Insurance, Weather, and Financial Stability

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Overview

Banks rely on insurers to absorb natural disaster risk of borrowers.

- Small literature, despite (growing) importance in practice!
- How important is insurance supply quantitatively for bank lending and risk-taking?
- What frictions does bank-insurer interaction create?

This paper: Model + historical evidence from crop insurance in U.S.

- Stylized model: insurance supply $\uparrow \rightarrow$ bank risk-taking $\uparrow \rightarrow$ bank default risk $\uparrow$
- Empirics: 1980 expansion of crop insurance supply: lending $\uparrow$, loan risk $\uparrow$, bank risk $\rightarrow$

Literature & Contribution

What do we know? Insurance supply $\uparrow \rightarrow$ Credit supply and demand $\uparrow$

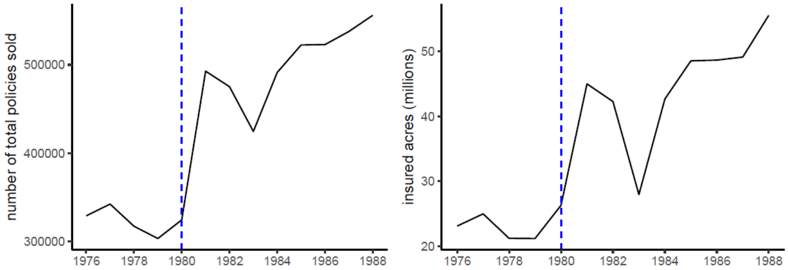
- Banks rely on insurers for monitoring safety-enhancing investments by borrowers (Garmaise and Moskowitz 2009)
- Banks are unwilling to bear natural disaster risk (Sastry 2022; Sastry et al. 2023)
- Availability of insurance creates moral hazard incentives for banks (Bhutta and Keys 2022)
- Mortgage demand positively affected by insurance supply (Damast et al. 2024)

This paper: Focus on bank fragility

1980 reform

- Expand scope of federal crop insurance program (FCIP) geographically and across commodities
- Subsidies of up to 30% of premiums

⇒ Plausibly exogenous increase in insurance supply:



⇒ Would be great to understand better the cross-sectional differences in the reform's impact. E.g., which counties benefited more than others?

Revisiting the model

Mean-variance bank chooses loan portfolio size S (= leverage) while insuring fraction $1-k$ at fair price:

$$\mathbb{E}[V] - rS - \frac{\alpha}{2} var(V) = M(S) - \frac{\alpha}{2} k^2 S^2 \sigma^2 - rS$$

with $M(S)$ the expected payout, $\frac{M(S)}{S} > M'(S) > 0$ and $M''(S) < 0$, r the financing cost. Then:

$$\frac{M'(S) - r}{S} = \alpha k^2 \sigma^2.$$

An increase in insurance supply ($k \downarrow$) implies more leverage S

$$\frac{\partial S}{\partial k} = \frac{2\alpha k S \sigma^2}{M''(S) - \alpha k^2 \sigma^2 - r} < 0$$

and a higher probability to default $P(V < XS) = F\left(\frac{XS - M(S)}{kS\sigma}\right)$

$$\frac{\partial PD}{\partial k} = \frac{\partial PD}{\partial S} \frac{\partial S}{\partial k} = F' \frac{(X - M')kS\sigma - (XS - M)k\sigma}{k^2 S^2 \sigma^2} \frac{\partial S}{\partial k} = \underbrace{F'}_{>0} \times \underbrace{\frac{M - M'S}{k^2 S^2 \sigma}}_{>0} \underbrace{\frac{\partial S}{\partial k}}_{<0} < 0$$

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Is this a model of risk-taking or credit supply?

Is a larger S necessarily "bad"?

An Alternative Model of Risk-Taking

Suppose: Bank without equity & with fixed unit balance sheet size

chooses expected loan repayment μ with implied risk $\sigma(\mu) = e^{b\mu}$ with $b \in (0, 1/\alpha)$

insures fraction $1 - k \in [0,1]$ of portfolio at actuarially fair price

$$\max_{\mu} \mu - \frac{\alpha}{2}(k\sigma)^2$$

Optimal portfolio $\mu^* = \frac{1}{2b} \log \frac{1}{\alpha b k}$

Optimal bank risk $k\sigma^* = k \cdot \frac{1}{\sqrt{\alpha b k}} = \sqrt{\frac{k}{\alpha b}}$

Higher insurance supply ($k \downarrow$) $\Rightarrow$ Lower risk ($k\sigma^* \downarrow$) & higher expected repayment ($\mu^* \uparrow$)

$\Rightarrow$ Lower default probability:

$$\frac{\partial}{\partial k} P\left(\varepsilon < \frac{Dr_D - \mu^*}{k\sigma^*}\right) = F'\left[-\underbrace{\frac{\partial \mu^*}{\partial k}}_{<0} \frac{1}{k\sigma^*} - \underbrace{\frac{\partial k\sigma^*}{\partial k}}_{>0} \underbrace{\frac{Dr_D - \mu^*}{(k\sigma^*)^2}}_{<0} \right] > 0$$

Here, more insurance supply has opposite effect on bank's PD.

Model: Suggestions

Current model: bank chooses leverage $\rightarrow$ default risk.

$\Rightarrow$ Not possible to choose higher loan risk without expanding balance sheet.

$\Rightarrow$ Higher leverage is socially efficient ($NPV > 0 \Leftrightarrow M'(S) > r$) if defaults without deadweight cost

Suggestions:

- Fix bank leverage.
- Include friction transparently through moral hazard: higher insurance supply reduces incentives for banks to monitor borrowers while insurers are not able to observe monitoring activity.

  $\Rightarrow$ Squares well with moral hazard of banks and private mortgage insurers before great financial crisis (Bhutta and Keys 2022)
- If bank monitoring is sufficiently elastic to insurance supply, then more insurance can be inefficient.

Empirical Specification

Goal: Estimate insurance supply $\rightarrow$ bank lending.

Specification: $\text{Lending}_{bct} = \beta_1 \text{Insurance Coverage}_{ct} + \gamma \text{Insurance Coverage}_{ct} \times \mathbf{1}(t > 1980) + ...$

with $\text{Insurance Coverage}_{ct} = \text{Total insured acres}_{ct}$ (scaling by county size would make sense!)

Interpretation of coefficients:

- β_1: How much more credit do banks provide in counties with more insurance coverage?
  Obvious confounders: (weather) risk, financial strength of farmowners, local economy
- β_2: Difference in correlation between lending and coverage post 1980

  Does this capture the effects of insurance supply? E.g., if true model is
  $\text{Lending}_{bct} = \gamma^* \text{Insurance Coverage}_{ct} + \xi_{bct}$, then $\hat{\gamma} = 0$ although
  insurance supply $\uparrow \rightarrow$ coverage $\uparrow \rightarrow$ lending $\uparrow$

  $\Rightarrow$ Substitute $\text{Insurance Coverage}_{ct}$ with **ex-ante exposure to reform**$_c$:
  % of newly-covered crop varieties in 1979, $\mathbf{1}$(Newly covered county), $\mathbf{1}$(Bank in farm loan business)

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Minor Comments

- Standard errors should also be clustered at bank level to remove autocorrelation of bank-level variables
- It is not clear why realized weather shocks should affect bank lending. Instead, weather shocks affect farmowners' ability to repay loans and, thus, bank profitability (Tables 7-10)
- Exposure to heat, e.g., due to heatwaves, increases "cooling degree days" but is also an extreme weather event and, thus, included in losses reported by SHELDUS. Thus, so-defined "chronic" risks are also part of "acute" risks and not separated.

Conclusion

- Important topic
- Well-written, thought-provoking
- Model: very useful guidance

  $\Rightarrow$ Mapping of risk-taking from data to model
- Novel (historical) data

  $\Rightarrow$ Offers more in terms of identification!

Thank you for the opportunity to discuss this paper!

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