# Can Global Uncertainty Promote International Trade?

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## Our Question...

Very much inspired by a variety of measures of uncertainty in trade:

- Allen (2014), Handley and Limao (2017), Steinwender (2018), de Sousa, Disdier and Gaigne (2018), Caldara, *et. al.* (2019)...

Let's take simple endowment uncertainty and put it in a standard equilibrium trade model to measure information costs and benefits.

- Armington model of trade + asymmetric info + general equilibrium.
- With CES preferences, we find that **information may reduce trade**. Why? How general?
- Raises puzzles and helps to interpret existing measures.

## Main Idea

**Conventional wisdom**...

- Information frictions increase volatility of the terms of trade.
- Risk averse agents trade less.

**Our insights...**

1. **GE**: Information frictions increase expected terms of trade as well.

   Risk preferences mediate the mean–variance tradeoff.

2. **Two risks:** Consumption volatility and unbalanced bundle.

   Elasticity across goods mediates the risks tradeoff.

   - High substitution: Trade less to consume more of certain home good.
   - Low substitution: Trade more to insure minimal amount of foreign good.

# Model

## Model: Time and Consumers

Repeated, static model.

Two countries each produce one good ($x$ and $y$)

A continuum of agents in each country, with 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.

## Timing / Equilibrium

1. Observe own idiosyncratic shock, $z$, and domestic aggregate shock $\mu$.
2. Receive noisy and common signal about foreign aggregate shock:
   - $x$-country: $\tilde{m}_y = \mu_y + \eta_y, \quad \eta_y \sim \mathcal{N}(0, \tilde{s}_y^2)$,
   - $y$-country: $\tilde{m}_x = \mu_x + \eta_x, \quad \eta_x \sim \mathcal{N}(0, \tilde{s}_x^2)$.

   Update beliefs with Bayes' law:

$$\hat{m}_y = \mathbb{E}[\mu_y | \mathcal{I}_x] \quad \text{and} \quad \hat{m}_x = \mathbb{E}[\mu_x | \mathcal{I}_y].$$

3. Agents choose exports ex-ante given a forecasted relative price:

$$t_x(z_x, \mu_x, \hat{m}_y) \text{ and } t_y(z_y, \mu_y, \hat{m}_x) \text{ maximize } \mathbb{E}[U|\mathcal{I}].$$

4. Markets clear at realized relative price $p(\mu_x, \mu_y, \hat{m}_x, \hat{m}_y)$.
5. Consume.

## Aggregation

Individual exports

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

Aggregate exports

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

Relative price of home to foreign goods or terms of trade

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

Up means home goods more valuable.

What are the effects of global uncertainty on trade?

## Plan of Attack

**Global uncertainty:** symmetric changes in signal noise $\tilde{s}$

This changes endowment *uncertainty*, not endowment *volatility*.

- **Two steps:**
  1. How does uncertainty affect the mean and variance of terms of trade?
  2. How do the mean and variance of the terms of trade affect exports?
- Risk sharing interpretation

How does uncertainty affect the mean and variance of terms of trade?

Result 1 (**Uncertainty reduces correlation of exports.**)

In a neighborhood around complete certainty ($\tilde{s}_x^2$ and $\tilde{s}_y^2$ equal zero), more uncertainty moves the covariance between aggregate exports toward zero.

To understand this, consider these two cases...

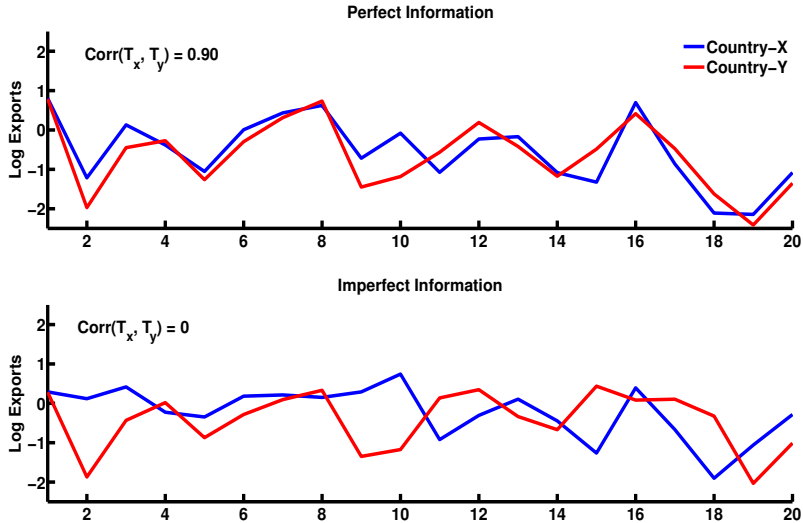
- **Perfect information:** $Corr[T_x, T_y] > 0$

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

- **No information:** $Corr[T_x, T_y] = 0$

  Exports are uncorrelated. Can't covary with what you don't know.

# Uncertainty Decreases Coordination



## Uncertainty Increases BOTH Variance and Mean of $p$

### Result 2 (**Uncertainty increases mean and variance of $p$**)

Lower export correlation $Corr[T_x, T_y] \downarrow \ldots$

- Increases the terms of trade **variance** for both countries

$$\mathrm{Var}\,[p] \;\approx\; 2\mathbb{CV}^2[T_x]\,(1 - Corr[T_x, T_y] \downarrow).$$

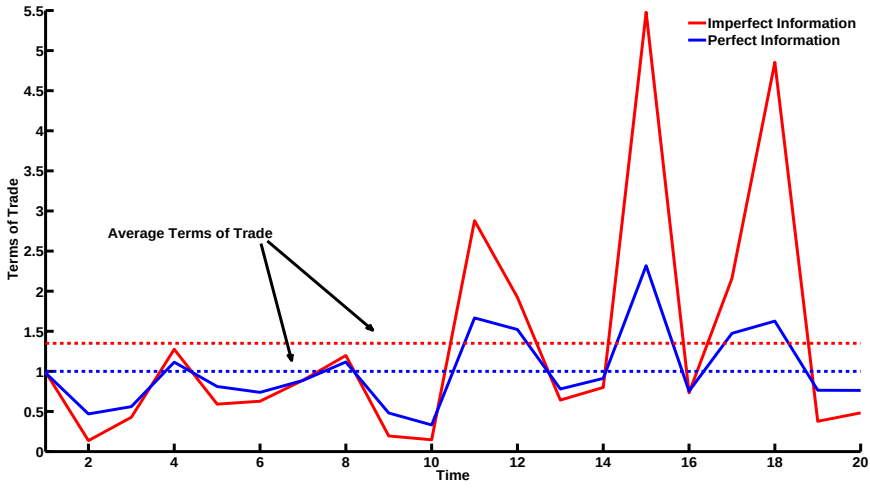
- Increases the terms of trade **expectation** for both countries

$$\mathbb{E}\,[p] \;\approx\; 1 + \mathbb{CV}^2[T_x]\,(1 - Corr[T_x, T_y] \downarrow).$$

where $\mathbb{CV}^2 \equiv \mathrm{Var}/\mathbb{E}^2$ is the coefficient of variation squared.

**Higher uncertainty $\Longrightarrow$ less coordination: "variance effect" and "mean effect."**

## Uncertainty Increases BOTH Variance and Mean of $p$




This is the ratio of the two lines plotted in the last figure ($p = T_y / T_x$).

How do the mean and variance of the terms of trade affect exports?

### Proposition 1

Suppose the mean and variance change in $\frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]}$ and $\frac{d\mathrm{Var}_x[p]}{\mathrm{Var}_x[p]}$.

Then **average exports increase** if:

$$\underbrace{\mathcal{A}_1}_{\text{risk aversion}} \frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]} + \frac{\mathbb{CV}_x^2[p]}{2}\left\{ \underbrace{\mathcal{A}_2}_{\text{prudence}} \frac{d\mathrm{Var}_x[p]}{\mathrm{Var}_x[p]} + \underbrace{\mathcal{A}_3}_{\text{temperance}} \frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]} \right\} > 0$$

What controls the overall trade response? Attitudes towards risk!

- $\mathcal{A}_1$ Risk Aversion $(U'')$ $\Longrightarrow$ Substitution Effect
- $\mathcal{A}_2$ Prudence $(U''')$ $\Longrightarrow$ Precautionary Motive
- $\mathcal{A}_3$ Temperance $(U'''')$ $\Longrightarrow$ Risk Disaggregation

## Variance-Return Tradeoff: CES

### Proposition 1

Suppose the mean and variance change in $\frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]}$ and $\frac{d\mathrm{Var}_x[p]}{\mathrm{Var}_x[p]}$.

Then **average exports increase** if:

$$\underbrace{\theta}_{\text{risk aversion}} \frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]} + \frac{\mathbb{CV}_x^2[p]}{2}\left\{\underbrace{-\theta(1-\theta)}_{\text{prudence}}\frac{d\mathrm{Var}_x[p]}{\mathrm{Var}_x[p]} + \underbrace{\theta(1-\theta)(2-\theta)}_{\text{temperance}}\frac{d\mathbb{E}_x[p]}{\mathbb{E}_x[p]}\right\} > 0$$

What controls the overall trade response? Attitudes towards risk!

$\mathcal{A}_1$ Risk Aversion $(U'')$ $\implies$ $\theta$

$\mathcal{A}_2$ Prudence $(U''')$ $\implies$ $-\theta(1-\theta)$

$\mathcal{A}_3$ Temperance $(U'''')$ $\implies$ $\theta(1-\theta)(2-\theta)$

## Variance-Return Tradeoff: CES

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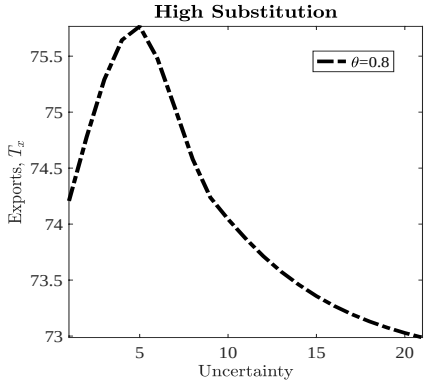
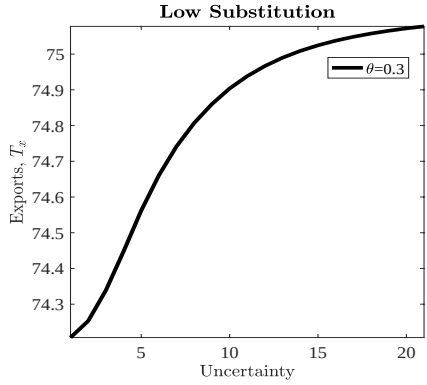
With CES, a clear variance-return tradeoff:

- More volatile return $\Rightarrow$ less exports
- More average return $\Rightarrow$ more exports

## CES: High vs. low substitution




- High substitution: uncertainty decreases trade.
- Low substitution: uncertainty increases trade.
- Cobb-Douglas ($\theta \to 0$): fixed shares, uncertainty does not affect trade.

# Uncertainty Improves Risk Sharing

## Uncertainty Improves Risk Sharing

**Changes in the terms of trade share risk** (Cole and Obstfeld, 1991).

- High prices compensate for low endowment and vice versa.

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

- Example: Low home endowment $\mu_x$, low home exports $T_x$.
  - With info: Foreign exports respond $T_y \downarrow$, $p \uparrow$
  - Without info: Foreign exports don't respond $\bar{T}_y$, $p \uparrow\uparrow\uparrow$

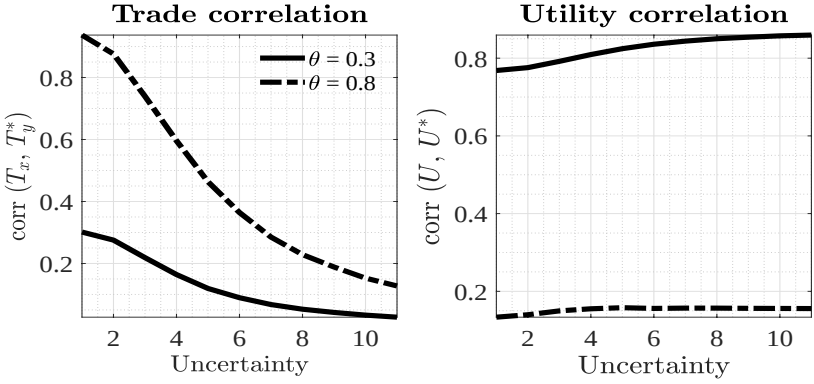
**Uncertainty makes terms of trade more responsive!**

- Risk sharing is most effective when both parties are uninformed.
- Especially in low endowment states.

## Uncertainty Improves Risk Sharing

Uncertainty generates...

- Less trade coordination.
- More utility correlation $\Longrightarrow$ Risk sharing.



# What if Export Contracts Depend on Price?

## Price Contingent Export Contracts

No signals. Two types of agents in each country:

- Mass $\alpha$: Submit price contingent exports

$$t_x^C(z_x, p) \cong \text{perfect information outcome}$$

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

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

How does trade change as we complete markets (i.e. increase $\alpha$)?

**Completing markets is equivalent to reducing uncertainty.**

## Conclusion

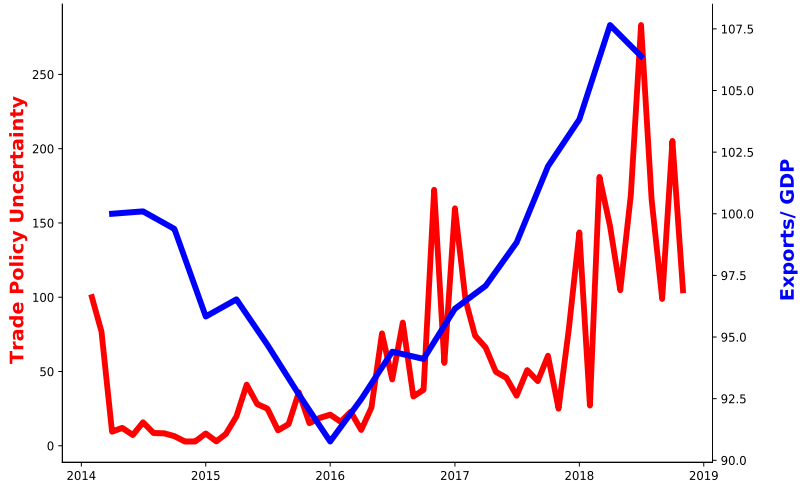
**"Plain vanilla" model yielded complex and unexpected results...**

- Uncertainty dampens export coordination.
  - Affects variance and mean of the terms of trade.
  - Trade's response: 3 sufficient statistics.
- CES preferences and plausible elasticities $\rightarrow$ uncertainty increases trade.

**What do we do with this?**

- Are we measuring aggregate uncertainty?
  - Volatility is different.
  - Product/firm/partner characteristics: no GE effects.
- Or are preferences / models incomplete?
  Agenda: What model features are consistent with facts?

# Food for thought: Trade policy uncertainty and US exports




Source: Trade policy uncertainty comes from the Categorical Economic Policy Uncertainty Index for the U.S. constructed by Baker, Bloom, and Davis. Exports and GDP from NIPA.

# Appendix

## Numerical exercise

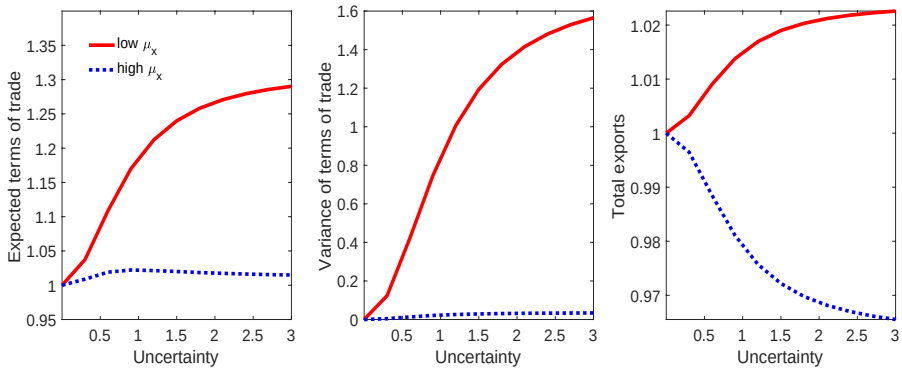
Table: Summary of Model Parameters

| Parameter | $\theta$ | $\sigma$ | $m_x = m_y$ | $s_x = s_y$ | $\sigma_x = \sigma_y$ | $\tilde{s}_x = \tilde{s}_y$ |
|---|---|---|---|---|---|---|
| Value | $0.3, 0.8$ | $1 - \theta$ | $0$ | $1$ | $\sqrt{2}$ | $[0, \infty]$ |

## State dependence

Assume goods have low substitution ($\theta = 0.3$) ...

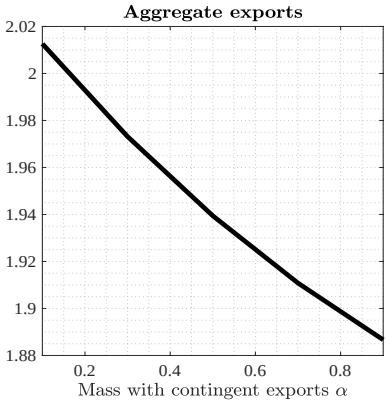
- With low $\mu_x$: Effects of uncertainty are amplified
- Risk sharing is most valuable in low states

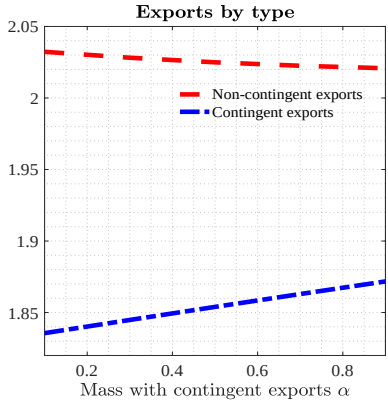


## Price Contingent Export Contracts

When goods are complements ($\theta = 0.3$) ...

- Less uncertainty decreased trade
- Contingent exports also decrease trade

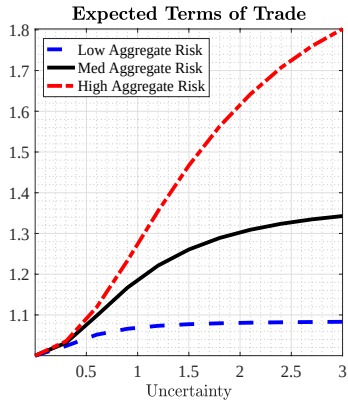


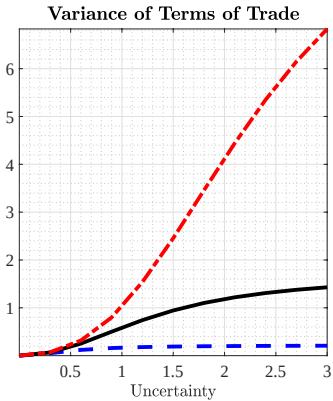



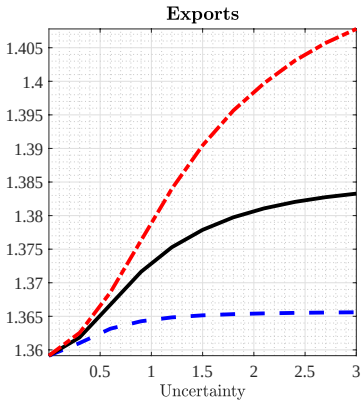
## Changes in Aggregate Risk

When goods are complements ($\theta = 0.3$) ...

- For given uncertainty, trade increasing in aggregate risk



## Welfare and uncertainty

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

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

- 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 case:

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

- Uncertainty alters the welfare tradeoff
  - Decreases coordination $\mathrm{Cov}[c_x, c_y]$
  - Decreases consumption volatility $\mathbb{CV}[c_x]$ and $\mathbb{CV}[c_y]$

- In CES case, key is elasticity of substitution