Speculation and Risk Sharing with New Financial Assets

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Recent financial innovations vastly increased trading opportunities. Roughly 1200 types of derivatives as of 1994 (Duffie and Rahi, 1995). Traditional view: Facilitates risk sharing. Doesn’t account for belief disagreements. Naturally creates speculation which 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.
A risk sharing model with belief disagreements

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

Key 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**.
Important mechanism: Hedge-more/bet-more

Speculative variance increases through two channels:

1. New assets generate new bets.
2. **New assets amplify existing bets (hedge-more/bet-more).**

New asset on which there is agreement increases speculative variance!
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.

Belief disagreements change the driving force behind financial innovation.

Financial innovation and security design: Has not explored belief disagreements.

- Exceptions: Brock, Hommes, Wagener (2009), Dieckmann (2009), Weyl (2007)...

Belief disagreements and asset pricing: Has not focused on portfolio risks.
Outline of the talk

- Simple example to illustrate the two channels.
- The main result.
- Welfare implications.
Consider a standard risk sharing setting

- One consumption good (a dollar), two dates, \(\{0, 1\}\).
- Trader, \(i \in I\), has:
  - Endowment, \(e_i\), 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:

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

s.t. \( n_i = e_i - x_i'p + w_i + x_i'a. \)

Key assumption: Heterogeneous beliefs (agree to disagree).

Equilibrium: Traders optimize and markets clear (\( \sum_i x_i^j = 0 \) for each \( j \)).
Simple example to illustrate channels

- Two traders, \( i \in \{1, 2\} \), with \( \theta_i \equiv \theta \) for each \( i \).
- Risks perfectly negatively correlated:

\[
    w_1 = \nu \text{ and } w_2 = -\nu.
\]

where

\[
    \nu = \nu_1 + \alpha \nu_2 \text{ and } \nu_1, \nu_2 \sim \mathcal{N}(0, 1) \text{ are uncorrelated.}
\]

No trade benchmark:

\[
    n_1 = e_1 + \nu \text{ and } n_2 = e_2 - \nu.
\]

Portfolios are risky because background risks cannot be hedged.
Suppose traders have common beliefs $\nu_1, \nu_2 \sim N(0, 1)$. Suppose asset with payoff $a^1 = \nu$ introduced. Trader 1’s position and net worth:

$$x^1_1 = -1 \text{ and } n_1 = e_1.$$ 

**Traditional view:** Financial innovation facilitates risk sharing and reduces 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:
  
  \[
  x_1^1 = \underbrace{-1}_{\text{risk sharing portfolio}} + \underbrace{\frac{1}{\theta \left(1 + \alpha^2\right)}}_{\text{speculative portfolio}},
  \]

  \[
  n_1 = e_1 + \frac{\varepsilon}{\theta} \frac{v_1 + \alpha v_2}{1 + \alpha^2}.
  \]

**Large disagreements, \( \varepsilon > \theta \left(1 + \alpha^2\right) \): Innovation increases risks.**
Next consider a second asset, $a^2 = v_2$. Agreement on payoff.

Earlier single asset case:

$$x_1^1 = -1 + \frac{\varepsilon}{\theta} \left( \frac{1}{1 + \alpha^2} \right).$$

dampening

Two assets, hedge-more/bet-more:

$$x_1^1 = -1 + \frac{\varepsilon}{\theta} \quad \text{asset 1, betting}$$
$$x_2^1 = -\alpha \frac{\varepsilon}{\theta} \quad \text{asset 2, hedging}$$

$$n_1 = e_1 + \frac{\varepsilon}{\theta} v_1.$$ 

Innovation further increases risks by amplifying speculation.
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 $\{N(\mu^v_i, \Lambda^v)\}_i$.

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

Closed form solution for both prices and portfolios.
Define **average variance** of net worths:

\[
\Omega = \frac{1}{|I|} \sum_{i \in I} \frac{\theta_i}{\theta} \var_i(n_i).
\]

**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

- Compare economies with $J_O$ and $J_O \cup J_N$ assets (old and new).

**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:

\[
\sigma_i^S = \frac{1}{\theta_i e_i^{relative}} \text{Sharpe}_i^S.
\]

std. of speculative portfolio return  Speculator's Sharpe ratio

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

- Financial innovation generates a Pareto improvement.
- But welfare conclusion can be overturned in two alternative settings...
Inefficiencies driven by belief distortions

Disagreements might stem from psychological distortions:

- Pareto arguably not appropriate.
- **Belief-neutral criterion** by Brunnermeier, Simsek, Xiong (2012).
- Consider welfare with respect to any convex combination belief, \( h \):

\[
N_h = \sum_{i \in I} E_h [n_i] - \frac{\theta_i}{2} \text{var}_h (n_i),
\]

\[
= E_h \left[ \sum_{i \in I} e_i + w_i \right] \underbrace{- \frac{\bar{\theta}}{2} \Omega}_{\text{belief-neutral welfare measure}}.
\]

Financial innovation is belief-neutral inefficient iff it increases \( \Omega \).
Inefficiencies driven by externalities

**Portfolio choices might be associated with externalities:**
- Financial intermediaries under government protection.
- Negative externalities depend on portfolio risks.
- Innovation might be inefficient even in the Pareto sense.

Common element across the two sources of inefficiencies:
**Portfolio risks are central to (partial) welfare analysis.**
Belief disagreements can change the effect of recent innovations on portfolio risks, as well as the driving force behind those innovations.

Future work: Empirical analysis and policy implications.
A true story of famous economists

Joe Stiglitz
Believes natural, 90%
Has $100

Bob Wilson
Believes synthetic, 90%
Has $100

Pillow worth: $50
They decide to bet, at some cost

Side bet, total $200
Destroy pillow to find out
Pillow replaced by the winner ($50)
They realize that this is Pareto optimal

Expected return from the bet:

\[
90\% \times (\$100 - \$50) \\
-10\% \times \$100 = \$35
\]

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\[
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\]

Both Bob and Joe find the bet desirable
The bet is **Pareto efficient**!
The end of the story is unknown

The bet induces a wealth transfer
But a perfectly good pillow is destroyed

The increase in portfolio risks ~ Destroyed pillow.