Information Globalization

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June 1, 2016

Big Picture

Questions:

What are the nature of the frictions to international trade?

How do information frictions affect the incentives to trade?

This Paper:

Two-country, two-good, endowment economy + **asymmetric information**

- Agents know home endowment, noisy signals about foreign endowment.
- Exports are chosen before terms of trade are realized.

Derive conditions when information frictions decrease or **increase** trade.

- "Standard model" with CES preferences and plausible elasticities of substitution. . . information frictions **increase** trade.

Main Idea...

Conventional wisdom...

- Information frictions introduce volatility in the terms of trade.
- Concave objective function $\Rightarrow$ information friction reduces trade.

Our insights...

1. Information frictions affect the expected terms of trade as well.

   Thus, trade's response depends on the tradeoff between a higher mean, but more variance. General equilibrium is key.

2. Trade's response to variance depends on "precautionary" motives.

   Trade less and consume more of certain home good or...trade more to insure a minimal amount of the foreign good?

Our Contribution...

Very much inspired by two papers...

- Allen (2014),
- Steinwinder (2015).

Our value added: A general account of how information frictions affect trade.

- An very standard model of trade + simple model of asymmetric info, in general equilibrium.
- General conditions on preferences that describe how and why trade is affected by information frictions.
- (Hopefully) Pave the way for future empirical applications.

Model: Time and Consumers

Repeated, static model.

Two countries (x and y); a continuum of agents in each country.

Preferences:

$$\mathbb{E}\left[U(c_x, c_y)\right].$$

- U is increasing and concave in both goods.

Model: Endowments and Consumption Opportunities

Individual endowments:

- Country x agents: z_x units of good x, $\ln z_x \sim \mathcal{N}(\mu_x, \sigma_x^2)$,
- Country y agents: z_y units of good y, $\ln z_y \sim \mathcal{N}(\mu_y, \sigma_y^2)$.

Aggregate shocks:

- Country x: $\mu_x \sim \mathcal{N}(m_x, s_x^2)$,
- Country y: $\mu_y \sim \mathcal{N}(m_y, s_y^2)$.

Budget sets (for a typical x agent)

$$c_x \in [0, z_x - t_x], \quad \text{and} \quad c_y \in [0, pt_x]$$

where t_x are exports; p is the relative price of good x to good y.

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

Model: Timing and Information Structure

Distributional parameters known; realizations not.

Timing. . .

1. Observe own idiosyncratic shock, z, and domestic aggregate shock μ.
2. Receive noisy and common signal about foreign aggregate shock:
   - 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. Write export contracts (next slide).
4. Markets clear at realized relative price p.
5. Consume.

Export Contracts

We consider two contracting arrangements...

1. Non-state-contingent contracts: All agents choose exports ex-ante given a forecasted relative price.

   The baseline.

2. State-contingent contracts: Some agents can choose price-contingent menu of exports.

   End of the talk—how market incompleteness matters.

Forecasting Prices

Key issue: Agents must forecast relative prices given μ_x and $\tilde{m}_y$.

1. My beliefs about foreign productivity:

$$F(\mu_y|\mathcal{I}_x) = \mathcal{N}\left(\hat{m}_y, \hat{s}_y^2\right) \quad \text{where} \quad \hat{m}_y = \frac{s_y^{-2} m_y + \tilde{s}_y^{-2} \tilde{m}_y}{s_y^{-2} + \tilde{s}_y^{-2}}, \quad \hat{s}_y^2 = \frac{1}{s_y^{-2} + \tilde{s}_y^{-2}}$$

2. My beliefs about foreign beliefs about my productivity:

$$F(\hat{m}_x|\mathcal{I}_x) = \mathcal{N}\left(\hat{\hat{m}}_x, \hat{\hat{s}}_x^2\right) \quad \text{where} \quad \hat{\hat{m}}_x = \frac{s_x^{-2} m_x + \tilde{s}_x^{-2} \mu_x}{s_x^{-2} + \tilde{s}_x^{-2}}, \quad \hat{\hat{s}}_x^2 = \frac{\tilde{s}_x^{-2}}{(s_x^{-2} + \tilde{s}_x^{-2})^2}$$

Note: Posterior means $(\hat{m}_y, \hat{\hat{m}}_x)$ are sufficient statistics to forecast the price.

Equilibrium

A competitive rational expectations 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 $\{F(\mu_x|\mathcal{I}_y), F(\hat{m}_y|\mathcal{I}_y)\}$
- a price function $p(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y)$

such that...

- given beliefs and price function, exports policies maximize utility,
- export policies are consistent with market clearing and the price function.

Aggregation

Individual exports

$$t(z_x, \mu_x, \hat{m}_y).$$

Aggregate exports

$$T_x = \int t(z_x, \mu_x, \hat{m}_y) f(z_x) dz_x$$

Relative price of home to foreign goods or terms of trade

$$p = \frac{T_y}{T_x}.$$

Plan of Attack

Main exercise:

How do symmetric changes in the precision $\tilde{s}^{-2}$ of signals affect trade?

How we answer this question . . .

1. Conditions on utility.
2. How information affects the mean and variance of the terms of trade.
3. How information affects trade.
4. Parametric/numerical examples.

If time. . . risk sharing, state-contingent contracts, other interpretations.

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Condition M: Increase in $\mathbb{E}[p]$, Increases Exports.

Let $\rho_y \equiv -\frac{C_y U_{yy}}{U_y}$ coefficient of relative risk aversion of risky good y.

Condition M: If the utility function satisfies

$$\rho_y \left(1 - \frac{U_{xy}/p}{U_{yy}}\right) < 1,$$

the marginal utility of exports is strictly increasing in the terms of trade.

$\Longrightarrow$ **An increase in $\mathbb{E}[p]$, increases exports.**

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Two perspectives on this condition...

- Requires low complementarity (U_{xy} small or negative).
- Requires low risk aversion (adjusted for second good (Karni '79)).

Condition V: Increase in $Var(p)$ Increases Exports.

Let $\pi_y \equiv -\frac{C_y U_{yyy}}{U_{yy}}$ be the coefficient of relative prudence (RP) of risky good y.

Condition V: If the utility function satisfies

$$\pi_y \left(1 - \frac{U_{xyy}/p}{U_{yyy}}\right) > 2,$$

then expected marginal utility of exports is strictly convex in the terms of trade.

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Condition to have **"precautionary"** motives dominate.

- Rothschild and Stiglitz (1971): Save less and consume more with certainty today **or** save more to insure a minimal level of consumption tomorrow?
- In our context: Trade less and consume more of home good with certainty **or** trade more to insure a minimal amount foreign good.
- Depends on third derivative of utility function or "prudence" as above.

Two Conditions on Utility (Everything together...)

Condition M: **low complementarity**

$$\rho_y \left(1 - \frac{U_{xy}/p}{U_{yy}}\right) < 1,$$

the marginal utility of exports is strictly increasing in the terms of trade.

Condition V: **large prudence**

$$\pi_y \left(1 - \frac{U_{xyy}/p}{U_{yyy}}\right) > 2,$$

then marginal utility of exports is strictly convex in the terms of trade.

Two important implications:...

- Condition **M**: $\Rightarrow$ an increase in $\mathbb{E}[p]$ increases exports.
- Condition **V**: $\Rightarrow$ an increase in $Var[p]$ increases exports.

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Information Increases Coordination

Proposition 1 (**Information Increases Coordination**)

If utility satisfies Condition **M**, then more information increases the covariance between aggregate exports

To understand this, consider these two cases...

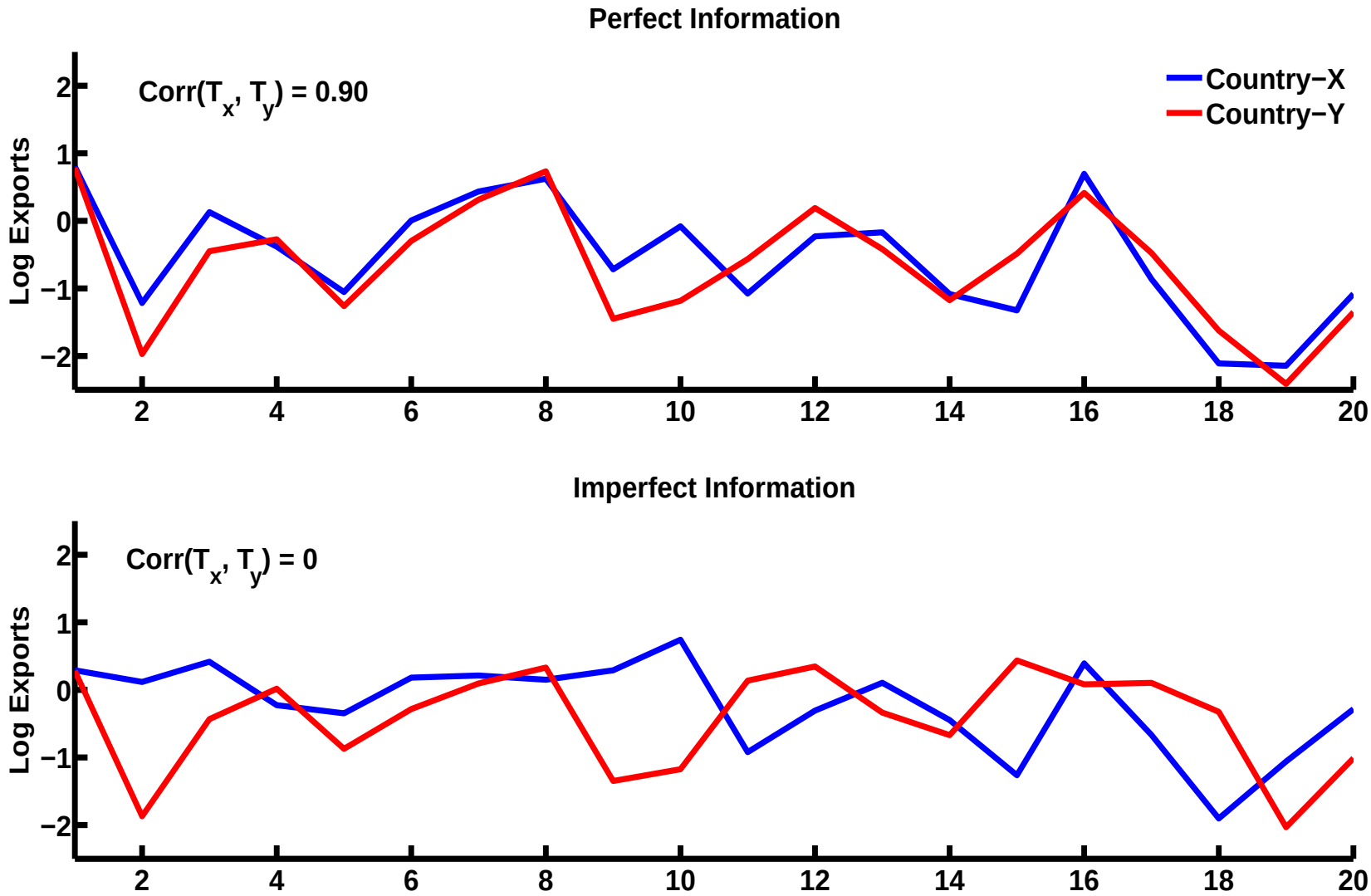
- Perfect information:

  Positive shock in foreign, they export more. Home knows his terms of trade will improve, thus export more and substitute into the foreign good.

- No information:

  Home country does not know this and exports just on his state. Exports are uncorrelated.

Information Increases Coordination



Information Reduces TOT Volatility and Mean

Proposition 2 (**Information Reduces the Volatility and the Mean**)

More coordination decreases...

1. The volatility of the terms of trade for both countries— "variance effect."
2. The expected terms of trade for both countries— "mean effect."

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Unconditional variance of the terms of trade

$$\mathrm{Var}\left(\frac{p_x}{p_y}\right) \approx \frac{2\mathrm{Var}[T_x]}{\mathbb{E}[T_x]^2} - \frac{2\mathrm{Cov}[T_x, T_y]}{\mathbb{E}[T_x]^2}.$$

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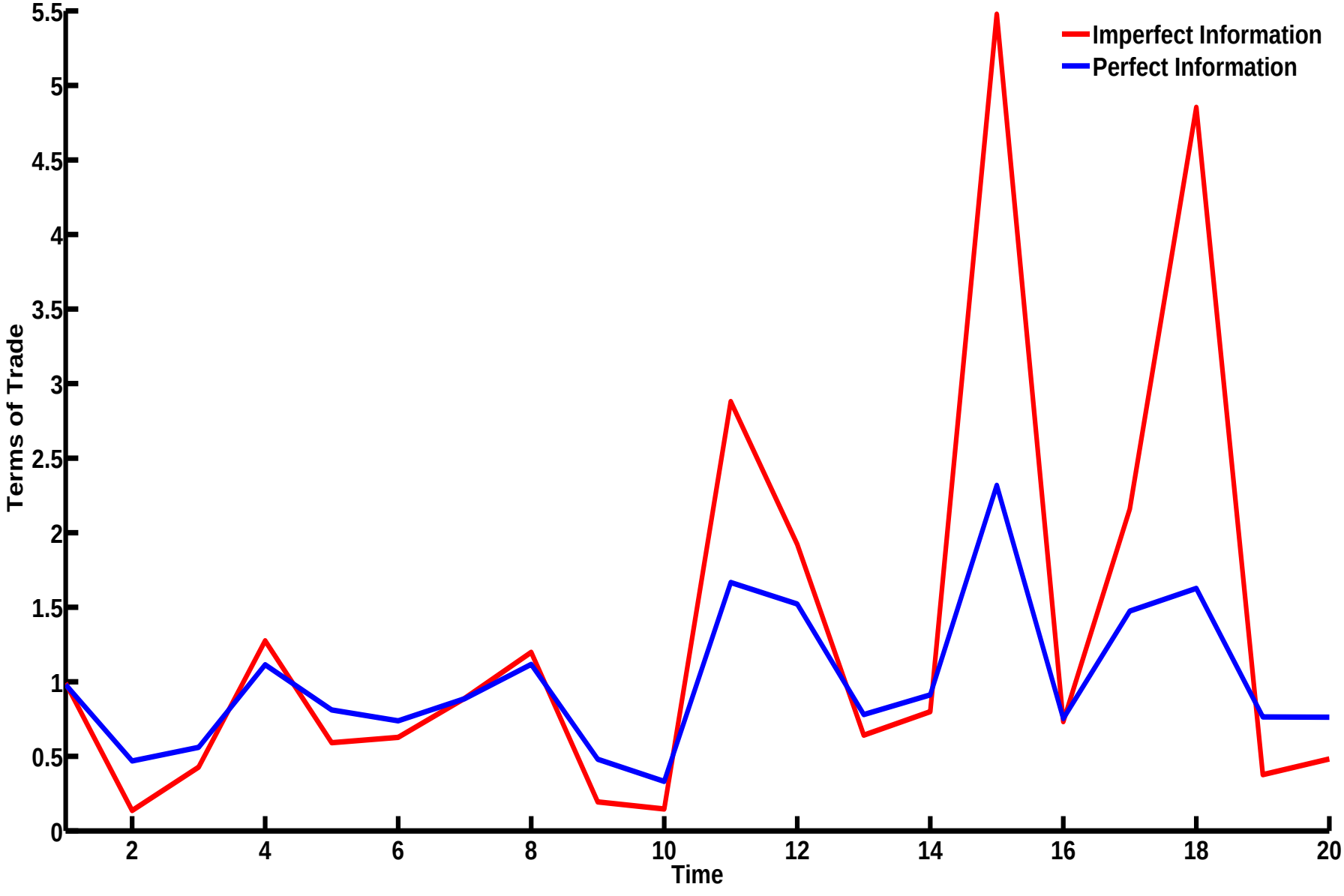
Unconditional mean of the terms of trade

$$\mathbb{E}\left[\frac{p_x}{p_y}\right] \approx 1 + \frac{\mathrm{Var}[T_x]}{\mathbb{E}[T_x]^2} - \frac{\mathrm{Cov}[T_x, T_y]}{\mathbb{E}[T_x]^2}.$$

Information Reduces Terms of Trade Volatility



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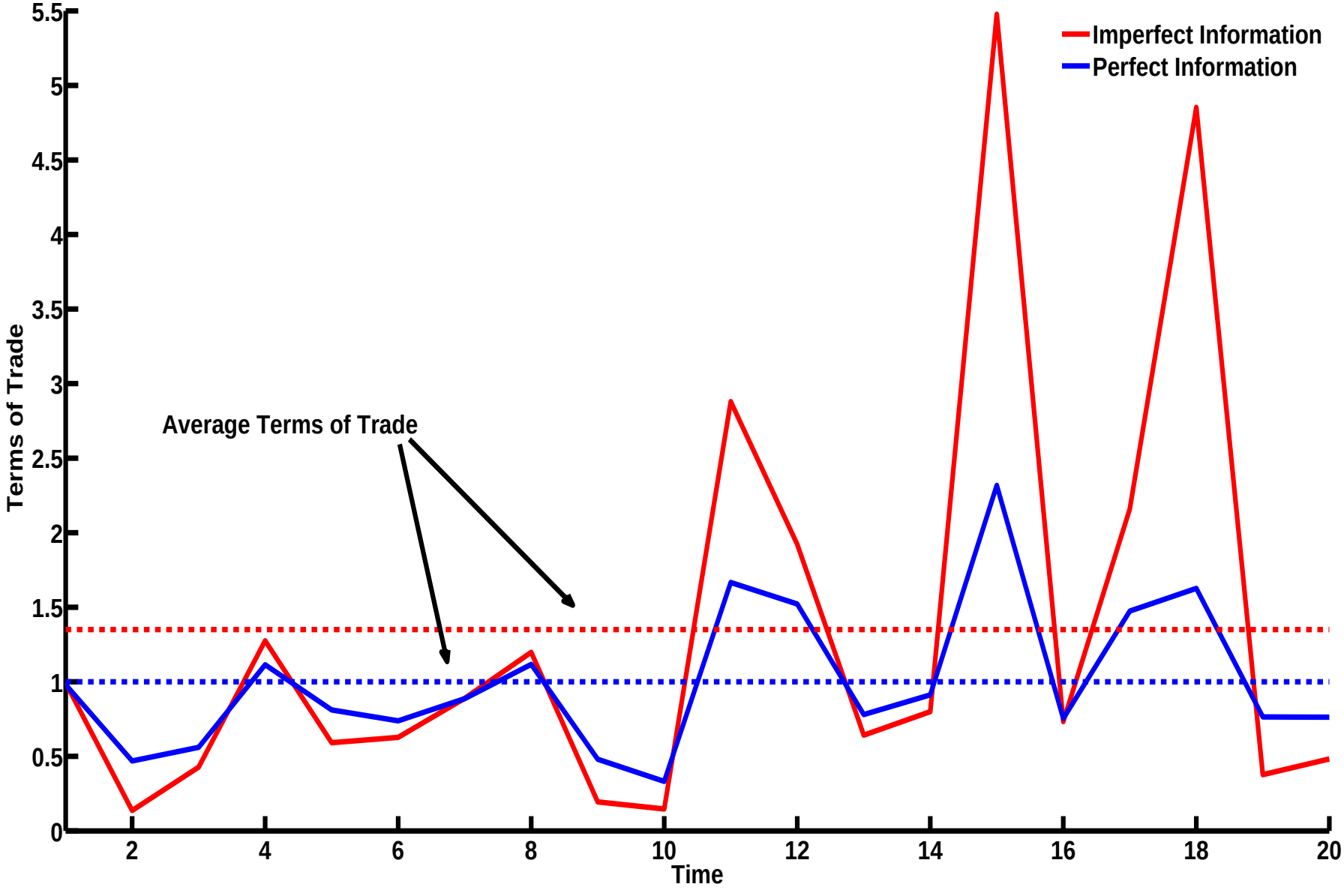

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If time. . . risk sharing, state-contingent contracts, other interpretations.

Mean Effect vs. Variance Effect

Proposition 3 (**Mean vs. Variance**)

The change in aggregate exports coming from an increases in information is the sum of Condition **M** and Condition **V**

$$\frac{\partial T}{\partial \mathbb{C}[T_x, T_y]} = \text{Condition } \mathbf{M} + \text{Condition } \mathbf{V}$$

Previous result: Information lowers the mean and variance of the terms of trade.

This result: the change in trade depends on the sum of...

- The response to the mean, Condition **M** (lower mean, less trade).
- The response to the variance, Condition **V** (lower variance, less trade).

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Example #1: Cobb-Douglas Utility

Utility of the form

$$\mathbb{E}[U(c_x, c_y)] = \mathbb{E}[c_x^{\alpha} c_y^{1-\alpha}] = \mathbb{E}[(z_x - t_x)^{\alpha}(pt_x)^{1-\alpha}]$$

In this case, policies are independent of terms of trade:

$$t_x = (1 - \alpha)z_x$$

More information does not affect trade.

- Condition $\mathbf{M} = 0$
- Condition $\mathbf{V} = 0$

Example #2: "CES like" Utility

Utility of the form

$$U(c_x, c_y) = c_x^{\theta} + c_y^{\theta}.$$

With perfect information, delivers the same trade results as in CES model.

Example #2: "CES like" Utility

Utility of the form

$$U(c_x, c_y) = c_x^\theta + c_y^\theta.$$

If $\theta > 0$, substitutability and no precautionary savings:

- Condition **M** is satisfied $\Rightarrow$
  1. Coordination leads to lower expected terms of trade, lower variance.
  2. Lower expected terms of trade decreases trade.
- Condition **V** is violated $\Rightarrow$ lower volatility increases trade.

Example #2: "CES like" Utility

Utility of the form

$$U(c_x, c_y) = c_x^\theta + c_y^\theta.$$

If $\theta < 0$, large complementarity and precautionary savings:

- Condition **M** is violated $\Rightarrow$
  1. Coordination leads to higher expected terms of trade, higher variance.
  2. Higher expected terms of trade decreases trade.
- Condition **V** is satisfied $\Rightarrow$ more volatility increases trade.

Example #3: CES

Utility of the form

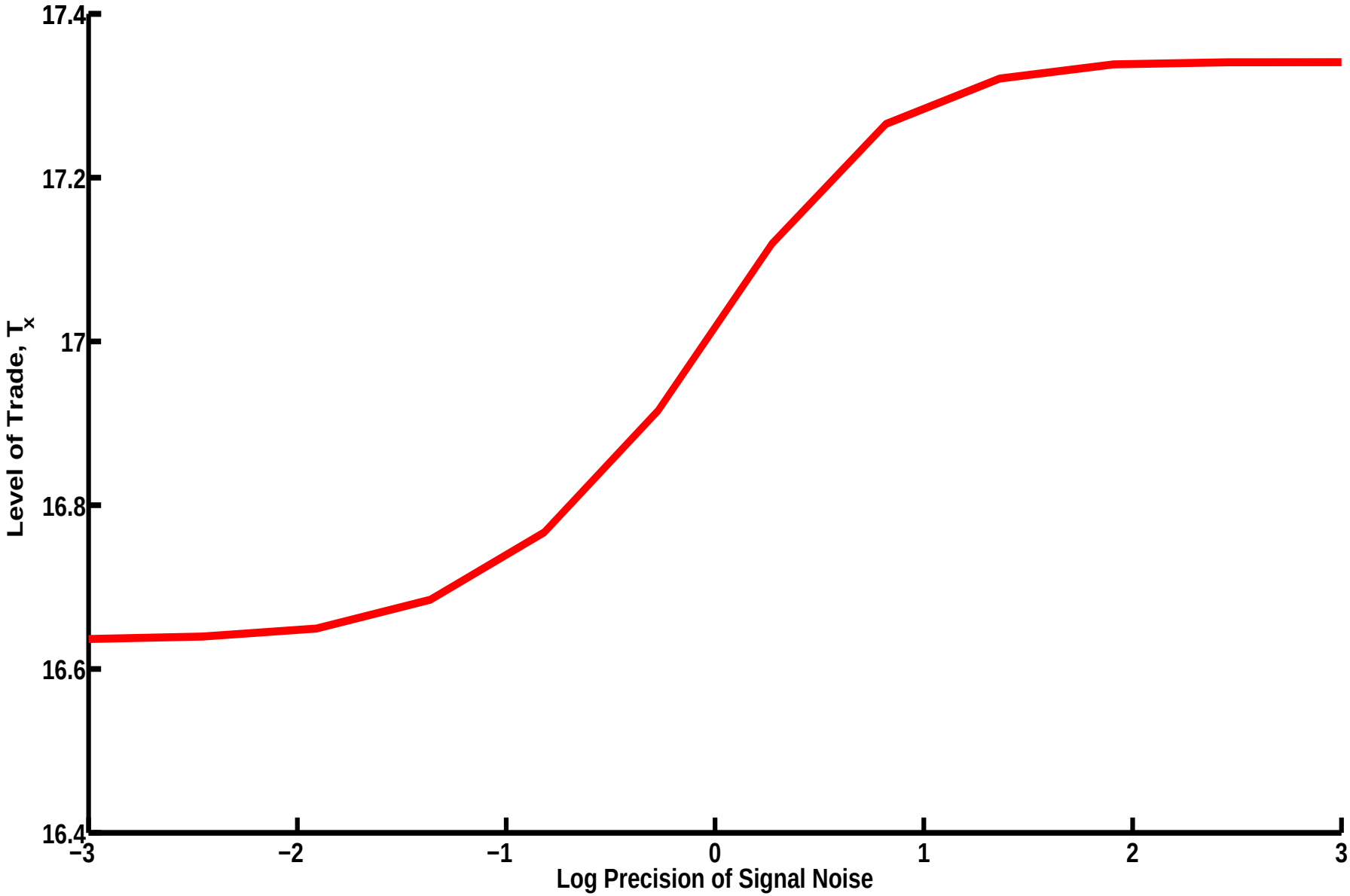
$$U(c_x, c_y) = (c_x^\theta + c_y^\theta)^{\frac{1}{\theta}}.$$

- With the elasticity of substitution $= \frac{1}{1-\theta}$.

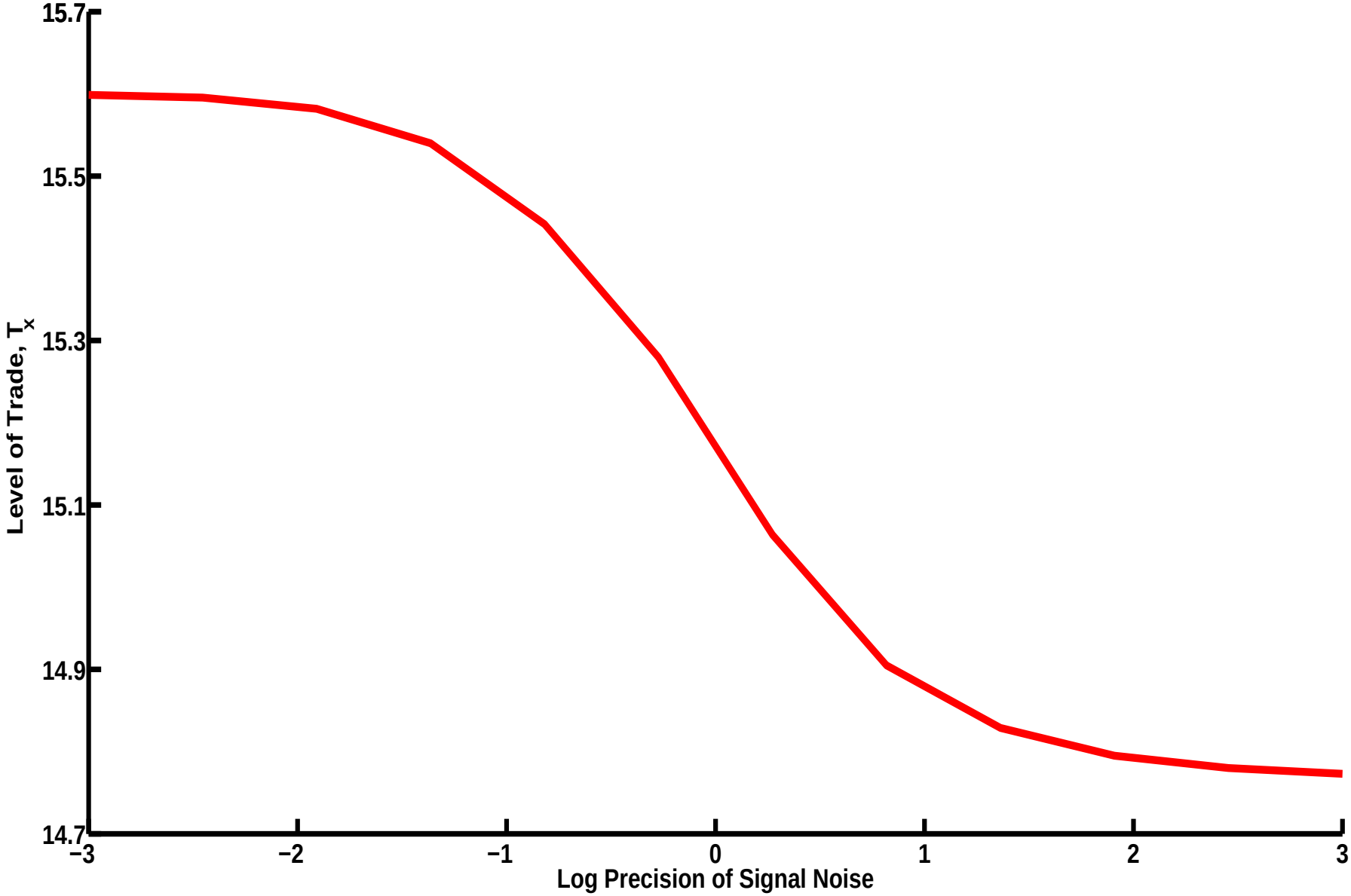
This is complicated because of the non-separability.

Next slides illustrate results numerically...its all about θ.

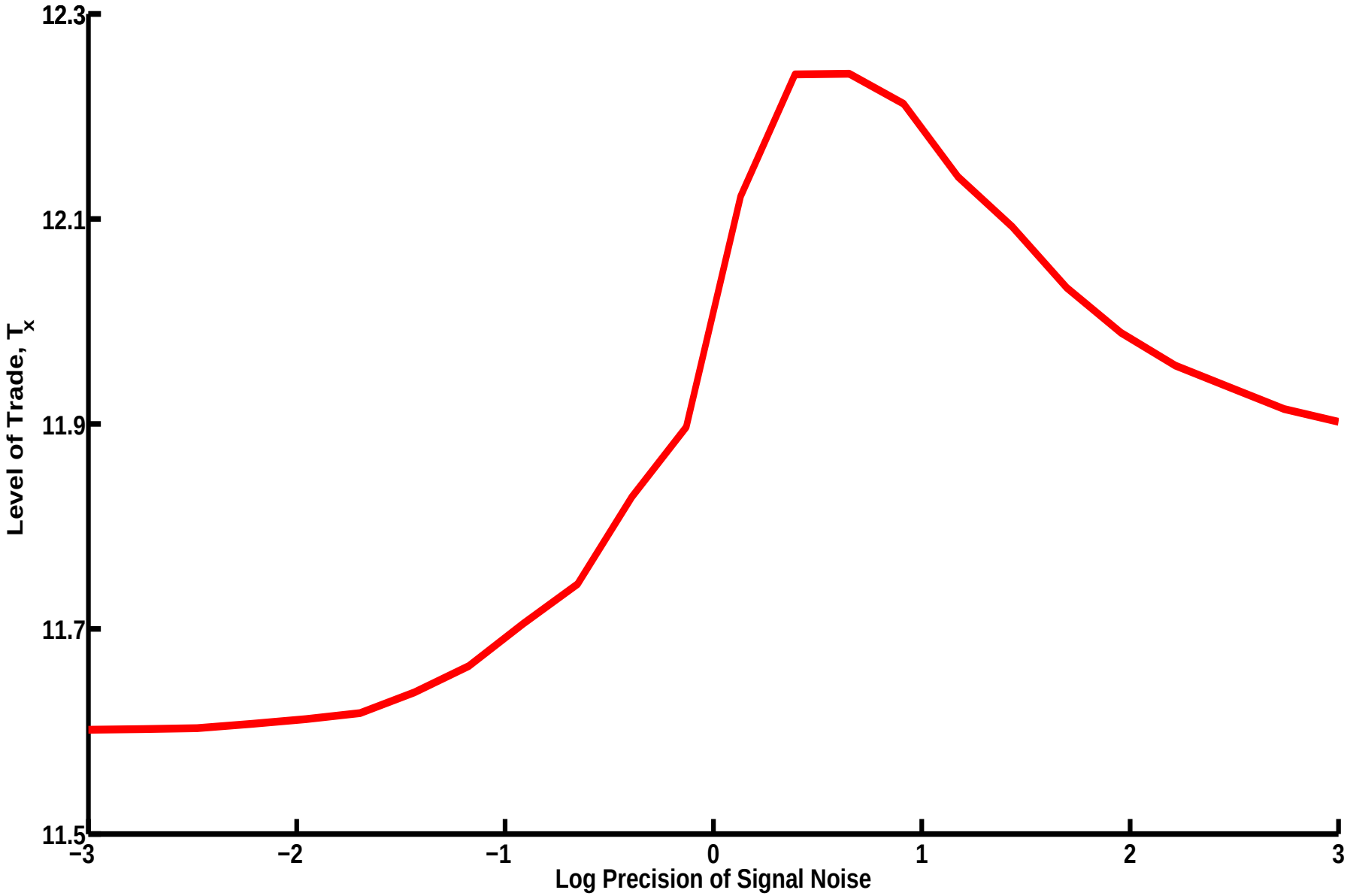
CES, $\theta < 0$: Information Increases Trade



CES, $\theta = 0.25$: Information Decreases Trade



CES, $\theta = 0.75$: Information Increases and Decreases Trade



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If time. . . **risk sharing**, state-contingent contracts, other interpretations.

Information Reduces Risk Sharing

Insight from Cole and Obstfeld (1991)

- Changes in the terms of trade share risk...
- The amount depends on how prices fluctuate with endowments... high prices compensate for low endowment and vice versa.
- Cobb-Douglas case...
  - Trade shares are fixed achieving complete risk sharing.
  - Terms of trade absorb and appropriately transfer changes in endowments.

Information increases coordination and...

- Terms of trade are less responsive to changes in endowments
- Less risk sharing

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State Contingent Export Contracts...

Is more information equivalent to completing markets? Yes.

No signals. Two types of agents in each country:

- Mass α: Submit price contingent exports

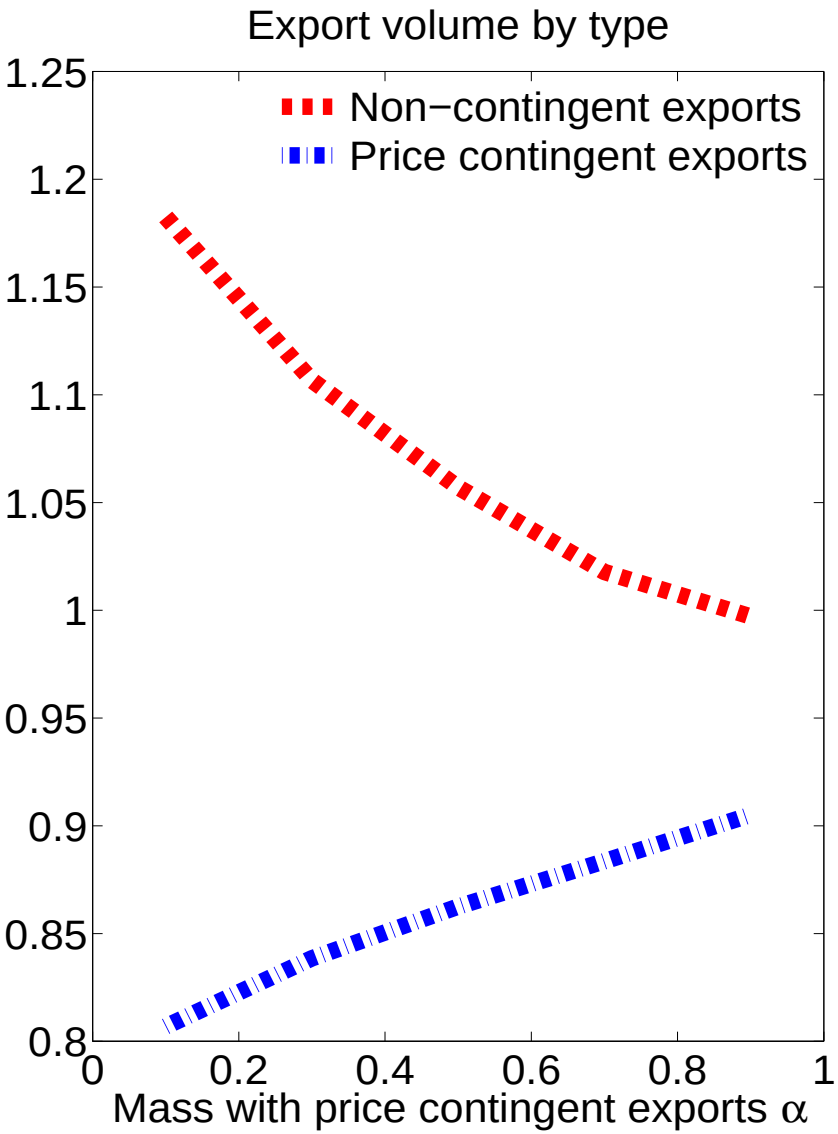
$$t_x^C(p(\mu_x, \mu_y)) \cong \text{to perfect information}$$

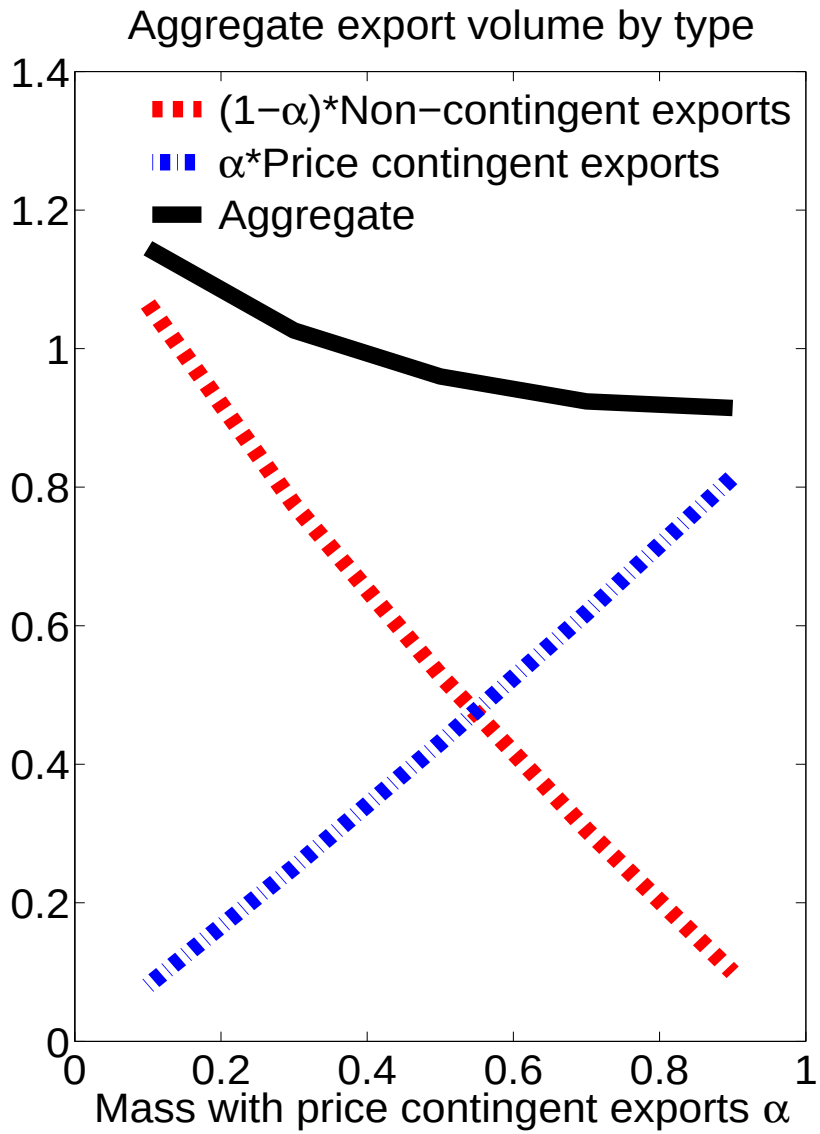
- Mass $(1 - \alpha)$: Submit non-contingent exports

$$t_x^N(\mu_x) \cong \text{to signal model w/ zero precision}$$

How does trade change as we complete markets (i.e. increase α)?

State Contingent Export Contracts ($\theta = 0.75$)





Conclusion...

"Plain vanilla" model yielded complex and unexpected results...

- Information leads to coordination affecting both the mean and variance of the terms of trade.
- Derived conditions when these forces work to increase or decrease trade.
  - Trade's response to mean depends on substitutavility/complimentarity.
  - Trade's response to variance depends on "precautionary" motives.
- CES preferences and plausible elasticities of substitution... information frictions increase trade.

Far more subtle answer than expected.

- Many interesting questions for both theory and empirics.

Appendix

Does welfare increase with more information?

- Ex-ante utility — before receiving own endowment — involves trade-off:

  balanced bundle ($\mathrm{Cov}[c_x, c_y]$) vs. consumption volatility ($\mathbb{CV}[c_x], \mathbb{CV}[c_y]$).

- Deviation between ex-ante expected utility and its Taylor approximation around the certainty equivalent $\overline{U} = U(\mathbb{E}[c_x], \mathbb{E}[c_y])$ for "CES like" case:

$$\frac{\mathbb{E}[U(c_x, c_y)]}{\overline{U}} - 1 \propto (1-\theta)\left[\frac{\mathrm{Cov}[c_x, c_y]}{\mathbb{E}[c_x]\mathbb{E}[c_y]} - \frac{\mathbb{CV}[c_x]^2}{2} - \frac{\mathbb{CV}[c_y]^2}{2}\right]$$

- Information increases trade coordination and...
  - Increases $\mathrm{Cov}[c_x, c_y]$
  - Decreases $\mathbb{CV}[c_x]$ and increases $\mathbb{CV}[c_y]$ $\sim$ volatility effects cancel out

- In CES case, key is elasticity of substitution
  - As $\theta < 1$, welfare increases w/info
  - More general cases still baking...