Speculation and Risk Sharing with New Financial Assets

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Does financial innovation reduce risks?

- Traditional view: Financial innovation helps diversify and share risks.
- But **new assets generate new uncertainties**.
- **Belief disagreements** and **speculation** come as by-product. Tends to increase risks.
- Example from recent crisis: Subprime CDOs and their CDSs.

**This research:** Effect of financial innovation on portfolio risks when traders have both risk sharing and speculation motives.
Consider a risk sharing setting with belief disagreements.

Standard risk sharing model with mean-variance preferences:
- Background risks and financial assets.

New assumption: **Belief disagreements** about asset payoffs.
- Financial innovation = Expansion of assets.
- Measure of portfolio risks:

\[
\text{Average variance} = \text{Uninsurable variance} + \text{Speculative variance}.
\]

**Main result:** Financial innovation always decreases uninsurable variance and **always increases speculative variance**.
Speculative variance increases through two channels:

1. New assets generate new disagreements.
2. New assets amplify speculation on existing disagreements (hedge-more/bet-more).

New asset on which there is agreement increases speculative variance!
Is risk sharing a major factor in endogenous innovation?

Endogenous financial innovation: Both risk sharing and speculation motives for trade generate innovation incentives.

1. With common beliefs, endogenous assets minimize the average variance among all choices.

2. With large belief disagreements, endogenous assets maximize the average variance among all choices.

Belief disagreements change the nature of endogenous financial innovation!

Outline of the talk

- A simple example to illustrate the two channels.
- The main result.
- Brief discussion of welfare implications.
Consider a standard risk sharing setting

- One consumption good (a dollar), two dates, \( \{0, 1\} \).
- Trader, \( i \in I \), has:
  - Endowment, \( e \), at date 0.
  - **Background risks:** Random endowment, \( w_i \), at date 1.
- Consumes only at date 1. Investment options:
  - Cash: Yields one dollar for dollar.
  - **Risky assets**, \( j \in J \), in fixed supply (zero).
- Asset \( j \) pays \( a^j \) dollars at date 1, and trades at price \( p^j \) date 0.
Consider mean-variance preferences with het. priors

Trader $i$ solves:

$$
\max_{x_i} E_i [n_i] - \frac{\theta_i}{2} \text{var}_i [n_i],
$$

s.t. $n_i = e - x'_i p + w_i + x'_i a.$

**Key assumption:** Traders have *heterogeneous prior beliefs*.

**Equilibrium:** Prices, $p$, and allocations, $\{x_i\}_i$, such that traders optimize and markets clear ($\sum_i x'_i = 0$ for each $j$).

**Next:** Simple example.
Example: Traditional common-beliefs benchmark

- Risks, $\nu_1, \nu_2 \sim N(0,1)$, i.i.d. Define $\nu = \nu_1 + \alpha \nu_2$.
- Two traders with $\theta_1 = \theta_2 \equiv \theta$ and risks $w_1 = \nu$ and $w_2 = -\nu$.

**Benchmark:** Common (and correct) beliefs.

- **Autarky:** Net worths, $n_1 = e + \nu$ and $n_2 = e - \nu$.
- **Innovation:** Asset with payoff $a^1 = \nu$ introduced.
- Trader 1’s position and net worth:

  $$x_1^1 = -1 \text{ and } n_1 = n_2 = e.$$  

With common beliefs, financial innovation reduces portfolio risks.
Next consider the case with belief disagreements:

- Traders’ beliefs for $v_2$ is as before. Belief for $v_1$:

  \[
  \text{Trader 1: } N(\varepsilon, 1). \quad \text{Trader 2: } N(-\varepsilon, 1).
  \]

- Parameter, $\varepsilon$, captures the level of disagreement.

- Trader 1’s position and net worth:

  \[
  x_1^1 = \left( -\frac{1}{\theta} \frac{1}{1 + \alpha^2} \right), \quad n_1 = e + \frac{\varepsilon}{\theta} \frac{v_1 + \alpha v_2}{1 + \alpha^2}.
  \]

Large belief disagreements, $\varepsilon > \theta (1 + \alpha^2)$: Financial innovation increases risks.
Next consider the introduction of a second asset:

- Earlier single asset case:
  
  \[ x_1^1 = -1 + \frac{\varepsilon}{\theta} \frac{1}{1 + \alpha^2}. \]

- Additional asset with payoff, \( a^2 = \nu_2 \) (agreement on payoff).

- Trader 1’s position and net worth:
  
  \[ x_1^1 = -1 + \frac{\varepsilon}{\theta} \text{asset 1, betting} \]
  \[ x_2^1 = -\alpha \frac{\varepsilon}{\theta} \text{asset 2, hedging} \]

  \[ n_1 = e + \frac{\varepsilon}{\theta} \nu_1. \]

New asset with agreement increases portfolio risks.

Intuition: Hedge-more/bet-more (and risk more).
General environment

Risks: \( \mathbf{v} = (v_1, \ldots, v_m)' \).

- Net worths, \( w_i \), and asset payoffs, \( a_j \), are linear combinations of \( \mathbf{v} \).

**Assumption (A1).** Traders’ beliefs are given by \( \{ N(\mu_i^\mathbf{v}, \Lambda^\mathbf{v}) \}_i \).

\( \implies \) They agree on variance of \( \mathbf{v} \). Might disagree on means.

Sufficient statistics:

- \( N(\mu_i, \Lambda) \): trader’s belief for asset payoffs.
- \( \lambda_i \): common belief for covariance of \( w_i \) and \( a \).
Characterization of equilibrium

Equilibrium portfolios: $x_i = x_i^R + x_i^S$ where:

$$x_i^R = -\Lambda^{-1} \tilde{\lambda}_i$$

Risk sharing portfolio

$$x_i^S = \Lambda^{-1} \frac{\tilde{\mu}_i}{\theta_i}$$

Speculative portfolio

Relative covariance:

$$\tilde{\lambda}_i = \lambda_i - \frac{\bar{\theta}}{\theta_i |I|} \sum_{\hat{i} \in I} \lambda_{\hat{i}}.$$ 

Relative optimism:

$$\tilde{\mu}_i = \mu_i - \frac{1}{|I|} \sum_{\hat{i} \in I} \frac{\bar{\theta}}{\theta_{\hat{i}}} \mu_{\hat{i}}.$$
Define **average variance** of net worths:

\[ \Omega = \frac{1}{|l|} \sum_{i \in l} \frac{\theta_i}{\bar{\theta}} \text{var}_i (n_i). \]

**Lemma:** With common beliefs, the equilibrium portfolios minimize \( \Omega \) subject to resource constraints, \( \sum_i x_i = 0. \)

- Define **uninsurable variance**, \( \Omega^R \), as the minimum possible \( \Omega \).
- Define **speculative variance** as the residual:

\[ \Omega = \underbrace{\Omega^R}_{\text{uninsurable variance}} + \underbrace{\Omega^S}_{\text{speculative variance}}. \]
Main result: Financial innovation increases spec. variance

- Notation: Economy $\mathcal{E}(\hat{J})$ with assets $\hat{J} \subset J$.
- Compare $\mathcal{E}(J_O)$ and $\mathcal{E}(J_O \cup J_N)$ (old and new assets).

Theorem (Financial Innovation and Portfolio Risks)

(i) Financial innovation always reduces the uninsurable variance:

$$\Omega^R (J_O \cup J_N) \leq \Omega^R (J_O).$$

(ii) Financial innovation always increases the speculative variance:

$$\Omega^S (J_O \cup J_N) \geq \Omega^S (J_O).$$
Intuition for the main result

- Consider the economy with only speculation reason for trade.
- Then, a textbook result applies:

\[ \sigma_i^S = \frac{1}{\theta_i e^{\theta_i^{\text{relative}}}} \text{Speculator’s Sharpe ratio} \]

- With more assets, \( \text{Sharpe}_i^S \) increases through the two channels.
- Thus, the speculative variance also increases.

Caveat: Equilibrium is Pareto efficient. Should we be worried?
Based on a true story of famous economists

BOB:
thinks synthetic, certain
has $100

JOE:
thinks natural, certain
has $100

Pillow owned by both, worth: $50
They decide to take a side bet, at some cost

**BOB**: synthetic

**JOE**: natural

**Side bet, total: $200**
*Destroy pillow to find out!*

**Pillow owned by both, worth: $50**
They realize that this is Pareto optimal.

**BOB: synthetic**
Subjective utility: $200 > $100 + $50/2

**JOE: natural**
Subjective utility: $200 > $100 + $50/2

Both are better off:
Pareto optimal to destroy!

Pillow owned by both, worth: $50
The end of the story is unknown

BOB: synthetic
Subjective utility:
$200 > $100 + $50/2

JOE: natural
Subjective utility:
$200 > $100 + $50/2

$50 worth pillow lost according to both
Nothing produced (pure transfer)
Pareto optimality seems unsatisfactory

The increase in portfolio risks ~ Destroyed pillow.
Suppose belief differences come from **behavioral distortions**.

**Practical problem:** Which belief to use for welfare?

**Solution by Brunnermeier, Simsek, Xiong (2012):** Use all beliefs!

- An allocation is belief-neutral inefficient if it is inefficient **under any convex combination of agents’ beliefs**.

Financial innovation is **belief-neutral inefficient** when it increases $\Omega$. 
Effect of financial innovation on portfolio risks when traders have risk sharing and speculation motive for trade.

- **Main result:** Financial innovation increases speculative variance.
- **Important channel:** Hedge-more/bet-more.
- **Endogenous innovation:** Driven in part by belief disagreements.

**Future work:** Welfare effects and policy implications.