Information Globalization, Risk Sharing and International Trade

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Motivation

- Puzzle: low level of cross-country trade.
  - **Trade frictions:** tariffs, transportation, distribution, language
  - **Information frictions:** search frictions, unknown quality
    But if international trade $<$ domestic trade, home agents must know something foreigners do not (asymmetry).

- Question:
  Do **asymmetric** information frictions about aggregate conditions explain low trade?

This paper

- Two-country, two-good, endowment economy (standard Armington).
- One new ingredient: Asymmetric information
  - Agents know home endowment, noisy signals about foreign endowment.
  - Relative price ($P_{foreign\ good}/P_{home\ good}$) is uncertain.
    Exporting is risky.
- Results: Information globalization (reductions in signal noise).
  - Reduces risk-sharing
  - Reduces trade share
  - Increases expected utility

What's New About This?

- Information about match-specific variables (no asymmetry)
  Allen (2013), Petropoulou (2011), Rauch Watson (2004), Eaton et.al. (2011)
  Why is domestic trade is so much higher?

- Information about aggregate conditions
  Steinwender (2014)
  Does partial eqbm logic extend to general eqbm?

- This paper: Information asymmetry in general equilibrium.
  Uncertainty about what others know (asymmetric info) affects relative prices. Reverses PE effect on trade.

Key Ideas

- Information inhibits risk-sharing (Hirschleifer '79)
  Example: Two independent lotteries.
- Maximum risk-sharing = maximum trade.
  $\downarrow$ risk-sharing $\rightarrow$ $\downarrow$ trade
- Unlike financial market, less info $\rightarrow$ more risky activity.
  Because of 2 goods. Hedge risk by exporting more.
- Effect works through second-order beliefs.

Takeaways

1. The equilibrium effects of information frictions are important.
2. We should look for other information asymmetries.

Environment (standard part)

- 1 period, 2 countries (x and y), a continuum of agents in each.
- **Preferences**: Risk neutral on CES composite consumption

$$\mathbb{E}\left[(c_x^\theta + c_y^\theta)^{1/\theta}\right], \quad \theta \in (0,1)$$

- **Individual endowments**:
  - country x firm: z_x units of good x, $\ln z_x \sim \mathcal{N}(\mu_x, \sigma_x^2)$
  - country y firm: z_y units of good y, $\ln z_y \sim \mathcal{N}(\mu_y, \sigma_y^2)$
- **Aggregate shocks**: $\mu_x \sim \mathcal{N}(m_x, s_x^2)$, $\mu_y \sim \mathcal{N}(m_y, s_y^2)$
- **Budget sets**: agents take price q (units of x per y) as given

$$\textit{in country } x: \quad c_x \in [0, z_x - t_x], \quad c_y \in \left[0, \frac{t_x}{q}\right]$$

$$\textit{in country } y: \quad c_y^* \in [0, z_y - t_y], \quad c_x^* \in [0, t_y q]$$

Budgets imply: (i) no resale, (ii) $t, c \geq 0$, and (iii) no financial markets.

Timing and Information Structure (new part)

1. Observe own z and domestic μ. All parameters known.
2. Receive noisy signal about μ abroad (common signal):
   - $x - country$: $\tilde{m}_y = \mu_y + \eta_y, \quad \eta_y \sim N(0, \tilde{s}_y^2)$
   - $y - country$: $\tilde{m}_x = \mu_x + \eta_x, \quad \eta_x \sim N(0, \tilde{s}_x^2)$
3. Choose exports t before observing $q \Rightarrow$ **Forecast price**
4. International market clears at q.
5. Consumption is realized.

Forecasting international price

- To forecast price q, a firm forms 1st & 2nd order beliefs (suffic stats):

1. **What are my beliefs about foreign productivity?**
   $\mu_y | \mathcal{I}_x \sim \mathcal{N}\left(\hat{m}_y, \hat{s}_y^2\right)$

$$\hat{m}_y = \frac{s_y^{-2} m_y + \tilde{s}_y^{-2} \tilde{m}_y}{s_y^{-2} + \tilde{s}_y^{-2}}, \quad \hat{s}_y^2 = \frac{1}{s_y^{-2} + \tilde{s}_y^{-2}}$$

2. **What are my beliefs about foreign beliefs about my productivity?**
   $\hat{m}_x | \mathcal{I}_x \sim \mathcal{N}\left(\hat{\hat{m}}_x, \hat{\hat{s}}_x^2\right),$

$$\hat{\hat{m}}_x = \frac{s_x^{-2} m_x + \tilde{s}_x^{-2} \mu_x}{s_x^{-2} + \tilde{s}_x^{-2}}, \quad \hat{\hat{s}}_x^2 = \frac{\tilde{s}_x^{-2}}{(s_x^{-2} + \tilde{s}_x^{-2})^2}$$

Equilibrium

- An equilibrium is
  - export policy: $t_x(z_x, \mu_x, \hat{m}_y)$ and $t_y(z_y, \mu_y, \hat{m}_x)$
  - beliefs $\{F(\mu_y|\mathcal{I}_x), F(\hat{m}_x|\mathcal{I}_x)\}$ and $\{F(\mu_x|\mathcal{I}_y), F(\hat{m}_y|\mathcal{I}_y)\}$
  - price function $q(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y)$

1. Given beliefs and price function, exports maximize utility.
2. Price q clears the international market.

- Solution:

$$Policy: \quad t = z\Psi(\mu, \hat{m}) \implies T = \underbrace{e^{\mu + \frac{\sigma^2}{2}}}_{\text{aggregate endowment}} \underbrace{\Psi(\mu, \hat{m})}_{\text{trade share}}$$

$$Price: \quad q = \frac{T_x}{T_y} = \underbrace{e^{\mu_x - \mu_y + \frac{1}{2}(\sigma_x^2 - \sigma_y^2)}}_{\text{relative fundamentals}} \frac{\Psi}{\Psi^*}$$

Details

Parameter Choice

- Results will be theoretical and numerical. For numerical results,

Table: **Summary of Model Parameters**

Parameter	$m_x = m_y$	$\sigma_x = \sigma_y$	$s_x = s_y$	θ
Value	0	$\sqrt{2}$	1	0.75

- Eliminate asymmetry in fundamentals, only asymmetry is from info.
- Mean of aggregate log endowment is 1.
- Elasticity of substitution is $1/(1-\theta) = 4$.
- Variance s matters relative to signal precision. We vary signal precision.
- Results are averages over many simulations.

Parameters

Results Overview

- **Information globalization**: Vary precision $\tilde{s}^{-2}$.
  (symmetric changes)
- Main result: Information globalization reduces trade.
- Three parts to the explanation:
  1. **Trade Coordination**: Information $\uparrow$ $Corr[T_x, T_y]$
  2. **Risk sharing**: $\downarrow$ $Corr[C, C^*]$, $Corr[C_x, C_y]$
  3. **Trade flows**: $\downarrow$ export share $\mathbb{E}[\Psi/(1-\Psi)]$. Volume $E[T]$ ambiguous.
- At the end: welfare and the role of elasticity.

Result 1: Information $\uparrow$ coordination

Proposition

In a neighborhood around perfect information, increasing the precision of both countries' signals $\tilde{s}^{-2}$ reduces var$(\Psi \perp \Psi^*)$.

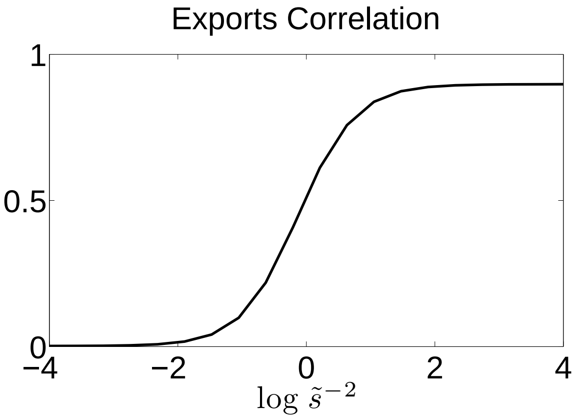
- Ex: With perfect info, $\Psi = 1 - \Psi^*$.
  Co-linearity $\rightarrow$ var$(\Psi \perp \Psi^*) = 0$.
- Coordination motive: When other country exports more, relative price of your good rises, more incentive for you to export.
- Export choice:

$$\max_{\Psi} z_x \mathbb{E}\left[\left((1-\Psi)^\theta + \left(\frac{\Psi}{q}\right)^\theta\right)^{1/\theta} \Big| (\mu_x, \hat{m}_y)\right]$$

More foreign exports enters as lower q. Raises benefit of exporting Ψ.

Result 1: Information ↑ coordination

- Without information, coordination is impossible.



Horizontal axis is log signal precision. Vertical axis is $corr(T_x, T_y)$.

Result 2: Information $\downarrow$ risk-sharing

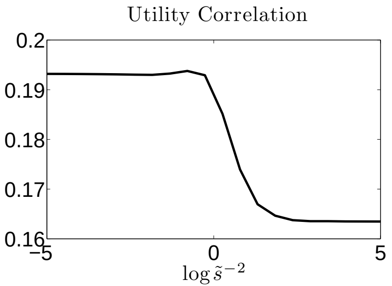
- Recall that information facilitates coordination. Next: Coordination prevents prices from fluctuating enough to share risk.

Proposition

Take the home country's export policy as given by fixing the distribution of T_x. If foreign firms coordinate more (var$(T_y \perp T_x)$ falls), then var$(1/q)$ decreases.

- Relative price is $q = T_x/T_y$.
- When T_x and T_y move proportionately, q stays constant.
- Like a sticky price.
- But price changes are central to risk-sharing.
  High prices compensate for low endowment & v-versa.

Result 2: Information ↓ risk-sharing



- Consumption correlation measures risk-sharing.
- Ex: with perfect risk-sharing
  - All endowments are split proportionately: $T_x = \alpha\mu_x$, $T_y = (1-\alpha)\mu_y$.
  - Exports are uncorrelated: $corr(T_x, T_y) = 0$ because endowments (μ_x and μ_y) are uncorrelated.
  - But consumption is perfectly correlated: $corr(C, C^*) = 1$.

Result 3: Information $\downarrow$ trade

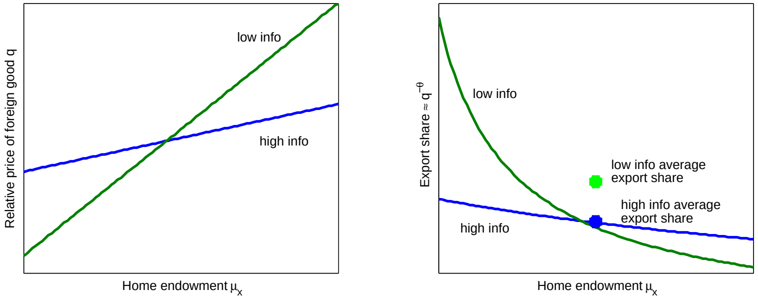
- Recall that information $\downarrow$ price variance.
- Next result proves that lower price variance reduces trade (holding mean price and covariance with consumption fixed).

Proposition

Holding fixed $cov(C^{1-\theta}, q^{\theta})/E[C^{1-\theta}]$*, a mean-preserving decrease in* $var(1/q)$ *increases the trade share* $\Psi/(1-\Psi)$*.*

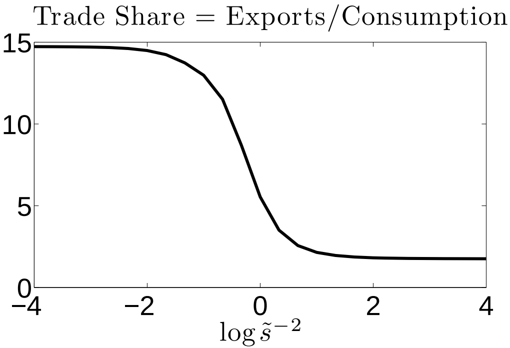
Why? b/c exports are a convex function of price.

Result 3: Information ↓ trade



- Information flattens the price function (sticky price).
- Exports are convex function of that relative price.
  Convexity is hedging risk of low foreign consumption (c_y).
- Lower price variance → lower average trade.

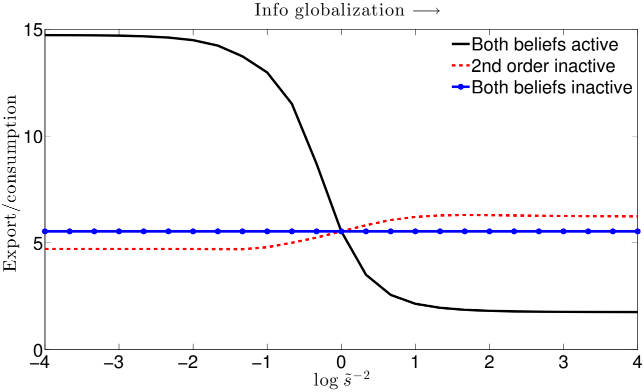
Result 3: Information ↓ trade



- Doubling precision can halve the trade share (near $\tilde{s}^{-2} = 1$).

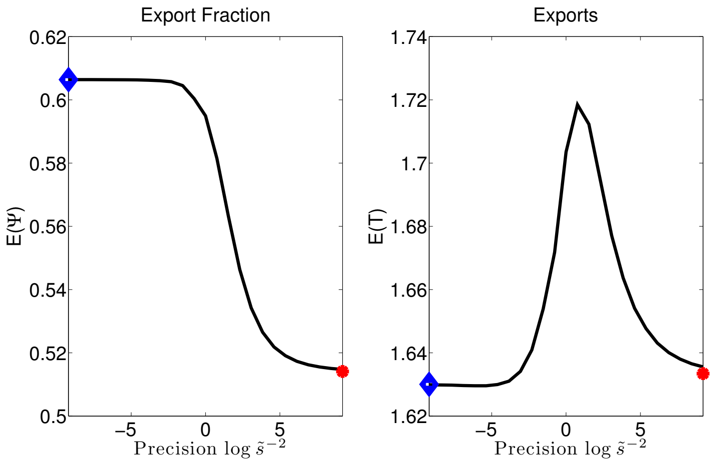
Key Mechanism: 2nd-order beliefs

- Fix beliefs about other country's precision (2nd order inactive). Increase true signal precision (1st order active). Trade does not fall.



Trade share vs. total exports

- Decrease in share $\mathbb{E}[\Psi/(1-\Psi)]$ and non-monotonic effect on volume $\mathbb{E}[T]$.



Non-monotonic effect on volume $\mathbb{E}[T]$

- How can volume rise while share falls?
  - Since $T = e^{\mu+\frac{\sigma^2}{2}}\Psi = f\Psi$:

$$\uparrow \mathbb{E}[T] = \mathbb{E}\left[f\right]\mathbb{E}[\Psi] \downarrow + \mathbb{C}\left[f,\Psi\right] \uparrow$$

- Covariance comes from **coordination**:
  - As $\tilde{s}^{-2}$ rises, good shocks at home can be better anticipated abroad:

$$f_x \uparrow \quad T_x \uparrow \quad \Longrightarrow_{\hat{m}_x} \quad \mathbb{E}[q|\mathcal{I}_y] \uparrow \quad T_y \uparrow$$

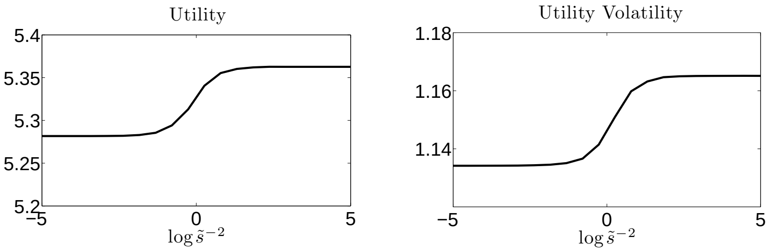
  - Foreign response is better anticipated at home, inducing more exports:

$$T_y \uparrow \quad \Longrightarrow_{\hat{\hat{m}}_x} \quad \mathbb{E}[q|\mathcal{I}_x] \downarrow \quad T_x \uparrow$$

Uncertainty

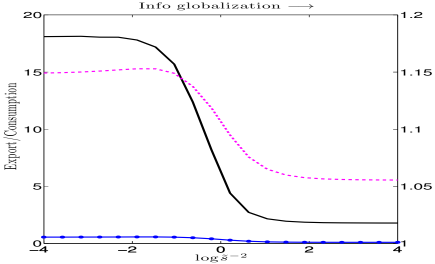
Information increases welfare

Information globalization increases average utility, but also increases utility volatility.



- Trade correlation → balanced consumption bundles. Balance increases utility.

The Role of Elasticity



- Elasticity of substitution does not change the direction of the info effect on trade.
- For low elasticity (blue line = 1.01, almost Cobb-Dgls) trade shares nearly constant.
- For medium (pink =1.25) and high (black=4) elasticity, trade share is more sensitive to information.

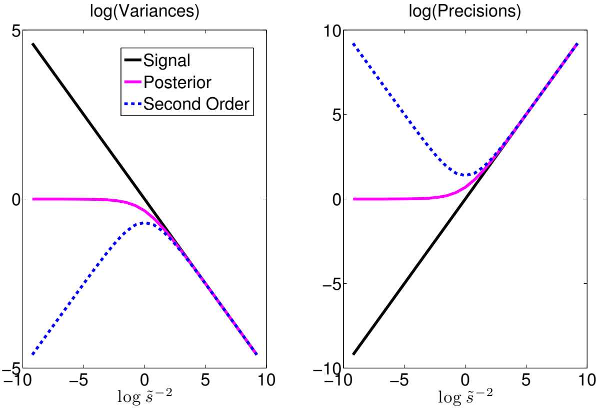
Conclusion

- Asymmetric information frictions don't look at all like iceberg costs.
- Why does better information reduce trade?
  - It allows us to coordinate exports more,
  - which makes the relative price sticky.
  - Mathematically: Export share is a convex function of relative price, so less variation in relative price makes export share fall.
  - Economically: Sticky prices share less risk. Less risk sharing $\rightarrow$ less trade.
- What frictions might inhibit cross-border trade?
  - Firm-specific info? Maybe equilibrium effects are weaker.
  - Delegation and monitoring frictions?
- Why don't countries share more risk? b/c they know too much.

Additional material

How does uncertainty change with information?

- Uncertainty about foreign shocks decreases with signal precision.
- Uncertainty about foreign beliefs increases, then decreases.



back

Parameters

- Model parameters

Parameter	$m_x = m_y$	$\sigma_x = \sigma_y$	$s_x = s_y$	θ
Value	0	$\sqrt{2}$	1	0.75

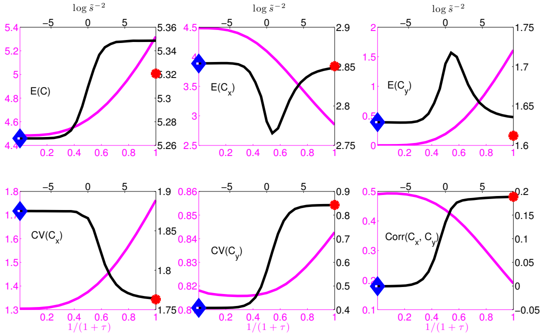
- Solve fixed point problem (Ψ, Ψ^*, q).
- Simulate independent random draws of productivity and signal noise.
- Compute unconditional moments.

back

Utility components

- A second order approximation to $\mathbb{E}[C]$ around $(\mathbb{E}[C_x], \mathbb{E}[C_y])$ yields:

$$\bar{C} + \frac{(1-\theta)\bar{C}}{2}\left(\frac{\mathbb{E}[C_x]}{\bar{C}}\right)^{\theta}\left(\frac{\mathbb{E}[C_y]}{\bar{C}}\right)^{\theta}\Big(\underbrace{2(1+Corr[C_x, C_y])\mathbb{CV}[C_x]\mathbb{CV}[C_y]}_{\text{balance}} - \underbrace{(\mathbb{CV}[C_x]+\mathbb{CV}[C_y])^2}_{\text{volatility}}\Big)$$



Characterization (1/2)

- **Optimal exports**: Every firm exports the same fraction of their endowment

$$t(z, \mu_x, \hat{m}_y) = z\Psi(\mu_x, \hat{m}_y), \quad t(z, \mu_x, \hat{m}_y) = z\Gamma(\mu_x, \hat{m}_y)$$

- **Aggregate exports**

$$T_x(\mu_x, \hat{m}_y) = \int z_x \Psi(\mu_x, \hat{m}_y) dF(z_x|\mu_x) = e^{\mu_x + \frac{1}{2}\sigma_x^2}\Psi(\mu_x, \hat{m}_y) = f_x \Psi(\mu_x, \hat{m}_y)$$

$$T_y(\mu_y, \hat{m}_x) = \int z_y \Gamma(\mu_y, \hat{m}_x) dF(z_y|\mu_y) = e^{\mu_y + \frac{1}{2}\sigma_y^2}\Gamma(\mu_y, \hat{m}_x) = f_y \Gamma(\mu_y, \hat{m}_x)$$

- **Equilibrium relative price**

$$q(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y) = f(\mu_x, \mu_y)\frac{\Psi(\mu_x, \hat{m}_y)}{\Gamma(\mu_y, \hat{m}_x)}$$

where $f(\mu_x, \mu_y) \equiv \exp[(\mu_x - \mu_y) + 1/2(\sigma_x^2 - \sigma_y^2)]$ is relative fundamentals.

Characterization (2/2)

- Optimal fraction of exports depends on what agents believe will be the fraction of output that others will export.

$$\begin{aligned}
\Psi(\mu_x, \hat{m}_y) &= \arg\max \int\int \left((1-\Psi)^\theta + \left(\frac{\Psi}{(1+\tau) q(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y)} \right)^\theta \right)^{1/\theta} dF(\mu_y|\mathcal{I}_x) dF(\hat{m}_x|\mathcal{I}_x) \\
\Gamma(\mu_y, \hat{m}_x) &= \arg\max \int\int \left((1-\Psi)^\theta + \left(\frac{\Psi q(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y)}{(1+\tau)} \right)^\theta \right)^{1/\theta} dF(\mu_y|\mathcal{I}_x) dF(\hat{m}_x|\mathcal{I}_x) \\
q(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y) &= f(\mu_x, \mu_y) \frac{\Psi(\mu_x, \hat{m}_y)}{\Gamma(\mu_y, \hat{m}_x)}
\end{aligned}$$

- Fixed point problem:

$$\begin{aligned}
\Psi &= g_1(\mathcal{I}_x, q) \\
\Gamma &= g_2(\mathcal{I}_y, q) \\
q &= f \frac{\Psi}{\Gamma}
\end{aligned}$$

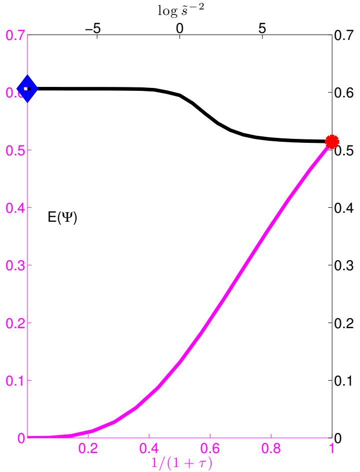
back

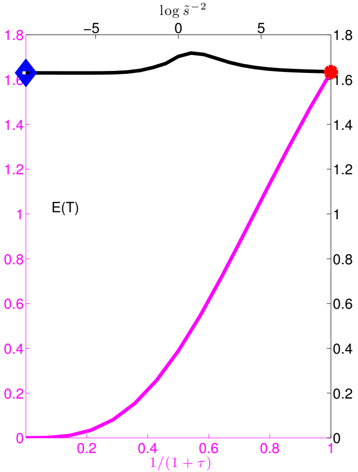
Information decreases trade but increases utility and risk.

	No info $\tilde{s}^{-2} = 0$	Noisy signals $\tilde{s}^{-2} = 2$	Full info $\tilde{s}^{-2} = \infty$
$\frac{\text{Exports}}{\text{Endowment}}$	0.60	0.58	0.51
	(0.26)	(0.24)	(0.22)
Total Exports	1.63	1.72	1.63
	(0.66)	(1.09)	(1.37)
Relative Price of y	1.32	1.19	1.09
	(1.36)	(0.79)	(0.42)
Utility	5.25	5.30	5.33
	(1.13)	(1.15)	(1.16)

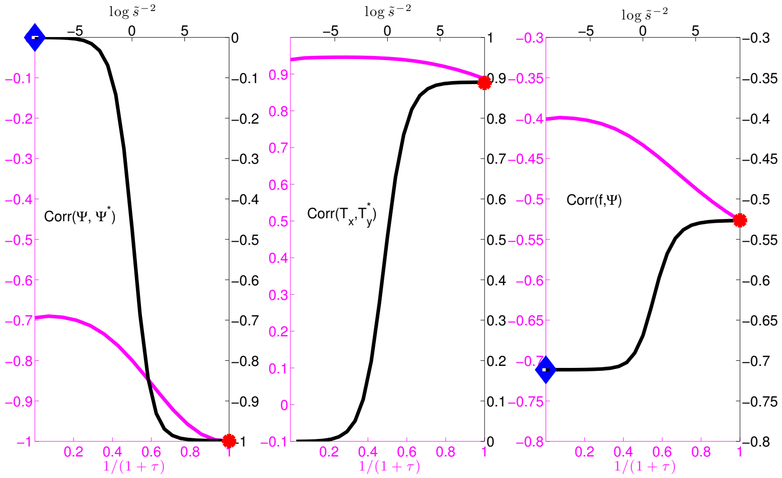
- Averages (dispersion) across simulations.
- Total endowment in each country: average 4.48 (5.79).

Trade flows with both frictions (same scale)

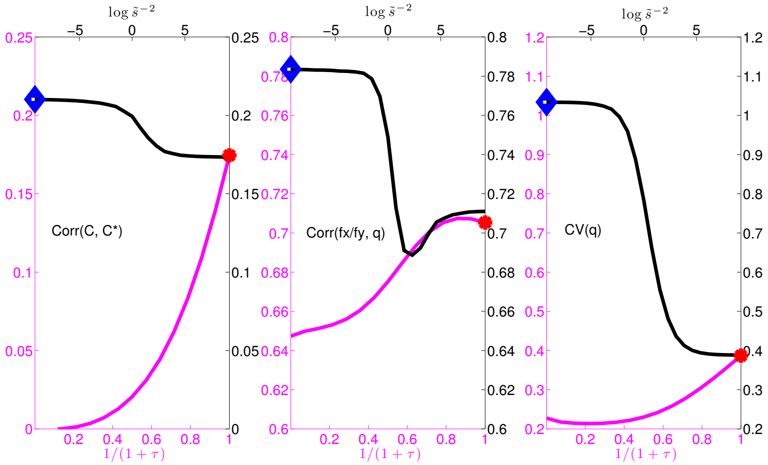




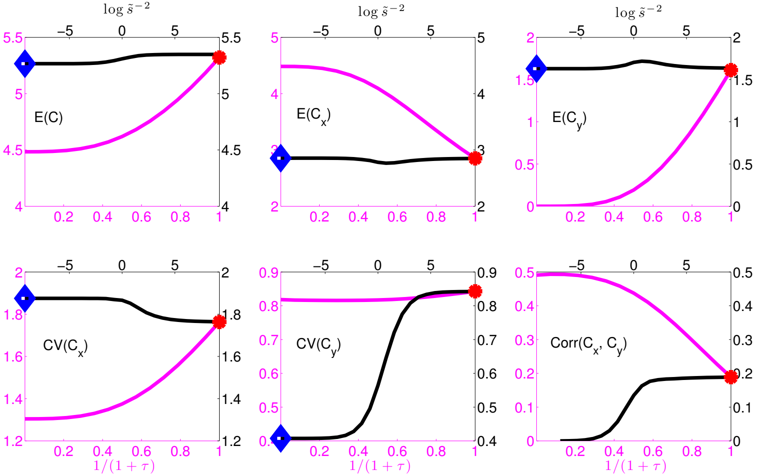
Coordination with both frictions (same scale)



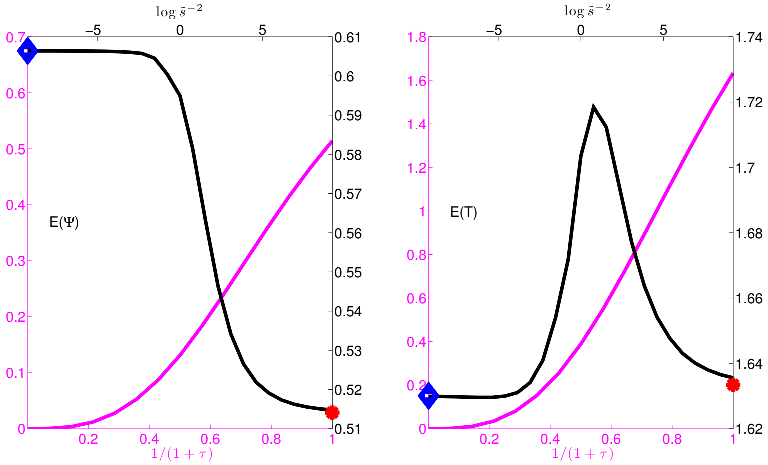
Risk sharing with both frictions (same scale)



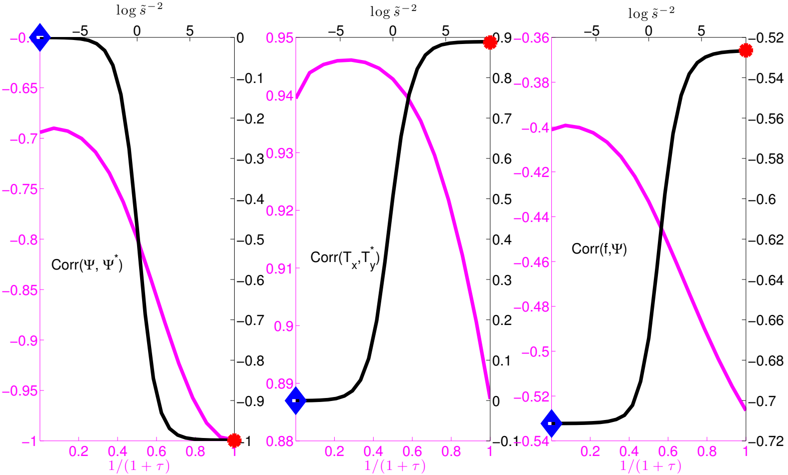
Utility components with both frictions (same scale)



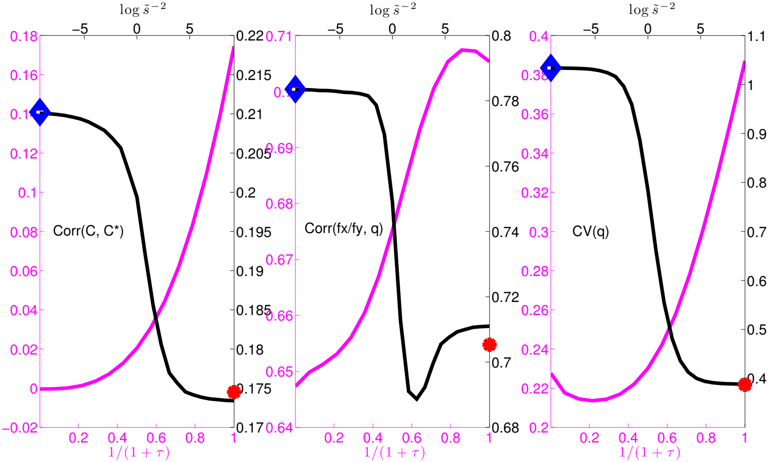
Trade flows with both frictions (individual scales)



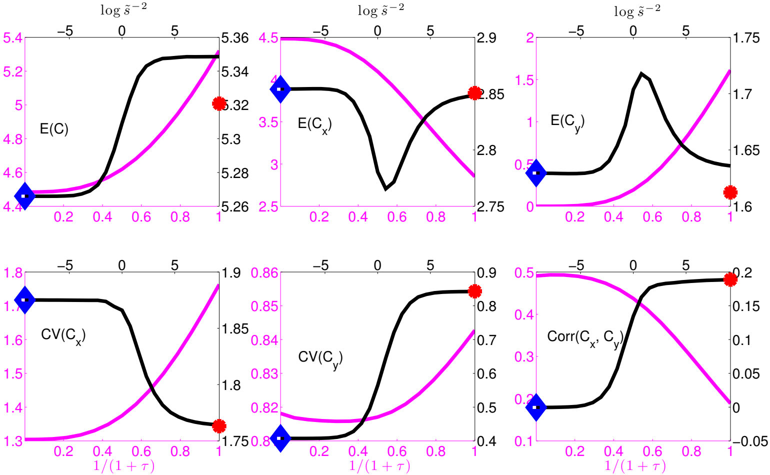
Coordination with both frictions (individual scales)



Risk sharing with both frictions (individual scales)

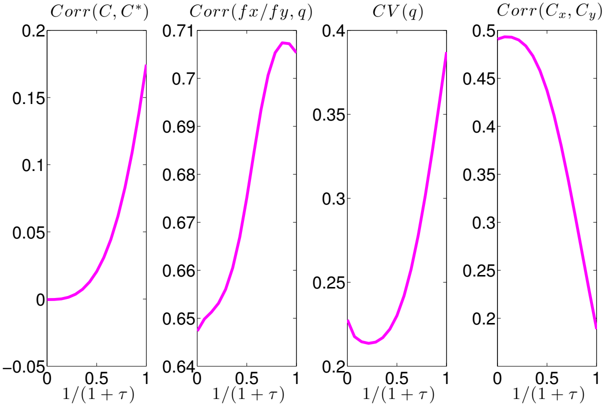


Utility components with both frictions (individual scales)



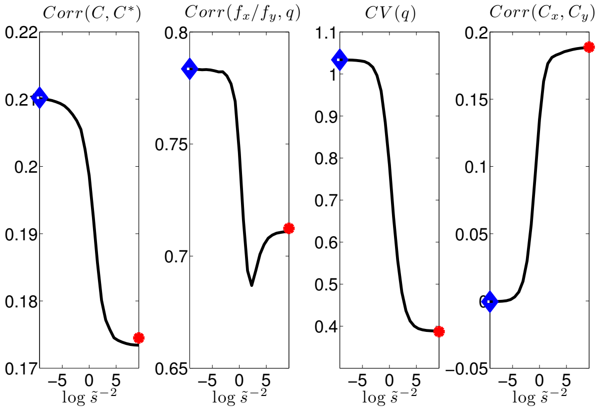
Trade liberalization increases risk sharing

- Utility correlation rises: $Corr[C, C^*] \uparrow$.
- Prices allow shocks to be transmitted, good hedge.
- Consumptions reflect *iid* endowments.



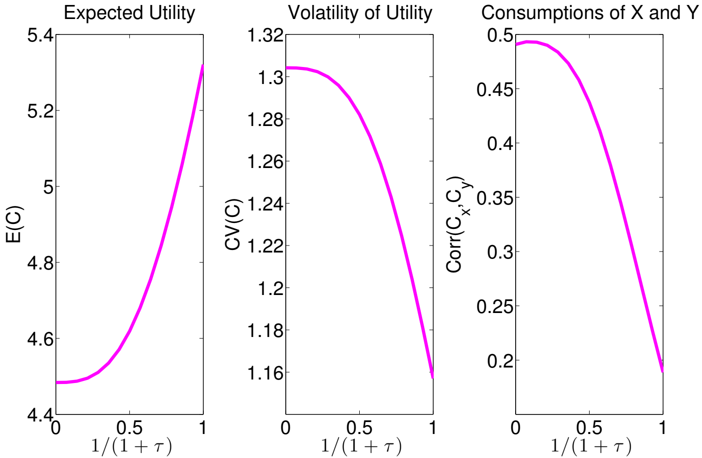
Information globalization decreases risk sharing

- Utility correlation falls: $Corr[C, C^*] \downarrow$.
- Terms of trade are a less effective to hedge against productivity shocks. (**?**, **?**).



Trade liberalization increases welfare

- Trade liberalization increases utility $\mathbb{E}[C]$ and decreases its volatility.



Information globalization increases welfare

- Utility $\mathbb{E}[C]$ and its volatility increase.