Long-Run Price Elasticity of Trade and the Trade-Comovement Puzzle

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Motivation

- Countries with closer trade ties have more synchronized business cycles
  - **Frankel and Rose (1998)**, Clark and van Wincoop (2001), Calderson Chong and Stein (2002), Otto, Voss and Willard (2001), Bordo and Helbling (2003), Baxter and Kouparitsas (2005), Kose and Yi (2006) Inklaar, Jong-A-Pin and de Haan (2008), diGiovanni and Levchenko (2010), Johnson (2014)

Table: Updated Frankel and Rose (1998) regression.

	Dependent Variable: GDP correlation ij		
	OLS	OLS bottom 50%	OLS top 50%
$trade_{ij}$	0.0323^{**}	-0.019	0.0532^{**}
	(0.0154)	(0.03)	(0.025)

10th to 90th percentile ⇒ corr up by .11, relative to median 0.52

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- Puzzle for IRBC theory (Kose and Yi, 2006)
  - productivity shocks, labor-leisure choice, some financial integration

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- Puzzle for IRBC theory (Kose and Yi, 2006)
  - productivity shocks, labor-leisure choice, some financial integration
- No compelling resolution to date (without changing shock structure)

This Paper

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- Analytically characterize the source of the puzzle in standard theory

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- Show puzzle attributed to counterfactual assumption: SRE=LRE
- Propose resolution of the puzzle: modeling of low SRE & high LRE
- Show it works quantitatively in an exercise a la Kose and Yi (2006)

Basic Idea

Δ Trade ——— Δ Co-movement

Basic Idea

Basic Idea

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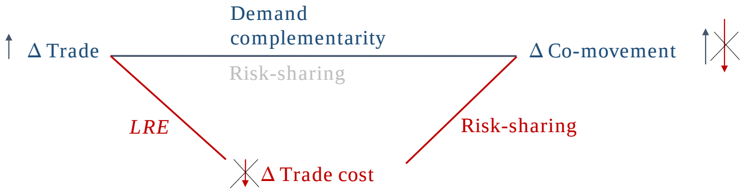
Basic Idea

Basic Idea


Δ Trade
Demand complementarity
Risk-sharing
Δ Co-movement
LRE
Risk-sharing
Δ Trade cost

Basic Idea



- Incomplete market setup close to implementing perfect risk-sharing

Basic Idea

- Incomplete market setup close to implementing perfect risk-sharing
- Terms of trade movements generate risk-sharing even under autarky

Roadmap

Roadmap

- Literature / contribution
- Theory: Puzzle and its resolution
  - analyze forces behind the puzzle and link them to modeling assumptions of standard theory
- Quantitative analysis
  - show modeling trade elasticity has quantitatively significant effects

Related Literature

1. Empirical relation between trade and business cycle comovement
   - Frankel and Rose (1998), Clark and van Wincoop (2001), Calderson Chong and Stein (2002), Otto, Voss and Willard (2001), Bordo and Helbling (2003), Baxter and Kouparitsas (2005), Kose and Yi (2006), Inklaar, Jong-A-Pin and de Haan (2008), diGiovanni and Levchenko (2010)
2. Trade-comovement puzzle and its resolution
   - Kose and Yi (2006) - trade-comovement puzzle
   - Liao and Santacrue (2015), Johnson (2014): TFP comovement correlated with trade, Johnson shows that given sectoral correlations it is insufficient to resolve the puzzle
   - de Soyres (2017), diGiovanni and Levchenko (2010): Trade-linkages that strengthen complementarity

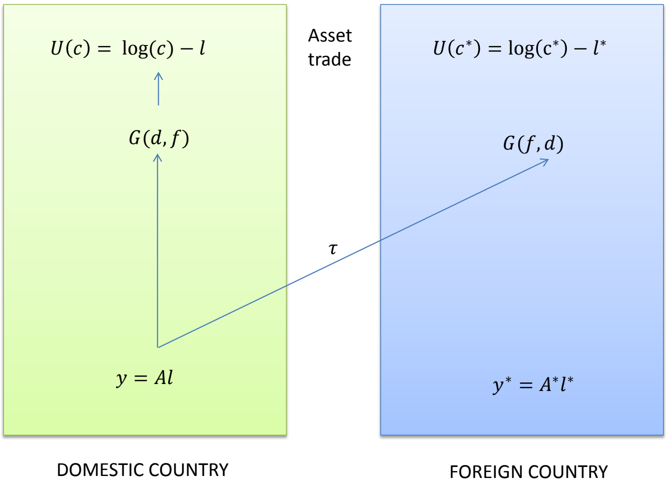
Theory

Mechanisms Underlying Trade-Comovement Puzzle

Setup

- Two symmetric countries (home/foreign)
- Country-specific goods: $G(d,f) = (\frac{1}{2}(d/2)^{\frac{\rho-1}{\rho}} + \frac{1}{2}(f/2)^{\frac{\rho-1}{\rho}})^{\frac{\rho}{\rho-1}}$
- Iceberg trade cost: $d + d^* + \tau d^* = y \quad f^* + f + \tau f = y^*$
- Quasi-linear labor-leisure choice: $u(d,f,l) = \log(G(d,f)) - l$
- Productivity shocks: $y = Al \quad y^* = A^* l^*$
- Complete markets

Setup


$U(c) = \log(c) - l$
$G(d, f)$
$y = Al$
Asset trade
τ
$U(c^*) = \log(c^*) - l^*$
$G(f, d)$
$y^* = A^* l^*$
DOMESTIC COUNTRY
FOREIGN COUNTRY

Household problem

- Representative household solves:

$$\sum_{t} \sum_{s^t} \beta^t \{u(d(s^t), f(s^t), l(s^t))\}$$

subject to

$$d(s^t) + p(s^t) f(s^t)(1+\tau) + \sum_{s^{t+1}} Q(s^{t+1}) B(s^{t+1}) = B(s^t) + w(s^t) l(s^t),$$

where good d is the numéraire (globally); s^t is history of shocks.

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- Foreign household budget constraint:

$$p(s^t)f^*(s^t)+d^*(s^t)(1+\tau)+\sum_{s^{t+1}} Q(s^{t+1})B^*(s^{t+1}) = B^*(s^t)+p(s^t)w^*(s^t)l^*(s^t).$$

Firm problem

- Wages given by marginal product:

$$w(s^t) = A(s^t)$$

$$w^*(s^t) = A^*(s^t)$$

Feasibility and Market Clearing

- Production and trade in goods

$$d(s^t) + d^* + \tau d^*(s^t) = y(s^t) = A(s^t)l(s^t)$$

$$f(s^t) + f^*(s^t) + \tau f^*(s^t) = y^*(s^t) = A^*(s^t)l^*(s^t)$$

- Asset trade

$$B(s^t) + B^*(s^t) = 0$$

- Competitive equilibrium defined as usual. Welfare theorems apply.

Measurement: Trade

- Steady-state level of trade

$$\bar{x} = \frac{\text{Imports}}{\text{GDP}} = \frac{\bar{p}\bar{f}(1+\tau)}{\bar{d} + \bar{p}\bar{f}(1+\tau)}$$

Measurement: Trade-Comovement Link

- Business-cycle comovement: spillover $\mathcal{S}$

$$\mathcal{S} = \frac{d \log y}{d \log A^*}$$

  - impact of foreign productivity on domestic GDP
  - monotonic with correlation
  - for one parameterization of the model

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- Trade-comovement link: $\mathcal{L}$

$$\mathcal{L} = \frac{\mathbf{d}\mathcal{S}}{\mathbf{d}\bar{\mathbf{x}}} = \frac{\mathbf{d}\mathcal{S}}{\mathbf{d}\tau} \frac{\mathbf{d}\tau(\bar{\mathbf{x}})}{\mathbf{d}\bar{\mathbf{x}}}$$

  - comparison across parameterizations of the model
  - if we change τ to induce different level of steady state trade $\bar{x}$, how does spillover change
  - we know that $\tau(\bar{x}) = (\frac{1}{\bar{x}} - 1)^{\frac{1}{\rho - 1}} - 1$.

Trade Elasticity

- Short-run trade elasticity (business cycle response to terms of trade p)

$$SRE = |\frac{d\log(d/f)}{d\log p}|$$

- Long-run trade elasticity (steady-state response to trade cost τ)

$$LRE = |\frac{d\log d/f}{d\log(1+\tau)}|$$

Lemma

$SRE = LRE.$

Assumptions

Assumption (*Gravity*)

$\rho > 1$ *so that* $d\tau(\bar{x})/d\bar{x} < 0$.

Assumption (*Home-bias*)

$0 \leq \bar{x} < 1/2$.

Mechanisms Underlying Trade-Comovement Puzzle

Proposition

To a first order approximation, $\mathcal{L} < 0$.

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- Model's dynamics around SS can be represented as follows:

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\hat{y}(s^t) &= \alpha\hat{A} + \eta\hat{p}(s^t) + \chi R(s^t) \\
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where

$$R(s^t) = B(s^t) - \sum_{s^{t+1}|s^t} Q(s^{t+1})B(s^{t+1}) + (1 - p(s^t))(1 + \tau(\bar{x}))f(s^t)$$

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where

$$\begin{aligned} d + f(1 + \tau(\bar{x})) &= wl + R \\ d^*(1 + \tau(\bar{x})) + f^* &= w^* l^* - R \end{aligned}$$

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$$

where

$$
\frac{\partial u(d(s^t), f(s^t), l(s^t))}{\partial d(s^t)}(1+\tau(\bar{x})) = \frac{\partial u(f^*(s^t), d^*(s^t), l^*(s^t))}{\partial d^*(s^t)}
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where

$$
\frac{1}{c(s^t)} G_d(s^t)(1 + \tau(\bar{x})) = \frac{1}{c^*(s^t)} G_d^*(s^t)
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where

$$w(s^t)(1+\tau(\bar{x})) = (1+\tau(\bar{x}))p(s^t)w^*(s^t))$$

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where

$$p(s^t) = \frac{w(s^t)}{w^*(s^t)} = \frac{A(s^t)}{A^*(s^t)}$$

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(risk-sharing)

where

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Decomposition of Trade-Comovement Relation in Model

- Implied decomposition of trade-comovement link: $\mathcal{L} = \mathcal{L}_C + \mathcal{L}_R$

$$\begin{aligned} \mathcal{L}_C &= \frac{\partial\left[\eta(\pi+\theta\mu)\right]}{\partial\tau}\frac{d\tau(\bar{x})}{d\bar{x}} \\ \mathcal{L}_R &= \frac{\partial\left[\chi\mu\right]}{\partial\tau}\frac{d\tau(\bar{x})}{d\bar{x}} \end{aligned}$$

$$\left[\begin{array}{c} \mathcal{S}_C = \eta(\pi+\theta\mu) \\ \mathcal{S}_R = \chi\mu \end{array}\right]$$

Complementarity Channel

Lemma

$\mathcal{L}_C = 1$ $[\mathcal{S}_C = \eta(\pi + \theta\mu) = \bar{x}]$ *since* $\eta = -\bar{x}$ *and* $\pi + \theta\mu = -1$.

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- Trade increases comovement 1-to-1 $\Rightarrow \mathcal{L}_C = 1$.

Risk-Sharing Channel

Lemma

$\mathcal{L}_R < -1$ $[\mathcal{S}_R = \chi\mu]$ *where* $\chi = -1$ *and* $\mu = \bar{x}((\rho - 1)(1 - 2\bar{x}) + \rho)$.

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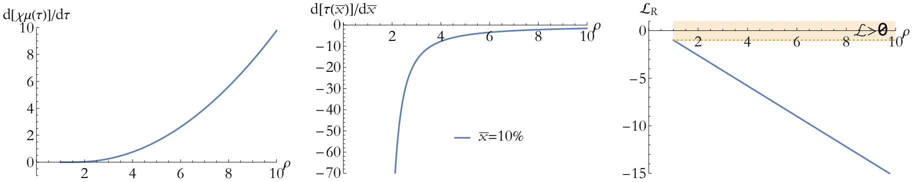
- Trade & trade cost lowers comovement more than 1-to-1 $\Rightarrow \mathcal{L}_R < -1$.

Risk-Sharing Channel & Trade Elasticity ρ

Figure: $\mathcal{L}_R = \frac{d(\chi\mu(\tau))}{d\tau}\big|_{\tau(\bar{x})}\frac{d\tau}{dx}\big|_{\tau(\bar{x})}$ as a function of SRE generated by ϕ vs. ρ.



Theory

Long-run Trade Elasticity and Trade-Comovement Puzzle

Setup

- Convex adjustment cost of adjusting import share d/f

$$u(d, f, l) = \log(G(d, f)) - \Phi(d, f) - l$$

- where

$$\Phi(d, f) = \phi \left(\frac{f}{d} \frac{\bar{d}}{\bar{f}} - 1 \right)^2$$

Trade Elasticity

- Short-run trade elasticity (business cycle response to terms of trade p)

$$SRE = |\frac{d\log(d/f)}{d\log p}|$$

- Long-run trade elasticity (steady-state response to trade cost τ)

$$LRE = |\frac{d\log d/f}{d\log(1+\tau)}|$$

Lemma

LRE is independent of ϕ and SRE is strictly decreasing in ϕ.

LR Trade Elasticity and Trade-Comovement Puzzle

Proposition

To a first order approximation, $\mathcal{L} > 0$ for sufficiently high ϕ.

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Risk-sharing Channel ($\phi \to \infty$)

Lemma

$\mathcal{L}_R(\phi) \to -1 + 4\bar{x} > -1 \quad [\mathcal{S}_R = \chi\mu]$ *where* $\chi = -1$ *and* $\mu \to -\bar{x}(2\bar{x} - 1)$.

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$$\hat{\mathcal{S}}_R \equiv \underbrace{\text{effect of } R \text{ on } l}_{\text{(income effect of } R\text{)}} + \text{effect of } A^* \text{ on } R$$

$$\begin{aligned}
\hat{y}(s^t) &= \alpha \hat{A} + \eta \hat{p}(s^t) + \chi R(s^t) \\
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R(s^t) &= \mu(\hat{A}^* - \hat{A})
\end{aligned}$$

Risk-sharing Channel ($\phi \to \infty$)

Lemma

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$$\hat{\mathcal{S}}_R \equiv \underbrace{\text{effect of } R \text{ on } l}_{\text{(income effect of } R\text{)}} + \underbrace{\text{effect of } A^* \text{ on } R}_{\text{(optimal risk-sharing transfer size)}}$$

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Decomposition of Trade-Comovement Relation

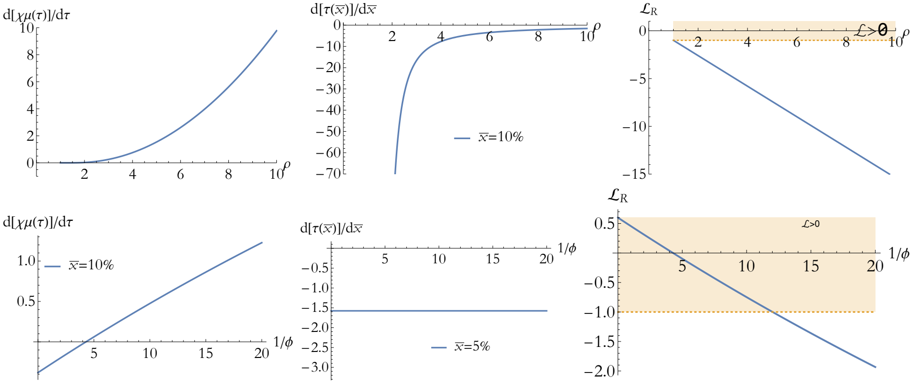
- Decomposition of Trade-comovement link $\mathcal{L} = \mathcal{L}_C + \mathcal{L}_R$:

$$\begin{aligned} \mathcal{L}_C &= \frac{\partial \left[\eta(\pi + \theta\mu)\right]}{\partial \tau} \frac{d\tau(\bar{x})}{d\bar{x}} \\ \mathcal{L}_R &= \frac{\partial \left[\chi\mu\right]}{\partial \tau} \frac{d\tau(\bar{x})}{d\bar{x}} \end{aligned}$$

$$\left[\begin{array}{c} \mathcal{S}_C = \eta(\pi + \theta\mu) \\ \mathcal{S}_R = \chi\mu \end{array} \right]$$

Risk-Sharing Channel & Trade Elasticity ρ

Figure: $\mathcal{L}_R = \frac{d(\chi\mu(\tau))}{d\tau}\Big|_{\tau(\bar{x})} \frac{d\tau}{dx}\Big|_{\tau(\bar{x})}$ as a function of SRE generated by ϕ vs. ρ.



Summary

Demand complementarity
Δ Trade
Δ Co-movement
Risk-sharing
LRE
Risk-sharing
Δ Trade cost

Robustness: Nonseparable Utility Function

$$u(c,l) = \frac{(c^{\zeta}(L-l)^{1-\zeta})^{1-\sigma}}{1-\sigma}$$

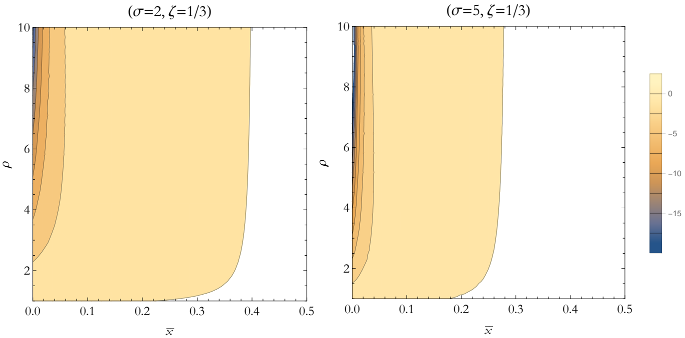


Figure: The negative region of the trade-comovement link $\mathcal{L}$ for nonseparable CRRA utility function, $\sigma = 2, \zeta = 1/3$ (left panel) and $\sigma = 5, \zeta = 1/3$ (right panel).

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- Extend Backus, Kehoe and Kydland (1995):
  - extended to a 3 country system (H,F,ROW)
  - infinite time horizon
  - the same adjustment friction
  - other standard business cycle features (capital, convex adjustment costs etc...)

Quantitative Model

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  - to match long-run and short-run elasticities as in Drozd & Nosal (2012)

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- Improves business cycle statistics

Conclusions

- Trade-comovement puzzle intimately related standard model's counterfactual assumption of equal short- and long-run trade elasticity
- Modeling high long-run and low short-run trade elasticity promising in resolving trade-comovement puzzle
- More broadly, trade elasticity relevant for shock transmission in a large class of models