Real Exchange Rate and Net Trade Dynamics: Financial and Trade Shocks

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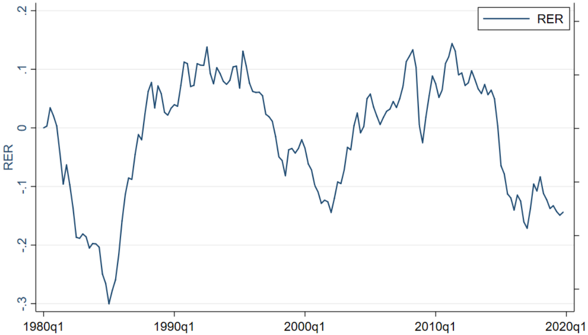
- Missing: Three additional features of the RER

Features of the RER



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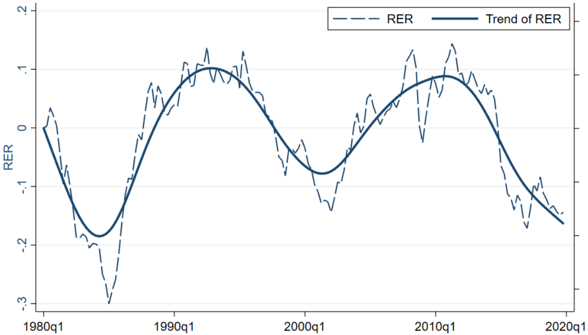

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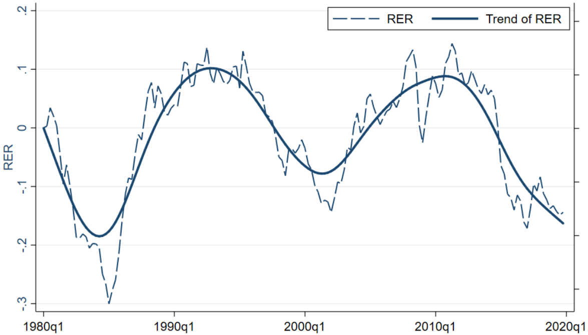

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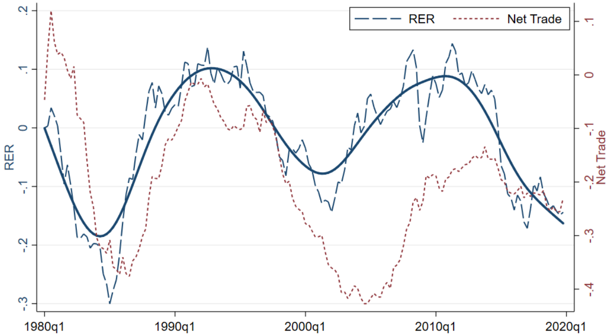

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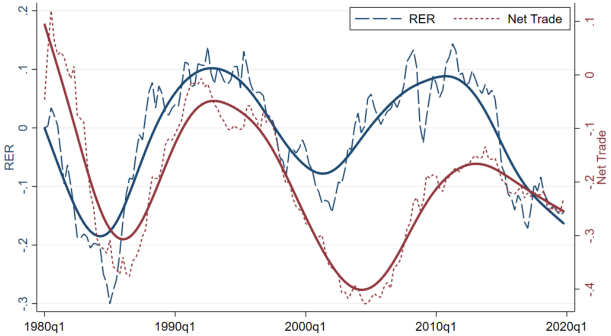

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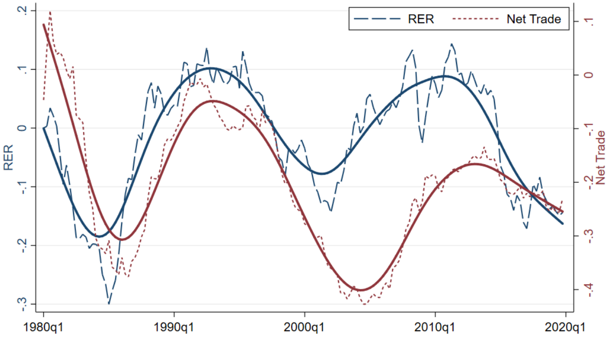

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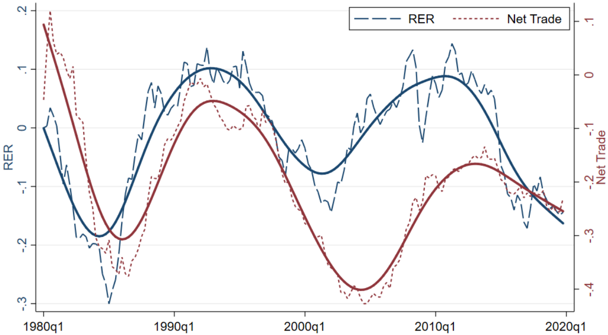

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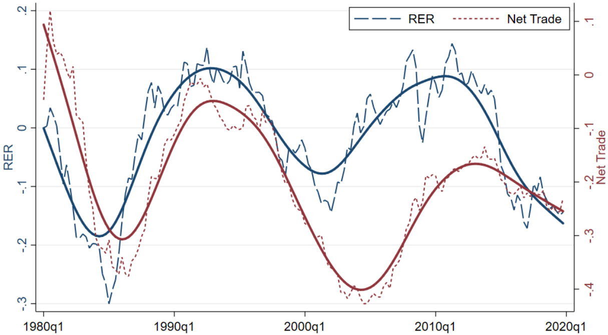

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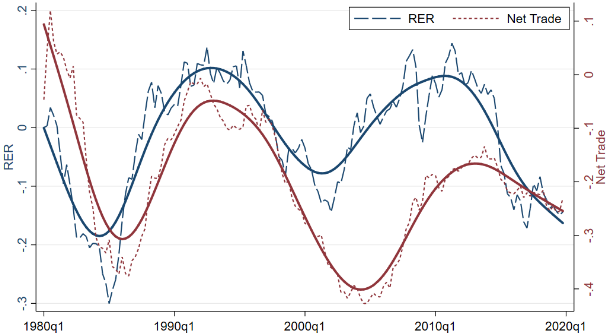

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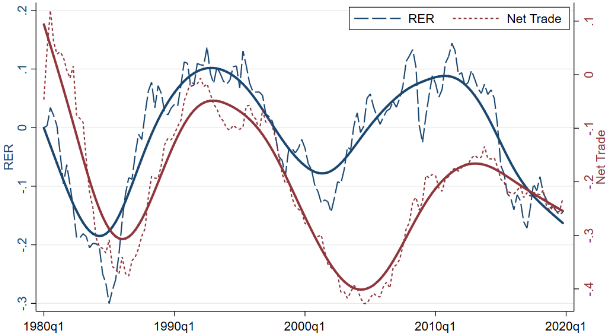

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- Show that model is consistent with RER dynamics at full spectrum of frequencies
- Evaluate the role of financial and trade shocks

Mechanism & Findings

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Trade shocks explain 70% of low frequency variations in the RER

Literature Review

International macro models

- Backus, Kehoe and Kydland (1994)
- Rabanal and Rubio-Ramirez (2015), Gornemann, Guerrón-Quintana and Saffie (2020)

Contribution: Discipline dynamic trade with microfoundations on exporters

RER and capital flows in International Finance & International Trade

- Devereux and Engel (2002), Gabaix and Maggiori (2015), Farhi and Gabaix (2016), Itskhoki and Mukhin (2021)
- Obstfeld and Rogoff (2000), Eaton, Kortum and Neiman (2016), Reyes-Heroles (2016), Alessandria and Choi (2021), Sposi (2021), Alessandria, Bai and Woo (2022)

Contribution: Build the bridge between two strands of literature

Measurement of trade costs

- Levchenko, Lewis and Tesar (2010), Fitzgerald (2012)
- Head and Mayer (2014)

Contribution: Explore generalized specification of trade costs

Outline

Benchmark Model

Calibration and Identification
- (1) High Frequency Comovement with Net Trade

Untargeted: RER at All Frequencies
- (2) Low Frequency Comovement with Net Trade
- (3) High/Low Frequency Decomposition
- (0) High Frequency Disconnect to Other Variables

Application: Role of Financial and Trade Shocks

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- Common productivity shocks a_{ct}, differential productivity shocks a_{dt}, financial shocks ψ_t, and trade shocks ξ_t

Household (ROW)

Lifetime utility

$$\mathbb{E}\left[\sum_t \beta^t \frac{\left(C_t^\eta (1 - L_t)^{1-\eta}\right)^{1-\sigma}}{1-\sigma}\right]$$

Budget constraints

$$C_t + I_t = W_t L_t + R_t^k K_t + \Pi_t$$

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- Capital adjustment cost

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

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Consumption and Labor

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$$\underbrace{i_t - i_t^*}_{\text{interest differentials}} - \underbrace{\mathbb{E}_t\left[\Delta q_{t+1}\right]}_{\text{changes in RER}} \neq 0$$

- Deviations to the Uncovered Interest Parity

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- Deviations to the Uncovered Interest Parity
- Alternative microfoundations of the deviations result in an equivalent condition (Schmitt-Grohé and Uribe 2003, Itskhoki and Mukhin 2017, Yakhin 2021)

Aggregation Technology

- ROW & US composite goods

$$Y_{Rt} \qquad Y_{Ut}$$

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- ROW & US composite goods aggregated into final goods

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  - Variable markup & incomplete RER passthrough

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- Continuum of firms $j \in [0, 1]$
- Heterogeneous in idiosyncratic productivity

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- Fixed cost of exporting $f_{m_{j,t-1}}$
  - Fixed cost for starters $f_0 >$ continuing exporters f_1
  - Dixit (1989), Baldwin and Krugman (1989), Das et al. (2007), Alessandria and Choi (2007, 2021)

Dynamic Trade: Sunk Cost of Exporting

- The dynamic problem of a firm

$$V_t(\mu_t, m_{t-1}, S_t) = \max_{m_t, p_{Rt}, p^*_{Rt}, l_t, k_t} p_{Rt} y_{Rt} + m_t Q_t p^*_{Rt} y^*_{Rt} - W_t l_t - R^k_t k_t$$

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- Threshold technology to change status

$$W_t f_m - \pi(\mu_{mt}) = \Omega_t \mathbb{E}_t [V_{t+1}(\mu_{t+1}, 1, S_{t+1}) - V_{t+1}(\mu_{t+1}, 0, S_{t+1})], \quad m \in \{0, 1\}$$

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- Mass of exporters evolves as

$$N_t = N_{t-1}\ Pr[\mu \geq \mu_{1t}] + (1 - N_{t-1})\ Pr[\mu \geq \mu_{0t}]$$

  - Slow evolving firm distribution $\rightarrow$ Gradual response of aggregate trade

Shocks to Trade Cost

- Resource constraint of producer j

$$y_{jt} = y_{j,Rt} \qquad + m_{jt} y^*_{j,Rt}$$

More IRF Empirical Robustness

Shocks to Trade Cost

- Resource constraint of producer j

$$y_{jt} = y_{j,Rt} e^{\xi_{Rt}} + m_{jt} y^{*}_{j,Rt} e^{\xi^{*}_{Rt}}$$

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  - ROW $\rightarrow$ US: ξ^*_{Rt}
  - US $\rightarrow$ ROW: ξ_{Ut}

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  - ($\xi_t = \xi^*_{Rt} - \xi_{Ut}$: Only the differential cost affects the RER and net trade)

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- Domestic trade cost
  - ROW $\rightarrow$ ROW: $\xi_{Rt} \stackrel{?}{=} 0$
  - US $\rightarrow$ US: $\xi^*_{Ut} = 0$

▸ More ▸ IRF ▸ Empirical ▸ Robustness

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- Domestic trade cost
  - ROW $\rightarrow$ ROW: $\xi_{Rt} = \tau \xi_t / 2$, $\tau \in \mathbb{R}$
  - US $\rightarrow$ US: $\xi^*_{Ut} = 0$
  - (Capture changes in trade barrier among ROW countries)

▸ More ▸ IRF ▸ Empirical ▸ Robustness

Domestic Trade Cost

- $\tau \in \mathbb{R}$ determines the elasticity of domestic cost to international cost

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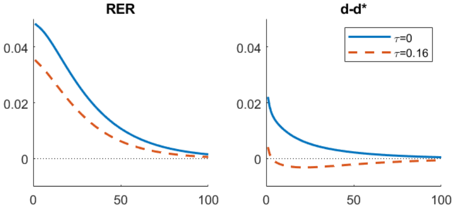

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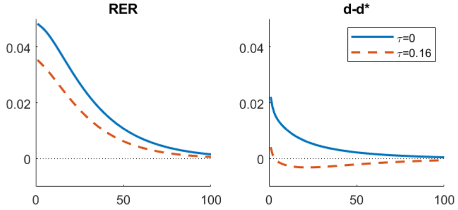

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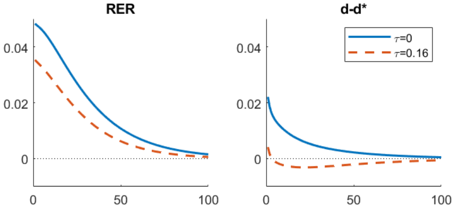

- $\rho(\Delta RER, \Delta c - \Delta c^*) < 0$ in data (Backus-Smith Puzzle)
  - Financial shocks generate negative correlation
  - Trade shocks do not offset

Shock Processes

- Trade shocks $\quad \xi_t = \rho_\xi \xi_{t-1} + \varepsilon_{\xi t}, \quad \varepsilon_{\xi t} \sim N(0, \sigma_\xi^2)$
- Financial shock $\quad \psi_t = \rho_\psi \psi_{t-1} + \epsilon_{\psi t}, \quad \varepsilon_{\psi t} \sim N(0, \sigma_\psi^2)$
- Idiosyncratic productivity shocks $\quad \mu_{jt} \overset{iid}{\sim} N(0, \sigma_\mu^2)$
- Aggregate productivity shocks

$$\begin{bmatrix} a_t \\ a_t^* \end{bmatrix} = \begin{bmatrix} a_{ct} + a_{dt}/2 \\ a_{ct} - a_{dt}/2 \end{bmatrix}$$

$$a_{ct} = \rho_{ac} a_{ct-1} + \varepsilon_{ac,t} \qquad \varepsilon_{ac,t} \sim N(0, \sigma_{ac}^2)$$

$$a_{dt} = \rho_{ad} a_{dt-1} + \varepsilon_{ad,t} \qquad \varepsilon_{ad,t} \sim N(0, \sigma_{ad}^2)$$

Outline

Benchmark Model

Calibration and Identification

(1) High Frequency Comovement with Net Trade

Untargeted: RER at All Frequencies

(2) Low Frequency Comovement with Net Trade

(3) High/Low Frequency Decomposition

(0) High Frequency Disconnect to Other Variables

Application: Role of Financial and Trade Shocks

Conclusion

Data

- Period: 1980Q1 - 2019Q4
- US and ROW (10 Countries)
- Real exchange rate: Effective exchange rate indices, Narrow (BIS)
- Y, C, I, X, M: National account volume estimates (OECD)
- US real interest rate: Effective federal funds rate (IMF), CPI (OECD)
- ROW real interest rate: Money market rates (IMF, OECD, BOJ), CPI (OECD)
- US exporter characteristics (Bernard and Jensen 1999, Alessandria and Choi 2014)

Preview of Calibration

- Standard parameters: Exogenouly set
- Export market parameters: Set to match exporter microdata
- Shocks and adjustment costs: Jointly estimate to match targeted moments

Exogenously Set Parameters

Parameter		Value	Target Moment
Discount Factor	β	0.99	Annual interest rate of 4%
Risk Aversion	σ	2	Intertemporal elasticity of substitution of 0.5
Weight on Consumption	η	0.36	Hours worked
Capital Share	α	0.36	Capital share of income
Elasticity of Substitution across Varieties	θ	3.5	Producer markup of 40%
Elasticity of Substitution between H and F	ρ	1.5	Itskhoki and Mukhin (2021)
Home Bias	γ	0.097	Trade-to-GDP ratio of 14%
Persistence Common Productivity	ρ_{a_c}	0.98	GDP persistence
Persistence Differential Productivity	ρ_{a_d}	0.98	GDP persistence
Depreciation Rate	δ	0.02	Itskhoki and Mukhin (2021)

Exporter Parameters

Parameter		Value	Target
Fixed cost of new exporters	f_0	0.07	Export participation of 25%
Fixed cost of incumbent exporters	f_1	0.04	Exit rate of 3.5%
Volatility of idiosyncratic productivity	σ_μ	0.08	Exporter premium of 75%
Pricing to market parameter	ζ	1.00	Exchange rate pass-through of 60%

Estimated Parameters

Parameter		Value	Identification
Financial shock, volatility	σ_ψ/σ_{a_c}	0.57	$\rho\left(\Delta c - \Delta c^*, \Delta q\right)$
Financial shock, persistence	ρ_ψ	0.99	$\rho\left(i - i^*\right)$
Trade shock, volatility	σ_ξ/σ_{a_c}	17.01	$\sigma(xm)/\sigma(q)$
Trade shock, persistence	ρ_ξ	0.98	$\rho\left(\Delta xm, \Delta q\right)$
Trade shock, within-country share	τ	0.17	$\rho(\Delta d, \Delta d^*)$
Productivity differentials, volatility	$\sigma_{a_d}/\sigma_{a_c}$	1.24	$\rho(\Delta y, \Delta y^*)$
Adjustment cost of portfolio	ξ_b	0.06	$\rho(xm)$
Adjustment cost of capital	κ	1.59	$\sigma(\Delta inv)/\sigma(\Delta y)$

Targeted Moments

Moments	Data	Baseline
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.10	-0.11
$\rho\left(\Delta xm, \Delta q\right)$	0.30	0.29
$\sigma(xm)/\sigma(q)$	1.12	1.12
$\rho(xm)$	0.98	0.93
$\rho(\Delta y, \Delta y^{*})$	0.40	0.39
$\rho(\Delta d, \Delta d^{*})$	0.34	0.34
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.60
$\rho\left(i - i^{*}\right)$	0.90	0.88

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- (1) Small comovement between RER and net trade at higher frequency

Targeted Moments

Moments	Data	Baseline	No trade shock
$\rho\left(\Delta c-\Delta c^{*},\Delta q\right)$	-0.10	-0.11	-0.09
$\rho\left(\Delta xm,\Delta q\right)$	0.30	0.29	0.85
$\sigma(xm)/\sigma(q)$	1.12	1.12	2.50
$\rho(xm)$	0.98	0.93	0.99
$\rho(\Delta y,\Delta y^{*})$	0.40	0.39	0.41
$\rho(\Delta d,\Delta d^{*})$	0.34	0.34	0.34
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.60	2.62
$\rho\left(i-i^{*}\right)$	0.90	0.88	0.80

- (1) Small comovement between RER and net trade at higher frequency
- Without trade shocks, counterfactual high frequency moments

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Low Frequency Comovement with Net Trade

- Elasticity of trade measured by

$$xm_t = \rho\,(tot_t + q_t) + (d_t^* - d_t)$$

  - Common to multi-good trade models
  - xm_t Net trade, tot_t Terms of trade, d_t Domestic absorption

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  - Additional term ϵ_t (Baseline: trade shocks, firm distribution)

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- Error correction model
  (Hooper et al. 2000, Marquez 2002, Alessandria and Choi 2021)

$$\Delta xm_t = \beta + \rho_{SR}\,\Delta(tot_t + q_t) + \Delta(d_t^* - d_t) \\ - \alpha\left\{xm_{t-1} - \rho_{LR}\left(tot_{t-1} + q_{t-1}\right) - \left(d_{t-1}^* - d_{t-1}\right)\right\} + \varepsilon_t$$

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- Simulate models for 10,000 periods and use the latter half to regress the ECM

(2) LR Elasticity Larger than SR

Table: Trade Elasticity

	Data	Baseline
Short run	0.20	0.35
	(0.05)	(0.02)
Long run	1.16	0.80
	(0.25)	(0.09)

Data Shocks

(2) LR Elasticity Larger than SR

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	Data	Baseline	No Dynamics
Short run	0.20	0.35	0.59
	(0.05)	(0.02)	(0.02)
Long run	1.16	0.80	0.55
	(0.25)	(0.09)	(0.07)

- Without Dynamic Trade, SR elasticity $\approx$ LR elasticity

▸ Data ▸ Shocks

(3) Successfully Captures the Shape of the RER Spectrum

Table: Frequency Decomposition

Frequency	Data	Baseline
High	0.02	0.03
Business Cycle	0.15	0.10
Low	0.83	0.87

(3) Successfully Captures the Shape of the RER Spectrum

Table: Frequency Decomposition

Frequency	Data	Baseline	No Dynamics
High	0.02	0.03	0.02
Business Cycle	0.15	0.10	0.04
Low	0.83	0.87	0.94

- Without dynamics, assigns too much variance to low frequency
    - "Excess persistence puzzle" (Rabanal and Rubio-Ramirez 2015)
    - With dynamics, quantities more inelastic & RER moves more on impact

(0) Disconnect to Other Variables

- Output (Meese-Rogoff Puzzle)
- Interest rate (Forward Premium Puzzle)
- Consumption (Backus-Smith Puzzle) – Targeted

BC Moments

Disconnect: Output (Meese-Rogoff Puzzle)

- Theory: RER is strongly connected to macro quantities
- Data: RER follows near random walk process, 3-6 more volatile than Y

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	Data	Baseline
$\sigma(\Delta q)/\sigma(\Delta y)$	4.24	4.12
$\rho(\Delta q)$	$\approx$0	-0.02
$\rho(q)$	0.97	0.96

Disconnect: Output (Meese-Rogoff Puzzle)

- Theory: RER is strongly connected to macro quantities
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	Data	Baseline	No Trade Shock	No Financial Shock
$\sigma(\Delta q)/\sigma(\Delta y)$	4.24	4.12	3.03	2.89
$\rho(\Delta q)$	$\approx$0	-0.02	-0.05	0.01
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- Financial shocks are relatively important for higher frequency movements
- Trade shocks generate large persistence

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	Data	Baseline
β_{Fama}	-1.34 (0.52)	0.35
R^2	0.02	0.004

Disconnect: Interest Rate (Forward Premium Puzzle)

$$\mathbb{E}_t[\Delta q_{t+1}] = \alpha + \beta_{Fama}\,(i_t - i_t^*) + u_t$$

- Theory: $\beta_{Fama} \approx 1$
  - High interest rates predict currency depreciation (no arbitrage)
- Data: $\hat{\beta}_{Fama} < 0, R^2 \approx 0$
  - Interest rates have low explanatory power

	Data	Baseline	No Trade Shock	No Financial Shock
β_{Fama}	-1.34 (0.52)	0.35	-0.22	1.20
R^2	0.02	0.004	0.001	0.14

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β_{Fama}	-1.34 (0.52)	0.35	-0.22	1.20
R^2	0.02	0.004	0.001	0.14

- Financial shocks give negative β_{Fama} by directly generating UIP Deviations

Disconnect: Consumption (Backus-Smith Puzzle)

- Theory: Consumption is high when price is low (perfect risk sharing)
- Data: RERs are negatively correlated with relative consumption

Disconnect: Consumption (Backus-Smith Puzzle)

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	Data	Baseline
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.10	-0.11

Disconnect: Consumption (Backus-Smith Puzzle)

- Theory: Consumption is high when price is low (perfect risk sharing)
- Data: RERs are negatively correlated with relative consumption

	Data	Baseline	No Trade Shock	No Financial Shock
$\rho(\Delta c - \Delta c^*, \Delta q)$	-0.10	-0.11	-0.16	0.24

Disconnect: Consumption (Backus-Smith Puzzle)

- Theory: Consumption is high when price is low (perfect risk sharing)
- Data: RERs are negatively correlated with relative consumption

	Data	Baseline	No Trade Shock	No Financial Shock
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.10	-0.11	-0.16	0.24

- Financial shocks are important for negative correlation

Outline

Benchmark Model

Calibration and Identification
- (1) High Frequency Comovement with Net Trade

Untargeted: RER at All Frequencies
- (2) Low Frequency Comovement with Net Trade
- (3) High/Low Frequency Decomposition
- (0) High Frequency Disconnect to Other Variables

Application: Role of Financial and Trade Shocks

Conclusion

Variance Decomposition into Frequencies

	Data	Baseline
High	0.02	0.03
Business cycle	0.15	0.10
Low	0.83	0.87

Variance Decomposition into Frequencies

	Data	Baseline	No Trade Shock
High	0.02	0.03	0.06
Business cycle	0.15	0.10	0.16
Low	0.83	0.87	0.78

Variance Decomposition into Frequencies

	Data	Baseline	No Trade Shock	No Financial Shock
High	0.02	0.03	0.06	0.01
Business cycle	0.15	0.10	0.16	0.06
Low	0.83	0.87	0.78	0.93

Variance Decomposition into Frequencies

	Data	Baseline	No Trade Shock	No Financial Shock
High	0.02	0.03	0.06	0.01
Business cycle	0.15	0.10	0.16	0.06
Low	0.83	0.87	0.78	0.93

- Trade shocks important for lower frequency variations
- Financial shocks matter more for higher frequencies

$h-$quarter ahead Variance Decomposition

Table: Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h = 1$
Trade Shock	47.78
Financial Shock	49.51
Productivity Shock	2.71

$h-$quarter ahead Variance Decomposition

Table: Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h = 1$	8
Trade Shock	47.78	64.73
Financial Shock	49.51	30.43
Productivity Shock	2.71	4.84

$h-$quarter ahead Variance Decomposition

Table: Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h=1$	8	32	80
Trade Shock	47.78	64.73	71.55	66.37
Financial Shock	49.51	30.43	18.44	19.32
Productivity Shock	2.71	4.84	10.01	14.30

$h-$quarter ahead Variance Decomposition

Table: Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h=1$	8	32	80
Trade Shock	47.78	64.73	71.55	66.37
Financial Shock	49.51	30.43	18.44	19.32
Productivity Shock	2.71	4.84	10.01	14.30

- Financial shocks matters primarily in the short run
- Trade shocks account for 70% of variance in the long run

Robustness

1. Specification of dynamic trade (Input adjustment cost)
2. SR/LR trade elasticity (Armington elasticity and fixed exporting costs)
3. Estimation methods (Bayesian)
4. Pricing to market (Kimball aggregator)
5. Within-ROW trade costs
6. Empirical approach for trade costs

Outline

Benchmark Model

Calibration and Identification

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Untargeted: RER at All Frequencies

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Application: Role of Financial and Trade Shocks

Conclusion

Conclusion

Model extended with trade shocks and dynamic trade can reproduce

- Full spectrum of the RER
- Comovement of net trade and the RER at all frequencies

without compromising

- High frequency disconnect with output, consumption and interest rate

Financial shocks matter for high frequency

Trade shocks crucial for low frequency – major source of RER variations

“Rising Current Account Dispersion: Financial or Trade Integration?”

with George Alessandria and Yan Bai

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  and the contribution of average financial/trade frictions

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- **Cross-sectional** changes in capital flows
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- Salient features in data over the last few decades
  - Net trade flows have become dispersed across countries
  - Gross trade flows have risen significantly

“Rising Current Account Dispersion: Financial or Trade Integration?”

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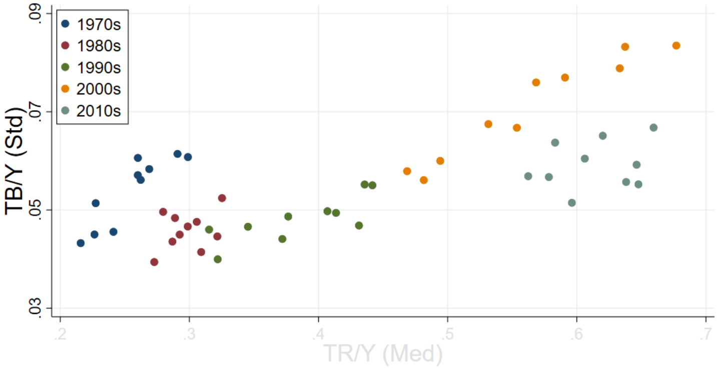
- **Cross-sectional** changes in capital flows
  and the contribution of **average** financial/trade **frictions**

- Salient features in data over the last few decades
  - Net trade flows have become dispersed across countries
  - Gross trade flows have risen significantly

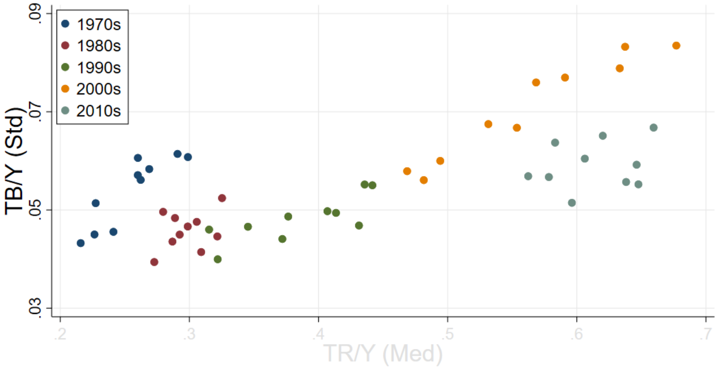
- This paper
  - Evaluate the role of financial and trade integrations
  - N-country GE model quantified with cross-sectional data of 50 countries

Trade Balance Has Become Dispersed over Time



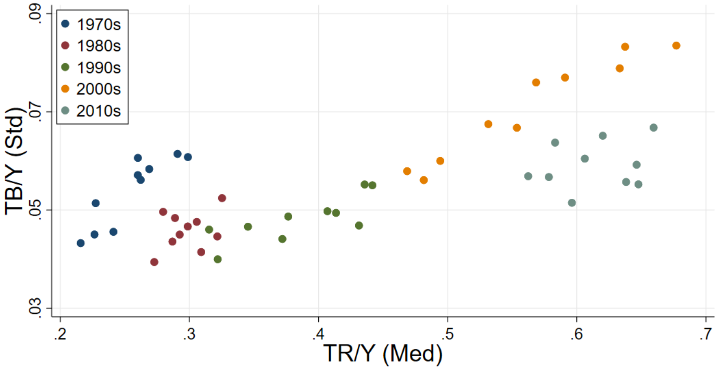
$$\frac{\textit{Trade Balance}}{Y}$$

Trade Balance Has Become Dispersed over Time



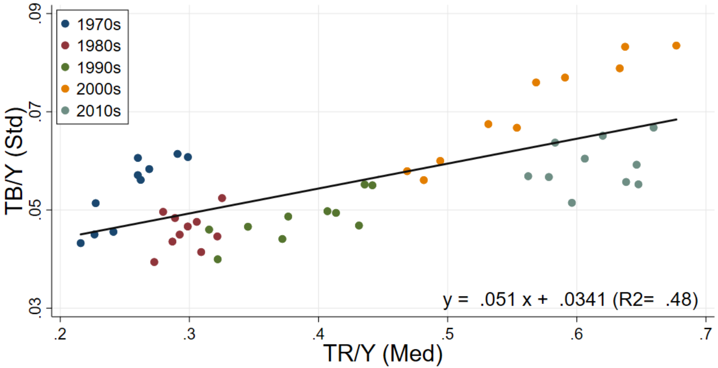
$$\frac{Trade\ Balance}{Y} = \frac{Trade\ Balance}{Gross\ Trade} \times \frac{Gross\ Trade}{Y}$$

Gross Trade Flows Have Risen over Time



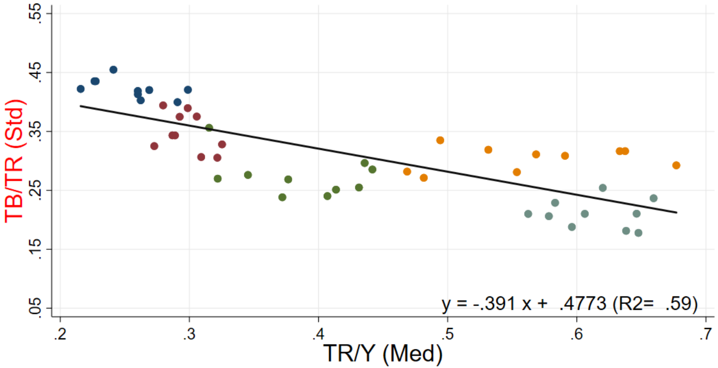
$$\frac{Trade\ Balance}{Y} = \frac{Trade\ Balance}{Gross\ Trade} \times \frac{Gross\ Trade}{Y}$$

Net & Gross Trade Flows Have Risen over Time



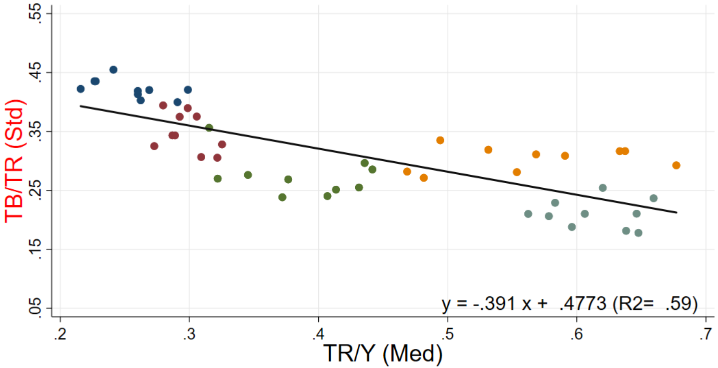
$$\frac{Trade\ Balance}{Y} = \frac{Trade\ Balance}{Gross\ Trade} \times \frac{Gross\ Trade}{Y}$$

Net Flows “Stable” when Controlling for Trade Growth



$$\frac{Trade\ Balance}{Y} = \frac{Trade\ Balance}{Gross\ Trade} \times \frac{Gross\ Trade}{Y}$$

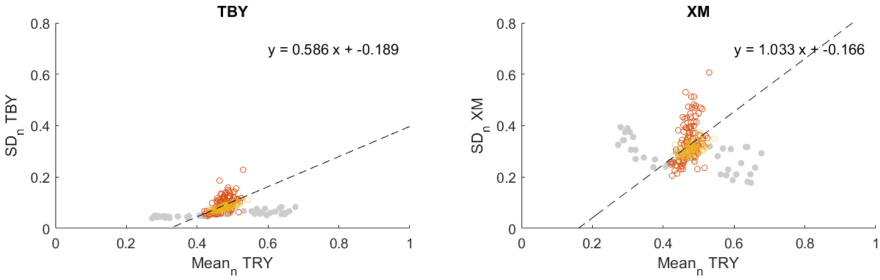
Net Flows "Stable" when Controlling for Trade Growth



$$\frac{Trade\ Balance}{Y} = \frac{Trade\ Balance}{Gross\ Trade} \times \frac{Gross\ Trade}{Y}$$

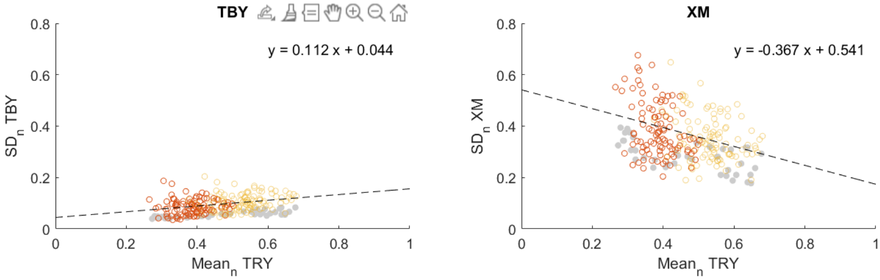
- Growing dispersion from scale effect

Varying Financial Frictions



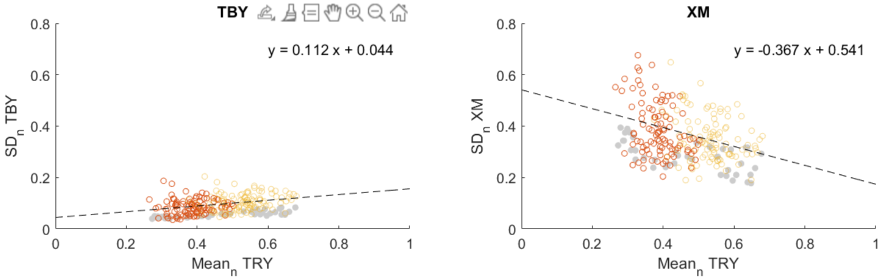
- Not enough increase in gross trade
- Excess dispersion in net trade

Varying Trade Frictions



- Increase in the scale of gross trade
- Dispersion in net trade from the increase in gross trade

Varying Trade Frictions



- Increase in the scale of gross trade
- Dispersion in net trade from the increase in gross trade

Rises in net&gross international trade – consequence of trade integration

Moving Forward

- Interplay of financial and trade barriers in business cycle transmission
- Implications for capital flows and prices
- Eventually, uncovering the nature of financial and trade shocks/frictions that remain to be a black box

Appendix

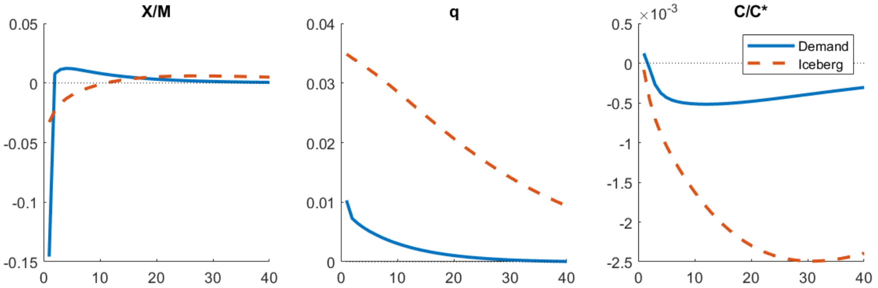
Puzzles in the RER

- Meese-Rogoff Puzzle
  - Theory: RER is strongly connected to macro quantities
  - Data: RER follows near random walk process, 3-6 more volatile than Y or C
- Backus-Smith Puzzle
  - Theory: Perfect risk sharing – consumption is high when price is low
  - Data: RERs are negatively correlated with relative consumption
- (Real) Forward Premium Puzzle
  - Theory: High interest rates predict currency depreciation
  - Data: High interest rates predict currency appreciations, with small R^2 (arbitrage)

◂ Motivation

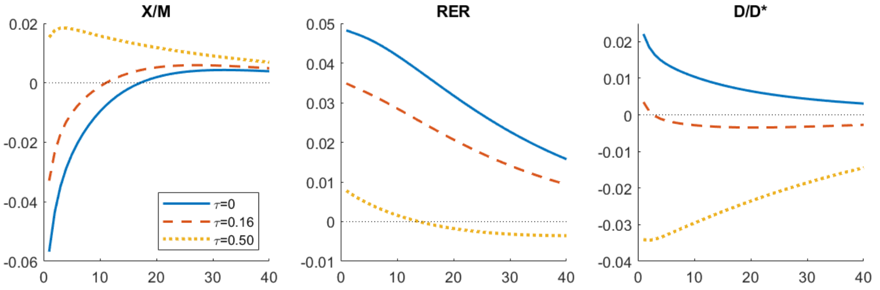
Demand Shock (Pavlova and Rigobon 2007)

$$D_t = \left[\left(e^{-\gamma \xi_t} \right)^{\frac{1}{\rho}} Y_{Rt}^{\frac{\rho-1}{\rho}} + \gamma^{\frac{1}{\rho}} \left(e^{\xi_t} \right)^{\frac{1}{\rho}} Y_{Ut}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$



Back

Mechanism of Trade Shock



- Size of τ matters for the amplification of trade shocks

Back

Inspecting the Mechanism

- How does the contribution of shocks to the $\rho(i - i^*, q)$ differ across models?

Table: $\rho(i - i^*, q)$

Model	All Shocks	No Trade Shock	No Financial Shock
Dynamic Trade	-0.06	-0.05	-0.50
Static Trade	0.25	0.66	0.01

▸ IRFs

XM Ratio in Baseline Model

$$x = (\log\gamma + (1-\theta^*)\xi_R^* + (1-\rho)p_R^* + D^* + q) - \left(q + p_R^* + \frac{1}{1-\theta^*}N\right)$$

$$m = (\log\gamma + (1-\theta)\xi_U + (1-\rho)p_U + D) - \left(p_U + \frac{1}{1-\theta}N^*\right)$$

$$\begin{aligned} xm = {} & \rho\,(tot + q) + (D^* - D) \\ & + \underbrace{((1-\theta^*)\xi_R^* - (1-\theta)\xi_U) + (1-\rho)\left(\frac{1}{1-\theta}N^* - \frac{1}{1-\theta^*}N\right)}_{\epsilon} \end{aligned}$$

Back

Error Correction Estimation: Data

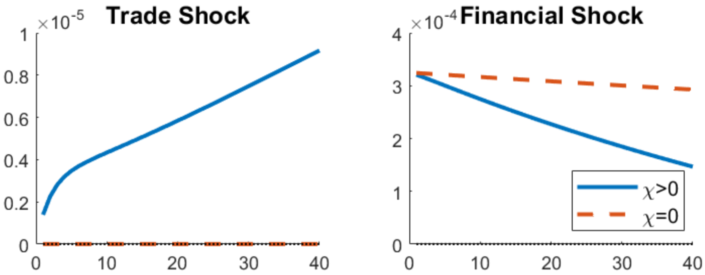
	(1) Constrained	(2) Unconstrained
Price SR	0.208***	0.203***
	(0.0499)	(0.0502)
Price LR	1.320***	1.161***
	(0.38)	(0.245)
Spending SR	*1*	0.621**
		(0.24)
Spending LR	*1*	0.490*
		(0.245)
Adjustment	0.0529**	0.0735***
	(0.0197)	(0.0207)
Constant	0.406***	0.442***
	(0.098)	(0.1)
Observations	158	158

Robust standard errors in parentheses

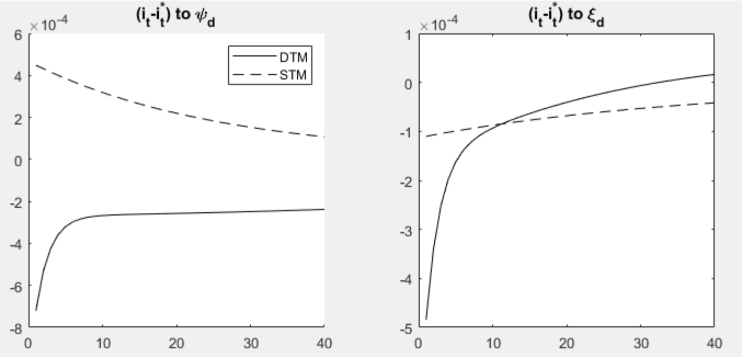
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Portfolio Adjustment Costs

Figure: IRF of UIP Deviations



IRFs

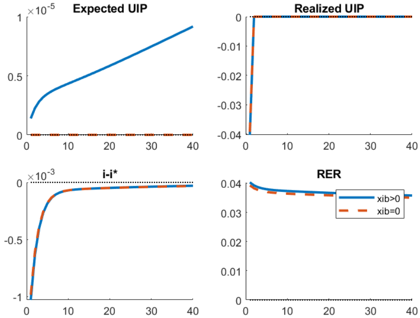


Financial Shocks generate negative interest rate differentials under Dynamic Trade

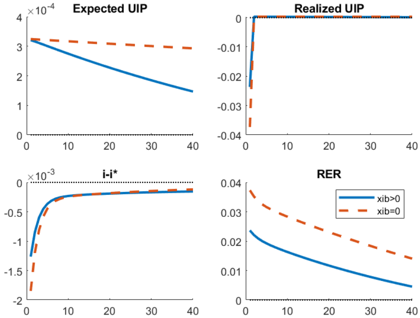
Trade Shocks induce larger negative effects under Dynamic Trade

Back

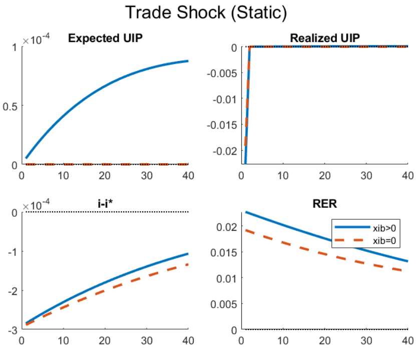
Trade Shock (Dynamic)



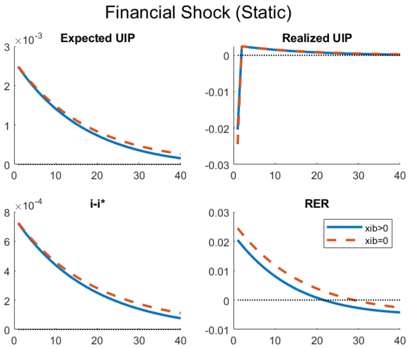
Financial Shock (Dynamic)



FP Puzzle



Trade Shock (Static)
Expected UIP
Realized UIP
i-i*
RER
xib>0
xib=0



Financial Shock (Static)
Expected UIP
Realized UIP
i-i*
RER
xib>0
xib=0

Estimation of τ

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: ξ^R							
$(\xi_R^* - \xi_U)$	0.199**		0.546*		0.493***		0.443	
	(0.0581)		(0.223)		(0.100)		(0.304)	
ξ_R^*		0.328***		0.843***		0.583***		0.972**
		(0.0798)		(0.166)		(0.0627)		(0.293)
Country FE			Y	Y			Y	Y
Spending Constraints					Y	Y	Y	Y
Observations	25	25	25	25	25	25	25	25
R-squared	0.338	0.423	0.207	0.530	0.513	0.790	0.0847	0.324

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Back

Trade Costs in Data

- Using the CES Demand function

$$\log Y_{Rt}^{*} = \rho \log(P_{Rt}^{*}/P_{t}^{*}) + \log D_{t}^{*} + \xi_{Rt}^{*}$$

- Y_{Rt}^{*} Exports to US
- D_{t}^{*} Domestic expenditure in US
- P_{Rt}^{*} Price of ROW goods in US
- P_{t} Aggregate price index in US

Trade Costs in Data

- Using the CES Demand function

$$\log Y^*_{Rt} = \rho \log(P^*_{Rt}/P^*_t) + \log D^*_t + \xi^*_{Rt}$$
$$\log Y_{Ut} = \rho \log(P_{Ut}/P_t) + \log D_t + \xi_{Ut}$$
$$\log Y_{Rt} = \rho \log(P_{Rt}/P_t) + \log D_t + \xi_{Rt}$$

  - Y^*_{Rt} Exports to US, Y_{Ut} Imports from US, Y_{Rt} Domestic consumption in ROW
  - D^*_t Domestic expenditure in US, D_t in ROW
  - P^*_{Rt} Price of ROW goods in US, P_{Rt} in ROW
  - P_t Aggregate price index in US, P in ROW

Trade Costs in Data

- Using the CES Demand function

$$\log Y^*_{Rt} = \rho \log(P^*_{Rt}/P^*_t) + \log D^*_t + \xi^*_{Rt}$$
$$\log Y_{Ut} = \rho \log(P_{Ut}/P_t) + \log D_t + \xi_{Ut}$$
$$\log Y_{Rt} = \rho \log(P_{Rt}/P_t) + \log D_t + \xi_{Rt}$$

  - Y^*_{Rt} Exports to US, Y_{Ut} Imports from US, Y_{Rt} Domestic consumption in ROW
  - D^*_t Domestic expenditure in US, D_t in ROW
  - P^*_{Rt} Price of ROW goods in US, P_{Rt} in ROW
  - P_t Aggregate price index in US, P in ROW

- Recover the residuals $\xi^*_{Rt}, \xi_{Ut}, \xi_{Rt}$

Trade Costs in Data

- Using the CES Demand function

$$
\begin{aligned}
\log Y^*_{Rt} &= \rho \log(P^*_{Rt}/P^*_t) + \log D^*_t + \xi^*_{Rt} \\
\log Y_{Ut} &= \rho \log(P_{Ut}/P_t) + \log D_t + \xi_{Ut} \\
\log Y_{Rt} &= \rho \log(P_{Rt}/P_t) + \log D_t + \xi_{Rt}
\end{aligned}
$$

  - Y^*_{Rt} Exports to US, Y_{Ut} Imports from US, Y_{Rt} Domestic consumption in ROW
  - D^*_t Domestic expenditure in US, D_t in ROW
  - P^*_{Rt} Price of ROW goods in US, P_{Rt} in ROW
  - P_t Aggregate price index in US, P in ROW

- Recover the residuals $\xi^*_{Rt}, \xi_{Ut}, \xi_{Rt}$

- Data: Annual, 1994-2019
  - Exports, imports (UN Comtrade)
  - Output, domestic expenditure (Penn World Table)
  - Price levels (Penn World Table)

Model Specification of Trade Costs

- Recall $\xi_{Rt} = \tau\xi_t/2 \quad \xi^*_{Rt} = \xi_t/2 \quad \xi_{Ut} = -\xi_t/2$

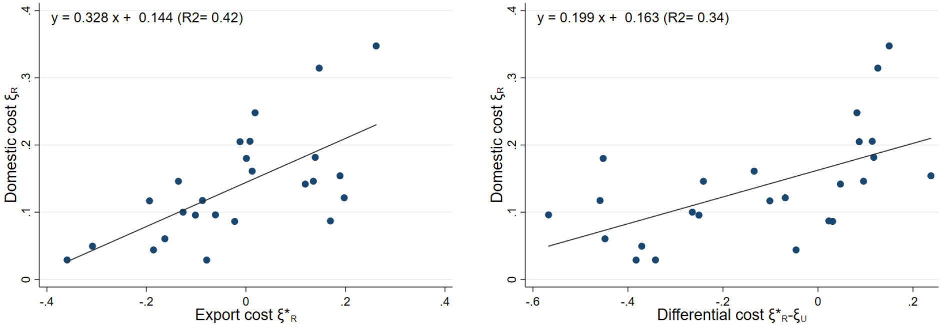
- Estimated $\tau > 0$, suggesting

$$\rho(\xi_{Rt},\ \xi^*_{Rt}) > 0 \qquad \rho(\xi_{Rt},\ \xi^*_{Rt} - \xi_{Ut}) > 0$$

  - International cost for ROW correlated with domestic cost

- Consistent with data?

Correlation of Domestic and International Costs



- Domestic cost positively correlated with international cost
- Robust to country fixed effects and constraints on expenditure coefficient ▸ Table

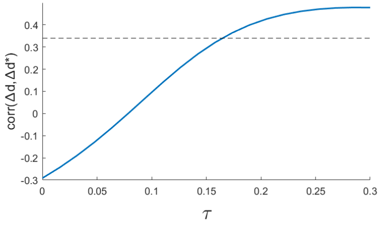
◂ T shock ◂ Robustness

Domestic Trade Cost

- $\tau \in \mathbb{R}$ determines the elasticity of domestic cost to international cost

$$\xi_{Rt} = \tau \xi_t / 2 \qquad \xi^*_{Rt} = \xi_t / 2 \qquad \xi_{Ut} = -\xi_t / 2$$

- Discipline with data on cross-country correlation of expenditure
  - If elastic, domestic costs move like international costs
  - Home and foreign consumers subject to similar shocks
  - Expenditures become more synchronized



- Similar mechanism as demand shocks with positive but small τ

D Shock

Conditional Variance Decomposition

Table: 1. Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h=1$	8	32	80
ξ: Trade Shock	65.33	74.50	86.66	90.81
ψ: Financial Shock	32.31	22.08	8.23	5.08
a: Productivity Shock	2.35	3.43	5.11	4.11

Spectrum

Business Cycle Moments

	Data	Baseline	No Trade Shock	No Fin Shock	No Prod Shock
$\sigma(\Delta c^*)/\sigma(\Delta y^*)$	0.83	0.65	0.68	0.62	1.74
$\rho(\Delta y^*, \Delta c^*)$	0.65	0.83	0.90	0.93	0.62
$\rho(\Delta y^*, \Delta z^*)$	0.68	0.86	0.98	0.88	0.60
$\rho(\Delta c, \Delta c^*)$	0.31	0.36	0.37	0.53	0.64
$\rho(\Delta inv, \Delta inv^*)$	0.31	0.39	0.46	0.42	0.07
$\rho(\Delta tot, \Delta q)$	0.49	0.98	1.00	1.00	0.97
$\sigma(\Delta tot)/\sigma(\Delta q)$	0.46	0.20	0.26	0.18	0.11

Disconnect

Short- and Long-Run Trade Elasticity

Elasticity	Data	Baseline	No Trade Shock	No Fin Shock
Short run	0.20 (0.05)	0.35 (0.02)	1.29	-0.72
Long run	1.16 (0.25)	0.80 (0.09)	1.78	0.32

Back

Robustness: Calibrated Parameters

Parameters	Baseline	Input Adj	Trade Elasticity	PTM	Kimball	$\tau = 0$
Financial shock, volatility $\sigma_\psi / \sigma_{a_c}$	0.57	0.86	0.65	0.30	0.62	1.50
Financial shock, persistence ρ_ψ	0.99	0.82	0.98	0.94	0.87	0.77
Trade shock, volatility $\sigma_\xi / \sigma_{a_c}$	17.01	3.34	3.58	38.35	14.10	10.84
Trade shock, persistence ρ_ξ	0.98	0.99	0.97	0.98	0.97	0.97
Trade shock, within-country share τ	0.17	0.17	0.56	0.07	0.12	$0^\ddagger$
Productivity differentials, volatility $\sigma_{a_d} / \sigma_{a_c}$	1.24	1.29	1.22	1.26	0.08	1.19
Adjustment cost of portfolios χ	0.06	7e-04	0.53	0.02	0.01	0.001
Adjustment cost of capital κ	1.59	14.47	3.75	11.97	10.28	14.01
Import adjustment cost ι	$0^\ddagger$	9.67	$0^\ddagger$	$0^\ddagger$	$0^\ddagger$	$0^\ddagger$
Armington elasticity ρ	$1.5^\ddagger$	$1.5^\ddagger$	2.57	$1.50^\ddagger$	$1.50^\ddagger$	$1.5^\ddagger$
Fixed cost of new exporters f_0	0.07	$0^\ddagger$	0.05	$0^\ddagger$	$0^\ddagger$	0.07
Fixed cost of incumbent exporters f_1	0.04	$0^\ddagger$	0.03	$0^\ddagger$	$0^\ddagger$	0.04
Volatility of idiosyncratic productivity σ_μ	0.08	$0^\ddagger$	0.02	$0^\ddagger$	$0^\ddagger$	0.08
Pricing to market parameter ζ	1.00	1.00	1.00	1.00	$0^\ddagger$	1.00
Kimball elasticity ν	-	-	-	-	0.40	-

Notes: Superscript ‡ denotes that the parameter is exogeneously set.

◂ DTM ◂ Trade Elasticity ◂ PTM ◂ Trade Costs

Robustness: Moments

Moments	Data	Baseline	Input Adj	Trade Elasticity	PTM	Kimball	$\tau = 0$
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.10	-0.11	-0.10	-0.03	-0.06	-0.14	0.14
$\rho\left(i - i^{*}\right)$	0.87	0.88	0.86	0.87	0.90	0.96	0.81
$\rho(\Delta y, \Delta y^{*})$	0.40	0.39	0.40	0.36	0.35	0.39	0.43
$\rho(\Delta d, \Delta d^{*})$	0.34	0.34	0.28	0.38	0.39	0.40	$0.00^{\dagger}$
$\rho(xm)$	0.98	0.93	0.96	0.93	0.94	0.98	0.93
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.60	2.59	2.60	2.60	2.64	2.62
$\rho\left(\Delta xm, \Delta q\right)$	0.30	0.29	0.30	0.31	0.32	0.27	0.49
$\sigma(xm)/\sigma(q)$	1.12	1.12	1.12	1.14	1.13	1.12	1.14
ρ_{SR}	0.20	$0.35^{\dagger}$	0.17	0.19	$0.59^{\dagger}$	$0.34^{\dagger}$	$0.89^{\dagger}$
ρ_{LR}	1.16	$0.80^{\dagger}$	$1.14^{\dagger}$	1.13	$0.55^{\dagger}$	$0.59^{\dagger}$	$1.36^{\dagger}$
High frequency share	0.02	$0.03^{\dagger}$	$0.06^{\dagger}$	$0.07^{\dagger}$	$0.02^{\dagger}$	$0.02^{\dagger}$	$0.04^{\dagger}$
BC frequency share	0.15	$0.10^{\dagger}$	$0.12^{\dagger}$	$0.16^{\dagger}$	$0.04^{\dagger}$	$0.01^{\dagger}$	$0.06^{\dagger}$
Low frequency share	0.83	$0.87^{\dagger}$	$0.82^{\dagger}$	$0.77^{\dagger}$	$0.94^{\dagger}$	$0.97^{\dagger}$	$0.90^{\dagger}$

Notes: Superscript † denotes that the moment is not targeted during the calibration procedure.

◂ DTM ◂ Trade Elasticity ◂ PTM ◂ Trade Costs

Dynamic Trade Specification

- Adjustment costs in the use of imported inputs in the final good aggregator
  - Erceg et al. (2006), Rabanal and Rubio-Ramirez (2015), Gornemann et al. (2020)
- The CES aggregator of the ROW retail sector is now given by

$$D_t = \left[Y_{Rt}^{\frac{\rho-1}{\rho}} + \gamma^{\frac{1}{\rho}} \left(\varphi_t Y_{Ut} \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

where φ_t captures the cost of adjusting the the use of imported inputs in the production of the final good. Its functional form is given by

$$\varphi_t = \left[1 - \frac{\iota}{2} \left(\frac{Y_{Ut}/Y_{Rt}}{Y_{Ut-1}/Y_{Rt-1}} - 1 \right)^2 \right].$$

ι determines the size of the adjustment cost

Table: Frequency Decomposition – Dynamic Trade Specifications

	Data	Baseline	Reduced-Form Dynamic Trade			
			All Shocks	No Trade Shock	No Fin Shock	No Prod Shock
Low frequency	0.83	0.87	0.82	0.68	0.97	0.80
BC frequency	0.15	0.10	0.12	0.21	0.02	0.13
High frequency	0.02	0.03	0.06	0.11	0.01	0.07

◂ Back

Trade Elasticity (Targeted)

Moments	Data	Baseline	Trade Elasticity
$\rho\,(\Delta c - \Delta c^{*}, \Delta q)$	-0.1	-0.11	-0.03
$\rho\,(i - i^{*})$	0.87	0.88	0.87
$\rho(\Delta y, \Delta y^{*})$	0.4	0.39	0.36
$\rho(\Delta d, \Delta d^{*})$	0.34	0.34	0.38
$\rho(xm)$	0.98	0.93	0.93
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.60	2.6
$\rho\,(\Delta xm, \Delta q)$	0.3	0.29	0.31
$\sigma(xm)/\sigma(q)$	1.12	1.12	1.14
ρ_{SR}	0.2	$0.35^{\dagger}$	0.19
ρ_{LR}	1.16	$0.80^{\dagger}$	1.13
High frequency share	0.02	$0.03^{\dagger}$	$0.07^{\dagger}$
BC frequency share	0.15	$0.10^{\dagger}$	$0.16^{\dagger}$
Low frequency share	0.83	$0.87^{\dagger}$	$0.77^{\dagger}$

Bayesian Estimation

Table: 1. Contribution to $h-$Quarter ahead FEV of the RER (%)

	$h=1$	8	32	80
ξ: Trade Shock	65.33	74.50	86.66	90.81
ψ: Financial Shock	32.31	22.08	8.23	5.08
a: Productivity Shock	2.35	3.43	5.11	4.11

Counterfactual Back

Trade shocks

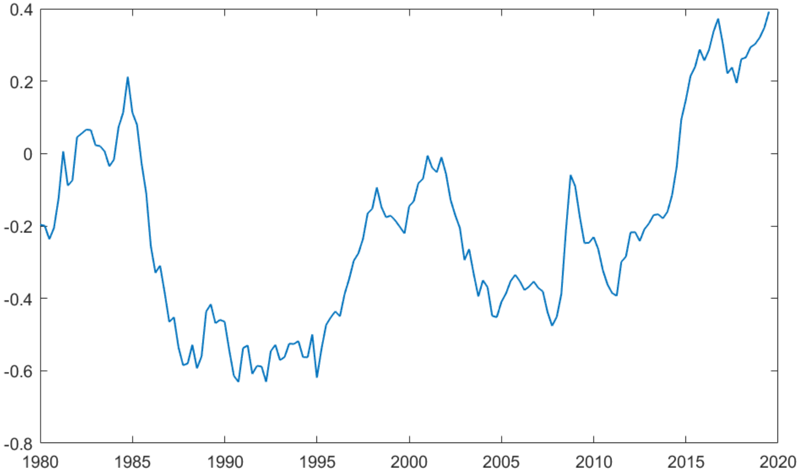


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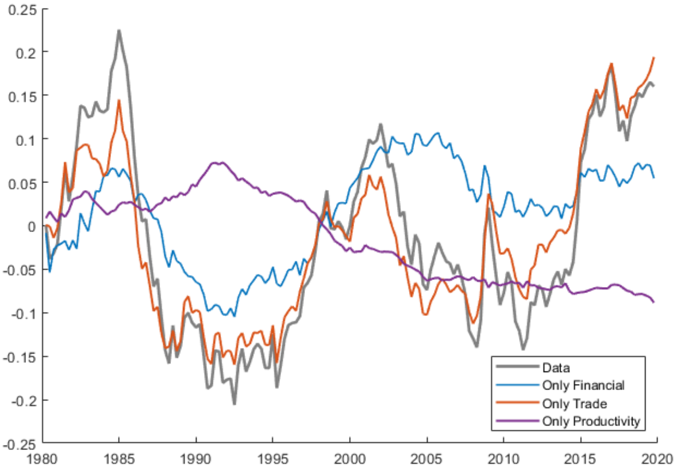
Figure: RER Dynamics Under Different Shocks



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Pricing-to-Market

- The Kimball aggregator for the final good production is given by

$$\int_0^1 \left[g\left(\frac{Y_{Rt}}{D_t}\right) + \gamma g\left(\frac{Y_{Rt}}{D_t}\right)\right] di = 1$$

where $g' > 0, g'' < 0, g''(1) = 0, 1, g(1) = g'(1) = 1$

- Demand function of ROW for the ROW and US composite goods are given by

$$Y_{Rt} = h\left(\frac{P_{Rt}}{P_t}\right) D_t \qquad Y_{Ut} = \gamma h\left(\frac{P_{Ut}}{P_t}\right) D_t.$$

where $h(\cdot) = g'^{-1}(\cdot)$ and satisfies $h(1) = 1, h' < 0$.

- Klenow and Willis (2016) demand schedule

$$h(x) = (1 - \epsilon log(x))^{\upsilon/\epsilon}$$

$\upsilon = 0.4$ and $\epsilon = 0.33$ implies the ER passthrough of 60%, as in our baseline case.

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Moments	Data	Static PTM	Static Kimball
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.1	-0.06	-0.14
$\rho\left(i - i^{*}\right)$	0.87	0.9	0.96
$\rho(\Delta y, \Delta y^{*})$	0.4	0.35	0.39
$\rho(\Delta d, \Delta d^{*})$	0.34	0.39	0.40
$\rho(xm)$	0.98	0.94	0.98
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.6	2.64
$\rho\left(\Delta xm, \Delta q\right)$	0.3	0.32	0.27
$\sigma(xm)/\sigma(q)$	1.12	1.13	1.12
ρ_{SR}	0.2	$0.59^{\dagger}$	$0.34^{\dagger}$
ρ_{LR}	1.16	$0.55^{\dagger}$	$0.59^{\dagger}$
High freq share	0.02	$0.02^{\dagger}$	$0.02^{\dagger}$
BC freq share	0.15	$0.04^{\dagger}$	$0.01^{\dagger}$
Low freq share	0.83	$0.94^{\dagger}$	$0.97^{\dagger}$

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Robustness: Within-ROW Trade Cost

Moments	Data	Baseline	$\tau = 0$
$\rho\left(\Delta c - \Delta c^{*}, \Delta q\right)$	-0.10	-0.11	0.14
$\rho\left(\Delta xm, \Delta q\right)$	0.30	0.29	0.14
$\sigma(xm)/\sigma(q)$	1.12	1.12	1.14
$\rho(xm)$	0.98	0.93	0.93
$\rho(\Delta y, \Delta y^{*})$	0.40	0.39	0.43
$\rho(\Delta d, \Delta d^{*})$	0.34	0.34	0.00*
$\sigma(\Delta inv^{*})/\sigma(\Delta y^{*})$	2.59	2.60	0.62
$\rho\left(i - i^{*}\right)$	0.90	0.88	0.81

T shock Robustness

Variance Decomposition with $\tau = 0$

	Data	Baseline	$\tau = 0$		
			All Shocks	No Trade Shock	No Financial Shock
Low frequency	0.83	0.87	0.90	0.61	0.97
BC frequency	0.15	0.10	0.06	0.24	0.02
High frequency	0.02	0.03	0.04	0.15	0.01

◂ T shock ◂ Robustness