

Insurance, Weather, and Financial Stability*

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**The views stated herein are those of the authors and are not necessarily the views of the Federal Reserve Bank of New York or the Federal Reserve System.*

Introduction

- Global warming will affect the risks of bank lending and potentially the stability of the banking sector
- How are these effects modified by the actions of the insurance sector and likely responses of the regulatory sector?

This paper:

1. Model the effect of insurance availability on banks' incentives
2. Expansion + restructuring of federal crop insurance in 1980 to test the model

⇒ **Key takeaways:**

- ↳ banks increased ag lending in counties with more insurance after 1980
- ↳ increase in risky lending compensated by insurance
- ↳ no net effect on banks' risk

Model: Key Ingredients

- Partial equilibrium, banks with mean/variance preferences.
- A bank has a portfolio of potential loans, with increasing total risk and diminishing marginal expected returns as the portfolio increases.
- Insurance programs replace a fraction of the portfolio with guaranteed payments. As long as insurance is subsidized the banks take on as much insurance as permitted by the program.
- (An extension considers the effect of repricing of insurance with changes in riskiness of lending)

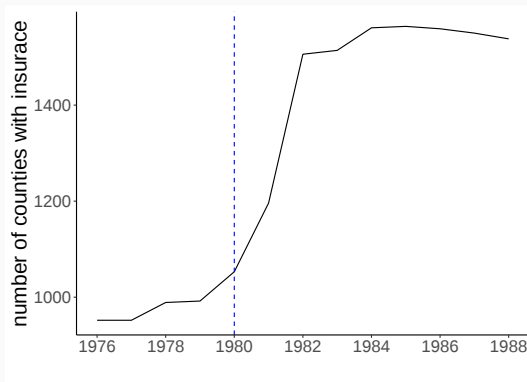
Empirical Implications

1. Introduction of insurance increases bank lending
2. On the margin, banks will take on riskier loans
3. While insurance reduces risk of given loans, it has ambiguous effect on overall quality of bank's loan portfolio.

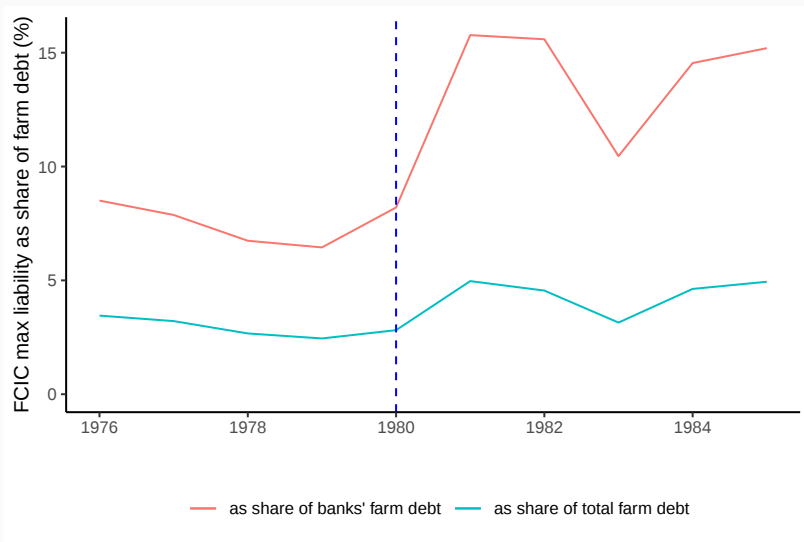
Empirical Setting and Data

- Profound revamp of federal crop insurance program in 1980
⇒ more crops, counties insured; customized policies; heavily subsidized premiums

1. Call report
 - ↳ including banks' ag exposure
2. USDA crop insurance data
 - ↳ insured acres by county-year
3. Weather data (Schlenker 2024)
 - ↳ over-exposure of crops to heat
 - ↳ isolate effect of crop insurance on banks



Federal Crop Insurance Liabilities a Meaningful Share of Farm Debt



$$\begin{aligned} Lending_{bct} = & \beta_1 \overbrace{\text{Insurance Coverage}_{ct}}^{\text{insured acres}} + \beta_2 \mathbf{1}(t > 1980) \\ & + \gamma \text{Insurance Coverage}_{ct} \times \mathbf{1}(t > 1980) + X_{bct} \end{aligned} \quad (1)$$

$$\begin{aligned} Lending_{bct+1} = & \gamma \overbrace{\text{Weather}_{ct}}^{\text{over-exposure to heat}} \times \text{Insurance Coverage}_{ct} \times \mathbf{1}(t > 1980) \\ & + \beta_1 \text{Weather}_{ct} + \beta_2 \text{Insurance Coverage}_{ct} + \beta_3 \mathbf{1}(t > 1980) \\ & + \beta_4 \text{Weather}_{ct} \times \text{Insurance Coverage}_{ct} \\ & + \beta_5 \text{Weather}_{ct} \times \mathbf{1}(t > 1980) \\ & + \beta_6 \text{Insurance Coverage}_{ct} \times \mathbf{1}(t > 1980) + X_{bct} \end{aligned} \quad (2)$$

Results I: Did Banks Lend More to Ag After 1980 Expansion?

	Dependent variable:			
	farm loan share Q3 (1)	farmland-secured loans share Q3 (2)	farm loan share Q3 (3)	farmland-secured loans share Q3 (4)
weather Q2			-0.34*** -6.73	0.02 1.01
insurance coverage	-0.75*** -6.89	-0.27*** -4.84	-0.64*** -5.51	-0.30*** -5.18
weather Q2 × insurance coverage			-0.19*** -3.11	0.08*** 2.62
weather Q2 × 1(t > 1980)			0.14** 2.15	-0.04 -1.36
insurance coverage × 1(t > 1980)	0.62*** 5.54	0.55*** 9.11	0.52*** 4.35	0.58*** 9.35
weather Q2 × insurance coverage × 1(t > 1980)			0.13* 1.89	0.03 0.65
bank FE	Y	Y	Y	Y
county FE	Y	Y	Y	Y
year FE	Y	Y	Y	Y
ag exposure	+ve	+ve	+ve	+ve
Observations	95,689	95,689	95,689	95,689

Note:

*p<0.1; **p<0.05; ***p<0.01

$$\begin{aligned} Risk_{bct+1} = & \beta_1 \text{Insurance Coverage}_{ct} + \beta_2 \text{Farm Loans}_{bct} + \beta_3 \mathbf{1}(t > 1980) \\ & + \beta_4 \text{Insurance Coverage}_{ct} \times \text{Farm Loans}_{bct} \\ & + \beta_5 \text{Insurance Coverage}_{ct} \times \mathbf{1}(t > 1980) \\ & + \beta_6 \text{Farm Loans}_{bct} \times \mathbf{1}(t > 1980) \\ & + \gamma \text{Insurance Coverage}_{ct} \times \text{Farm Loans}_{bct} \times \mathbf{1}(t > 1980) + X_{bct} \end{aligned} \quad (3)$$

Measures of *Risk*:

- return on loans, provisional losses, return on assets, charge-offs, Z-score

Results II: Did Banks' Risk Increase after 1980 Expansion?

	Dependent variable:				
	return on loans	provisional losses shares	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
insurance coverage	0.01 0.68	0.03** 2.09	-0.03*** -2.93	0.03** 2.10	
farm loans share Q3	0.04*** 5.38	-0.03*** -3.75	0.02*** 3.56	-0.02*** -2.85	
insurance coverage × farm loans share Q3	-0.02* -1.69	-0.02* -1.81	0.01* 1.94	-0.02 -1.58	
insurance coverage × 1(t > 1980)	-0.01 -0.41	0.06*** 2.80	-0.01 -0.90	0.06*** 2.94	4.71*** 5.79
farm loans share Q3 × 1(t > 1980)	-0.002 -0.18	0.15*** 8.94	-0.05*** -4.97	0.12*** 7.77	0.58 0.72
insurance coverage × farm loans share Q3 × 1(t > 1980)	0.04*** 2.96	0.06*** 4.19	-0.03*** -2.89	0.06*** 3.86	1.01* 1.92
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
Observations	87,049	87,052	87,049	87,049	31,814

Note:

*p<0.1; **p<0.05; ***p<0.01

Did Banks' Risk Increase Enough?

	Dependent variable:				
	return on loans	provisional losses share	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
weather Q2	0.09*** 8.87	0.003 0.48	0.03*** 7.08	-0.01 -1.23	
insurance coverage	-0.01 -0.32	0.02 1.15	-0.02** -2.31	0.03 1.44	
weather Q2 × insurance coverage	-0.0004 -0.03	0.04*** 4.28	-0.03*** -4.69	0.03*** 2.65	
weather Q2 × 1(t > 1980)	-0.16*** -11.60	-0.12*** -8.34	0.01 0.95	-0.11*** -7.62	1.58** 2.46
insurance coverage × 1(t > 1980)	0.01 0.50	0.07*** 3.34	-0.02 -1.28	0.07*** 3.19	4.73*** 5.74
weather Q2 × insurance coverage × 1(t > 1980)	-0.004 -0.26	-0.05*** -4.45	0.04*** 4.73	-0.06*** -3.70	-0.72 -1.45
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
Observations	87,049	87,052	87,049	87,049	31,815

Note:

*p<0.1; **p<0.05; ***p<0.01

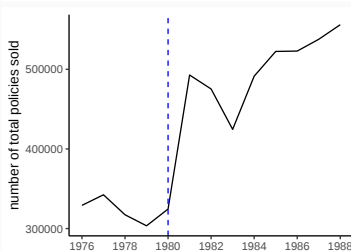
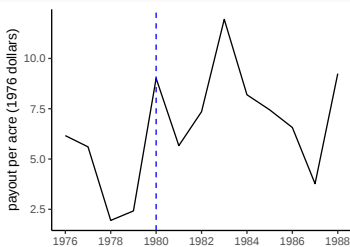
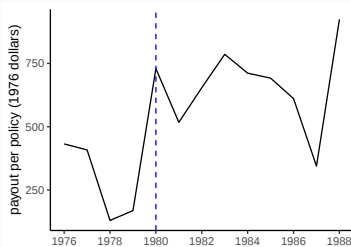
- Stronger results for ag banks (farm loan share of all loans $> 16\%$) [◀ Results](#)
- Stronger results for banks with equity/asset ratio below median [◀ Results](#)
- Results largely robust to using policies sold instead of insured acres [◀ Results](#)

Conclusion

- **Theory:** introduction of insurance increases bank lending; riskier loans on the margin; net effect on bank riskiness ambiguous
- **Empirical test:** after crop insurance expansion in 1980 banks lent more; riskier loans on the margin; no net increase in risk
- **Extrapolation to present:**
 1. reduction in insurance will cause banks to reduce exposure to climate-related risks
 2. reduction in exposure might not entirely offset the direct effect of increased risks on the overall riskiness of banks

Appendix

Crop Insurance: Before and After



Ag Banks: Lending

	Dependent variable:			
	farm loan share Q3	farmland-secured loans share Q3	farm loan share Q3	farmland-secured loans share Q3
	(1)	(2)	(3)	(4)
weather Q2			-0.47*** -6.09	0.05 1.40
insurance coverage	-0.83*** -4.81	-0.10 -1.39	-0.70*** -3.72	-0.15** -1.96
weather Q2 × insurance coverage			-0.24** -2.48	0.12*** 2.90
weather Q2 × 1(t > 1980)			0.26*** 2.62	-0.06 -1.32
insurance coverage × 1(t > 1980)	0.77*** 4.18	0.37*** 4.73	0.65*** 3.30	0.43*** 5.16
weather Q2 × insurance coverage × 1(t > 1980)			0.33*** 2.89	-0.08 -1.56
bank FE	Y	Y	Y	Y
county FE	Y	Y	Y	Y
year FE	Y	Y	Y	Y
ag exposure	ag banks only	ag banks only	ag banks only	ag banks only
Observations	48,695	48,695	48,695	48,695

Note:

*p<0.1; **p<0.05; ***p<0.01

◀ Back

Ag Banks: Risk

	Dependent variable:				
	return on loans	provisional losses share	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
insurance coverage	-0.02 -1.00	0.05** 2.33	-0.05*** -3.78	0.05** 2.06	
farm loans share Q3	0.05*** 4.77	-0.05*** -4.56	0.03*** 4.01	-0.05*** -4.42	
insurance coverage × farm loans share Q3	-0.04** -2.52	-0.003 -0.18	0.003 0.29	-0.003 -0.18	
insurance coverage × 1(t > 1980)	-0.003 -0.11	0.002 0.08	0.03 1.52	0.02 0.52	4.67*** 3.44
farm loans share Q3 × 1(t > 1980)	-0.02 -0.93	0.12*** 4.92	-0.03* -1.93	0.09*** 3.85	-1.31 -0.90
insurance coverage × farm loans share Q3 × 1(t > 1980)	0.07*** 3.92	0.06*** 2.96	-0.03** -2.16	0.05** 2.36	0.06 0.07
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
ag exposure	ag banks	ag banks	ag banks	ag banks	ag banks
Observations	44,875	44,878	44,875	44,875	13,755

Note:

*p<0.1; **p<0.05; ***p<0.01

Ag Banks: Risk + Weather Shocks

	Dependent variable:				
	return on loans	provisional losses share	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
weather Q2	0.08*** 6.20	0.01* 1.66	0.02*** 2.73	0.002 0.21	
insurance coverage	-0.05** -2.06	0.04** 2.03	-0.05*** -3.61	0.04* 1.78	
weather Q2 × insurance coverage	0.01 0.41	0.03** 2.36	-0.02** -2.38	0.03** 2.43	
weather Q2 × 1(t > 1980)	-0.10*** -5.02	-0.13*** -5.63	0.03** 2.29	-0.11*** -5.00	4.09*** 3.67
insurance coverage × 1(t > 1980)	0.02 0.93	0.01 0.45	0.02 1.33	0.02 0.76	4.96*** 3.65
weather Q2 × insurance coverage × 1(t > 1980)	-0.004 -0.24	-0.04** -2.47	0.03*** 2.75	-0.05*** -2.96	-0.64 -0.77
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
ag exposure	ag banks	ag banks	ag banks	ag banks	ag banks
Observations	44,875	44,878	44,875	44,875	13,755

Note:

*p<0.1; **p<0.05; ***p<0.01

Low Equity Ratio Banks: Lending

	<i>Dependent variable:</i>			
	farm loan share Q3	farm RE-backed loans share Q3	farm loan share Q3	farm RE-backed loans share Q3
	(1)	(2)	(3)	(4)
weather Q2			−0.30*** −5.90	0.02 0.71
insurance coverage	−0.90*** −7.28	−0.24*** −3.93	−0.87*** −6.84	−0.25*** −4.02
weather Q2 × insurance coverage			−0.03 −0.67	0.04 1.16
weather Q2 × 1(t > 1980)			0.09 1.29	−0.02 −0.43
insurance coverage × 1(t > 1980)	0.74*** 5.81	0.48*** 6.73	0.71*** 5.44	0.50*** 6.86
weather Q2 × insurance coverage × 1(t > 1980)			−0.01 −0.16	0.11** 2.54
bank FE	Y	Y	Y	Y
county FE	Y	Y	Y	Y
year FE	Y	Y	Y	Y
ag exposure	+ve	+ve	+ve	+ve
capital ratio	< median	< median	< median	< median
Observations	46,562	46,562	46,562	46,562

Note:

*p<0.1; **p<0.05; ***p<0.01

Low Equity Ratio Banks: Risk

	Dependent variable:				
	return on loans	provisional losses shares	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
insurance coverage	0.02 1.07	0.09*** 4.08	-0.05*** -3.30	0.07*** 3.13	
farm loans share Q3	0.05*** 4.84	-0.01 -0.66	0.004 0.59	0.003 0.21	
insurance coverage × farm loans share Q3	-0.004 -0.28	-0.01 -0.54	0.01 0.88	-0.0003 -0.02	
insurance coverage × 1(t > 1980)	0.0003 0.01	-0.01 -0.41	0.005 0.23	0.03 0.98	5.82*** 4.05
farm loans share Q3 × 1(t > 1980)	-0.02 -0.99	0.19*** 6.69	-0.07*** -4.04	0.14*** 5.52	-1.28 -0.96
insurance coverage × farm loans share Q3 × 1(t > 1980)	0.05*** 3.00	0.10*** 3.81	-0.04*** -2.94	0.09*** 3.33	1.85* 1.82
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
capital ratio	< median	< median	< median	< median	< median
Observations	42,123	42,123	42,123	42,123	14,877

Note:

*p<0.1; **p<0.05; ***p<0.01

Low Equity Ratio Banks: Risk + Weather Shocks

	Dependent variable:				
	return on loans	provisional losses share	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
weather Q2	0.10*** 7.82	0.02** 2.38	0.02*** 2.81	-0.001 -0.11	
insurance coverage	0.02 0.84	0.07*** 3.22	-0.04*** -2.67	0.07*** 2.89	
weather Q2 × insurance coverage	-0.02 -1.42	0.03** 2.55	-0.02** -2.47	-0.01 -0.17	
weather Q2 × 1(t > 1980)	-0.16*** -9.79	-0.14*** -5.81	0.03*** 2.60	-0.12*** -5.00	2.53** 2.38
insurance coverage × 1(t > 1980)	-0.001 -0.05	-0.02 -0.49	0.003 0.17	0.02 0.57	5.49*** 3.79
weather Q2 × insurance coverage × 1(t > 1980)	0.02 1.15	-0.08*** -4.29	0.04*** 3.21	-0.03 -0.93	-0.79 -0.88
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
Observations	42,123	42,123	42,123	42,123	14,877

Note:

*p<0.1; **p<0.05; ***p<0.01

Policies Sold Count: Lending

	Dependent variable:			
	farm loan share Q3 (1)	farmland-secured loans share Q3 (2)	farm loan share Q3 (3)	farmland-secured loans share Q3 (4)
weather Q2			−0.34*** −6.89	0.02 0.61
insurance coverage	−1.02*** −9.66	−0.34*** −5.64	−0.96*** −8.99	−0.35*** −5.61
weather Q2 × insurance coverage			−0.08* −1.67	0.04 1.33
weather Q2 × 1(t > 1980)			0.12** 1.99	−0.01 −0.34
insurance coverage × 1(t > 1980)	0.90*** 7.84	0.60*** 9.17	0.84*** 7.27	0.62*** 9.20
weather Q2 × insurance coverage × 1(t > 1980)			0.04 0.70	0.09** 2.38
bank FE	Y	Y	Y	Y
county FE	Y	Y	Y	Y
year FE	Y	Y	Y	Y
ag exposure	+ve	+ve	+ve	+ve
Observations	95,150	95,150	95,150	95,150

Note:

*p<0.1; **p<0.05; ***p<0.01

Policies Sold Count: Risk

	Dependent variable:				
	return on loans	provisional losses shares	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
insurance coverage	−0.004 −0.20	0.04** 2.52	−0.03*** −2.92	0.03* 1.86	
farm loans share Q3	0.05*** 5.37	−0.02*** −3.05	0.02*** 3.05	−0.02** −2.20	
insurance coverage × farm loans share Q3	−0.01 −0.47	0.0003 0.03	0.01 0.85	0.001 0.13	
insurance coverage × 1(t > 1980)	0.03 1.19	0.03 1.44	−0.01 −0.72	0.06** 2.55	6.18*** 6.35
farm loans share Q3 × 1(t > 1980)	−0.003 −0.19	0.15*** 9.15	−0.05*** −5.00	0.12*** 7.81	0.65 0.83
insurance coverage × farm loans share Q3 × 1(t > 1980)	0.04*** 3.10	0.05*** 3.30	−0.02** −2.47	0.04*** 2.75	0.72 1.19
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
Observations	86,621	86,624	86,621	86,621	31,474

Note:

*p<0.1; **p<0.05; ***p<0.01

Policies Sold Count: Risk + Weather Shocks

	Dependent variable:				
	return on loans	provisional losses share	return on assets	charge-offs share	Z-score
	(1)	(2)	(3)	(4)	(5)
weather Q2	0.09*** 8.28	0.01 1.13	0.03*** 6.17	-0.01 -1.09	
insurance coverage	-0.01 -0.68	0.03* 1.92	-0.03** -2.57	0.03* 1.70	
weather Q2 × insurance coverage	-0.01 -0.75	0.03*** 4.20	-0.02*** -3.65	0.01 0.48	
weather Q2 × 1(t > 1980)	-0.16*** -11.32	-0.12*** -8.26	0.01 1.15	-0.10*** -6.62	1.29** 2.05
insurance coverage × 1(t > 1980)	0.03 1.43	0.03 1.53	-0.01 -0.80	0.05** 2.28	6.15*** 6.32
weather Q2 × insurance coverage × 1(t > 1980)	0.01 0.72	-0.05*** -4.50	0.03*** 3.95	-0.03 -1.56	-0.74 -1.28
bank FE	Y	Y	Y	Y	Y
county FE	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y
farm loans share	+ve	+ve	+ve	+ve	+ve
Observations	86,621	86,624	86,621	86,621	31,475

Note:

*p<0.1; **p<0.05; ***p<0.01