entry and exit
- Measure cumulative contribution of net entry in US import data

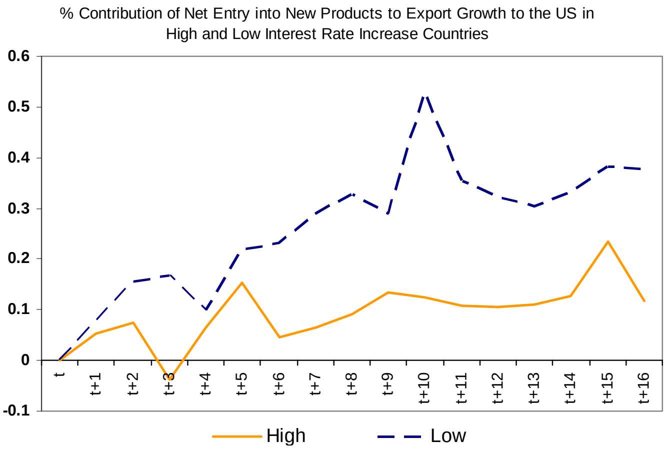
Importance of Extensive Margins for Exports

$$\frac{X(t)-X(t_0)}{[X(t_0)+X(t)]/2} =$$

$$\left(\frac{\sum\limits_{j\in CN^{t0,t}}[x(j,t_0)+x(j,t)]/2}{[X(t_0)+X(t)]/2}\right)\left(\frac{\sum\limits_{j\in CN^{t0,t}}[x(j,t)-x(j,t_0)]}{\sum\limits_{j\in CN^{t_0,t}}[x(j,t_0)+x(j,t)]/2}\right)$$

$$+\frac{NEN^{t_0,t}\overline{x}(t_0)}{[X(t_0)+X(t)]/2}+\frac{\sum\limits_{j\in EN_n^{t0,t}}[x(j,t)-\overline{x}(t_0)]}{[X(t0)+X(t)]/2}$$

$$-\frac{NEX^{t_0,t}\overline{x}(t_0)}{[X(t_0)+X(t)]/2}-\frac{\sum\limits_{j\in EX^{t0,t}}[x(j,t)-\overline{x}(t_0)]}{[X(t_0)+X(t)]/2}.$$


% Contribution of Net Entry into New Products to Export Growth to the US in High and Low Interest Rate Increase Countries
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
t
t+1
t+2
t+3
t+4
t+5
t+6
t+7
t+8
t+9
t+10
t+11
t+12
t+13
t+14
t+15
t+16
High
Low

Importance of Extensive Margins for Exports

- Custom data for Argentina, Colombia, Mexico, and Uruguay

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- Extensive margin defined as (1) product & destination and (2) product & destination & exporters

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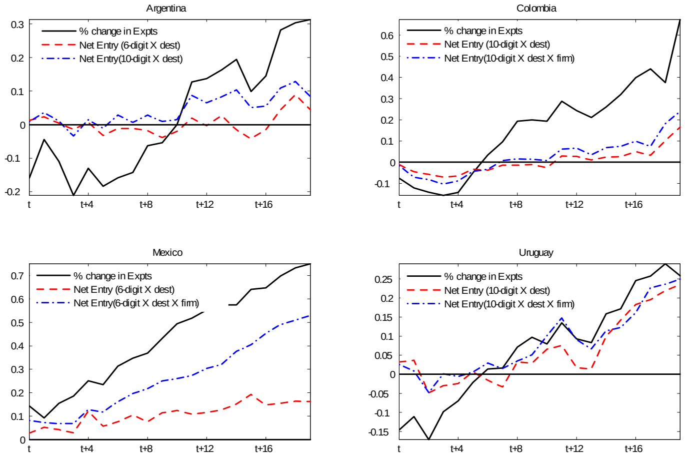

Model Intuition

- Aggregating across exporters, export revenues rise with higher Y, lower p_x, higher N

$$\Delta EXR = \left(\frac{\gamma - 1}{\theta - 1}\right) \Delta N + (1 - \gamma)\, \Delta p_x + \Delta Y$$

- γ and θ determine the magnitude of the extensive margin

Model Intuition

- Aggregating across exporters, export revenues rise with higher Y, lower p_x, higher N

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Combining pricing equation & export demand yields export elasticity

$$\frac{\Delta EXR}{\Delta rer} \approx \underbrace{\frac{\gamma - 1}{1 + \left(\frac{1}{\alpha} - 1\right)\gamma}}_{\text{Short-run}} + \underbrace{\left[\frac{\gamma - 1}{\theta - 1} + \frac{(\gamma - 1)\left(\frac{1}{\alpha} - 1\right)\frac{\gamma - \theta}{\theta - 1}}{1 + \left(\frac{1}{\alpha} - 1\right)\gamma}\right]\frac{\Delta N}{\Delta rer}}_{\text{Dynamic}}$$

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When $\alpha = 1$ these terms reduce to

$$\frac{\Delta EXR}{\Delta rer} = (\gamma - 1) + \frac{\gamma - 1}{\theta - 1}\frac{\Delta N}{\Delta rer}$$

Given extensive margin response $\left(\frac{\Delta N}{\Delta rer}\right)$ there should be a combination of (γ, θ) to match export elasticity

Calibration - Average Devaluation

Functional forms

$$
\begin{aligned}
u(C, L) &= \frac{\left(C - \lambda L^{\eta}\right)^{1-\sigma}}{1-\sigma} \\
G(X, M) &= \left[D^{\frac{\gamma-1}{\gamma}} + \omega^{\frac{1}{\gamma}} M^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \\
F_m(k) &= \left(\frac{k}{f_m v_m}\right)^{\frac{1}{v_{m-1}}}
\end{aligned}
$$

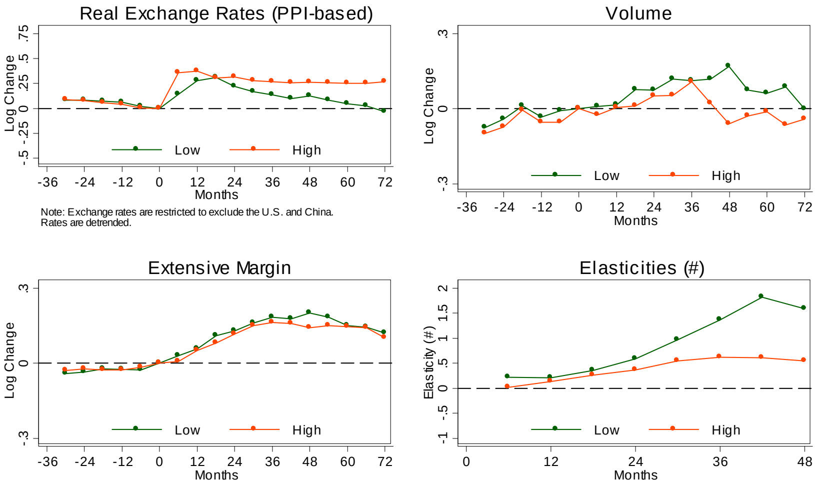
Calibration

Parameters	Target
$\overline{B}$	debt/imports=10
$v_0 = v_1$	extensive margin elasticty
f_0	exporter ratio $N = 25\%$
f_1	exit rate of exporter $1 - F_1(\kappa) = 1.5\%$
ω	trade share of 15%
α	ratio of rerppi to rercpi
θ	markup $= 50\%$
γ	standard (1.3)
λ	total labor normalization (L=1/3)
σ	standard (2)
η	standard (1.5)

=>Large sunk cost $(f_0/f_1 > 10)$

Figure 2: Exports to U.S., Detrended

By Interest rate



Note: Volume and Extensive margin are detrended

Comments on Gradual Expansion

- Iceberg cost models can't get a gradual expansion.

$$
\begin{aligned}
EX &= \left(P_x \tau\right)^{-\varepsilon} \\
\Delta ex &= -\varepsilon \left(\Delta p_x + \Delta \tau\right) \\
\varepsilon &= -\frac{\Delta ex}{\Delta p_x + \Delta \tau}
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$$

Need $\Delta\tau$ to offset changes in Δp_x initially
Financial friction models (i.e. trade credit) imply $\Delta\tau = \Delta r/4$

Comments on Gradual Expansion

- Fixed costs models can't get a gradual expansion.

$$
\begin{aligned}
EX &= N\left(P_x\tau\right)^{-\varepsilon} \\
\Delta ex &= \Delta n - \varepsilon\left(\Delta p_x + \Delta\tau\right) \\
\Delta n &= \alpha\left[-\varepsilon\left(\Delta p_x + \Delta\tau\right)\right] \\
\hat{\varepsilon} &= \varepsilon\left(1+\alpha\right) = -\frac{\Delta ex}{\Delta p_x + \Delta\tau}
\end{aligned}
$$

Model Outline

- Consumer's problem
- Final good producer's problem
- Exporter's problem
- Foreign demand
- Equilibrium

Exporter's Problem

Integrating over export costs, define expected value

$$EV_m = \int V_m(\kappa, S)\, dF_m$$

Differencing yields straightforward relationship

$$\Delta V = \pi + \frac{w}{z}\int_0^{\kappa^*} \kappa\left(dF_0(\kappa) - dF_1(\kappa)\right) + \frac{\left[F_1(\kappa^*) - F_0(\kappa^*)\right]\Delta V'}{1+R}$$

In steady state

$$\frac{w\kappa^*}{z} = \frac{\pi + \int_0^{\kappa^*}\left(F_1(\kappa) - F_0(\kappa)\right) d\kappa}{1+R}.$$

Export Demand

- From ROW demand for imports derive foreign demand per exporter as

$$\overline{EX}(S) = N^{\frac{\gamma-\theta}{\theta-1}} p_x^{-\gamma} Y,$$

  - Y is ROW income.
  - θ - elas. of subst. between varieties
  - γ - elas. of subst.between exports & ROW goods