Expectations and Credit Slumps

Antonio Falato
Federal Reserve Board

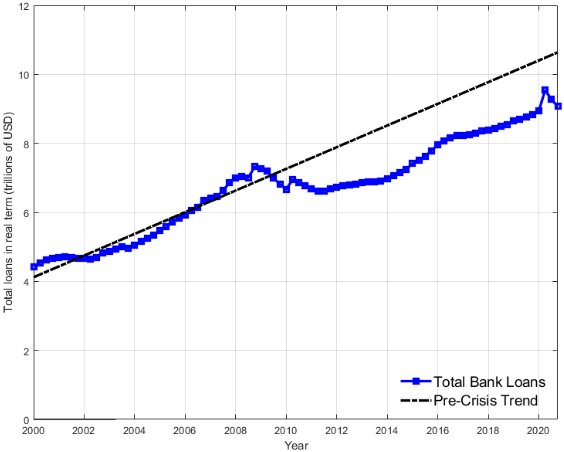
Jasmine Xiao
University of Notre Dame

July 11, 2023

NBER Summer Institute Impulse and Propagation Mechanisms

Question

- Why was bank lending so slow to recover after the 2008-09 financial crisis?



Sources: H.8 Assets and Liabilities of Commercial Banks in the U.S.

alternative

Our Explanation

- Banks over-extrapolate the past: they remained over-pessimistic long after 2009
- And persistent pessimism was a drag on their lending

Our Explanation

- Banks over-extrapolate the past: they remained over-pessimistic long after 2009
- And persistent pessimism was a drag on their lending

This Paper

- Uses new survey data to measure individual banks' expectations

Expectations & Real Outcomes: Greenwood and Schleifer (2014), Coibion and Gorodnichenko (2015), Angeletos et al. (2020), Bordalo et al. (2020), Rozsypal and Schlafmann (2020), Kohlhas and Walther (2021), Giglio et al. (2021), Ma et al. (2021), Farmer et al. (2022)

Our Explanation

- Banks over-extrapolate the past: they remained over-pessimistic long after 2009
- And persistent pessimism was a drag on their lending

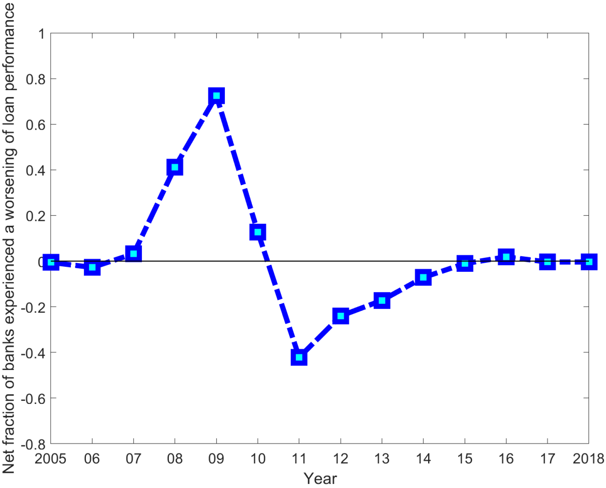
This Paper

- Uses new survey data to measure individual banks' expectations
- Constructs a model to quantify the macroeconomic consequences of distorted bank expectations

Expectations & Real Outcomes: Greenwood and Schleifer (2014), Coibion and Gorodnichenko (2015), Angeletos et al. (2020), Bordalo et al. (2020), Rozsypal and Schlafmann (2020), Kohlhas and Walther (2021), Giglio et al. (2021), Ma et al. (2021), Farmer et al. (2022)

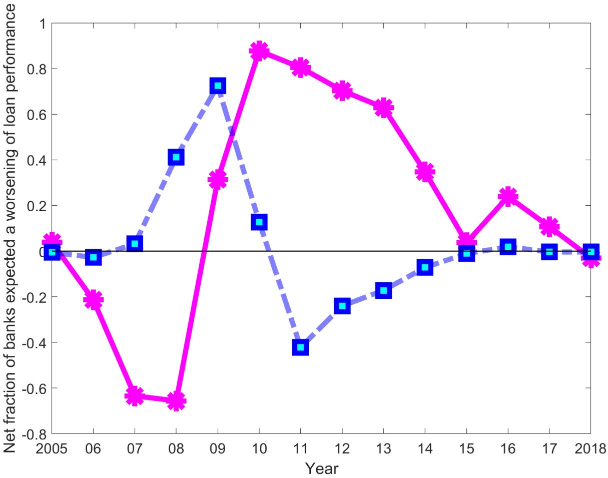
Expectations in Credit & Business Cycles: Krishnamurthy and Li (2020), Bordalo et al. (2021), Bianchi et al. (2021), L'Huillier et al. (2021), Maxted (2022)

Loan performance recovered quickly after the Great Recession



Source: Call Reports, Federal Reserve Board

Expected loan performance took long to recover after the Great Recession



Source: Senior Loan Officer Opinion Survey (SLOOS) on Bank Lending Practices, Federal Reserve Board

Bank Expectations: Senior Loan Officer Opinion Survey of Bank Lending Practices

- Since early 1990s: Inquiring banks about changes in their lending standards & changes in demand for loans (Bassett et al. (2014))
- Since 2004: Inquiring banks' expectations on changes in delinquencies & charge-offs in the coming year

Bank Expectations: Senior Loan Officer Opinion Survey of Bank Lending Practices

- Since early 1990s: Inquiring banks about changes in their lending standards & changes in demand for loans (Bassett et al. (2014))
- Since 2004: Inquiring banks' expectations on changes in delinquencies & charge-offs in the coming year

Assuming that economic activity progresses in line with consensus forecasts, what is your outlook for delinquencies and charge-offs on your bank's type X loans in the coming year?

- *1=improve substantially; 2=improve somewhat; 3=remain around current levels; 4=deteriorate somewhat; 5=deteriorate substantially*

Bank Expectations: Senior Loan Officer Opinion Survey of Bank Lending Practices

$$E_{it}[I^k_{i,t+1}] = \begin{cases} 1 & \text{if bank } i \text{ at } t \text{ expects an improvement in type-}k \text{ loan performance in } t+1 \\ 0 & \text{if bank } i \text{ at } t \text{ expects no change in type-}k \text{ loan performance in } t+1 \\ -1 & \text{if bank } i \text{ at } t \text{ expects a worsening in type-}k \text{ loan performance in } t+1 \end{cases}$$

$$E_{it}[I_{i,t+1}] = \sum_k \omega^k_{it} \times E_{it}[I^k_{i,t+1}]$$

ω^k_{it}: fraction of category-k loans outstanding in bank i's core loan portfolio.

Bank Expectations: Senior Loan Officer Opinion Survey of Bank Lending Practices

$$E_{it}[l^k_{i,t+1}] = \begin{cases} 1 & \text{if bank } i \text{ at } t \text{ expects an improvement in type-}k \text{ loan performance in } t+1 \\ 0 & \text{if bank } i \text{ at } t \text{ expects no change in type-}k \text{ loan performance in } t+1 \\ -1 & \text{if bank } i \text{ at } t \text{ expects a worsening in type-}k \text{ loan performance in } t+1 \end{cases}$$

$$E_{it}[l_{i,t+1}] = \sum_k \omega^k_{it} \times E_{it}[l^k_{i,t+1}]$$

ω^k_{it}: fraction of category-k loans outstanding in bank i's core loan portfolio.

Loan Performance: Call Reports

$$l^k_{it} = \begin{cases} 1 & \text{if bank } i \text{ experiences an improvement in type-}k \text{ loan performance in year } t \\ 0 & \text{if bank } i \text{ experiences no change in type-}k \text{ loan performance in year } t \\ -1 & \text{if bank } i \text{ experiences a worsening in type-}k \text{ loan performance in year } t \end{cases}$$

$$l_{it} = \sum_k \omega^k_{i,t-1} \times l^k_{it}$$

Dynamics of Bank Forecast Errors

$$R_{it}^{FE} = \alpha_t + \sum_{k=1}^{K} \beta_k R_{it-k}^{FE} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	k=1 year	k=2 year	k=3 year
β_k	0.233***	0.153***	0.024
[t]	[5.57]	[4.33]	[0.68]

- Forecast errors $R_{it}^{FE} = E_{it}[I_{i,t+1}] - I_{i,t+1}$ ($<$ 0 over-pessimistic)
- Sample period: 2010-2020

Fact 1: Forecast errors are persistent & positively predictable by lagged forecast errors
$\Longrightarrow$ Pessimism in the past two years breeds pessimism today

pseudo

Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	k=1 year	k=2 year	k=3 year
β_k	-0.071	0.239^{***}	0.048
[t]	[-0.52]	[2.96]	[0.55]

- Forecast errors $R^{FE}_{it} = E_{it}[I_{i,t+1}] - I_{i,t+1}$ (< 0 over-pessimistic)
- $\Delta Loans_{it}$: log change in loans relative to the pre-crisis (2004-2006) level
- Controlling for alternative hypotheses for slow recovery
- Sample period: 2010-2020

Fact 2: Past forecast errors robustly predict future loan growth

full table pseudo robustness

Cross-Sectional Results

▸ bank size ▸ loantype

- Small vs. large banks (defined by total loans)
- Types of loans: Consumer, Commercial & Industrial, Residential Real Estate, Consumer Real Estate

Fact 3: The behavioral bias matters more for large banks and real estate loans

Cross-Sectional Results

▸ bank size ▸ loantype

- Small vs. large banks (defined by total loans)
- Types of loans: Consumer, Commercial & Industrial, Residential Real Estate, Consumer Real Estate

Fact 3: The behavioral bias matters more for large banks and real estate loans

Nature of Bias

- Persistence of expected vs. actual loan performance

Dynamics of Expected vs. Realized Loan Performance

$$y_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k y_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Expected Loan Performance $y_{it} = E_{it}[l_{i,t+1}]$			Actual Loan Performance $y_{it} = l_{it}$		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
β_k	0.168***	0.111***	0.056	0.064	−0.070**	−0.086***
[t]	[5.04]	[3.13]	[1.27]	[0.70]	[−2.16]	[−3.36]
R^2		0.58			0.42	

- Sample period: 2010-2020

Fact 4: Banks over-extrapolate; beliefs follow AR(2)

Cross-Sectional Results

▸ bank size ▸ loantype

- Small vs. large banks (defined by total loans)
- Types of loans: Consumer, Commercial & Industrial, Residential Real Estate, Consumer Real Estate

Fact 3: The behavioral bias matters more for large banks and real estate loans

Nature of Bias

- Persistence of expected vs. actual loan performance $\Rightarrow$ overextrapolation
- Impact of realized outcome on beliefs $\Rightarrow$ delayed over-reaction in recovery

Fact 4: Banks over-extrapolate; beliefs follow AR(2)

▸ delayedOE

Goal

- Quantify the impact of behavioral bias on the slow recovery in lending after 2008

Goal

- Quantify the impact of behavioral bias on the slow recovery in lending after 2008

Agents

- A continuum of heterogeneous banks
  - Each finances a large number of risky projects (loans)
  - Loan defaults if the collateral value falls below a threshold
- A representative investor owns all banks & prices all loans (Gomes et al (2018))
  - Epstein-Zin preferences
  - For now: exogenous process for consumption

Uncertainty

- x_{t+1}: Bernoulli random variable

$$\text{Prob}(x_{t+1} = 1) = p_t$$

- p_t: aggregate shock ⇒ "disaster risk" (Barro (2006), Gourio (2012, 2013))

$$\log p_{t+1} = (1 - \rho_p) \log \tilde{p} + \rho_p \log p_t + \varepsilon_{p,t+1}$$

- ω_{it}: bank-specific shock

$$\omega_{i,t+1} = \rho_\omega \omega_{it} + \varepsilon_{\omega i,t+1}$$

Uncertainty

- x_{t+1}: Bernoulli random variable

$$\text{Prob}(x_{t+1} = 1) = p_t$$

- p_t: aggregate shock ⇒ "disaster risk" (Barro (2006), Gourio (2012, 2013))

$$\log p_{t+1} = (1 - \rho_p) \log \tilde{p} + \rho_p \log p_t + \varepsilon_{p,t+1}$$

- ω_{it}: bank-specific shock

$$\omega_{i,t+1} = \rho_\omega \omega_{it} + \varepsilon_{\omega i,t+1}$$

Expectations

- All agents have full information, but are not fully rational
- All agents over-extrapolate

$$\text{Prob}^{\mathcal{P}}(x_{t+1} = 1) = p_t^{\chi} {p_{t-1}}^{1-\chi}$$

$$\log p_{t+1} = (1 - \hat{\rho}_{1p} - \hat{\rho}_{2p}) \log \tilde{p} + \hat{\rho}_{1p} \log p_t + \hat{\rho}_{2p} \log p_{t-1} + \varepsilon_{p,t+1}$$

$$\omega_{i,t+1} = \hat{\rho}_{1\omega} \omega_{it} + \hat{\rho}_{2\omega} \omega_{i,t-1} + \varepsilon_{\omega i,t+1}$$

Bank's Problem

- Finance loans (L) by equity (E) and deposits (D)

$$V^C(L_{i,t-1}, D_{i,t-1}, E_{i,t-1}, \mathbf{s}_{it}) = \max_{Div_{it}, L_{it}} \left\{ Div_{it} + \Lambda(Div_{it}) + \mathrm{E}_t^{\mathcal{P}} \left[M_{t,t+1} \max \left[V^C(L_{it}, D_{it}, E_{it}, \mathbf{s}_{i,t+1}), 0 \right] \middle| \mathbf{s}_{it} \right] \right\}$$

subject to:

$$L_{it} = E_{it} + D_{it}$$

$$E_{it} = E_{it-1} - Div_{it} + r^L(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1}) L_{it} - rD_{it}$$

$$\frac{L_{it}}{E_{it}} \leq \lambda$$

$$\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$$

▸ portfolio ▸ SDF

Bank's Problem

- Finance loans (L) by equity (E) and deposits (D)
- Accumulate equity through retained earnings

$$V^C(L_{i,t-1}, D_{i,t-1}, E_{i,t-1}, \mathbf{s}_{it}) = \max_{Div_{it}, L_{it}} \left\{ Div_{it} + \Lambda(Div_{it}) + \mathrm{E}_t^{\mathcal{P}} \left[M_{t,t+1} \max \left[V^C(L_{it}, D_{it}, E_{it}, \mathbf{s}_{i,t+1}), 0 \right] \middle| \mathbf{s}_{it} \right] \right\}$$

subject to:

$$L_{it} = E_{it} + D_{it}$$

$$E_{it} = E_{it-1} - Div_{it} + r^L(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1}) L_{it} - rD_{it}$$

$$\frac{L_{it}}{E_{it}} \leq \lambda$$

$$\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$$

portfolio SDF

Bank's Problem

- Finance loans (L) by equity (E) and deposits (D)
- Accumulate equity through retained earnings
- Face a capital requirement constraint

$$V^C(L_{i,t-1}, D_{i,t-1}, E_{i,t-1}, \mathbf{s}_{it}) = \max_{Div_{it}, L_{it}} \left\{ Div_{it} + \Lambda(Div_{it}) + \mathrm{E}_t^{\mathcal{P}} \left[M_{t,t+1} \max \left[V^C(L_{it}, D_{it}, E_{it}, \mathbf{s}_{i,t+1}), 0 \right] \middle| \mathbf{s}_{it} \right] \right\}$$

subject to:

$$L_{it} = E_{it} + D_{it}$$

$$E_{it} = E_{it-1} - Div_{it} + r^L(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1})L_{it} - rD_{it}$$

$$\frac{L_{it}}{E_{it}} \leq \lambda$$

$$\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$$

portfolio SDF

Bank's Problem

- Finance loans (L) by equity (E) and deposits (D)
- Accumulate equity through retained earnings
- Face a capital requirement constraint
- Default if the continuation value becomes too low

$$V^C(L_{i,t-1}, D_{i,t-1}, E_{i,t-1}, \mathbf{s}_{it}) = \max_{Div_{it}, L_{it}} \left\{ Div_{it} + \Lambda(Div_{it}) + \mathrm{E}_t^{\mathcal{P}} \left[M_{t,t+1} \max \left[V^C(L_{it}, D_{it}, E_{it}, \mathbf{s}_{i,t+1}), 0 \right] \middle| \mathbf{s}_{it} \right] \right\}$$

subject to:

$$L_{it} = E_{it} + D_{it}$$

$$E_{it} = E_{it-1} - Div_{it} + r^L(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1}) L_{it} - rD_{it}$$

$$\frac{L_{it}}{E_{it}} \leq \lambda$$

$$\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$$

portfolio SDF

Bank's Problem

- Finance loans (L) by equity (E) and deposits (D)
- Accumulate equity through retained earnings
- Face a capital requirement constraint
- Default if the continuation value becomes too low
- Biased beliefs affect the return on loans and expected continuation value

$$V^C(L_{i,t-1}, D_{i,t-1}, E_{i,t-1}, \mathbf{s}_{it}) = \max_{Div_{it}, L_{it}} \left\{ Div_{it} + \Lambda(Div_{it}) + \mathrm{E}_t^{\mathcal{P}} \left[M_{t,t+1} \max \left[V^C(L_{it}, D_{it}, E_{it}, \mathbf{s}_{i,t+1}), 0 \right] \middle| \mathbf{s}_{it} \right] \right\}$$

subject to:

$$L_{it} = E_{it} + D_{it}$$

$$E_{it} = E_{it-1} - Div_{it} + r^L(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1}) L_{it} - rD_{it}$$

$$\frac{L_{it}}{E_{it}} \leq \lambda$$

$$\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$$

portfolio SDF

Calibration

- Goal: Quantify the impact of behavioral bias on the slow recovery after '08
- Calibrate two variants of the model at an annual frequency: OE and RE
- All shocks are determined according to their true processes
- Targeted moments: leverage, profit-to-equity, bank default rate, dynamics of bank forecast errors $\Rightarrow$ AR(2)

target fit

Model Fit

- Untargeted moments: business cycle correlations + autocorrelations of
  - Loan growth
  - Change in expected loan performance
  - Loan rate growth

Model Fit

Untargeted Moments

	Data	OE	RE
Annual loan growth			
Corr(ΔL_t, ΔGDP$_{t-1}$)	0.239	0.135	-0.015
Corr(ΔL_t, ΔGDP$_{t-2}$)	0.218	0.056	-0.136
Corr(ΔL_t, ΔI_{t-1})	0.207	0.597	0.123
Corr(ΔL_t, ΔI_{t-2})	0.118	0.160	-0.036
Annual change in expected loan performance			
Corr($\Delta \mathrm{E}_t$[LoanDefault$_{t+1}$], ΔGDP$_{t-1}$)	-0.023	-0.077	0.192
Corr($\Delta \mathrm{E}_t$[LoanDefault$_{t+1}$], ΔGDP$_{t-2}$)	0.295	0.230	0.134
Corr$\left(\Delta \mathrm{E}_t[\text{LoanDefault}_{t+1}], \Delta \mathrm{E}_{t-1}[\text{LoanDefault}_t]\right)$	0.465	0.197	-0.152
Corr$\left(\Delta \mathrm{E}_t[\text{LoanDefault}_{t+1}], \Delta \mathrm{E}_{t-2}[\text{LoanDefault}_{t-1}]\right)$	0.153	0.082	-0.094
Annual loan rate growth			
Corr(Δr_t^L, ΔGDP$_{t-1}$)	0.071	0.110	-0.301
Corr(Δr_t^L, ΔGDP$_{t-2}$)	0.022	0.009	-0.270
Corr(Δr_t^L, Δr_{t-1}^L)	0.017	0.177	-0.141
Corr(Δr_t^L, Δr_{t-2}^L)	-0.013	-0.072	-0.109

Model Fit

- Untargeted moments: business cycle correlations + autocorrelations of
  - Loan growth
  - Change in expected loan performance
  - Loan rate growth

- Model-implied regressions:
  - Serial correlations of forecast errors
  - Impact of forecast errors on future lending

Model Fit

Dynamics of Bank Forecast Errors

$$R_{it}^{FE} = \alpha_t + \sum_{k=1}^{K} \beta_k R_{it-k}^{FE} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Data		OE Model		RE Model	
	k=1 year (1)	k=2 year (2)	k=1 year (3)	k=2 year (4)	k=1 year (5)	k=2 year (6)
β_k	0.233***	0.153***	0.243**	0.169*	0.060	−0.031
[t]	[5.57]	[4.33]	[2.42]	[2.16]	[1.22]	[−0.73]

- RE: forecast errors unpredictable
- OE: serially correlated forecast errors

Model Fit

Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Data		OE Model		RE Model	
	k=1 year	k=2 year	k=1 year	k=2 year	k=1 year	k=2 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.071	0.239***	0.218**	0.187*	0.021	-0.082
[t]	[-0.52]	[2.96]	[2.79]	[2.10]	[0.55]	[-0.43]

- RE: no predictability
- OE: forecast errors predict future loan growth

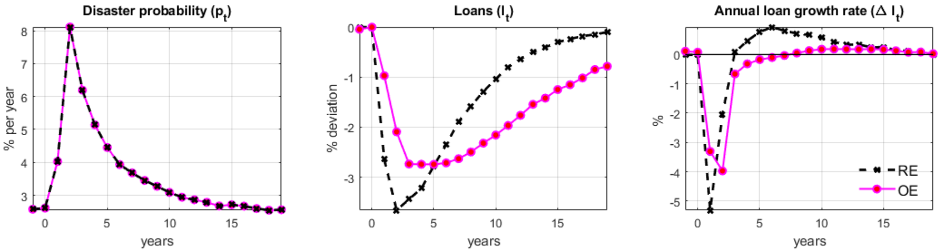
Main Exercise

- Model the 2008-09 financial crisis as two consecutive positive shocks to the disaster probability
- Look at the responses of aggregate loan growth, bank value, expectations
- Look at the counterfactual exercise (under rational expectations) to understand the impact of overextrapolation

▸ disaster realization ▸ by size ▸ policy

Main Exercise

IRF to a Temporary Increase in Disaster Probability

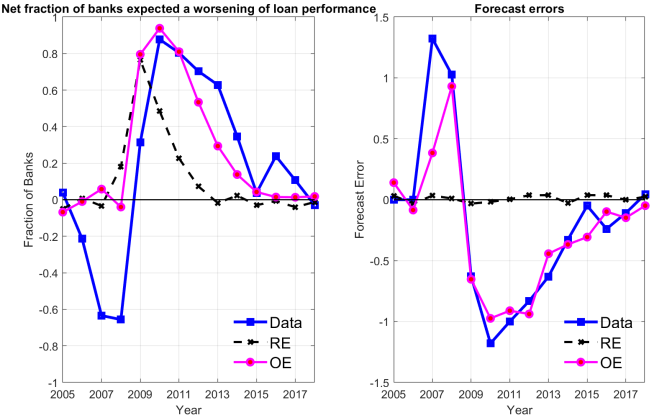


	Data	OE	RE
Years taken for the recovery of loan growth	7	7	3

IRF

Main Exercise

IRF to a Temporary Increase in Disaster Probability



Number of years taken for the recovery of:	Data	OE	RE
Net fraction of banks experience worsening	3	5	5
Net fraction of banks expect worsening	8	8	5

Mechanism

$$L\Big(L_{i,t-1}, E_{i,t-1}, p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\Big)$$

- Bias: Lending is decreasing in p_t as well as p_{t-1}
  - Even when the disaster probability starts to decrease, bank lending continues to decline

Mechanism

$$L\left(L_{i,t-1}, E_{i,t-1}, p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\right)$$

- Bias: Lending is decreasing in p_t as well as p_{t-1}
  - Even when the disaster probability starts to decrease, bank lending continues to decline
- Bias + balance sheet constraint: Realized loan return (r_{it}) increases more slowly as disaster probability decreases
  - Profit & equity recover more slowly
  - Lending increases more slowly

AR(1) vs AR(2)

Extension (1/2): General Equilibrium

- Do endogeneous movements in the deposit rate dampen the impact of bias?
- Households choose consumption C_t & savings D_t^h, subject to:

$$C_t + D_t^h = (1 + r_{t-1}^D) D_{t-1}^h + \int \Pi_{it} d\mu_t$$

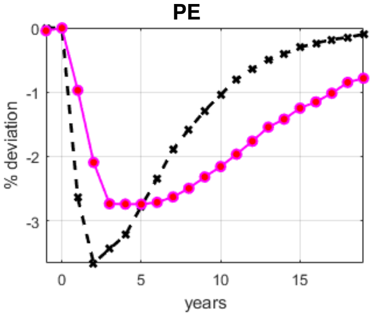
- Deposit market clearing: $\int (L_{it} - E_{it}) d\mu_t = D_t^h$
- Evolution of the aggregate equilibrium:

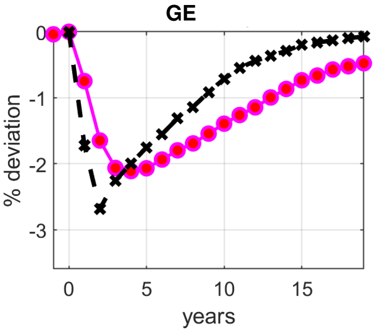
$$MU_t = \Gamma_u(p_t, p_{t-1}, \mu_t)$$
$$\mu_{t+1} = \Gamma_\mu(p_t, p_{t-1}, \mu_t)$$

- Krusell-Smith algorithm: approximate μ_t by current aggregate lending

Extension (1/2): General Equilibrium

Impact of a Temporary Increase in Disaster Probability $\Rightarrow r_t^D \downarrow$





- Real impact of behavioral bias remains significant

Extension (2/2): Comparison to Diagnostic Expectations

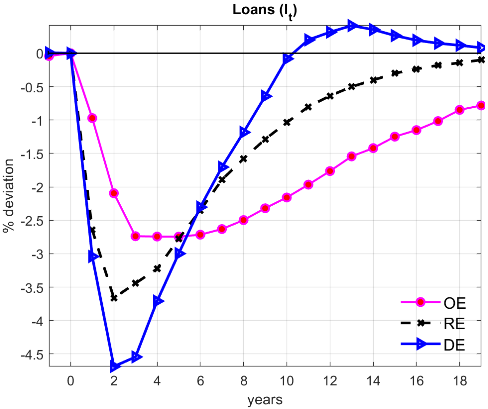
- OE: $\mathbf{s}_{it} = \{p_t, \omega_{it}, p_{t-1}, \omega_{i,t-1}\}$

$$\log p_{t+1} = (1 - \hat{\rho}_{1p} - \hat{\rho}_{2p}) \log \tilde{p} + \hat{\rho}_{1p} \log p_t + \hat{\rho}_{2p} \log p_{t-1} + \varepsilon_{p,t+1}$$
$$\omega_{i,t+1} = \hat{\rho}_{1\omega}\omega_{it} + \hat{\rho}_{2\omega}\omega_{i,t-1} + \varepsilon_{\omega i,t+1}$$

- DE: $\mathbf{s}_{it} = \{p_t, \omega_{it}, \varepsilon_{pt}, \varepsilon_{\omega it}\}$ (Bordalo et al. (2021))

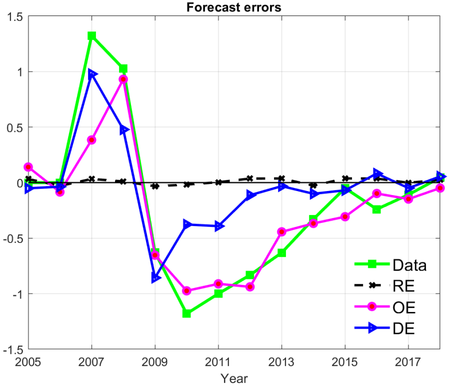
$$\log p_{t+1} = (1 - \rho_p) \log \tilde{p} + \rho_p \log p_t + \theta\varepsilon_{pt} + \varepsilon_{p,t+1}$$
$$\omega_{i,t+1} = \rho_\omega \omega_{it} + \theta\varepsilon_{\omega it} + \varepsilon_{\omega i,t+1}$$

Extension (2/2): Comparison to Diagnostic Expectations



- DE: overreaction SR; strong reversal LR
- OE AR(2): underreaction SR; overreaction LR

Extension (2/2): Comparison to Diagnostic Expectations

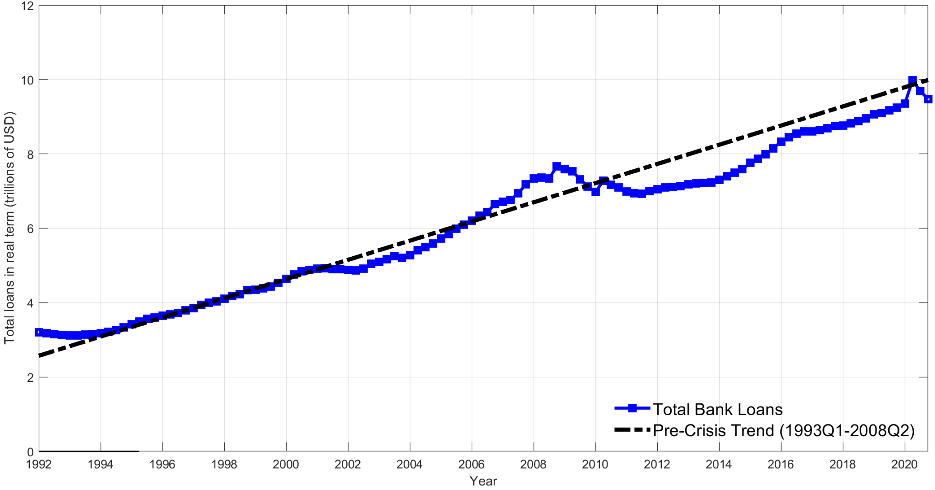


	Data		OE Model		DE Model	
	k=1 year	k=2 year	k=1 year	k=2 year	k=1 year	k=2 year
β_k	0.233***	0.153***	0.243**	0.169*	0.217*	-0.328*
[t]	[5.57]	[4.33]	[2.42]	[2.16]	[1.90]	[-2.02]

To Conclude

- Bank expectations are distorted – lasting pessimism
- And they matter for lending decisions – contribute to lending slumps
- Lasting bank pessimism hampers the effectiveness of balance-sheet policies

Figure: Total Loans in the US: Alternative Trend



Back

Table: Dynamics of Bank Forecast Errors

$$R_{it}^{FE} = \alpha_t + \sum_{k=1}^{K} \beta_k R_{it-k}^{FE} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Random Beliefs		Discretized Random Beliefs with Pseudo Beliefs	
	k=1 year	k=2 year	k=1 year	k=2 year
	(1)	(2)	(3)	(4)
β_k	0.002	-0.001	-0.006	-0.006
[t]	[0.12]	[-0.05]	[-0.38]	[-0.33]

Pseudo Forecast Errors

- Randomly draw FE from a normal distribution
  - Not predictable (as under rational expectations)
- Discretize FE: below/within/above 1SD from the median
  - Not predictable & similar estimates

Back

Table: Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Forecast Errors			Loan Performance		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.071	0.239^{***}	0.048			
[t]	[-0.52]	[2.96]	[0.55]			
g_k				-0.161	-0.199^{***}	-0.170^{**}
[t]				[-0.89]	[-2.49]	[-3.03]
R^2			0.14			

Back

Table: Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Random Beliefs		Discretized Random Beliefs with Pseudo Beliefs	
	k=1 year	k=2 year	k=1 year	k=2 year
	(1)	(2)	(3)	(4)
β_k	0.006	0.017	-0.006	-0.021
[t]	[0.37]	[1.64]	[0.27]	[0.99]

Pseudo Forecast Errors

- Randomly draw FE from a normal distribution
  - Do not predict future lending
- Discretize FE: below/within/above 1SD from the median
  - Do not predict future lending

Back

Table: Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Loan Demand			Crisis Loan Performance		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.141	0.220***	0.053	-0.169	0.236**	0.039
[t]	[-0.97]	[2.64]	[0.58]	[-0.95]	[2.36]	[0.45]
$Control_k$	0.053	0.092	0.120**	-0.200	0.465*	-0.187
[t]	[0.60]	[1.39]	[2.42]	[-0.95]	[1.93]	[-0.62]

	Bank Capital			Bank Liquidity		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.067	0.239***	0.048	-0.075	0.245***	0.043
[t]	[-0.48]	[2.96]	[0.55]	[-0.52]	[2.87]	[0.46]
$Control_k$	0.114	-0.182	-0.053	0.116**	-0.085**	-0.041
[t]	[0.77]	[-1.48]	[-0.49]	[2.07]	[-2.09]	[-0.57]

Back

Table: Bank Expectations and Lending Dynamics

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Exclude Largest Banks			Securitization		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.086	0.217**	0.049	-0.028	0.256***	0.049
[t]	[-0.65]	[2.46]	[0.79]	[-0.26]	[3.06]	[0.72]
$Control_k$				-0.057	-0.023	0.021*
[t]				[-0.97]	[-0.85]	[1.74]

	Pre-Crisis 2003-2005			Pre-Crisis 2002-2004		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	-0.038	0.239***	0.018	-0.042	0.223***	0.001
[t]	[-0.30]	[2.87]	[0.24]	[-0.34]	[2.64]	[0.02]

Back

Table: Bank Heterogeneity

$$R_{it}^{FE} = \alpha_t + \sum_{k=1}^{K} \beta_k R_{it-k}^{FE} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Small Banks			Large Banks		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
	(1)	(2)	(3)	(4)	(5)	(6)
β_k	0.254**	0.121*	0.107	0.308**	0.138**	-0.046
[t]	[2.15]	[1.73]	[1.28]	[4.64]	[2.14]	[-0.70]

Table: Bank Heterogeneity

$$\Delta Loans_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k R^{FE}_{it-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Small banks (bottom quartile by total loans)		
	k=1 year	k=2 year	k=3 year
β_k	0.021	0.258*	-0.079
[t]	[0.15]	[1.81]	[-0.86]
	Large banks (top quartile by total loans)		
	k=1 year	k=2 year	k=3 year
β_k	0.246	0.313**	0.121
[t]	[1.46]	[2.36]	[0.82]

Back

Table: Loan Heterogeneity

	C&I Loans			RRE Loans		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
β_k^{own}	0.023	0.025*	0.032	-0.021	0.092**	-0.045
[t]	[1.48]	[1.88]	[1.52]	[-0.30]	[2.37]	[-0.39]
β_k^{other}	0.021	0.015	0.021	0.050	0.036	0.037
[t]	[0.89]	[0.64]	[1.17]	[0.35]	[0.50]	[0.39]
	CRE Loans			Consumer Loans		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
β_k^{own}	0.091	0.111*	0.121	-0.212	0.005	0.125
[t]	[1.47]	[2.59]	[1.40]	[-1.25]	[0.03]	[-0.65]
β_k^{other}	-0.121	0.065	-0.010	0.042	0.215	0.142
[t]	[1.27]	[0.83]	[-0.14]	[0.29]	[1.40]	[1.15]

Back

Table: Additional Evidence on Bank Expectations

$$y_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k I_{i,t-k} + \sum_{k=1}^{K} g_k X_{it-k} + u_{it}$$

	Expected loan performance $y_{it} = E_{it}[I_{i,t+1}]$		Forecast errors $y_{it} = E_{it}[I_{i,t+1}] - I_{i,t+1}$	
	k=0 year	k=1 year	k=0 year	k=1 year
	(1)	(2)	(3)	(4)
β_k	-0.114*	-0.058*	-0.200***	0.147**
[t]	[-2.95]	[-1.94]	[-3.60]	[2.37]

Back

Endowment & Preferences

- Baseline model: exogenous process for consumption

$$C_{t+1} = C_t e^{\mu_c + \sigma_c \varepsilon_{c,t+1} + \xi x_{t+1}}$$

- Stochastic discount factor (Epstein-Zin preferences)

$$M_{t,t+1} = \beta^{\theta} \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(\frac{S_{t+1} + 1}{S_t} \right)^{-1+\theta}, \qquad \theta = \frac{1-\gamma}{1-1/\psi}$$

- Consumption-wealth ratio S_t

$$\mathrm{E}_t^{\mathcal{P}} \left[\beta^{\theta} \left(\frac{C_{t+1}}{C_t} \right)^{1-\gamma} \left(S_{t+1} + 1 \right)^{\theta} \right] = S_t^{\theta}$$

Back

Loan Portfolio (Gomes et al. (2020))

- Each bank holds an equal-weighted portfolio of a large number of loans
- Borrower j defaults on bank i at time t if $W_{ijt} < \kappa$. The bank can recover a fraction $1 - \mathcal{L}$ of the collateral value
- Payoff, price and return of loan portfolio:

$$\pi^L_{i,t+1}(x_{t+1}, \omega_{i,t+1}) = \underbrace{\kappa \text{Prob}\Big(W_{ij,t+1} \geq \kappa \Big| x_{t+1}, \omega_{i,t+1}\Big)}_{\text{Repay}} + \underbrace{(1-\mathcal{L})\mathrm{E}\Big[W_{ij,t+1}\mathbb{1}_{W_{ij,t+1}<\kappa}\Big| x_{t+1}, \omega_{i,t+1}\Big]}_{\text{Default}}$$

$$P^L_{it}(\mathbf{s}_{it}) = \mathrm{E}^{\mathcal{P}}_t\Big[M_{t,t+1}\pi^L_{i,t+1}(x_{t+1}, \omega_{i,t+1})\Big].$$

$$r^L_{i,t+1}(\mathbf{s}_{it}, x_{t+1}, \omega_{i,t+1}) = \frac{\pi^L_{i,t+1}(x_{t+1}, \omega_{i,t+1})}{P^L_{it}(\mathbf{s}_{it})} - 1$$

$\mathbf{s}_{it}$: exogenous states (depend on belief process)

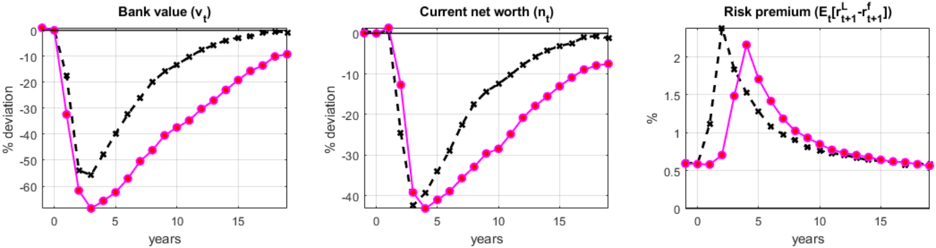
Back

Table: Targeted Moments

Description	Data	OE	RE
Leverage (mean)	8.50	8.72	8.69
Leverage (std)	2.95	3.10	2.50
Profit-to-equity (mean)	0.169	0.137	0.149
Bank default rate (mean)	0.041	0.062	0.053
Dynamics of bank forecast errors			
1-year	0.233	0.243	–
2-year	0.153	0.169	–

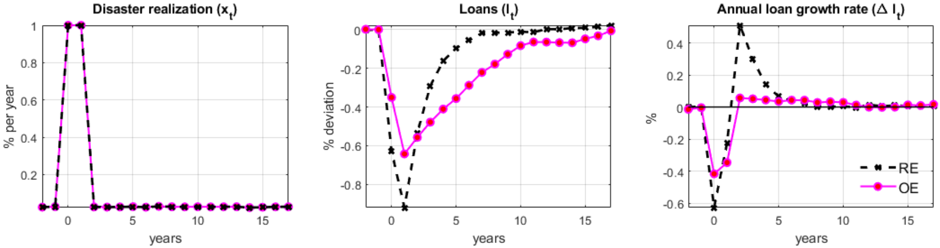
▸ Back

Figure: IRF to a Temporary Increase in Disaster Probability



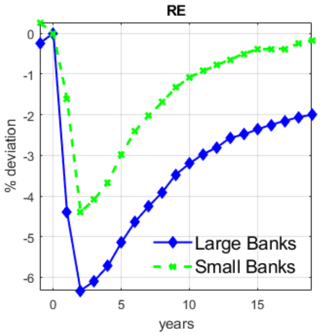
Back

Figure: Disaster in the Model



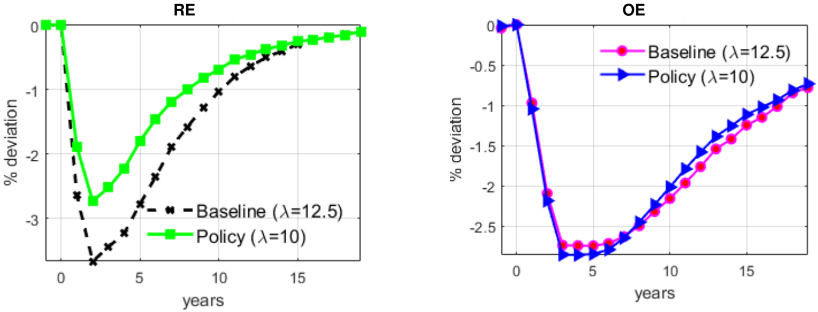
Back

Figure: IRF of Lending to a Temporary Increase in Disaster Probability (Large vs. Small Banks)



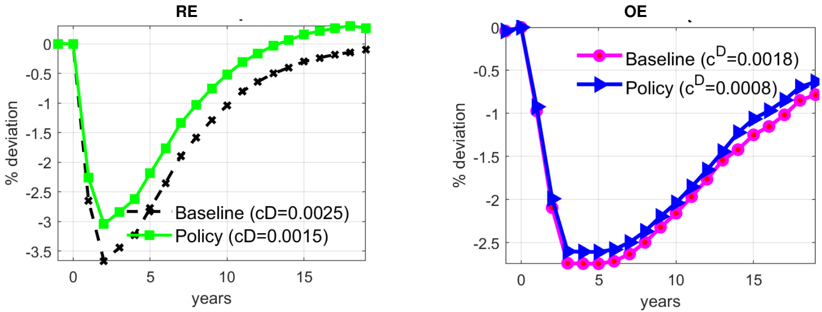
Back

Figure: IRF to a Temporary Increase in Disaster Probability
(Higher Capital Requirement 8% → 10%)



Back

Figure: IRF to a Temporary Increase in Disaster Probability (Lower Bank Funding Cost by 10 b.p.)



Back

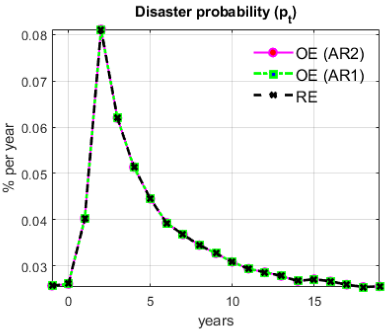
OE: AR(2) or AR(1) with higher persistence?

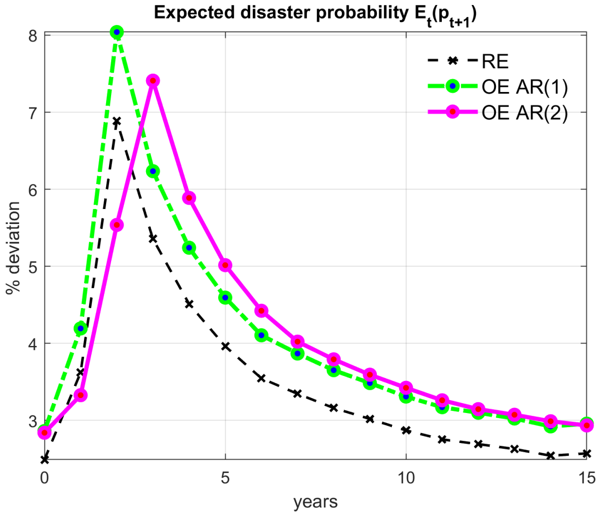
Let $P_t \equiv \log p_t$:

$$\begin{aligned} P_{t+1} &= (1-\hat{\rho}_{1p}-\hat{\rho}_{2p})\tilde{P} + \hat{\rho}_{1p}P_t + \hat{\rho}_{2p}P_{t-1} + \varepsilon_{p,t+1} \\ &= (1-\hat{\rho}_{1p}-\hat{\rho}_{2p})\tilde{P} + (\hat{\rho}_{1p}+\hat{\rho}_{2p})P_t - \hat{\rho}_{2p}\Delta P_t + \varepsilon_{p,t+1} \\ &= (1-\tilde{\rho}_p)\tilde{P} + \tilde{\rho}_p P_t \underbrace{-\hat{\rho}_{2p}\Delta P_t}_{\text{momentum}} + \varepsilon_{p,t+1} \end{aligned}$$

- AR(1): only current state of the economy (P_t) matters for expectation formation, regardless of whether $\tilde{\rho}_p$ is the true coefficient
- AR(2): captures an asymmetry, depending on where the economy has been

Figure: IRF to a Temporary Increase in Disaster Probability





- $\Delta P_t > 0 \Longrightarrow E_t^{AR(1)}(P_{t+1}) > E_t^{RE}(P_{t+1}) > E_t^{AR(2)}(P_{t+1})$
- $\Delta P_t < 0 \Longrightarrow E_t^{AR(2)}(P_{t+1}) > E_t^{AR(1)}(P_{t+1}) > E_t^{RE}(P_{t+1})$

Back