

“Trade in the Global Recession” (EKNR)

and

“Obstfeld and Rogoff’s International Macro Puzzles:  
A Quantitative Assessment” (EKN)

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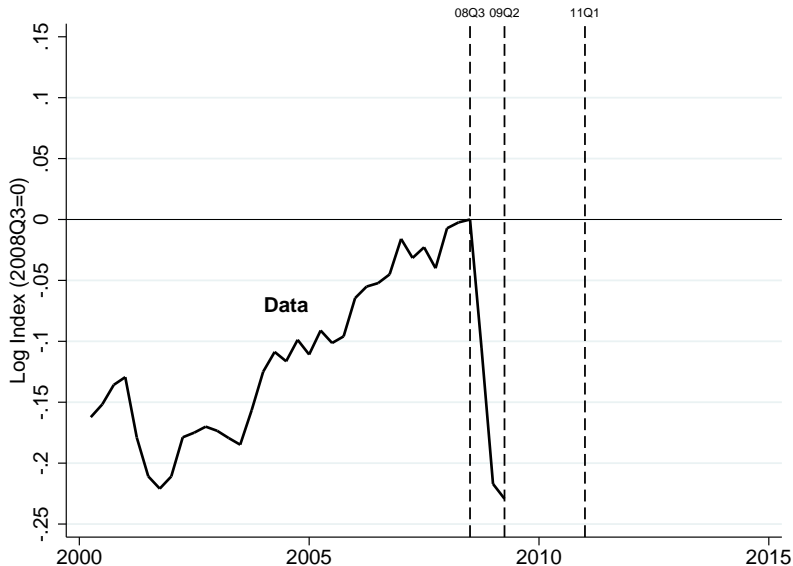
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# Introduction

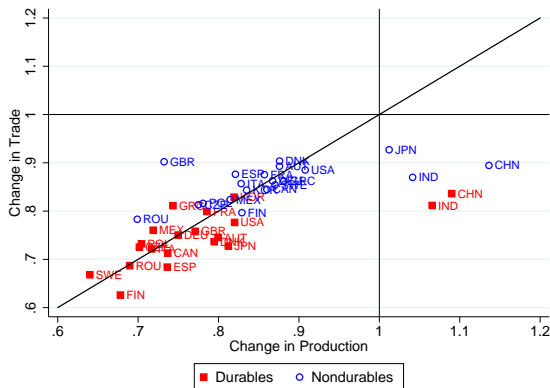
- International macro models typically have 2-countries without serious “geography”, limited I/O structure
- Trade models typically static, no capital and ignore the future
- Often, this is fine. But what if need dynamic and realistic representation of sector-country linkages?

## Application 1: "Trade and the Global Recession"

- Global Manufacturing Trade/GDP Dropped nearly 25%



# Application 1: “Trade and the Global Recession”



- Eichengreen (2009): “The collapse of trade has been absolutely terrifying ... we lack an adequate understanding of its causes.”
- Many single-country P.E. studies (theory and empirics)

## Application 2: OR (2001)'s 6 Puzzles

- Feldstein-Horioka (1980): Large and significant coefficient on regressions of investment on saving

	00-12	00-08	Data 09-12	Diff.
Saving	0.356** (0.146)	0.239 (0.150)	0.633*** (0.127)	0.866*** (0.197)
Observations	18	18	18	18
R-squared	0.31	0.16	0.62	0.61

- Obstfeld and Rogoff (2001) use 2-country stylized model to propose that trade frictions can explain this and other puzzles

## Application 2: OR (2001)'s 6 Puzzles

- **Charles Engel:**  
“... we need more study to be able to reconcile their compelling but simplified examples with the results that emerge from simulation of more fully specified dynamic models.”
- **John Leahy:**  
“... the effects ... might turn out to be quantitatively small in a realistically calibrated model.”

# What We Do

- Multi-country multi-sector dynamic GE framework for analyzing global fluctuations in GDP, production, and trade.
- Framework extracts shocks that fully “explain” data and can generate counterfactuals. Similar in spirit to CKM (2007).
- Use counterfactuals to understand drivers of trade/GDP and quantitatively evaluate O/R's hypothesis

## Related Literature

- **Trade Collapse:** Alessandria, Kaboski, and Midrigan (2010), Amiti and Weinstein (2011), Baldwin (2009), Bems, Johnson, and Yi (2013), Engel and Wang (2011), Levovici and Waugh (2012), Levchenko, Lewis, and Tesar (2010)
- **International Macro Puzzles:** Obstfeld and Rogoff (2001), Corsetti, Dedola, and Leduc (2008), Coeurdacier (2009), Fitzgerald (2012), Rabitsch (2012), Reyes-Heroles (2015)
- **Methodology:** Boileau (2002), Chari, Kehoe, McGrattan (2007), Deckle, Eaton, and Kortum (2008), Justiniano, Primiceri, and Tambalotti (2010), Kehoe, Ruhl, and Steinberg (2014), Caliendo and Parro (2014)



# Agenda

- Simplified Model
  - Less Sectors
  - No Intermediates
  - No I/O Heterogeneity
- Key Equations
- Change Formulation
- Backing Out Shocks
- Counterfactuals
- Applications / Results

# Simplified Economy: Technology and Preferences

- Multiple countries  $n = 1, \dots, \mathcal{N}$ .
- Good  $S$  (“Services”) is a CES bundle of varieties  $z \in [0, 1]$ .  
Nontraded and used for consumption.
- Good  $D$  (“Durables”) is a CES bundle of varieties  $z \in [0, 1]$ .  
Traded and used for investment.
- Country  $n$  may import durable variety from  $i$ , subject to  $d_{ni,t}$ .
- Complete markets, no uncertainty, perfect competition

## Simplified Economy: Technology and Preferences

- Production in country  $n$  of variety  $z$  in sector  $j \in \{D, S\}$ :

$$y_{n,t}^j(z) = a_{n,t}^j(z) B \left( L_{n,t}^j(z) \right)^{\beta^L} \left( K_{n,t}^j(z) \right)^{\beta^K}$$

- Efficiencies  $a_{n,t}^j(z)$  drawn from:

$$\Pr \left[ a_{n,t}^j(z) \leq a \right] = \exp \left( - \left( \frac{a}{\gamma A_{n,t}^j} \right)^{-\theta} \right)$$

- Factors of production are constrained by:

$$K_{n,t} = \int_0^1 K_{n,t}^D(z) dz + \int_0^1 K_{n,t}^S(z) dz$$

$$L_{n,t} = \int_0^1 L_{n,t}^D(z) dz + \int_0^1 L_{n,t}^S(z) dz$$

# Simplified Economy: Technology and Preferences

- Capital accumulation:

$$K_{n,t+1} = \chi_{n,t} \left( \frac{I_{n,t}}{K_{n,t}} \right)^\alpha K_{n,t} + (1 - \delta)K_{nt}$$

- Investment:

$$I_{n,t} = \left( \int_0^1 x_{n,t}^D(z)^{(\sigma-1)/\sigma} dz \right)^{\sigma/(\sigma-1)},$$

where  $x_{n,t}^D(z)$  is absorption in  $n$  of variety  $z$  of good  $D$ .

# Simplified Economy: Technology and Preferences

- Demand shocks allow for changes in relative spending:

$$U_n = \sum_{t=0}^{\infty} \rho^t \phi_{n,t} \ln C_{n,t}$$

- Consumption:

$$C_{n,t} = \left( \int_0^1 x_{n,t}^S(z)^{(\sigma-1)/\sigma} dz \right)^{\sigma/(\sigma-1)},$$

where  $x_{n,t}^S(z) = y_{n,t}^S(z)$  is absorption in  $n$  on vty  $z$  of good  $S$ .

# Simplified Economy: Planner's Problem

- We solve Planner's problem. Planner uses weights  $\omega_n$ .
- We impose a restriction so demand has no global component:

$$\sum_{n=1}^{\mathcal{N}} \omega_n \phi_{n,t} = 1$$

- We interpret shadow prices as competitive prices. For example, we replace  $\lambda_{n,t}^K$  with  $r_{n,t}$ .

▶ Planner's Lagrangian

# Simplified Economy: First Order Conditions

- Price of Consumption Good:

$$p_{n,t}^S = \frac{(w_{n,t})^{\beta^L} (r_{n,t})^{\beta^K}}{A_{n,t}^S}$$

- Capital Rental Rates:

$$r_{n,t} = p_{n,t}^j \beta^K \frac{y_{n,t}^j}{K_{n,t}^j}$$

- Labor Rental Rates:

$$w_{n,t} = p_{n,t}^j \beta^L \frac{y_{n,t}^j}{L_{n,t}^j}$$

# Simplified Economy: First Order Conditions

- Price of Investment Good:

$$p_{n,t}^D = \left[ \sum_{i=1}^{\mathcal{N}} \left( \frac{(w_{i,t})^{\beta^L} (r_{i,t})^{\beta^K} d_{ni,t}}{A_{i,t}^D} \right)^{-\theta} \right]^{-1/\theta}$$

- Bilateral Trade Shares:

$$\pi_{ni,t} = \left( \frac{(w_{i,t})^{\beta^L} (r_{i,t})^{\beta^K} d_{ni,t}}{p_{n,t}^D A_{i,t}^D} \right)^{-\theta}$$



# Simplified Economy: Consumption

- Consumption Spending and Production:

$$X_{n,t}^S = Y_{n,t}^S = p_{n,t}^S C_{n,t} = \omega_n \phi_{n,t}$$

- Numeraire is world consumption expenditure:

$$\sum_{n=1}^{\mathcal{N}} Y_{n,t}^S = \sum_{n=1}^{\mathcal{N}} X_{n,t}^S = \sum_{n=1}^{\mathcal{N}} p_{n,t}^S C_{n,t} = \sum_{n=1}^{\mathcal{N}} \omega_n \phi_{n,t} = 1$$

# Simplified Economy: Investment Euler

- Investment Euler ( $X_{n,t}^D = p_{n,t}^D I_{n,t}$ ):

$$\frac{p_{n,t}^D}{\alpha \chi_{n,t}} \left( \frac{X_{n,t}^D}{p_{n,t}^D K_{n,t}} \right)^{1-\alpha} = \rho r_{n,t+1} + \rho \frac{p_{n,t+1}^D}{\alpha \chi_{n,t+1}} \left( \frac{X_{n,t+1}^D}{p_{n,t+1}^D K_{n,t+1}} \right)^{1-\alpha} \times \left[ \chi_{n,t+1} (1-\alpha) \left( \frac{X_{n,t+1}^D}{p_{n,t+1}^D K_{n,t+1}} \right)^\alpha + (1-\delta) \right]$$

- Setting  $\alpha = 1$  and rearrange to get more standard form:

$$\frac{p_{n,t}^D}{\chi_{n,t}} = \rho \frac{\phi_{n,t+1}}{\phi_{n,t}} \frac{U'(C_{n,t+1})}{U'(C_{n,t})} \left[ \frac{p_{n,t+1}^D / \chi_{n,t+1}}{p_{n,t+1}^S / p_{n,t}^S} (1-\delta) + \frac{r_{n,t+1}}{p_{n,t+1}^S / p_{n,t}^S} \right]$$

# Simplified Economy: Production, GDP, Factor Payments

- Durable production  $Y_{n,t}^D$  must be globally absorbed  $X_{n,t}^D$ :

$$Y_{i,t}^D = \sum_{n=1}^{\mathcal{N}} \pi_{ni,t} X_{n,t}^D$$

- GDP:

$$Y_{n,t} = Y_{n,t}^D + Y_{n,t}^S$$

## Simplified Economy: System in Changes

- Now, imagine we have data on levels of GDP  $Y_{n,s}$ , Consumption  $Y_{n,s}^S$ , and trade shares  $\pi_{ni,s}$  at some  $s = t'$
- Assume the path of shocks  $\{\hat{\chi}_{n,s}, \hat{A}_{n,s}^D, \hat{L}_{n,s}, \hat{\phi}_{n,s}, \hat{d}_{ni,s}\}_{s=t'+1}^{s=\infty}$  in changes (i.e. where  $\hat{x}_{t+1} = x_{t+1}/x_t$ )
- With the vector  $\hat{K}_{n,t'+1}$ , we can iterate system forward. No need to know  $K_{n,t'}$  or  $\{\chi_{n,t'}, A_{n,t'}^D, L_{n,t'}, \phi_{n,t'}, d_{ni,t'}\}$
- 4 equations  $\times$  4 unknowns:  $\hat{Y}_{n,t+1}, \hat{Y}_{n,t+1}^S, \hat{\pi}_{n,t+1}, \hat{p}_{n,t+1}^D$ .

## Simplified Economy: System in Changes

- Combining Euler and Law of Motion for Capital:

$$\frac{1}{\rho} \frac{\hat{K}_{n,t+1}}{\hat{K}_{n,t+1} - (1 - \delta)} - \alpha \beta^K \frac{Y_{n,t} \hat{Y}_{n,t+1}}{X_{n,t}^D} = \hat{X}_{n,t+1}^D \left[ (1 - \alpha) + \frac{1}{\hat{\chi}_{n,t+1}} \left( \frac{\hat{K}_{n,t+1} \hat{\rho}_{n,t+1}^D}{\hat{X}_{n,t+1}^D} \right)^\alpha \frac{1 - \delta}{\hat{K}_{n,t+1} - (1 - \delta)} \right]$$

- Consumption (or non-traded Production):

$$\hat{X}_{n,t+1}^S = \hat{Y}_{n,t+1}^S = \hat{\phi}_{n,t+1}$$

# Simplified Economy: System in Changes

- Trade Prices:

$$\hat{p}_{n,t+1}^D = \left[ \sum_{i=1}^{\mathcal{N}} \pi_{ni,t} \left( \frac{\left( \frac{\hat{Y}_{i,t+1}}{\hat{L}_{i,t+1}} \right)^{\beta^L} \left( \frac{\hat{Y}_{i,t+1}}{\hat{K}_{i,t+1}} \right)^{\beta^K} \hat{d}_{ni,t+1}}{\hat{A}_{i,t+1}^D} \right)^{-\theta} \right]^{-1/\theta}$$

- Trade Shares:

$$\hat{\pi}_{ni,t+1} = \left( \frac{\left( \frac{\hat{Y}_{i,t+1}}{\hat{L}_{i,t+1}} \right)^{\beta^L} \left( \frac{\hat{Y}_{i,t+1}}{\hat{K}_{i,t+1}} \right)^{\beta^K} \hat{d}_{ni,t+1}}{\hat{p}_{n,t+1}^D \hat{A}_{i,t+1}^D} \right)^{-\theta}$$

# Simplified Economy: System in Changes

- So, given:
  - ① Data on  $Y_{n,t^l}$ , Consumption  $Y_{n,t^l}^S$ , and trade shares  $\pi_{ni,t^l}$ ,
  - ② Assumed shock values in changes, and
  - ③ A guess of  $\hat{K}_{n,t^l+1}$ ,

we get  $\{\hat{Y}_{n,t^l+1}, \hat{Y}_{n,t^l+1}^S, \hat{\pi}_{ni,t^l+1}\}$  and generate  $t^l + 1$  levels.

- We update capital growth with:

$$\hat{K}_{n,t^l+2} - (1-\delta) = \hat{\chi}_{n,t^l+1} \left( \frac{\hat{X}_{n,t^l+1}^D}{\hat{p}_{n,t^l+1}^D \hat{K}_{n,t^l+1}} \right)^\alpha \left[ \hat{K}_{n,t^l+1} - (1-\delta) \right]$$

- Repeat for the change from  $t^l + 1$  to  $t^l + 2$  and march forward

# Simplified Economy: Backing Out Shocks

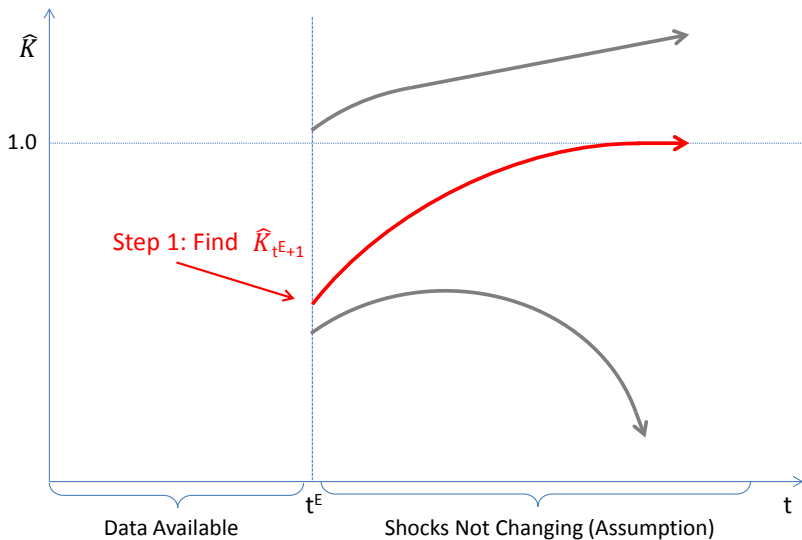
- Where do shocks and capital (in changes) come from?
- **Step 1:** Imagine all shocks stop changing after  $t^E$ , i.e.  $\{\hat{\chi}_s, \hat{A}_s^D, \hat{L}_s, \hat{\phi}_{n,s}, \hat{d}_{ni,s}\} = \{1, 1, 1, 1, 1\}$  for  $s > t^E$

We solve for the vector  $\hat{K}_{n,t^E+1}$  which – together with data on  $Y_{n,t^E}, Y_{n,t^E}^S, \pi_{ni,t^E}$  – leads to a steady state with:

$$\hat{K}_n = \hat{Y}_n = \hat{Y}_n^S = \hat{\pi}_{ni} = 1$$



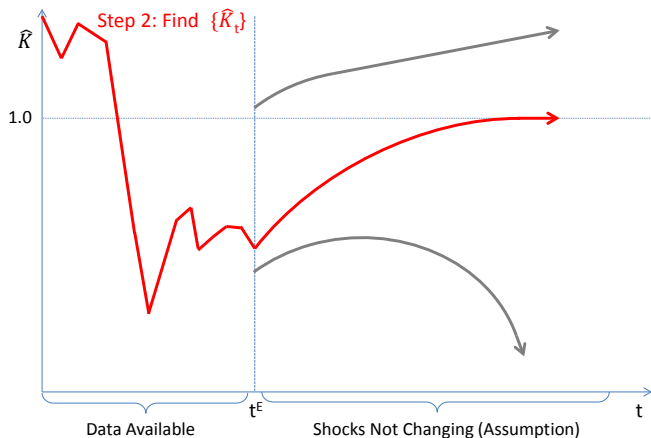
# Simplified Economy: Backing Out Shocks



## Simplified Economy: Backing Out Shocks

- Step 2:** Iterate backwards by substituting LOM for  $K$  into Euler ( $\chi$  cancels!) to get  $\hat{K}_{s+1}$  for  $s < t^E$ :

$$\frac{\hat{K}_{i,t}}{\hat{K}_{i,t} - (1 - \delta)} = \rho \beta^K \alpha \frac{Y_{i,t-1} \hat{Y}_{i,t}}{X_{i,t-1}^D} + \rho \hat{X}_{i,t}^D \left( (1 - \alpha) + \frac{1 - \delta}{\hat{K}_{i,t+1} - (1 - \delta)} \right)$$



# Simplified Economy: Backing Out Shocks

- **Step 3:** Given paths of  $\hat{K}_{n,t+1}$ ,  $\hat{Y}_{n,t+1}$ ,  $\hat{Y}_{n,t+1}^S$ ,  $\hat{p}_{n,t+1}^D$ , and  $\hat{\pi}_{ni,t+1}$ , can back out five shocks to fit data

① Labor Shocks  $\hat{L}_{n,t+1}$  from the data

② Demand Shocks from consumption spending growth:

$$\hat{\phi}_{n,t+1} = \hat{X}_{n,t+1}^C = \hat{Y}_{n,t+1}^C$$

③ Productivity Shocks from the Dual:

$$\hat{A}_{n,t+1}^D = \frac{\left(\frac{\hat{Y}_{n,t+1}}{\hat{L}_{n,t+1}}\right)^{\beta^L} \left(\frac{\hat{Y}_{n,t+1}}{\hat{K}_{n,t+1}}\right)^{\beta^K}}{\hat{p}_{n,t+1}^D} (\hat{\pi}_{nn,t+1})^{1/\theta}$$

## Simplified Economy: Backing Out Shocks

- **Step 3 Cont'd:** Given paths of  $\hat{K}_{n,t+1}$ ,  $\hat{Y}_{n,t+1}$ ,  $\hat{Y}_{n,t+1}^S$ ,  $\hat{\rho}_{n,t+1}^D$ , and  $\hat{\pi}_{ni,t+1}$ , can back out all other shocks to fit data

- 4 We back out trade frictions as:

$$\hat{d}_{ni,t+1} = \left( \frac{\hat{\pi}_{ni,t+1}}{\hat{\pi}_{ij,t+1}} \right)^{-1/\theta} \frac{\hat{\rho}_{n,t+1}^D}{\hat{\rho}_{i,t+1}^D}$$

- 5 We can then back out investment efficiencies as:

$$\hat{\chi}_{n,t+1} = \frac{\hat{K}_{n,t+2} - (1 - \delta) \hat{K}_{n,t+1}}{\hat{K}_{n,t+1} - (1 - \delta) \hat{K}_{n,t}} \left( \frac{\hat{X}_{n,t+1}^D}{\hat{\rho}_{n,t+1}^D \hat{K}_{n,t+1}} \right)^{-\alpha},$$

- Note: we don't need  $\chi_{n,t}$ ,  $A_{n,t}^D$ ,  $L_{n,t}$ ,  $\phi_{n,t}$ ,  $d_{ni,t}$ , or  $K_{n,t}$ .

## Simplified Economy: Counterfactuals

- Can analyze shocks on their own, can also run counterfactuals
- Some period, expectations about the future change
- We solve system forward from pre-shock initial conditions  $\{Y_{n,t}, Y_{n,t}^S, \pi_{ni,t}, \hat{K}_{n,t+1}\}$  but along new shock path
- 3 of the 4 equations of the system in changes apply.
- But investment  $\hat{I}_{n,t+1}$  must transition to new perfect foresight path, so Euler (4th equation) doesn't hold that quarter
- We solve this by guessing investment spending, iterating forward, and seeing if converge to SS. If not, new guess...

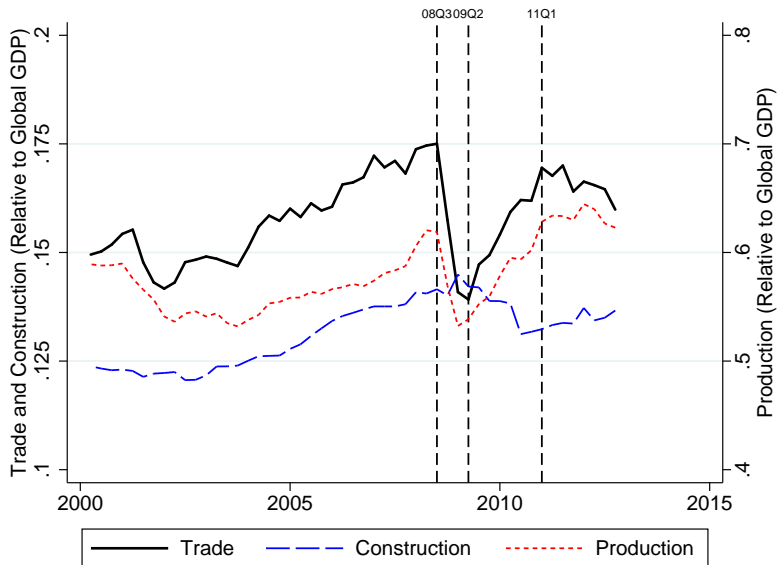
# Non-Simplified Model Used in Applications

- 1  $\mathcal{N} = 19$  or 21, four sectors  $j \in \Omega = \{C, D, N, S\}$
- 2 Output from sectors  $C$  and  $D$  accumulate into capital stocks
- 3 Output from sectors  $N$  and  $S$  can be consumed
- 4 Sectors  $D$  and  $N$  are tradable, sectors  $C$  and  $S$  are not
- 5 Production combines factors  $K^C$ ,  $K^D$ , and  $L$  with intermediates from  $j \in \Omega$
- 6 Input shares are country-sector specific:  $\beta_i^{K,jk}$ ,  $\beta_i^{L,j}$ , and  $\beta_i^{M,jl}$
- 7 Feed in exogenous deficits in the  $S$  sector
- 8 Relative demand for  $N$  and  $S$  impacted by  $\psi_{n,t}^N$

# Today's Agenda

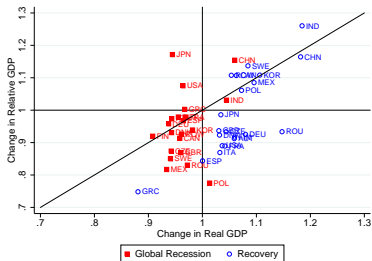
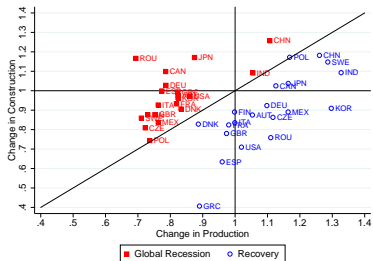
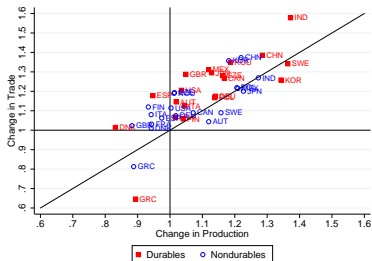
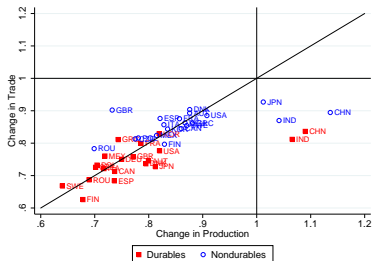
- Simplified Open-Economy Example
- **Application 1: Trade and the Global Recession**
- Application 2: Obstfeld and Rogoff's Int'l Macro Puzzles

# EKNR: "Trade and the Global Recession"





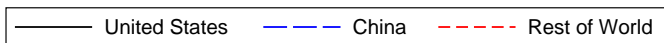
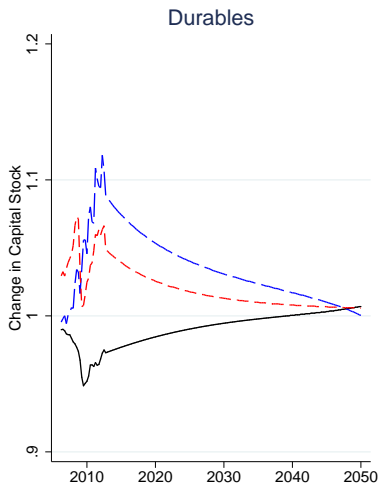
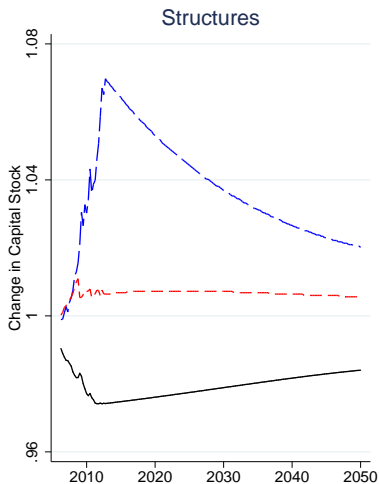
# EKNR: "Trade and the Global Recession"



# EKNR: “Trade and the Global Recession”

- We calibrate parameters and get I-O coefficients from OECD
- We use quarterly data in levels on:
  - ① Sectoral production  $Y_{n,t}^j$
  - ② Bilateral trade shares in each sector  $\pi_{ni,t}^j$
  - ③ Services deficits  $D_{n,t}^S$
- We use quarterly data in changes on:
  - ① Sectoral prices  $\hat{p}_{n,t}^j$
  - ② Growth in labor supply  $\hat{L}_{ni,t}^j$

# EKNR: Algorithm to Back Out Shocks



# EKNR: Backed-Out Shock Values

	$\hat{d}_i^D$			$\hat{d}_i^N$			$\Delta \frac{D_i^S}{V_i^F}$		
	Prior Period	Global Recession	Recov Period	Prior Period	Global Recession	Recov Period	Prior Period	Global Recession	Recov Period
<b>World</b>	<b>0.99</b>	<b>0.99</b>	<b>0.95</b>	<b>0.98</b>	<b>0.97</b>	<b>0.97</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
Canada	1.00	1.06	0.94	0.99	1.04	0.99	0.00	0.05	0.00
China	0.99	1.03	0.94	1.00	1.00	0.93	0.01	-0.02	0.03
France	1.02	0.97	0.98	0.99	0.97	0.98	0.00	-0.01	0.01
Germany	0.98	0.99	0.98	0.97	0.98	0.99	0.00	-0.03	0.00
India	0.96	1.10	0.94	0.96	1.04	0.97	0.00	-0.01	0.01
Italy	0.99	1.00	0.98	0.99	0.97	0.97	0.00	-0.02	0.00
Japan	1.02	0.93	0.95	0.97	1.00	1.00	0.00	-0.04	0.01
Mexico	0.98	0.94	0.88	0.99	0.96	0.99	0.00	0.01	0.00
United Kingdom	1.00	0.99	0.90	0.98	0.87	0.96	0.00	0.00	0.00
United States	0.99	1.00	0.94	0.98	0.98	0.98	0.00	-0.03	0.00
Rest of World	0.99	0.99	0.96	0.98	0.98	0.97	-0.01	0.06	-0.02

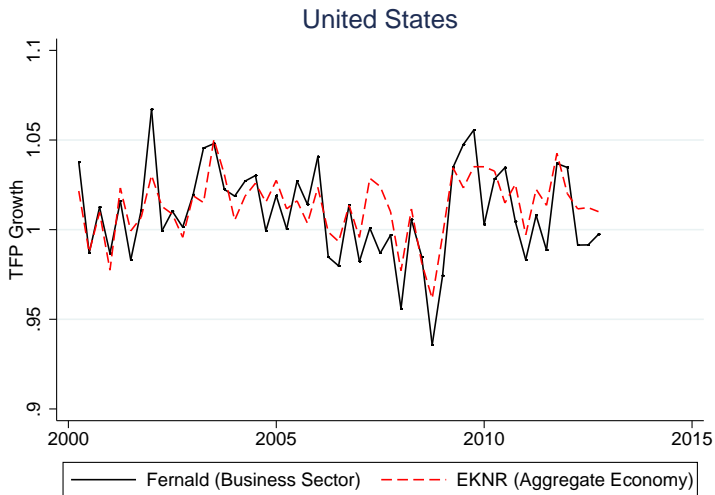
► Comparison to LLT

# EKNR: Backed-Out Shock Values

	$\hat{A}_i^C$			$\hat{A}_i^D$			$\hat{A}_i^N$		
	Prior Period	Global Recession	Recov Period	Prior Period	Global Recession	Recov Period	Prior Period	Global Recession	Recov Period
<b>World</b>	<b>1.00</b>	<b>0.92</b>	<b>1.05</b>	<b>1.02</b>	<b>1.02</b>	<b>1.02</b>	<b>1.01</b>	<b>1.03</b>	<b>1.02</b>
Canada	0.99	0.78	1.08	1.03	0.98	1.01	1.02	0.96	1.03
China	1.04	0.83	1.07	1.07	1.11	1.02	1.09	1.11	1.03
France	0.97	0.98	1.03	1.02	0.97	1.00	1.02	1.04	1.00
Germany	1.00	0.95	1.04	1.00	0.95	1.02	0.99	0.97	1.01
India	1.03	0.93	1.08	1.04	1.14	1.07	1.06	1.05	1.08
Italy	1.00	0.90	1.00	1.00	1.00	0.99	1.00	0.98	0.99
Japan	1.01	0.89	0.96	0.99	1.01	1.00	0.98	1.01	1.00
Mexico	1.02	0.96	1.05	1.01	0.92	0.94	1.03	0.93	1.04
United Kingdom	0.99	0.90	1.07	1.01	0.98	0.93	1.00	0.87	0.98
United States	0.99	0.98	1.04	1.01	1.02	1.00	0.99	1.18	0.96
Rest of World	1.00	0.90	1.06	1.03	0.97	1.05	1.03	0.96	1.05

# EKNR: Global Trade Counterfactuals

- Comparison of Domar-weighted Aggregate TFP



# EKNR: Backed-Out Shock Values

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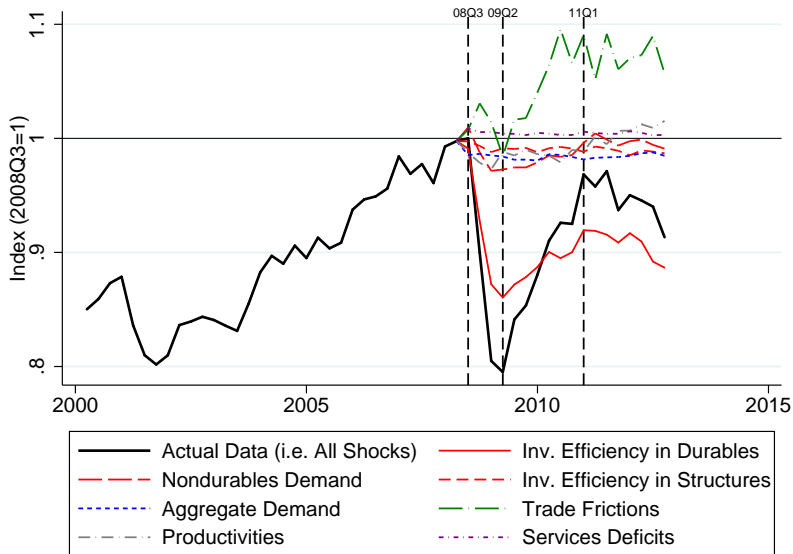
	$\hat{\chi}_i^C$			$\hat{\chi}_i^D$			$\hat{\phi}_i$		
	Prior	Global	Recov	Prior	Global	Recov	Prior	Global	Recov
	Period	Recession	Period	Period	Recession	Period	Period	Recession	Period
<b>World</b>	<b>1.01</b>	<b>0.98</b>	<b>0.98</b>	<b>0.99</b>	<b>0.77</b>	<b>1.08</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
Canada	1.04	1.10	1.01	0.95	0.69	1.07	1.03	0.89	1.08
China	1.08	1.24	1.05	1.04	1.04	1.10	1.13	1.16	1.09
France	1.06	0.90	0.93	1.00	0.72	1.02	1.01	0.94	0.96
Germany	0.98	0.97	0.95	1.01	0.74	1.04	0.99	0.96	0.95
India	1.03	1.03	1.04	1.03	0.85	1.11	1.03	0.93	1.18
Italy	1.03	0.94	0.94	1.01	0.63	1.06	1.01	1.01	0.93
Japan	0.93	1.23	1.05	0.96	0.88	1.03	0.93	1.25	1.00
Mexico	1.01	0.75	0.98	0.96	0.58	1.03	1.00	0.74	1.08
United Kingdom	1.02	0.85	0.87	0.98	0.75	1.00	0.98	0.74	0.93
United States	0.97	0.97	0.87	0.95	0.79	1.03	0.98	1.06	0.96
Rest of World	1.03	0.91	0.99	1.03	0.72	1.11	1.04	0.98	1.04

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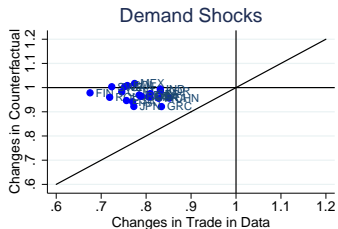
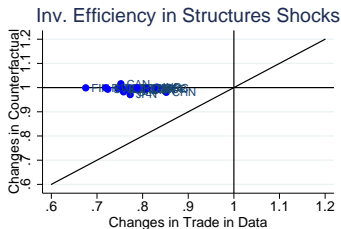
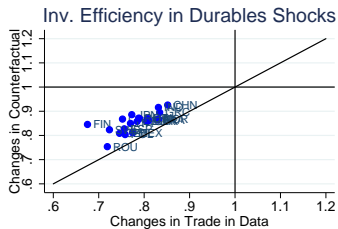
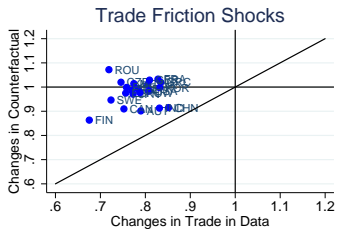
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# EKNR: Global Trade Counterfactuals

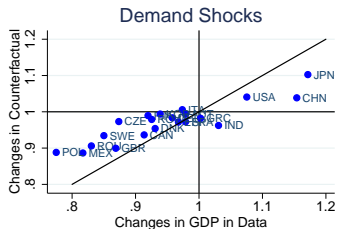
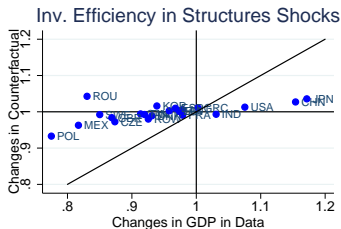
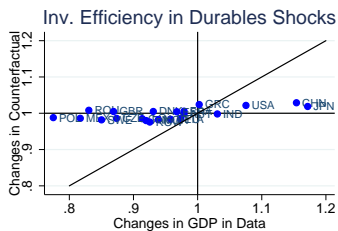
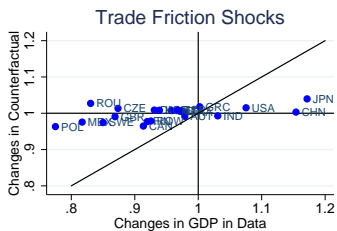




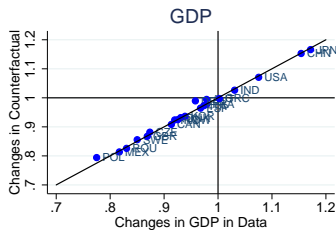
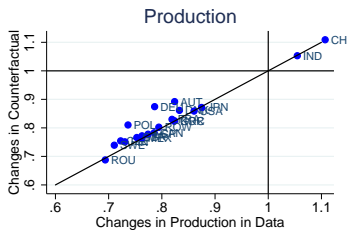
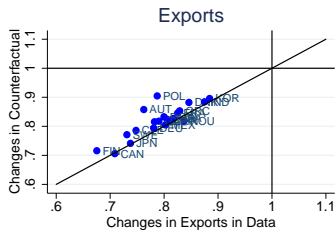
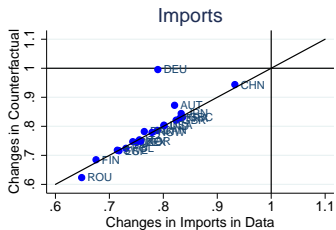
# EKNR: Country Trade Counterfactuals



# EKNR: Country GDP Counterfactuals



# EKNR: Impact of Non-DEU Shocks



## EKNR: Conclusions

- Decline in Trade during global recession primarily reflected change in spending composition away from tradables
- Shift in composition driven by durables investment shocks, not others (contemporaneous or future)
- Changes in relative nominal GDPs due to demand shocks
- Foreign shocks critical for some countries like DEU, domestic shocks matter most for others like USA
- Additional Uses for Framework: Impact of China slowdown? Recent global trade decline (See IMF WEO)?.

# Today's Agenda

- Simplified Closed-Economy Example
- Simplified Open-Economy Example
- Application 1: Trade and the Global Recession
- **Application 2: Obstfeld and Rogoff's Int'l Macro Puzzles**

# Introduction

- Obstfeld and Rogoff (Macro Annual 2001, “OR”) see international macro as replete with puzzles:
  - ① Home Bias in Absorption
  - ② Feldstein-Horioka Puzzle
  - ③ Home Bias in Equities
  - ④ Low Consumption Correlation
  - ⑤ Failure of Relative Purchasing Power Parity
  - ⑥ Exchange Rate Disconnect
- OR propose that all six can be accounted for by trade frictions
- Killing 6 birds with one stone! Plus, trade frictions are easier to measure than capital market imperfections
- OR’s story is provocative, but does it have quantitative bite?

# Generate World Without Trade Costs

- Remember we extract trade costs from data with:

$$\hat{d}_{ni,t+1}^j = \left( \frac{\pi_{ni,t+1}^j / \pi_{ni,t}^j}{\pi_{ii,t+1}^j / \pi_{ii,t}^j} \right)^{-1/\theta} \frac{p_{n,t+1}^j / p_{n,t}^j}{p_{i,t+1}^j / p_{i,t}^j}$$

- But trade cost reductions that hypothetically bring free trade would result in  $\pi_{ni,t+1}^j = \pi_{ii,t+1}^j$  and in  $p_{n,t+1}^j = p_{i,t+1}^j$
- So we can implement a counterfactual with:

$$\hat{d}_{ni,t+1}^{j,FT} = \left( \frac{\pi_{ii,t}^j}{\pi_{ni,t}^j} \right)^{-1/\theta} \frac{p_{i,t}^j}{p_{n,t}^j}$$

# Generate World Without Trade Costs

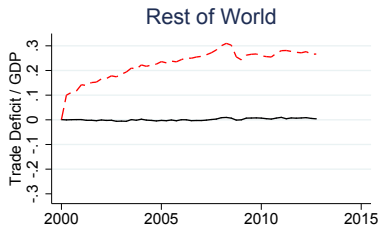
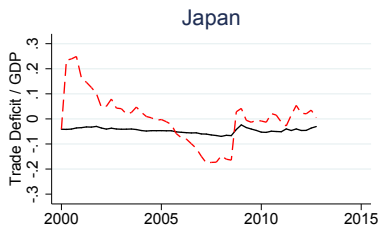
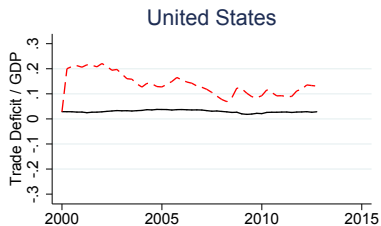
- We have data on  $\pi_{ni,t}$  as before
- We obtain  $(p_{i,t}^j/p_{n,t}^j)$  from the World Bank's ICP, using “Machinery and Equipment” for durables and “Food and beverages” and “Clothing and Footwear” for nondurables.
- We run counterfactuals from initial levels in 2000:Q1, where all shocks are taken from the data except that  $\hat{d}_{ni,t+1}^j = \hat{d}_{ni,t+1}^{j,FT}$  for 2000:Q2 and  $\hat{d}_{ni,t+1}^j = 1$  thereafter
- After transition, think of system as behaving as if it had no trade frictions but was otherwise identical



# Counterfactual World Trade



# Counterfactual Deficits



— Baseline    - - - Frictionless Trade

# Puzzle 1: Home Bias in Trade

## Ratio of Home Purchases to Imports in 2005:Q4

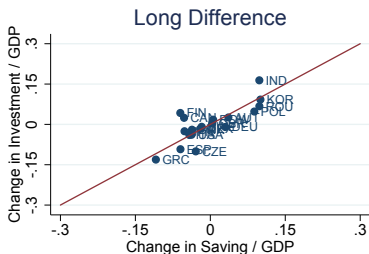
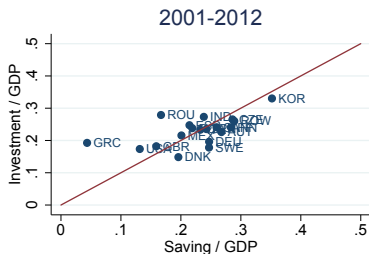
Country	Baseline		Frictionless Trade	
	Durables	Nondurables	Durables	Nondurables
Austria	0.30	0.50	0.02	0.02
Canada	0.75	1.99	0.05	0.04
Czech Republic	0.62	1.15	0.03	0.05
Denmark	0.17	0.42	0.01	0.01
Finland	1.19	2.14	0.03	0.02
Germany	1.16	1.37	0.07	0.05
Greece	1.12	1.84	0.02	0.02
India	3.24	8.00	0.06	0.12
Italy	2.42	3.14	0.07	0.07
Japan	6.39	6.50	0.13	0.06
Mexico	0.77	3.39	0.05	0.08
Poland	0.88	2.04	0.03	0.05
Romania	0.61	1.11	0.01	0.02
South Korea	3.30	4.56	0.14	0.06
Spain	1.50	2.56	0.06	0.06
Sweden	0.86	1.12	0.03	0.02
United Kingdom	0.63	1.67	0.04	0.04
United States	2.18	5.13	0.11	0.12
Rest of World	2.54	4.82	0.14	0.18

# Puzzle 1: Home Bias in Trade

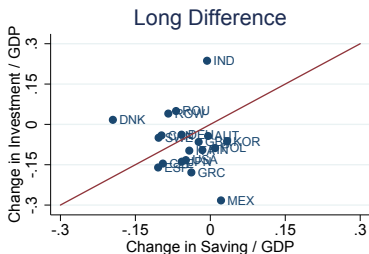
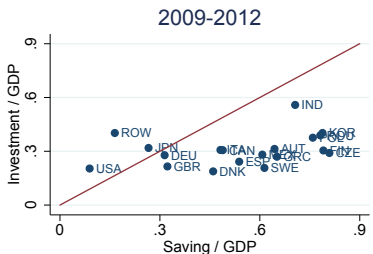
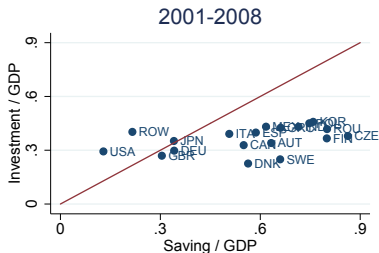
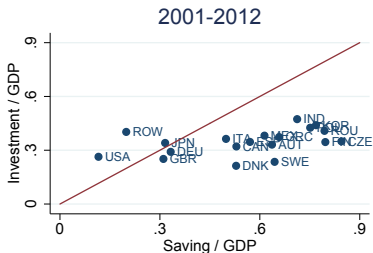
## Gravity Regressions in 2005:Q4

Country	Baseline		Frictionless Trade	
	Durables	Nondurables	Durables	Nondurables
Distance	-1.301*** (0.113)	-1.432*** (0.105)	0.000 (0.000)	0.000 (0.000)
Contiguous	0.073 (0.200)	0.148 (0.210)	0.000 (0.000)	0.000 (0.000)
Common Language	0.508*** (0.163)	0.554*** (0.120)	0.000 (0.000)	0.000 (0.000)
Constant	-3.217*** (0.187)	-4.188*** (0.167)	0.000 (0.000)	0.000 (0.000)
Importer FE	YES	YES	YES	YES
Exporter FE	YES	YES	YES	YES
Observations	306	306	306	306
R-squared	0.93	0.92	1.00	1.00

## Puzzle 2: Feldstein-Horioka (Baseline)



# Puzzle 2: Feldstein-Horioka (Counterfactual)

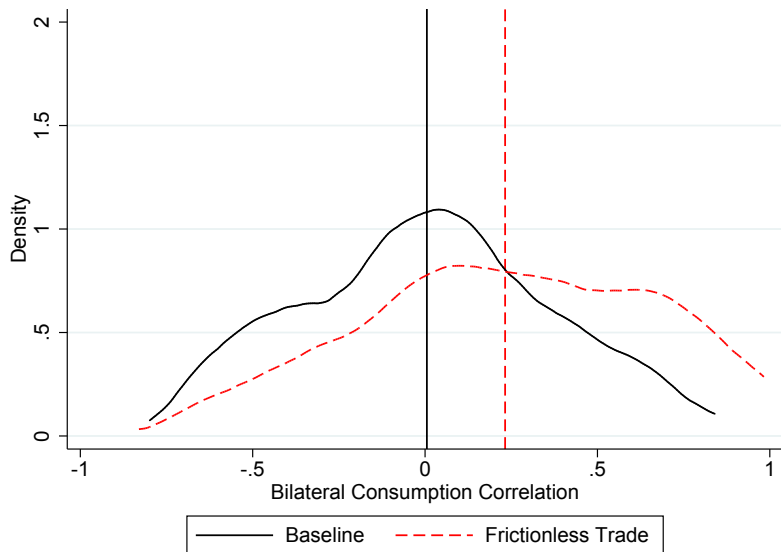


## Puzzle 2: Feldstein-Horioka

Dependent Variable: Investment

	Baseline				Frictionless Trade			
	2001-12	2001-08	2009-12	Long Difference	2001-12	2001-08	2009-12	Long Difference
Saving	0.378** (0.134)	0.254* (0.142)	0.630*** (0.120)	0.881*** (0.179)	0.146** (0.068)	0.148** (0.058)	0.141 (0.092)	-0.292 (0.441)
Constant	0.144*** (0.032)	0.174*** (0.034)	0.0852*** (0.028)	0.003 (0.010)	0.263*** (0.041)	0.280*** (0.036)	0.232*** (0.053)	-0.0822* (0.042)
Observations	19	19	19	19	19	19	19	19
R-squared	0.34	0.18	0.63	0.63	0.20	0.20	0.12	0.02

## Puzzle 4: Low International Consumption Correlations





## Puzzle 4: Low International Consumption Correlations

### Moments of Distribution of Bilateral Pairs

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	Quarterly		Annual	
	Baseline	Frictionless Trade	Baseline	Frictionless Trade
Mean	0.03	0.10	0.01	0.24
Median	0.04	0.10	0.01	0.23
Maximum	0.45	0.74	0.84	0.98
Minimum	-0.55	-0.45	-0.80	-0.83

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## Puzzle 5: Relative Purchasing Power Parity

### Standard Deviation of Inflation Across Countries

	Quarterly		Annual	
	Baseline	Frictionless Trade	Baseline	Frictionless Trade
Construction	0.177	0.147	0.073	0.049
Durables	0.095	0.000	0.048	0.000
Nondurables	0.100	0.000	0.051	0.000
Services	0.124	0.088	0.063	0.039
<b>CPI</b>	<b>0.114</b>	<b>0.060</b>	<b>0.059</b>	<b>0.030</b>

# Puzzle 6: Exchange Rate Disconnect

## Variation in Nominal GDP, Real GDP, Real Exchange Rate

	Quarterly						Annual					
	Baseline			Frictionless Trade			Baseline			Frictionless Trade		
	Nominal GDP	Real GDP	RER	Nominal GDP	Real GDP	RER	Nominal GDP	Real GDP	RER	Nominal GDP	Real GDP	RER
Austria	0.066	0.026	0.066	0.095	0.044	0.056	0.031	0.008	0.031	0.028	0.014	0.015
Canada	0.109	0.021	0.107	0.077	0.028	0.062	0.046	0.011	0.044	0.026	0.015	0.021
Czech Republic	0.102	0.020	0.100	0.117	0.073	0.050	0.062	0.014	0.057	0.043	0.028	0.018
Denmark	0.068	0.031	0.059	0.163	0.060	0.112	0.025	0.007	0.029	0.047	0.019	0.033
Finland	0.057	0.037	0.068	0.052	0.039	0.033	0.032	0.016	0.033	0.018	0.017	0.011
Germany	0.057	0.024	0.064	0.045	0.023	0.040	0.029	0.017	0.036	0.024	0.013	0.023
Greece	0.119	0.060	0.097	0.081	0.063	0.055	0.079	0.046	0.042	0.032	0.045	0.020
India	0.120	0.043	0.112	0.068	0.051	0.046	0.065	0.018	0.051	0.041	0.035	0.014
Italy	0.066	0.014	0.066	0.038	0.018	0.028	0.038	0.006	0.039	0.021	0.010	0.015
Japan	0.209	0.034	0.207	0.125	0.048	0.092	0.093	0.015	0.088	0.054	0.024	0.037
Mexico	0.164	0.027	0.164	0.082	0.029	0.062	0.084	0.016	0.072	0.034	0.016	0.022
Poland	0.152	0.031	0.167	0.070	0.031	0.063	0.070	0.018	0.076	0.033	0.022	0.026
Romania	0.179	0.066	0.170	0.104	0.067	0.085	0.095	0.032	0.075	0.052	0.043	0.019
South Korea	0.147	0.032	0.133	0.072	0.038	0.044	0.085	0.016	0.081	0.041	0.019	0.025
Spain	0.075	0.020	0.064	0.045	0.028	0.020	0.052	0.013	0.042	0.031	0.021	0.012
Sweden	0.086	0.028	0.079	0.061	0.032	0.039	0.049	0.012	0.041	0.032	0.019	0.015
United Kingdom	0.091	0.020	0.090	0.086	0.031	0.065	0.053	0.010	0.049	0.045	0.019	0.030
United States	0.153	0.020	0.147	0.119	0.033	0.096	0.067	0.012	0.060	0.053	0.020	0.040
Rest of World	0.050	0.007	0.050	0.048	0.019	0.040	0.030	0.003	0.029	0.025	0.009	0.019
<b>Pooled</b>	<b>0.120</b>	<b>0.042</b>	<b>0.115</b>	<b>0.089</b>	<b>0.051</b>	<b>0.065</b>	<b>0.064</b>	<b>0.033</b>	<b>0.056</b>	<b>0.042</b>	<b>0.037</b>	<b>0.030</b>

# Puzzle 6: Exchange Rate Disconnect

Dependent Variable: Log Change in Real GDP

	Quarterly				Annual			
	Baseline		Frictionless Trade		Baseline		Frictionless Trade	
Log Change in Nominal GDP	0.099*** (0.019)	0.064*** (0.017)	0.401*** (0.024)	0.369*** (0.021)	0.257*** (0.045)	0.146*** (0.027)	0.627*** (0.062)	0.505*** (0.041)
Constant	0.019* (0.006)	0.007 (0.008)	0.142*** (0.007)	0.138*** (0.007)	0.019*** (0.007)	0.013*** (0.004)	0.108*** (0.005)	0.100*** (0.003)
Country FE	NO	YES	NO	YES	NO	YES	NO	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	209	209	209	209
R-squared	0.37	0.63	0.70	0.82	0.48	0.86	0.70	0.92

# EKN Conclusions

- Obstfeld and Rogoff's proposition has quantitative bite
- We knew we needed trade frictions to explain bilateral trade
- Eliminating trade frictions large enough to explain home bias and gravity goes far in open-economy macro puzzles

# Overall Conclusions

- Framework can be confronted with realistic data on many countries to back out country sector quarter specific shocks.
  
- Many obvious additional applications:
  - Impact of China crash?
  - Monetary policy transmission?
  - Relevance of invoicing currency?
  - Imbalances within Eurozone?
  
- Next steps for model include incorporating:
  - Uncertainty
  - Imperfect Competition
  - Nominal Rigidities
  - Financial Market Frictions

# Extra Slides

## Simplified Economy: Planner's Problem

$$\begin{aligned}\mathcal{L} &= \sum_{n=1}^{\mathcal{N}} \sum_{t=0}^{\infty} \rho^t \omega_n \phi_{n,t} \ln C_{n,t} \\ &+ \rho^t \lambda_{n,t}^L \left[ L_{n,t} - \sum_{j \in \Omega} \int_0^1 L_{n,t}^j(z) dz \right] \\ &+ \rho^t \lambda_{n,t}^K \left[ K_{n,t} - \sum_{j \in \Omega} \int_0^1 K_{n,t}^j(z) dz \right] \\ &+ \rho^t \sum_{j \in \Omega} \int_0^1 \lambda_{n,t}^j(z) \left[ a_{n,t}^j(z) B \left( L_{n,t}^j(z) \right)^{\beta^L} \left( K_{n,t}^j(z) \right)^{\beta^K} - y_{n,t}^j(z) \right] \\ &+ \dots\end{aligned}$$



# Simplified Economy: Planner's Problem

...

$$\begin{aligned} & + \rho^t \lambda_{n,t}^S \left[ \left( \int_0^1 y_{n,t}^S(z)^{(\sigma-1)/\sigma} dz \right)^{\sigma/(\sigma-1)} - C_{n,t} \right] \\ & + \rho^t \lambda_{n,t}^D \left[ \left( \int_0^1 x_{n,t}^D(z)^{(\sigma-1)/\sigma} dz \right)^{\sigma/(\sigma-1)} - I_{n,t} \right] \\ & + \rho^t \int_0^1 \hat{\lambda}_{n,t}^D(z) \left[ y_{n,t}^D(z) - \sum_{m=1}^{\mathcal{N}} d_{mn,t} x_{mn,t}^D(z) \right] dz \\ & + \rho^t \int_0^1 \tilde{\lambda}_{n,t}^D(z) \left[ \sum_{i=1}^{\mathcal{N}} x_{ni,t}^D(z) - x_{n,t}^D(z) \right] dz \\ & + \rho^t \lambda_{n,t}^V \left[ \chi_{n,t} (I_{n,t})^\alpha (K_{n,t})^{1-\alpha} + (1-\delta)K_{n,t} - K_{n,t+1} \right], \end{aligned}$$

plus non-negativity and transversality [▶ Back](#)

# Simplified Economy: Consumption and Investment

- Investment Euler:

$$\frac{p_{n,t}^D}{\alpha \chi_{n,t}} \left( \frac{\chi_{n,t}^D}{p_{n,t}^D K_{n,t}} \right)^{1-\alpha} = \rho r_{n,t+1} + \rho \frac{p_{n,t+1}^D}{\alpha \chi_{n,t+1}} \left( \frac{\chi_{n,t+1}^D}{p_{n,t+1}^D K_{n,t+1}} \right)^{1-\alpha} \times \left[ \chi_{n,t+1} (1 - \alpha) \left( \frac{\chi_{n,t+1}^D}{p_{n,t+1}^D K_{n,t+1}} \right)^\alpha + (1 - \delta) \right]$$

- Divide the LHS by  $\omega_n = p_{n,t}^S C_{n,t} / \phi_{n,t}$  and the RHS by  $\omega_n = p_{n,t+1}^S C_{n,t+1} / \phi_{n,t+1}$ , and substitute  $\alpha = 1$  to get:

$$\frac{p_{n,t}^D}{\chi_{n,t}} = \rho \frac{\phi_{n,t+1}}{\phi_{n,t}} \frac{U'(C_{n,t+1})}{U'(C_{n,t})} \left[ \frac{p_{n,t+1}^D / \chi_{n,t+1}}{p_{n,t+1}^S / p_{n,t}^S} (1 - \delta) + \frac{r_{n,t+1}}{p_{n,t+1}^S / p_{n,t}^S} \right]$$

## EKNR (2015): Benefit of Multi-Sector, Multi-Country

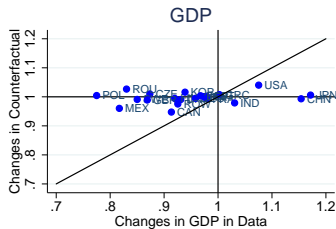
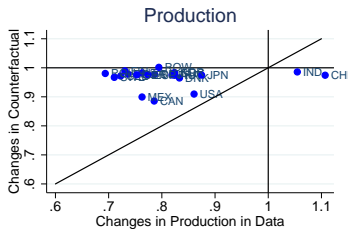
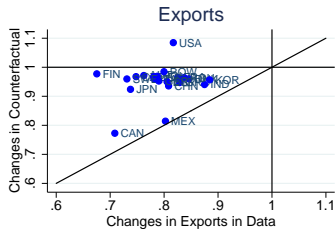
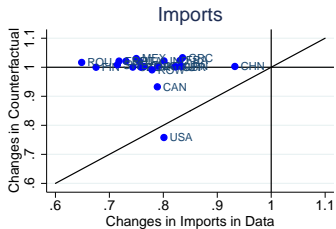
- Sector- and bilateral-specific wedges important for full story
- Compare our U.S. import demand wedge to LLT (2010):

$$\text{wedge} = \ln \hat{X}_{n,t+1}^M - \theta \left( \ln \frac{\hat{P}_{n,t+1}}{\hat{P}_{n,t+1}^M} \right) - \ln \hat{X}_{n,t+1}$$

	Overall, Non-Oil	Durables	Consumption
LLT	-0.401	-0.251	-0.019
	Manufacturing	Durables	Nondurables
EKNR	-0.561	-0.274	-0.011

- But LLT can only look at U.S. imports by sector. We find largely offsetting *positive* wedges elsewhere.

# EKNR (2015): Impact of Only U.S. Shocks



# EKNR (2015): Global Trade Counterfactuals

- Comparison of Domar-weighted Aggregate TFP



## EKNR (2015): Investment Efficiency vs. Productivity

- Large literature showing investment efficiency shocks matter for growth and fluctuations including Greenwood et al. (1997), Fisher (2006), Justiniano et al. (2010).
- Both  $\hat{\chi}^D$  and  $\hat{A}^D$  can reduce Trade/GDP, but have very different implications in open-economy
- As shown in Boileau (1999),  $\hat{\chi}^D$  shocks generate much greater output co-movement.
- Net export behavior differs too – negative  $\hat{\chi}^D$  generates countercycle trade balance, negative  $\hat{A}^D$  does opposite.
- What are these shocks? Won't shed light here, though promising for future work. Others, like Kondo and Papanikolaou (2015), microfound with financial frictions

## Some of the Challenges

- Recent trade models often written in “changes” to avoid need to calibrate bilateral trade frictions. Apply to macro side?
- Linearizing around SS may undesirable with 20+ countries with changing GDP shares, plus big shock
- Difficult to find high frequency data on durables vs. nondurables consumption, etc., for many countries