How Good is International Risk Sharing?

Stepping outside the Shadow of the Welfare Theorems

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November 2024

International Risk Sharing

- **Efficient allocation** requires

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  — **MRT** how many units of C it takes to increase C^* by one unit

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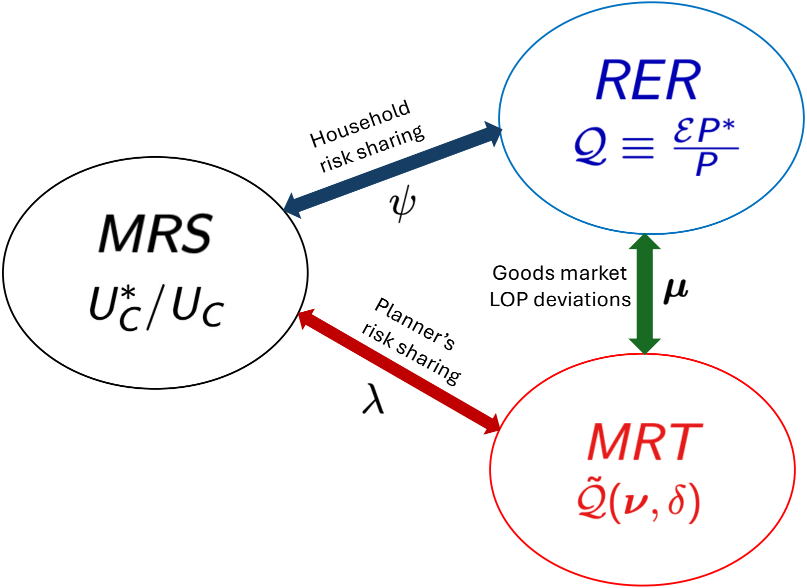
- Good reasons to be sceptical that $MRT \overset{?}{=} \mathcal{Q}$:

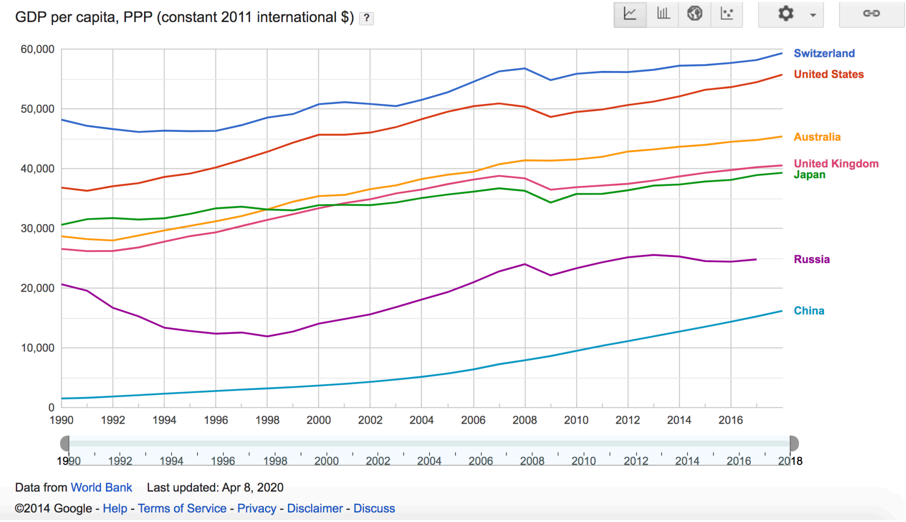
  — **macro**: exchange rates disconnected from TFP, output...

  — **micro**: alphabet soup of goods market frictions (PtM, PCP, LCP, DCP)



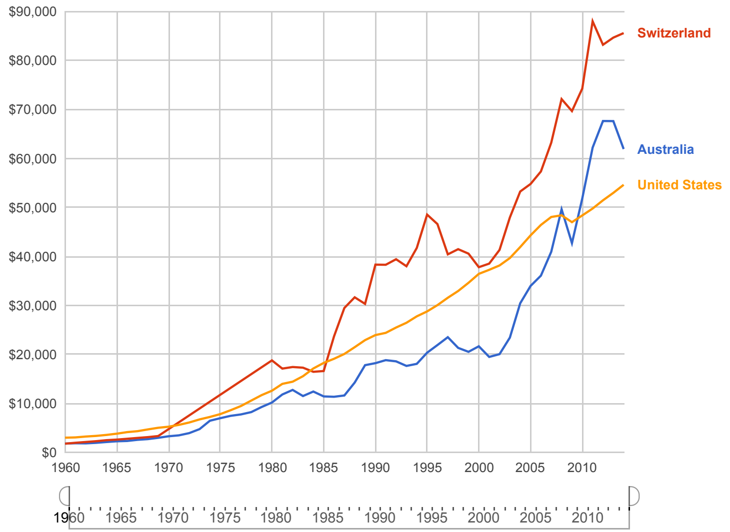
RER
$\mathcal{Q} \equiv \frac{\mathcal{E}P^*}{P}$
Household
risk sharing
ψ
MRS
U_C^*/U_C
Goods market
LOP deviations
$\boldsymbol{\mu}$
Planner's
risk sharing
λ
MRT
$\tilde{\mathcal{Q}}(\nu, \delta)$

Example: Switzerland



Example: Switzerland

GDP per capita (current US$) ?



Data from World Bank   Last updated: Jan 12, 2016

This Paper

1. **New method** based on recovering **technological MRT**:
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3. **Apply** to the data:
   - on average, risk-sharing wedge is small and $\mathrm{corr}(\Delta c - \Delta c^*, \Delta \tilde{q}) \approx 0.6$
   - connect to other measures of risk sharing:
     - consumption correlation: $\mathrm{corr}(\Delta c - \Delta c^*) < \mathrm{corr}(\Delta y - \Delta y^*)$
     - trade balance (counter)cyclicality: $\mathrm{corr}(\Delta nx_t, \Delta y - \Delta y^*) \approx 0$

- **International (mis)allocation**:
  - Consumption efficiency: Backus, Kehoe & Kydland (1992), Mendoza (1992), Backus & Smith (1993), Kollmann (1995), van Wincoop (1994, 1999), Lewis (1996), Aguiar & Gopinath (2007), Corsetti, Dedola & Leduc (2008), Bai & Zhang (2010, 2012), Fitzgerald (2012), Gourinchas & Jeanne (2013), Heathcote & Perri (2014), Ohanian, Restrepo-Echavarria & Wright (2018), Corsetti et al (2023)
  - Asset prices and portfolios: Brandt, Cochrane & Santa-Clara (2006), French & Poterba (1991), Baxter & Jermann (1997), Cole & Obstfeld (1991), Heathcote & Perri (2013), Coeurdacier & Gourinchas (2016), Farhi & Werning (2016), Coeurdacier & Rey (2013), Lewis & Liu (2023)
  - Wedge accounting: Chari, Kehoe & McGrattan (2007), Hsieh & Klenow (2009), Capelle & Pellegrino (2023), Kleinman, Liu & Redding (2023)
- **Exchange rates and risk sharing**:
  - Financial markets: Alvarez, Atkeson & Kehoe (2002), Jeanne & Rose (2002), Kollmann (2005), Gabaix & Maggiori (2015), Fornaro (2021), Itskhoki & Mukhin (2021, 2023)
  - Goods markets: Rogoff (1996), Engel (1999, 2011), Devereux & Engel (2003), Atkeson & Burstein (2008), Bianchi (2011), Corsetti, Dedola & Leduc (2018), Gopinath et al (2020), Amiti, Itskhoki & Konings (2019)

ENVIRONMENT

Environment

- **Two regions**: Home and Foreign (RoW)
- **Endowments**:
  - Armington model with country-specific goods/inputs
  - focus on efficiency of allocation given output

$$C_H + C_H^* = Y$$

$$C_F + C_F^* = Y^*$$

- **Preferences**:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t \frac{C_t^{1-\sigma}}{1-\sigma}, \qquad C = \left[(1-\gamma)^{\frac{1}{\theta}}\; C_H^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}}\; C_F^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$$

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Efficient Allocation

- Planner's problem:

$$\begin{aligned}\max_{\{C_{Ht},C_{Ft},C^*_{Ht},C^*_{Ft},C_t,C^*_t\}} \quad & \omega U(\{C_t\}) + U(\{C^*_t\}) \\ \text{s.t.} \quad & C(C_{Ht}, C_{Ft}) = C_t \\ & C^*(C^*_{Ht}, C^*_{Ft}) = C^*_t \\ & C_{Ht} + C^*_{Ht} = Y_t \\ & C_{Ft} + C^*_{Ft} = Y^*_t\end{aligned}$$

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$$\frac{\gamma}{1-\gamma}\frac{C_H}{C_F} = \tilde{S}^{\theta} = \frac{1-\gamma^*}{\gamma^*}\frac{C_H^*}{C_F^*}, \qquad \text{where } \tilde{S} \equiv \frac{\nu^*}{\nu}$$

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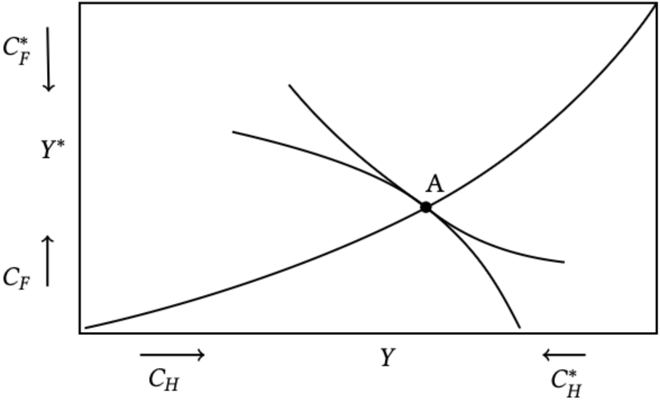

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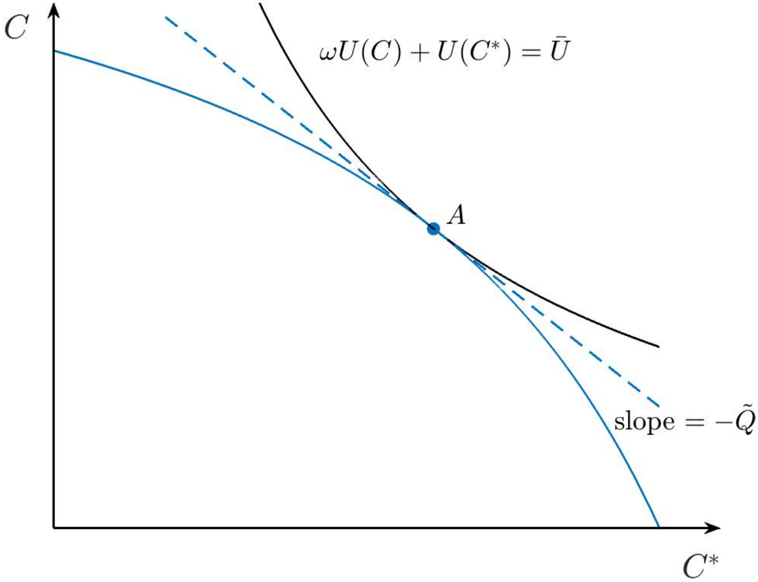

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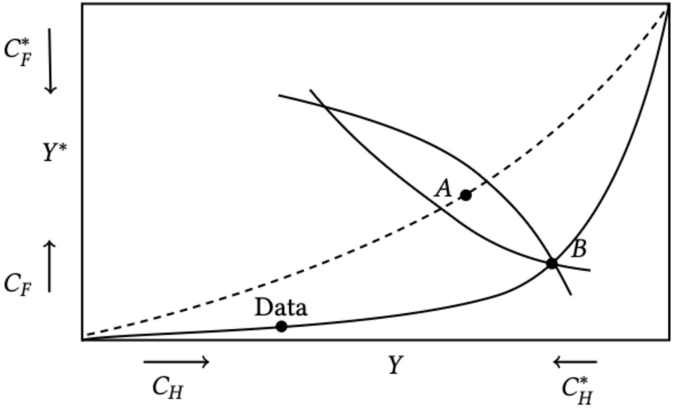

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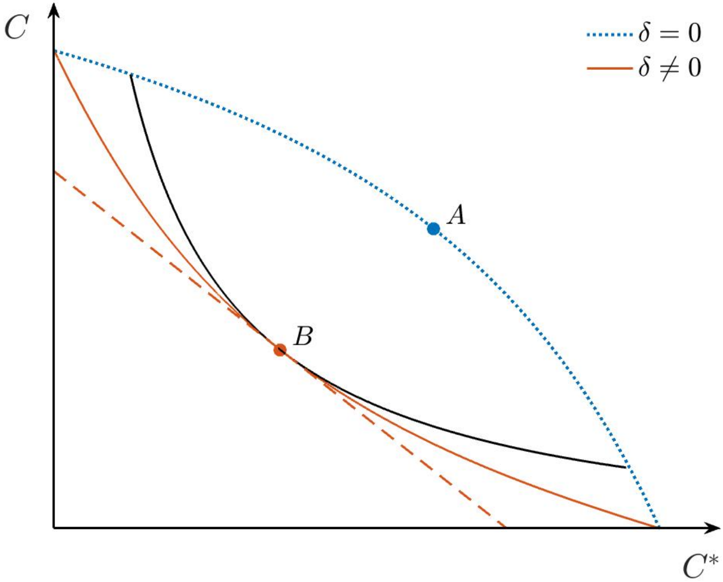

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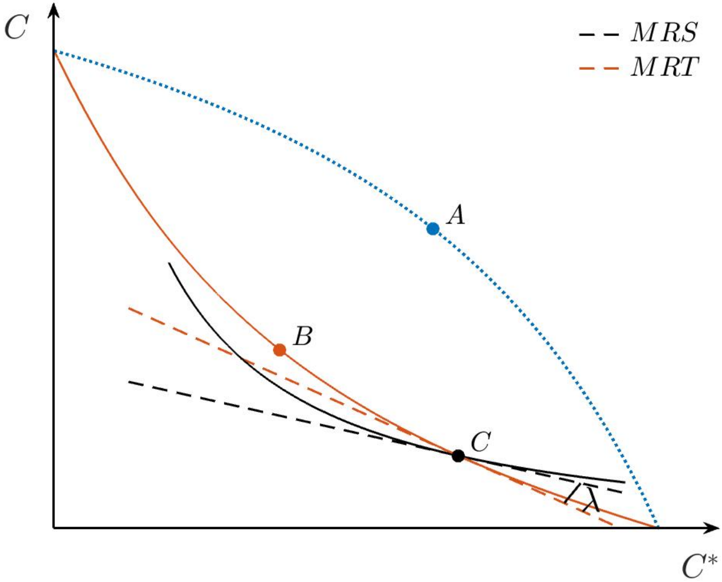

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Welfare

- General property of (λ, δ) decomposition:

$$\text{Welfare loss} = a_\lambda \lambda^2 + a_\delta \delta^2$$

  — orthogonal decomposition ("partial reform")
  — cf. general theory of the second best (interaction between frictions)
  — Symmetric Cole-Obstfeld case (log-Cobb-Douglas):

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- Mapping into general markup wedges (Baqaee-Farhi)

$$\boldsymbol{\mu} \equiv (\mu_H, \mu_H^*, \mu_F, \mu_F^*) \qquad \Rightarrow \qquad \tilde{\mu}_H \equiv \mu_H^*/\mu_H, \quad \tilde{\mu}_F \equiv \mu_F^*/\mu_F$$

  — simple mapping $\delta = \tilde{\mu}_F/\tilde{\mu}_H$ and a non-linear mapping of $\boldsymbol{\mu}$ into λ

  — Welfare loss in terms of Harberger triangles, but not-orthogonal

DECENTRALIZED EQUILIBRIUM

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- Alternative models of risk-sharing wedge ψ:
  1. AD securities with relative state-contingent taxes ψ_t (IM '24 in the spirit of CKM accounting)
  2. Balanced trade with international income transfers (Keynes' transfers)
  3. UIP shocks under incomplete markets (IM '21)

Goods Market

- **Goods market wedge**: reduced-form LOP deviations μ and μ^*:

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- **Proposition**: if $\mu = \mu^* = 0$, then $\delta = 0$ and $\lambda = \psi$.
- **Proposition**: $\forall \psi$, if $\mu = \mu^* = -\psi$, then $\lambda = 0$ and $\mathcal{Q} = e^{-\psi} \tilde{\mathcal{Q}}$.

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$$\mathcal{Q} = \frac{\mathcal{E}P_F^*}{P_H}\cdot\left[\frac{1-\gamma^*+\gamma^*(P_F^*/P_H^*)^{\theta-1}}{1-\gamma+\gamma(P_F/P_H)^{1-\theta}}\right]^{\frac{1}{1-\theta}}$$

- **Proposition**: if $\mu=\mu^*=0$, then $\delta=0$ and $\lambda=\psi$.
- **Proposition**: $\forall\psi$, if $\mu=\mu^*=-\psi$, then $\lambda=0$ and $\mathcal{Q}=e^{-\psi}\tilde{\mathcal{Q}}$.
- **Proposition**: if $\psi=0$ and $\mu^*=\mu$, then $\lambda=\mu$ and $\mathcal{Q}=e^{\mu}\tilde{\mathcal{Q}}$.

Shocks and Wedges

1. **LOP/PCP** $\mu = \mu^* = 0$:

$$\lambda = \psi, \qquad \delta = 0$$

— real exchange rate reflects social costs $\mathcal{Q} = \tilde{\mathcal{Q}}$

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3. **DCP** $\mu = 0, \mu^* = \kappa q$. As $\kappa \to 1$:

$$1 + \lambda = \left[(1+\psi)\frac{Y}{Y^*}\right]^{\frac{1}{2(1-\gamma)}}, \qquad 1 + \delta = \left(\frac{1}{1+\psi}\right)^{\frac{1-2\gamma}{1-\gamma}} \left(\frac{Y}{Y^*}\right)^{\frac{1}{1-\gamma}}$$

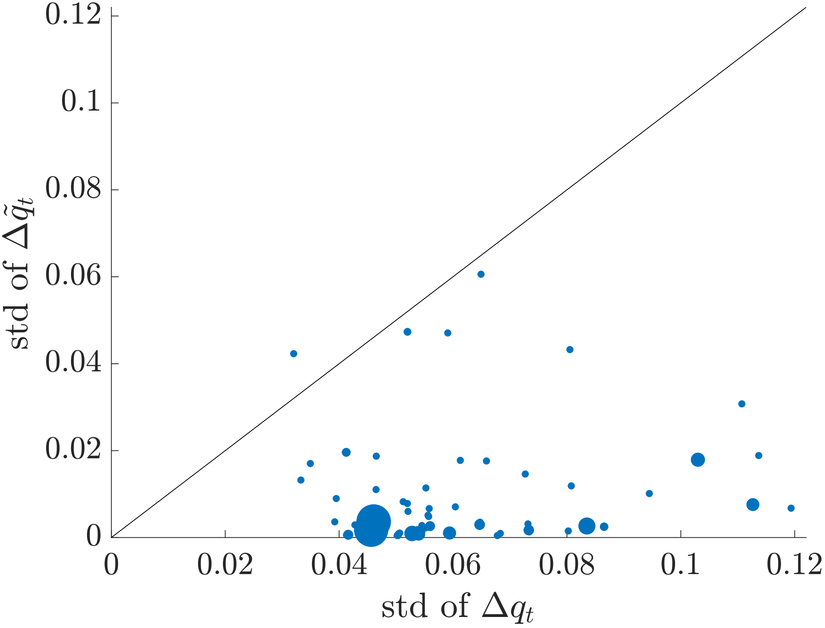
— state wedge δ can arise from financial shocks ψ

EMPIRICAL RESULTS

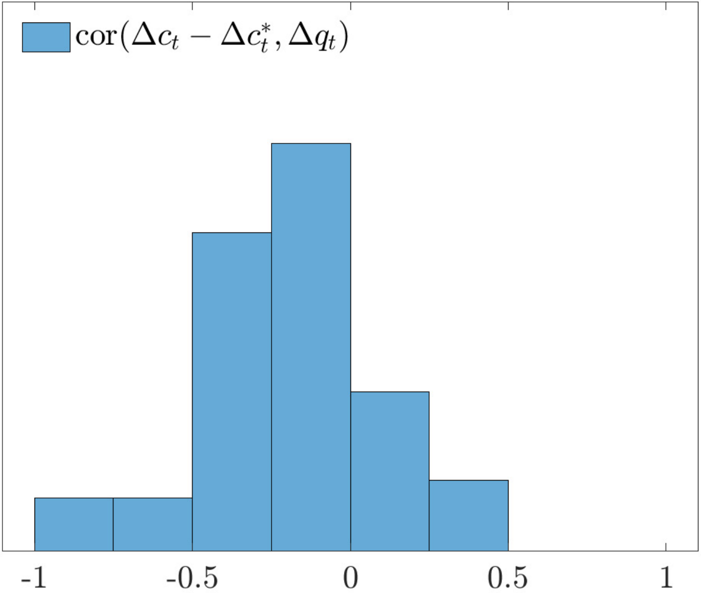
Data and Calibration

- **Data**:
  - $Y_t, C_t, IM_t, EX_t, \mathcal{Q}_t$ from WDI
  - balanced panel from 2000-2019 for about 60 countries
  - analysis for each country against the RoW
- **Calibration**:
  - $\theta = 4$, $\sigma = 2$, $\beta = 0.96$ (annual)
  - γ, γ^* from trade shares in base year details
  - caveat: real quantities not observed in levels, calibrate base-year ω, δ
- **Estimation**:
  - generalize model to allow for absorption $A \equiv C + I + G = GDP - NX$
  - back out $\{C_{Ht}, C_{Ft}, C^*_{Ht}, C^*_{Ft}\}$ from $\{Y_t, C_t\}$ details
  - compute $\{\delta_t, \lambda_t, \tilde{\mathcal{Q}}_t\}$ from planner's problem details

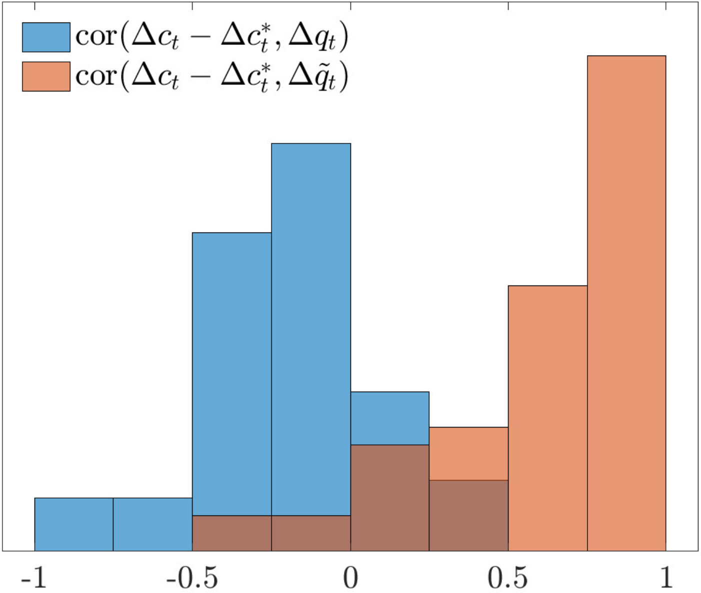
Volatility: RER vs MRT



Backus-Smith Correlation: RER vs MRT



Backus-Smith Correlation: RER vs MRT



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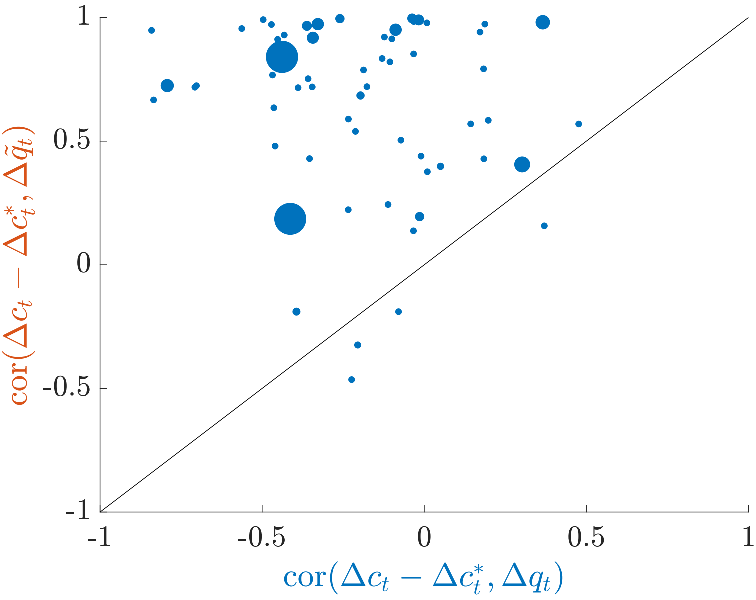
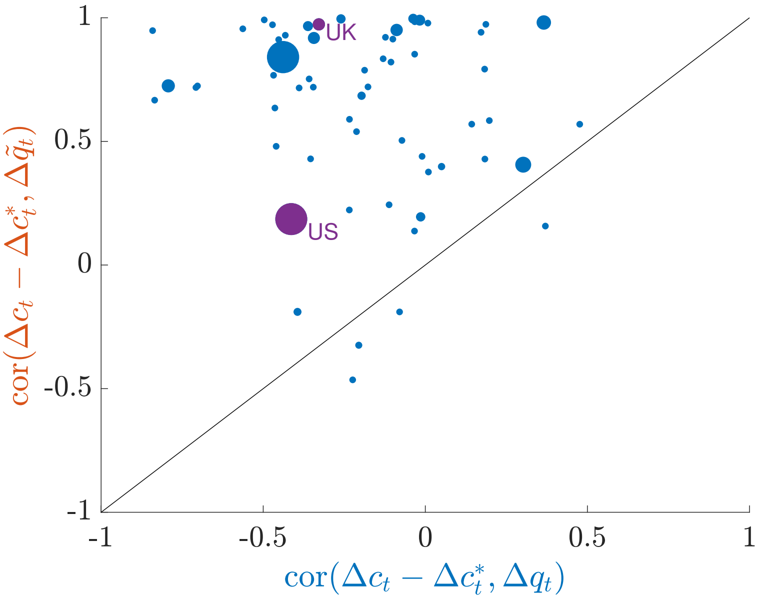
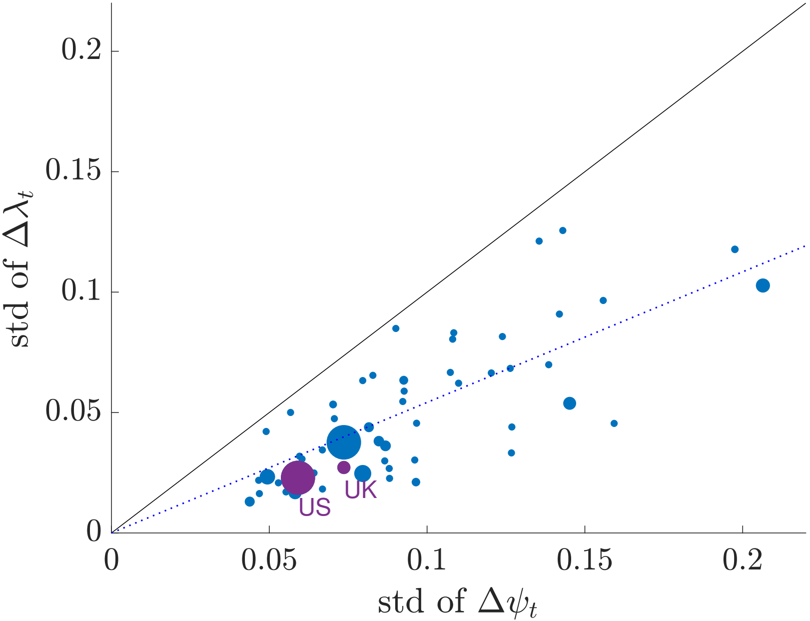
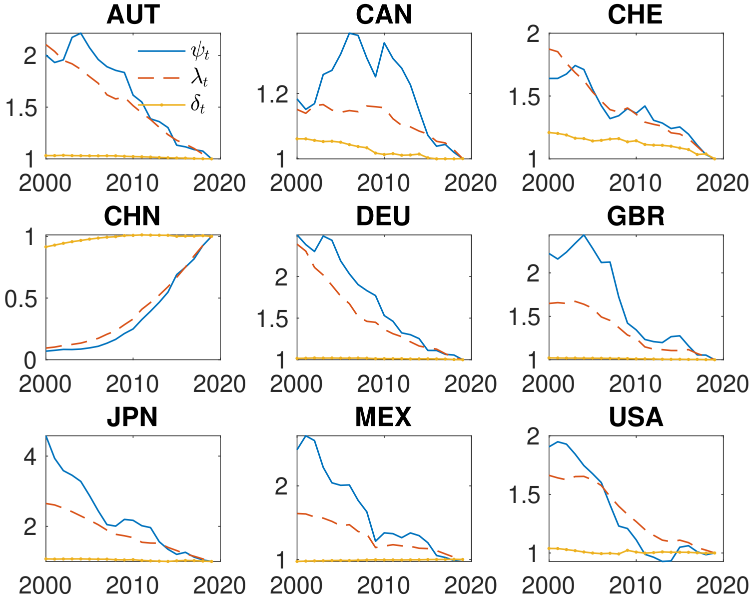


Backus-Smith Correlation: RER vs MRT



Wedges and Welfare

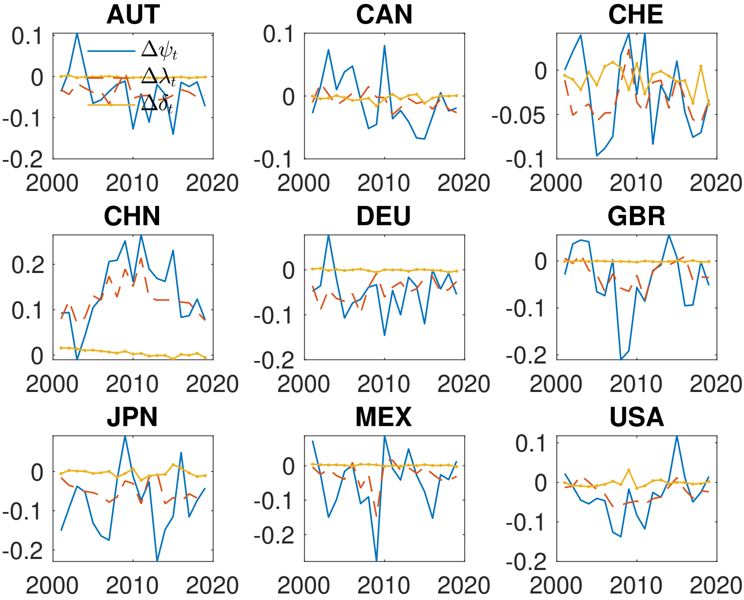




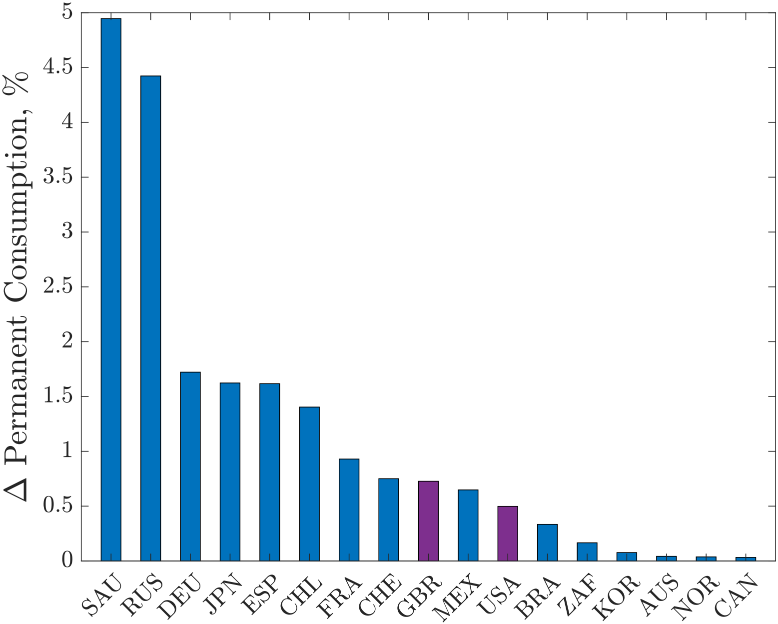
AUT
CAN
CHE
CHN
DEU
GBR
JPN
MEX
USA
ψ_t
λ_t
δ_t
2000
2010
2020

Time Series

First Differences

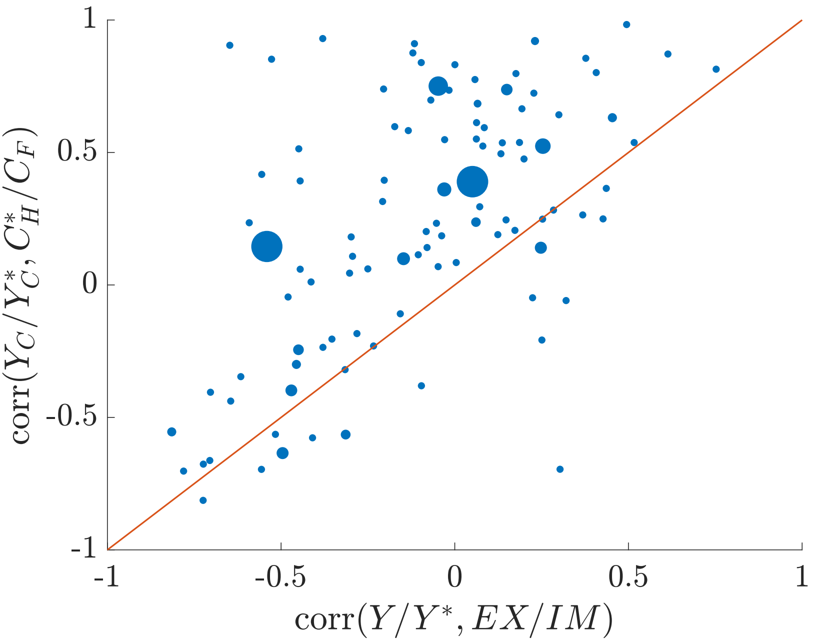


Welfare

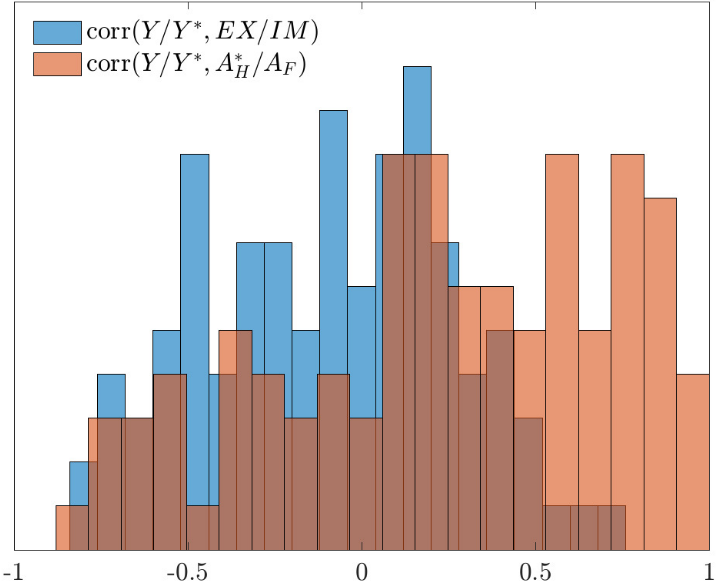


Δ Permanent Consumption, %
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
SAU
RUS
DEU
JPN
ESP
CHL
FRA
CHE
GBR
MEX
USA
BRA
ZAF
KOR
AUS
NOR
CAN

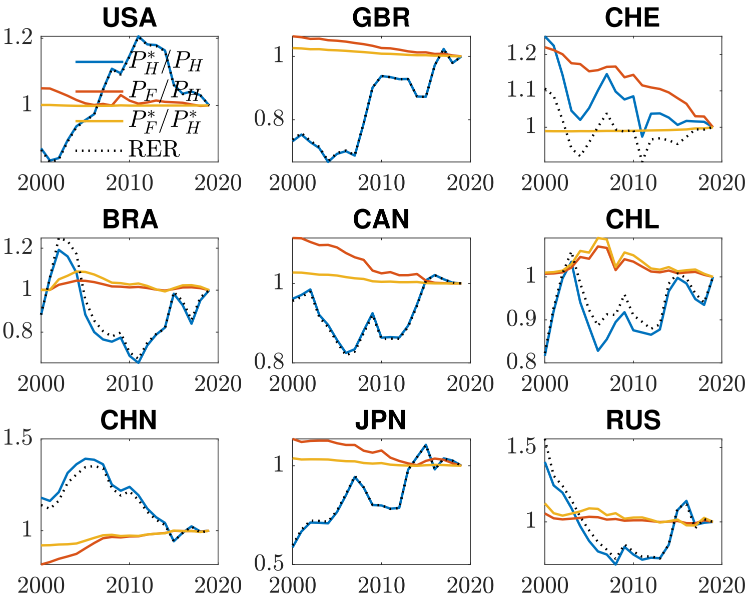
NX cyclicality



NX cyclicality



Pricing to Market: LCP



Conclusion

- How good is international risk sharing?
- Backus-Smith is a poor measure
- Propose a simple alternative
- **Better than one might think!**

Conclusion: Switzerland

- Large financial shock ψ
- Little change in relative prices within county, $\delta \approx 0$
- Little change in real incomes
  - wages and prices increase proportionally
- Large change in international relative prices
  - real exchange rate, relative wages
  - in proportion with ψ
- Small risk-sharing wedge λ
- Exporter and financial profits and losses?

APPENDIX

Efficient Allocation

- Planner's problem:

$$\max_{\{C_H, C_F, C_H^*, C_F^*, C, C^*\}} \quad \omega U(C) + U(C^*)$$

$$\begin{aligned} \text{s.t.} \qquad C(C_H, C_F) &= C & \mu \\ C^*(C_H^*, C_F^*) &= C^* & \mu^* \\ C_H + C_H^* &= Y & \nu \\ C_F + C_F^* &= Y^* & \nu^* \end{aligned}$$

- Optimality conditions:

$$\underbrace{\frac{\partial C / \partial C_F}{\partial C / \partial C_H}}_{MRS_{HF}} = \underbrace{\frac{\nu^*}{\nu}}_{\tilde{S}} = \underbrace{\frac{\partial C^* / \partial C_F^*}{\partial C^* / \partial C_H^*}}_{MRS_{HF}^*}, \qquad \underbrace{\frac{U_C^*}{\omega U_C}}_{MRS_{CC^*}} = \underbrace{\frac{\mu^*}{\mu}}_{\tilde{Q}} = \underbrace{\frac{\nu \frac{C_H^*}{C^*} + \nu^* \frac{C_F^*}{C^*}}{\nu \frac{C_H}{C} + \nu^* \frac{C_F}{C}}}_{MRT_{CC^*}}$$

- **Proposition**: international allocation is efficient iff

$$\frac{\gamma}{1-\gamma} \frac{C_H}{C_F} = \frac{1-\gamma^*}{\gamma^*} \frac{C_H^*}{C_F^*}, \qquad \frac{1}{\omega} \left(\frac{C}{C^*} \right)^{\sigma} = \left[\frac{(1-\gamma^*) \left(\frac{1-\gamma^*}{\gamma^*} \frac{C_H^*}{C_F^*} \right)^{\frac{1-\theta}{\theta}} + \gamma^*}{1 - \gamma + \gamma \left(\frac{\gamma}{1-\gamma} \frac{C_H}{C_F} \right)^{\frac{1-\theta}{\theta}}} \right]^{\frac{1}{1-\theta}}$$

back

Analytical Example

- **Special case**: $\sigma = \theta = 1$, $\gamma = \gamma^*$, $\omega = 1$

- Aggregate consumption and output pin down δ and λ:

$$C^{1+\kappa} = \frac{1+\lambda+\kappa\eta}{1+\lambda+\kappa}\left(\frac{\kappa(1+\lambda-\eta)}{1+\kappa(1+\lambda)}\right)^{\kappa} Y Y^{*\kappa}$$

$$C^{*1+\kappa} = \frac{1+\kappa\eta}{1+\kappa(1+\lambda)}\left(\frac{\kappa(1-\eta)}{1+\lambda+\kappa}\right)^{\kappa} Y^{\kappa} Y^{*}$$

where $\kappa \equiv \frac{\gamma}{1-\gamma}$ and $\eta = \eta(\delta)$: $\frac{1-\eta}{1+\kappa\eta}\frac{1+\lambda-\eta}{1+\lambda+\kappa\eta} = \frac{1}{1+\delta}$

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- Shadow values and distorted MRT:

$$MRT = \frac{\mu^*}{\mu} = \underbrace{\left(\frac{1+\frac{\kappa\eta}{1+\lambda}}{1+\kappa\eta}\right)^{1-\gamma}\left(\frac{1-\frac{\eta}{1+\lambda}}{1-\eta}\right)^{\gamma}}_{=1 \text{ when } \eta=0} \cdot \left(\underbrace{\frac{1+\kappa+\kappa\lambda}{1+\kappa+\lambda} \cdot \frac{Y}{Y^*}}_{=\nu^*/\nu}\right)^{1-2\gamma}$$

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- MRT around *undistorted SS* $\bar{\delta} = \bar{\eta} = \bar{\lambda} = 0$ (first-order approximation):

$$\mathrm{d}\log MRT \approx (1-2\gamma)(y - y^*) - (1-2\gamma)^2\lambda$$

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- Welfare (second-order approximation):

$$W(\lambda, \delta) = \log Y + \log Y^* - \gamma(1-\gamma)\left[\lambda^2 + \frac{1}{4}\delta^2\right]$$

back

Estimation I

- Define real absorption:

$$A \equiv C + I + G, \qquad A^* \equiv C^* + I^* + G^*$$

- Assume the same CES aggregator for C, I, G:

$$A^{\frac{\theta-1}{\theta}} = (1-\gamma)^{\frac{1}{\theta}} A_H^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} A_F^{\frac{\theta-1}{\theta}}$$

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- Rewrite resource constraints using hat algebra and solve for $\hat{A}_H, \hat{A}_F, \hat{A}_H^*, \hat{A}_F^*$:

$$(1-\bar{\chi})\hat{A}_H + \bar{\chi}\hat{A}_H^* = \hat{Y}, \qquad (1-\bar{\gamma})\hat{A}_H^{\frac{\theta-1}{\theta}} + \bar{\gamma}\hat{A}_F^{\frac{\theta-1}{\theta}} = \hat{A}^{\frac{\theta-1}{\theta}},$$

$$\bar{\chi}^*\hat{A}_F + (1-\bar{\chi}^*)\hat{A}_F^* = \hat{Y}^*, \qquad (1-\bar{\gamma}^*)\hat{A}_F^{*\frac{\theta-1}{\theta}} + \bar{\gamma}^*\hat{A}_H^{*\frac{\theta-1}{\theta}} = \hat{A}^{*\frac{\theta-1}{\theta}},$$

where import and export trade shares are given by

$$\bar{\gamma} = \gamma^{\frac{1}{\theta}}\left(\frac{\bar{C}_F}{\bar{C}}\right)^{\frac{\theta-1}{\theta}}, \quad \bar{\gamma}^* = \gamma^{*\frac{1}{\theta}}\left(\frac{\bar{C}_H^*}{\bar{C}^*}\right)^{\frac{\theta-1}{\theta}}, \qquad \bar{\chi} \equiv \frac{\bar{C}_H^*}{\bar{Y}}, \qquad \bar{\chi}^* \equiv \frac{\bar{C}_F}{\bar{Y}^*}$$

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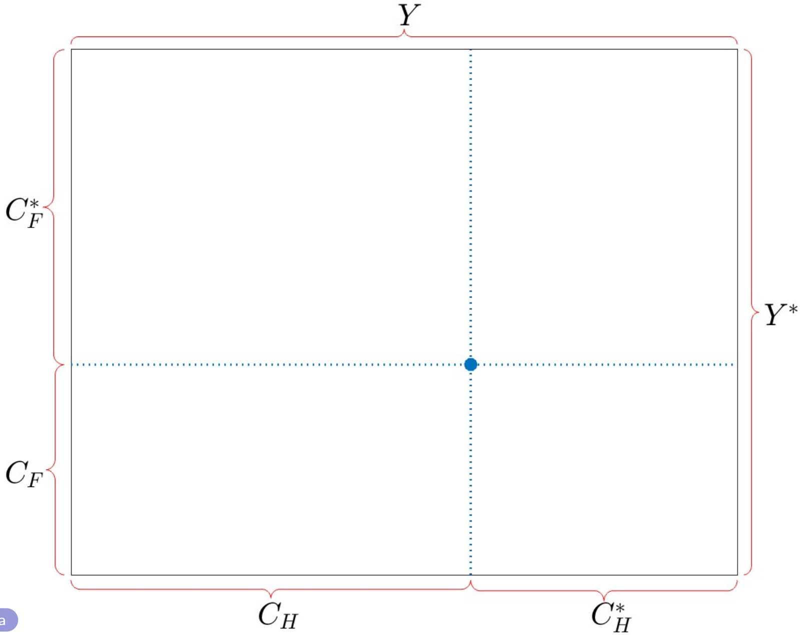
- Recover consumption components:

$$\hat{C}_H = \hat{A}_H\frac{\hat{C}}{\hat{A}}, \qquad \hat{C}_F = \hat{A}_F\frac{\hat{C}}{\hat{A}}, \qquad \hat{C}_H^* = \hat{A}_H^*\frac{\hat{C}^*}{\hat{A}^*}, \qquad \hat{C}_F^* = \hat{A}_F^*\frac{\hat{C}^*}{\hat{A}^*}$$

data



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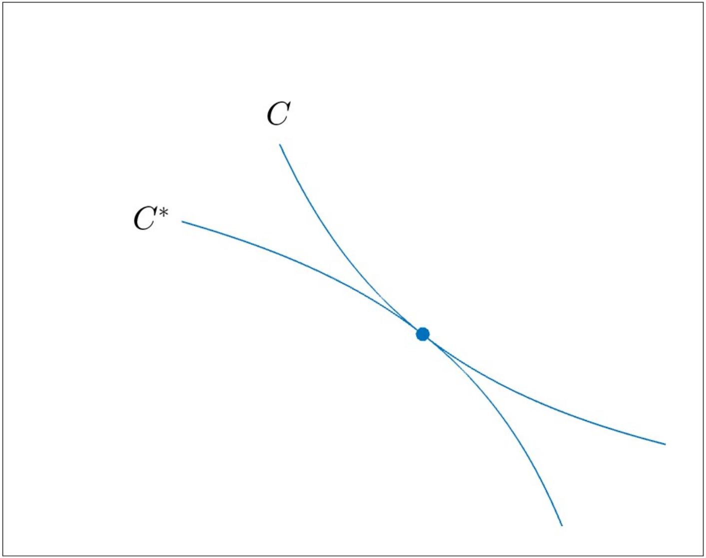
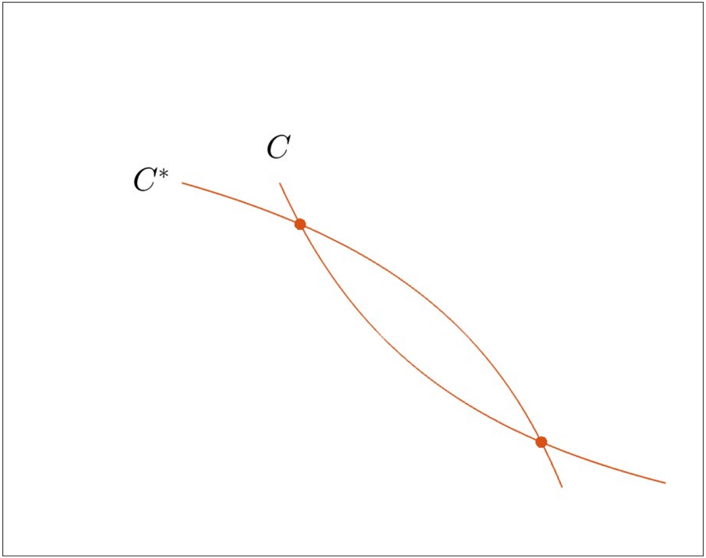
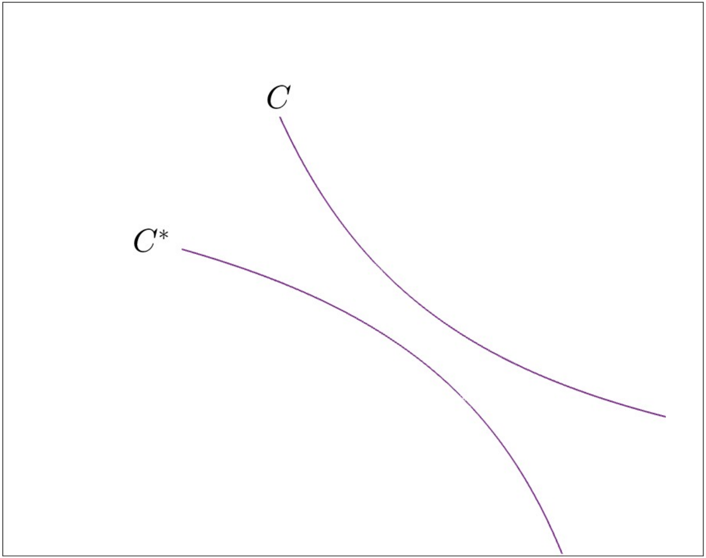

C
C^*

Identification

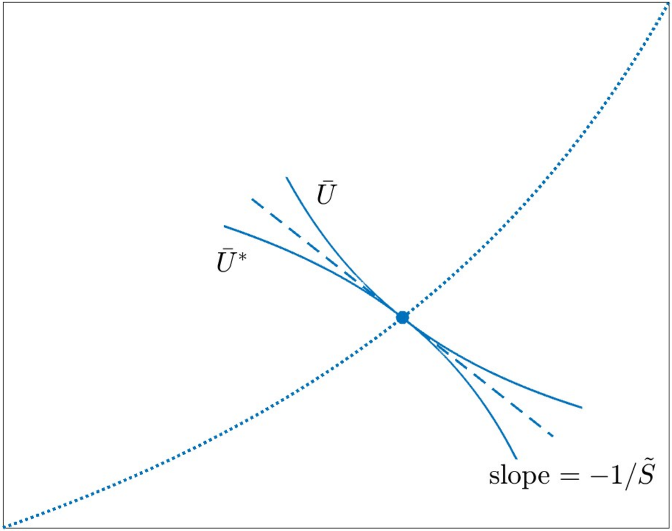


Identification



▸ data

Edgeworth Box



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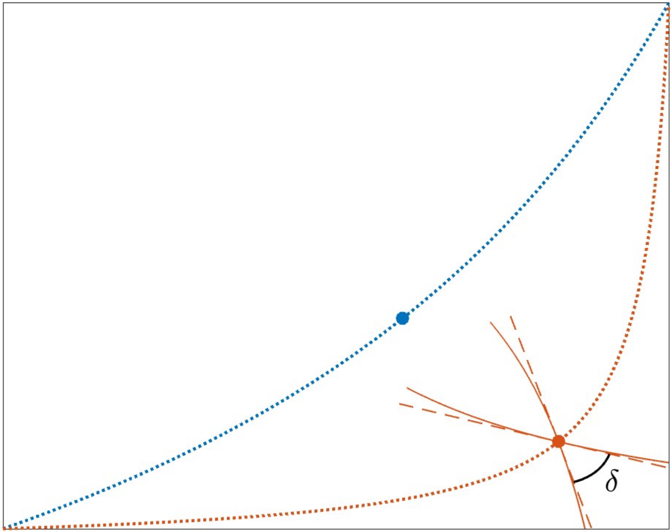
Edgeworth Box



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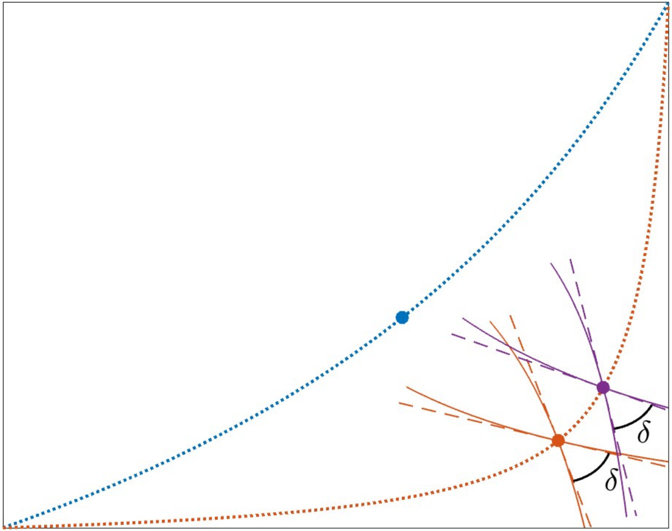
Edgeworth Box



▸ back

- Solve for $\lambda, \nu, \nu^*, \eta$ from planner's FOCs in growth rates:

$$(1-\bar{\gamma})\lambda \hat{C}^{1-\sigma}\left(\frac{\hat{C}_H}{\hat{C}}\right)^{\frac{\theta-1}{\theta}} = (1-\bar{\chi})\hat{C}_H \nu - \eta$$

$$\bar{\gamma}\lambda \hat{C}^{1-\sigma}\left(\frac{\hat{C}_F}{\hat{C}}\right)^{\frac{\theta-1}{\theta}} = \bar{\chi}^* \hat{C}_F \nu^* + \eta$$

$$\bar{\gamma}^* \hat{C}^{*1-\sigma}\left(\frac{\hat{C}_H^*}{\hat{C}^*}\right)^{\frac{\theta-1}{\theta}} = \bar{\chi}\hat{C}_H^* \nu + \eta$$

$$(1-\bar{\gamma}^*)\hat{C}^{*1-\sigma}\left(\frac{\hat{C}_F^*}{\hat{C}^*}\right)^{\frac{\theta-1}{\theta}} = (1-\bar{\chi}^*)\hat{C}_F^* \nu^* - \eta$$

- Distorted risk sharing:

$$\left(\frac{\hat{C}}{\hat{C}^*}\right)^{\sigma} = \lambda \frac{\bar{\chi}\frac{\hat{C}_H^*}{\hat{C}^*}\nu + (1-\bar{\chi}^*)\frac{\hat{C}_F^*}{\hat{C}^*}\nu^*}{(1-\bar{\chi})\frac{\hat{C}_H}{\hat{C}}\nu + \bar{\chi}^*\frac{\hat{C}_F}{\hat{C}}\nu^*}$$

Estimation II

- Solve for $\lambda, \nu, \nu^*, \eta$ from planner's FOCs in growth rates:

$$(1-\bar{\gamma})\lambda \hat{C}^{1-\sigma}\left(\frac{\hat{C}_H}{\hat{C}}\right)^{\frac{\theta-1}{\theta}} = (1-\bar{\chi})\hat{C}_H\nu - \eta$$

$$\bar{\gamma}\lambda \hat{C}^{1-\sigma}\left(\frac{\hat{C}_F}{\hat{C}}\right)^{\frac{\theta-1}{\theta}} = \bar{\chi}^*\hat{C}_F\nu^* + \eta$$

$$\bar{\gamma}^*\hat{C}^{*1-\sigma}\left(\frac{\hat{C}^*_H}{\hat{C}^*}\right)^{\frac{\theta-1}{\theta}} = \bar{\chi}\hat{C}^*_H\nu + \eta$$

$$(1-\bar{\gamma}^*)\hat{C}^{*1-\sigma}\left(\frac{\hat{C}^*_F}{\hat{C}^*}\right)^{\frac{\theta-1}{\theta}} = (1-\bar{\chi}^*)\hat{C}^*_F\nu^* - \eta$$

- Base-year system maps $\bar{\gamma}, \bar{\gamma}^*, \bar{\chi}, \bar{\chi}^*$ into base-year $\lambda, \nu, \nu^*, \eta$:

$$(1-\bar{\gamma})\lambda = (1-\bar{\chi})\nu - \eta$$
$$\bar{\gamma}\lambda = \bar{\chi}^*\nu^* + \eta$$
$$\bar{\gamma}^* = \bar{\chi}\nu + \eta$$
$$1-\bar{\gamma}^* = (1-\bar{\chi}^*)\nu^* - \eta$$

data

Estimation III

- Real variables $X \in \{Y, C, A\}$ computed in growth rates relative to base year:

$$\hat{X}_{it} = \frac{X_{it}}{\bar{X}_i}, \qquad \hat{X}^*_{it} = \frac{\sum_j w^X_j \hat{X}_{jt} - w^X_i \hat{X}_{it}}{1 - w^X_i}, \qquad w^X_i \equiv \frac{\bar{X}_i}{\sum_j \bar{X}_j}$$

- In base year, measure GDP, Exp and Imp in dollar values and compute

i) import shares (in values):

$$\bar{\gamma} \equiv \gamma^{\frac{1}{\theta}} \left(\frac{\bar{C}_F}{\bar{C}}\right)^{\frac{\theta-1}{\theta}} = \frac{IM}{GDP - NX}, \qquad \bar{\gamma}^* \equiv \gamma^{*\frac{1}{\theta}} \left(\frac{\bar{C}^*_H}{\bar{C}^*}\right)^{\frac{\theta-1}{\theta}} = \frac{EX}{\sum_{j \neq i}(GDP_j - NX_j)}$$

ii) export shares (in real units):

$$\bar{\chi} \equiv \frac{\bar{C}^*_H}{\bar{Y}} = \frac{EX}{\frac{GDP-EX}{PPP} + EX}, \qquad \bar{\chi}^* \equiv \frac{\bar{C}_F}{\bar{Y}^*} = \frac{IM}{\sum_{j \neq i} \frac{GDP_j - EX_j}{PPP_j} + IM}$$

data