Expectations and Credit Slumps

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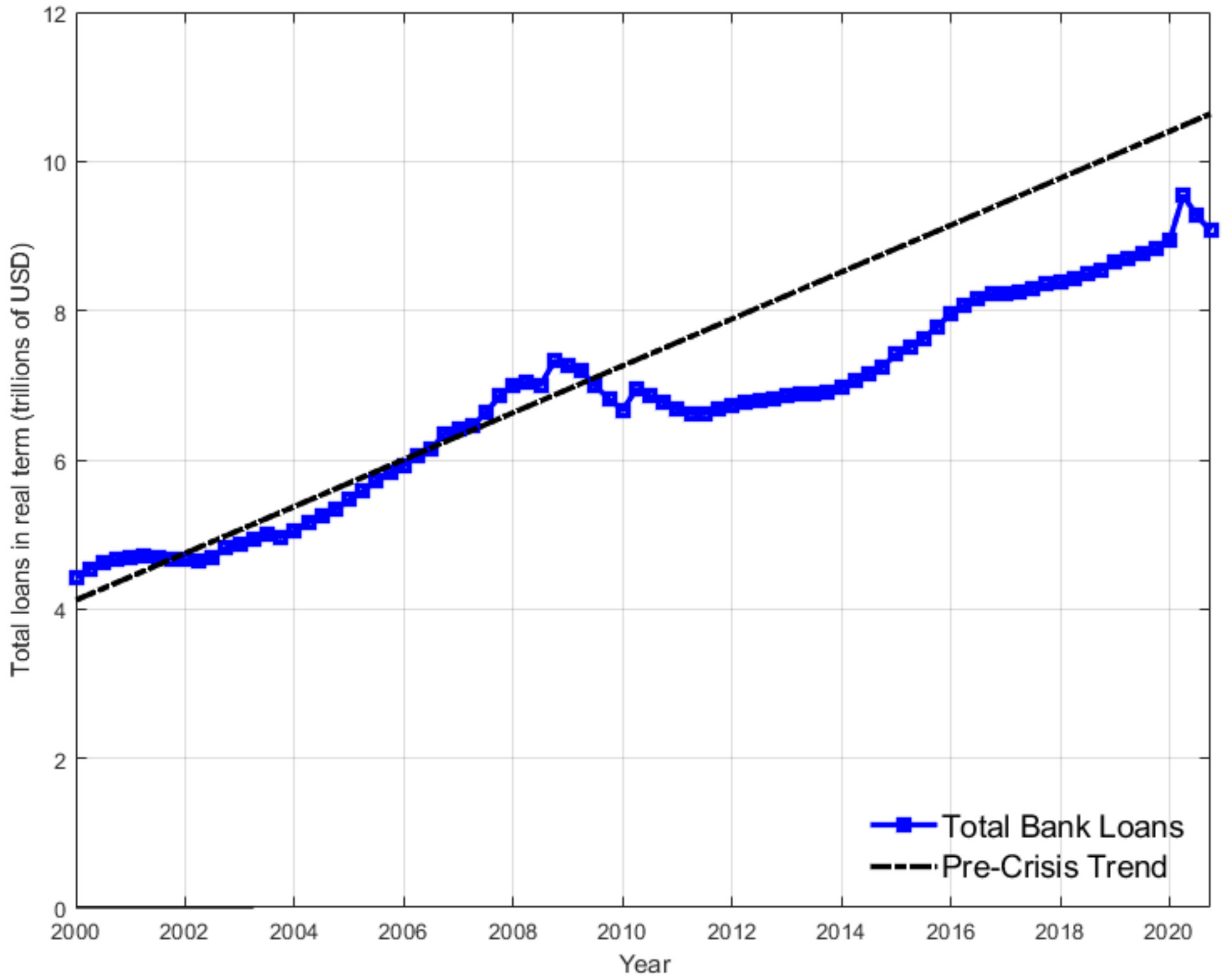
Question

- 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.

Our Explanation

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

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- 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

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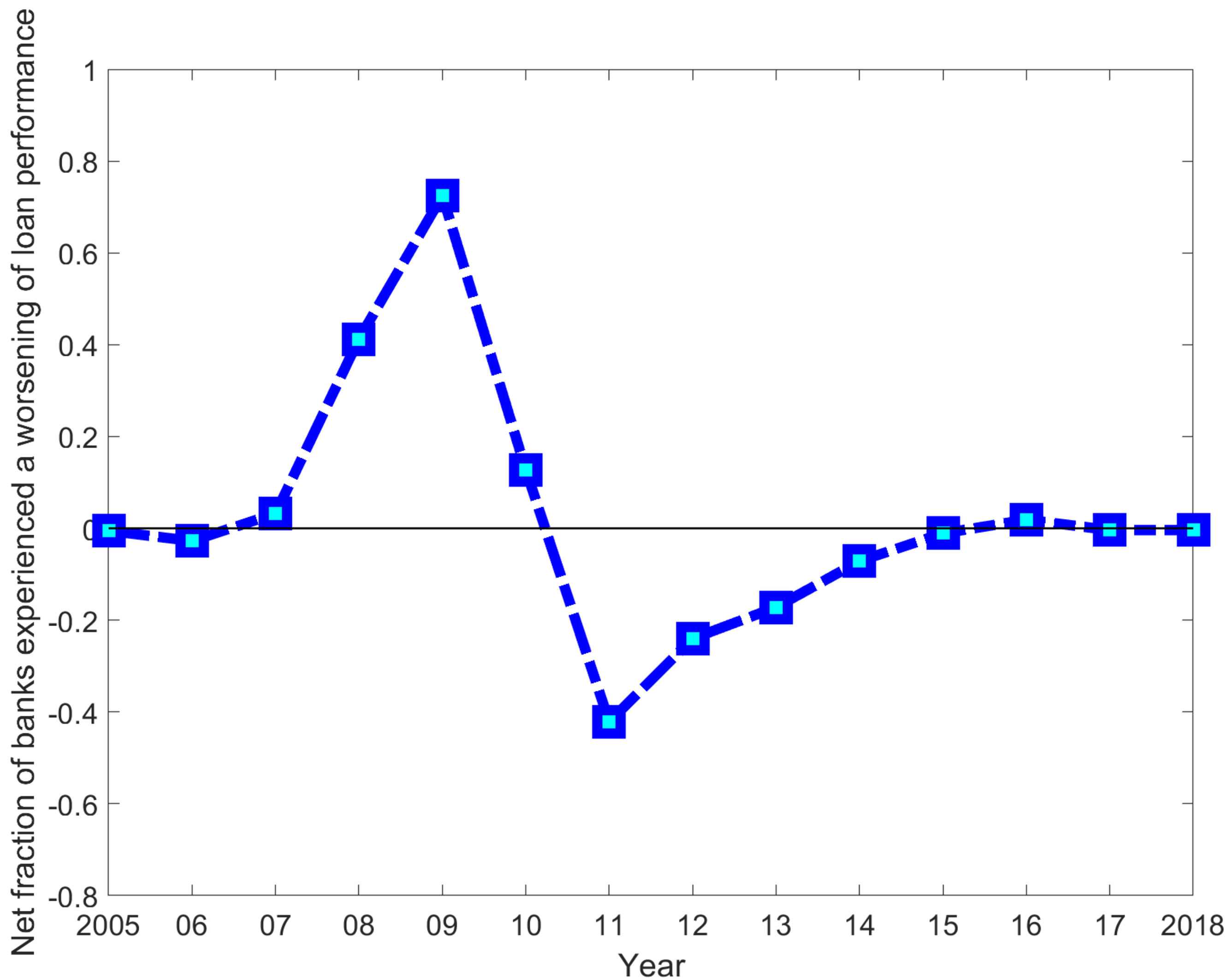
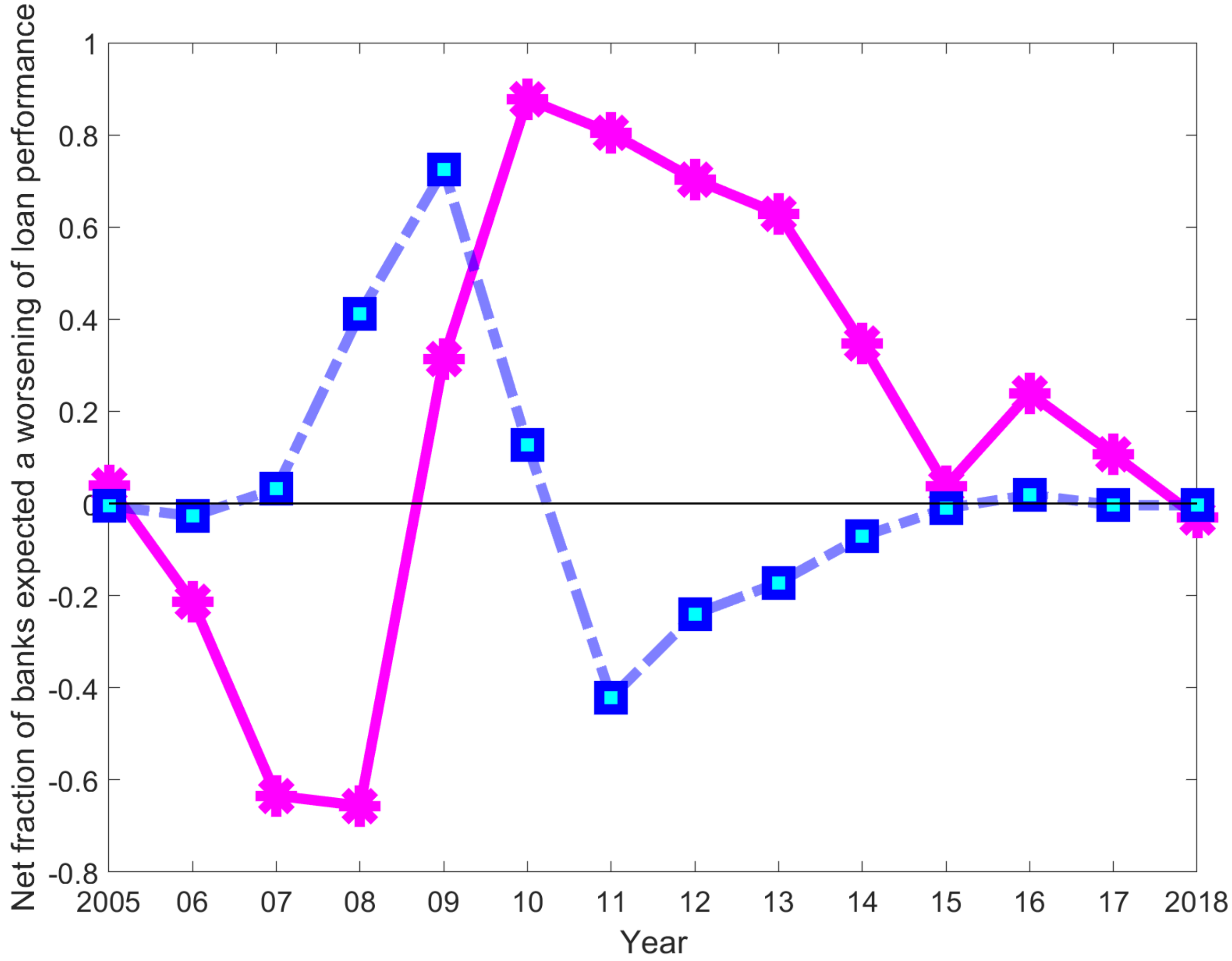
Expectations in Credit & Business Cycles: Krishnamurthy and Li (2020), Bordalo et al. (2021), Bianchi et al. (2021), L'Huillier et al. (2021), Maxted (2022)

Loan performance recovered quickly after the Great Recession



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

Expected loan performance took long to recover after the Great Recession



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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

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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*

Forecast errors:

$$R_{it}^{FE} = E_t[I_{i,t+1}] - I_{i,t+1}$$

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

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

$$E_t[l_{i,t+1}] = \sum_k \omega_{it}^k \times E_t[l_{i,t+1}^k]$$

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

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Loan Performance: Call Reports

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

$$l_{it} = \sum_k \omega_{i,t-1}^k \times l_{it}^k$$

Dynamics of Bank Forecast Errors

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

	k=1 year	k=2 year	k=3 year
β_k	0.233***	0.153***	0.024
[t]	[5.57]	[4.33]	[0.68]
R^2		0.59	

- R_{it}^{FE}: forecast errors ($<$ 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

▸ loans

Bank Expectations and Lending Dynamics

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

	k=1 year	k=2 year	k=3 year
β_k	-0.071	0.239^{***}	0.048
[t]	[-0.52]	[2.96]	[0.55]
R^2		0.14	

- R^{FE}_{it}: forecast errors (<0: over-pessimistic)
- $\Delta Loans_{it}$: log change in loans relative to the pre-crisis level
- Sample period: 2010-2020

Fact 2: Past forecast errors have significant predictive power for future loan growth, even after controlling for loan demand and tighter regulation

▸ robustness ▸ loans

Bank Heterogeneity

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

	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]

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

▸ FE ▸ loan type

Goal

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

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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

Uncertainty

- x_{t+1}: Bernoulli random variable

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

- p_t: aggregate shock $\Rightarrow$ "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

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

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Expectations

- All agents have full information, but are not fully rational
- Over-extrapolation

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

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

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

Bank's Problem

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

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

subject to:

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

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

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

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

▸ payoff ▸ SDF

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

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Bank's Problem

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

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payoff SDF

Bringing Model to Data

- 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

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- Targeted moments: leverage, profit-to-equity, bank default rate, dynamics of bank forecast errors $\Rightarrow$ AR(2) ▸ target
- Untargeted moments: business cycle correlations + autocorrelations of
  - Loan growth
  - Change in expected loan performance
  - Loan rate growth

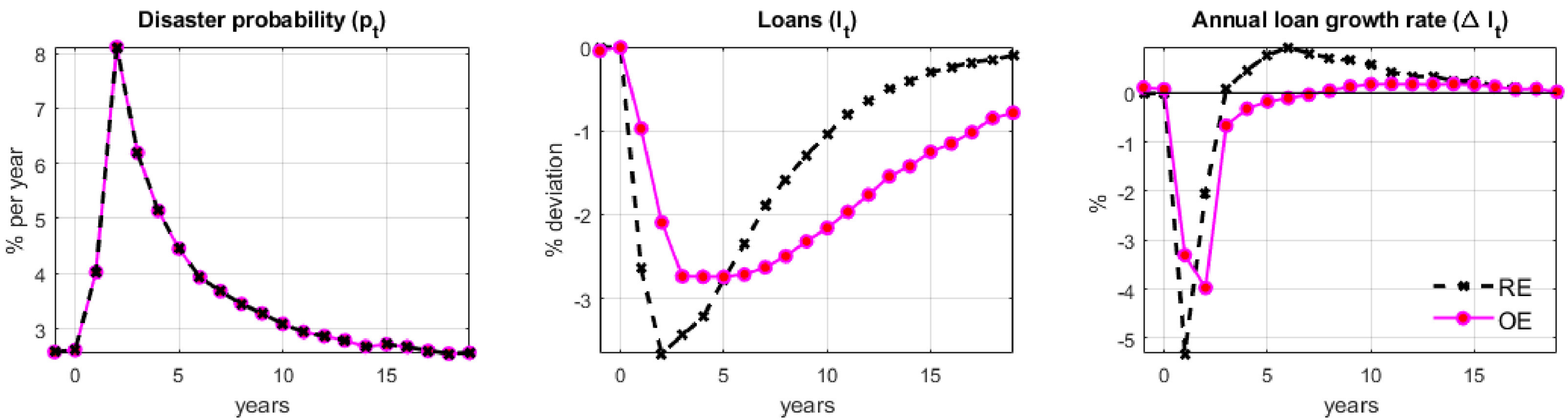
  Goal: Test the business cycle properties of bank behavior

▸ moments

Main Exercise

- We 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
- Look at the responses of large vs. small banks (defined by size of loan portfolio)

IRF to a Temporary Increase in Disaster Probability



	Data	OE	RE
Years taken for the recovery of loan growth	7	7	3
Net fraction of banks expect worsening	8	8	5

▸ IRF ▸ disaster

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

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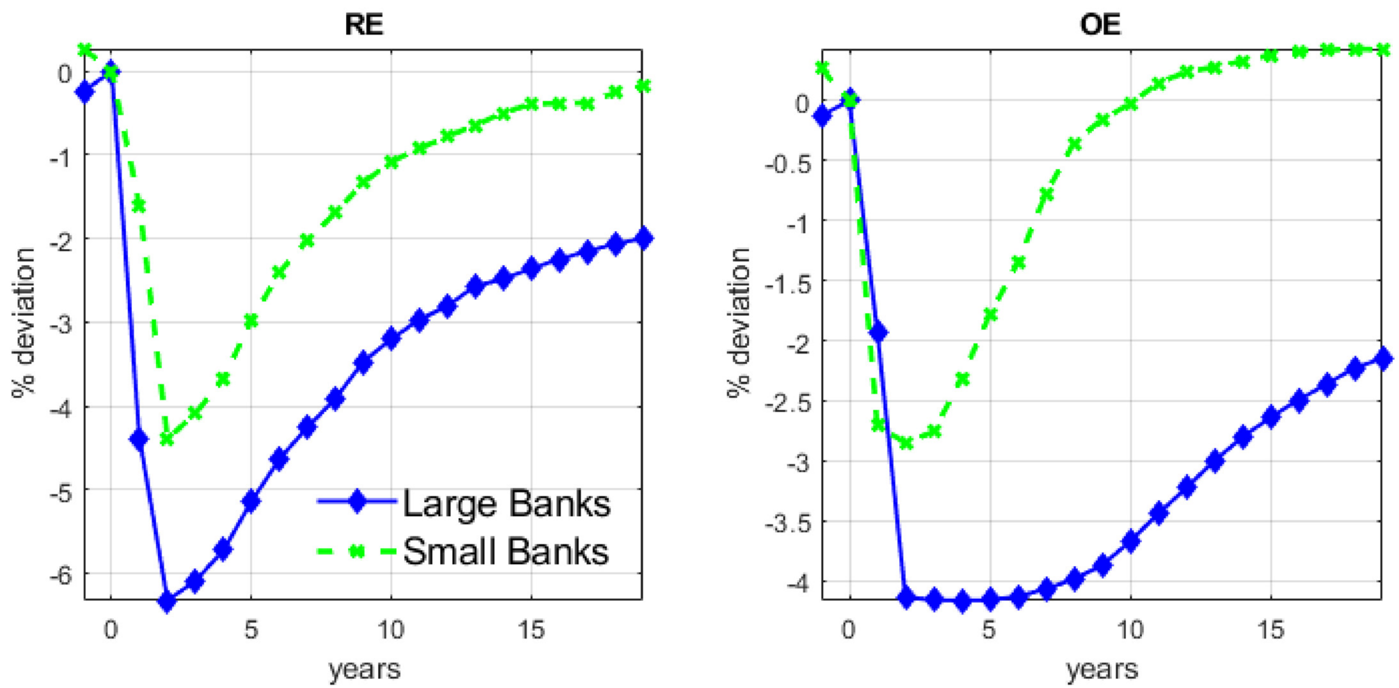
- Bias: Lending is decreasing in p_t as well as p_{t-1}
  - Even when the disaster probability starts to decrease, bank lending continues to decline

- Bias + balance sheet constraint: Realized loan return (r_{it}) increases more slowly as disaster probability decreases
  - Profit & equity (E_{it}) recover more slowly
  - Lending increases more slowly

AR(2) intuition

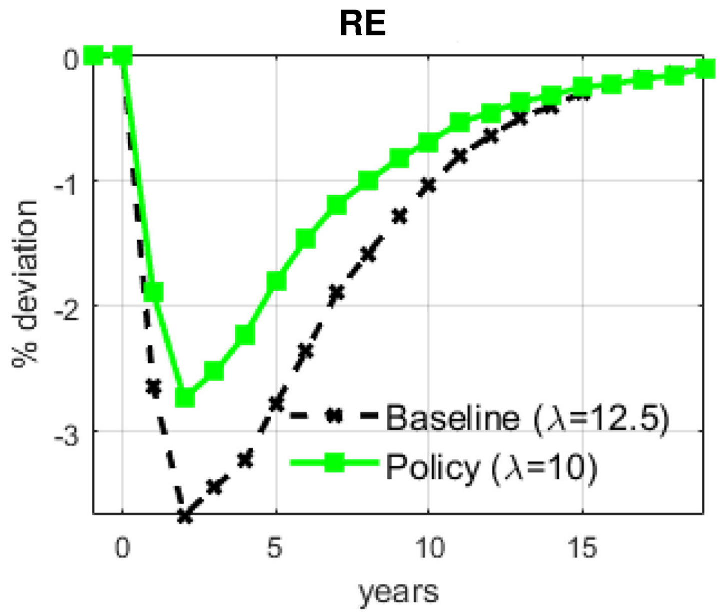
IRF of Lending to a Temporary Increase in Disaster Probability (Large vs. Small Banks)

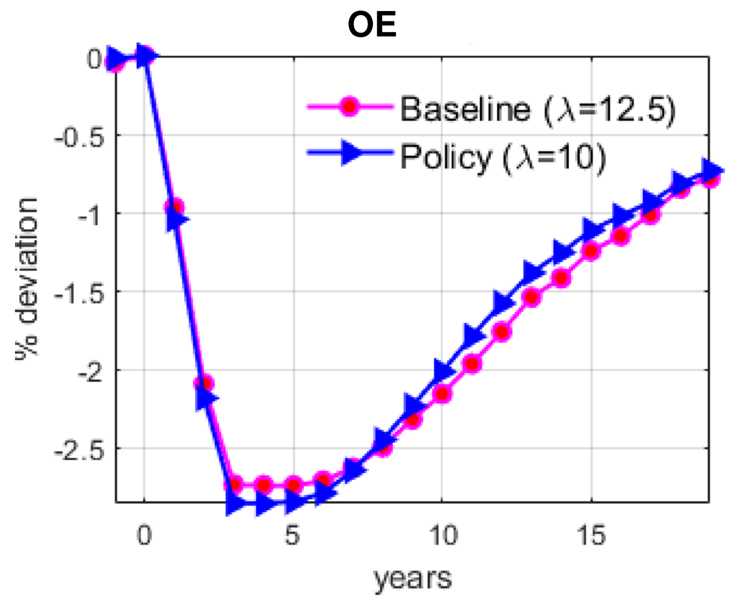


Additional Exercises: Policy Impact

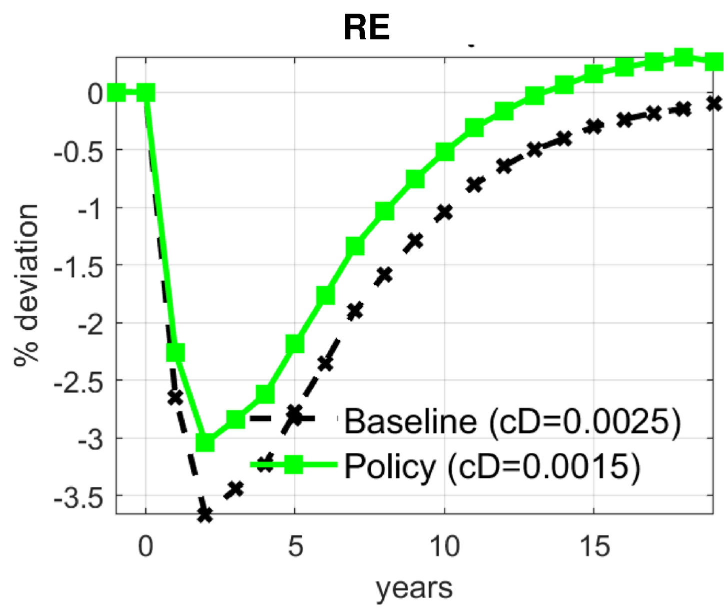
- Capital requirement: increase the minimum equity-to-asset ratio from 8% to 10%
- Monetary policy: lower r^D by 10 basis points

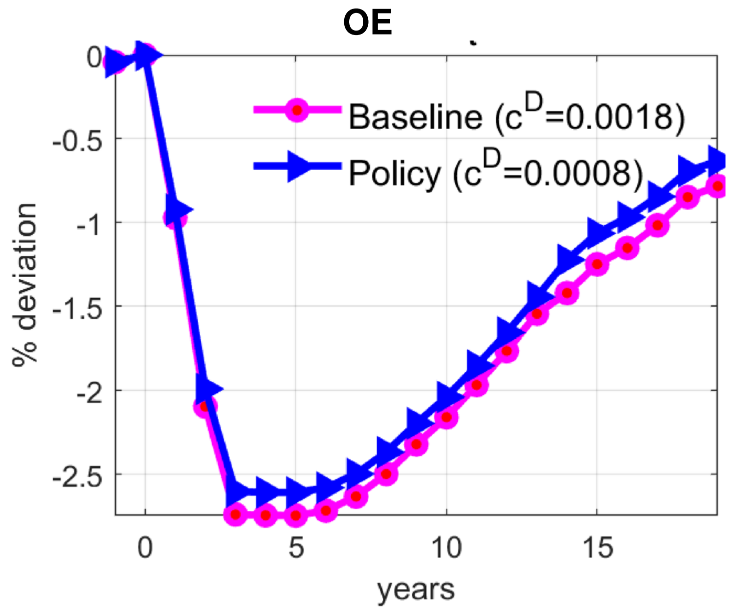
IRF of Lending to a Temporary Increase in Disaster Probability
Higher Capital Requirement





IRF of Lending to a Temporary Increase in Disaster Probability Lower Bank Funding Cost





To Conclude

- Bank expectations are distorted – lasting pessimism
- And they matter for lending decisions – contribute to lending slumps
- Lasting bank pessimism also hampers the effectiveness of financial policies (QE, etc)

Table: Dynamics of Bank Forecast Errors and Loan Performance

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

	Forecast Errors			Loan Performance		
	k=1 year	k=2 year	k=3 year	k=1 year	k=2 year	k=3 year
β_k	0.233***	0.153***	0.024	0.064	−0.070**	−0.086***
[t]	[5.57]	[4.33]	[0.68]	[0.70]	[−2.16]	[−3.36]
R^2		0.59			0.42	

▸ Back

Table: Bank Expectations and Lending Dynamics, Controlling for Alternatives

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

	Loan Demand			Crisis Loan Performance		
	k=1 year (1)	k=2 year (2)	k=3 year (3)	k=1 year (4)	k=2 year (5)	k=3 year (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 (1)	k=2 year (2)	k=3 year (3)	k=1 year (4)	k=2 year (5)	k=3 year (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

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	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: 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 Heterogeneity

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

	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]

Back

Loan Portfolio

- 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

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- 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:

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

Loan Portfolio

- 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:

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

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

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

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

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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

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

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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	–

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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($\Delta \mathrm{E}_t[\text{LoanDefault}_{t+1}]$, ΔGDP_{t-1})	-0.023	-0.077	0.192
Corr($\Delta \mathrm{E}_t[\text{LoanDefault}_{t+1}]$, 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($\Delta \mathrm{E}_t[r^L_{t+1}]$, ΔGDP_{t-1})	0.071	0.110	-0.301
Corr($\Delta \mathrm{E}_t[r^L_{t+1}]$, ΔGDP_{t-2})	0.022	0.009	-0.270
Corr($\Delta \mathrm{E}_t[r^L_{t+1}]$, $\Delta \mathrm{E}_{t-1}[r^L_t]$)	0.017	0.177	-0.141
Corr($\Delta \mathrm{E}_t[r^L_{t+1}]$, $\Delta \mathrm{E}_{t-2}[r^L_{t-1}]$)	-0.013	-0.072	-0.109

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Figure: IRF to a Temporary Increase in Disaster Probability

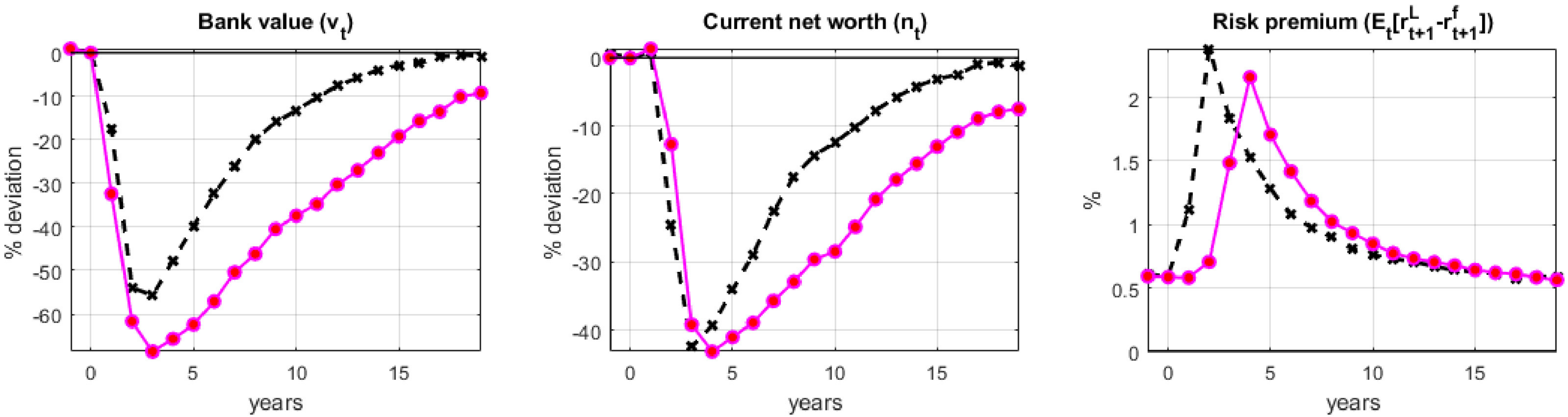

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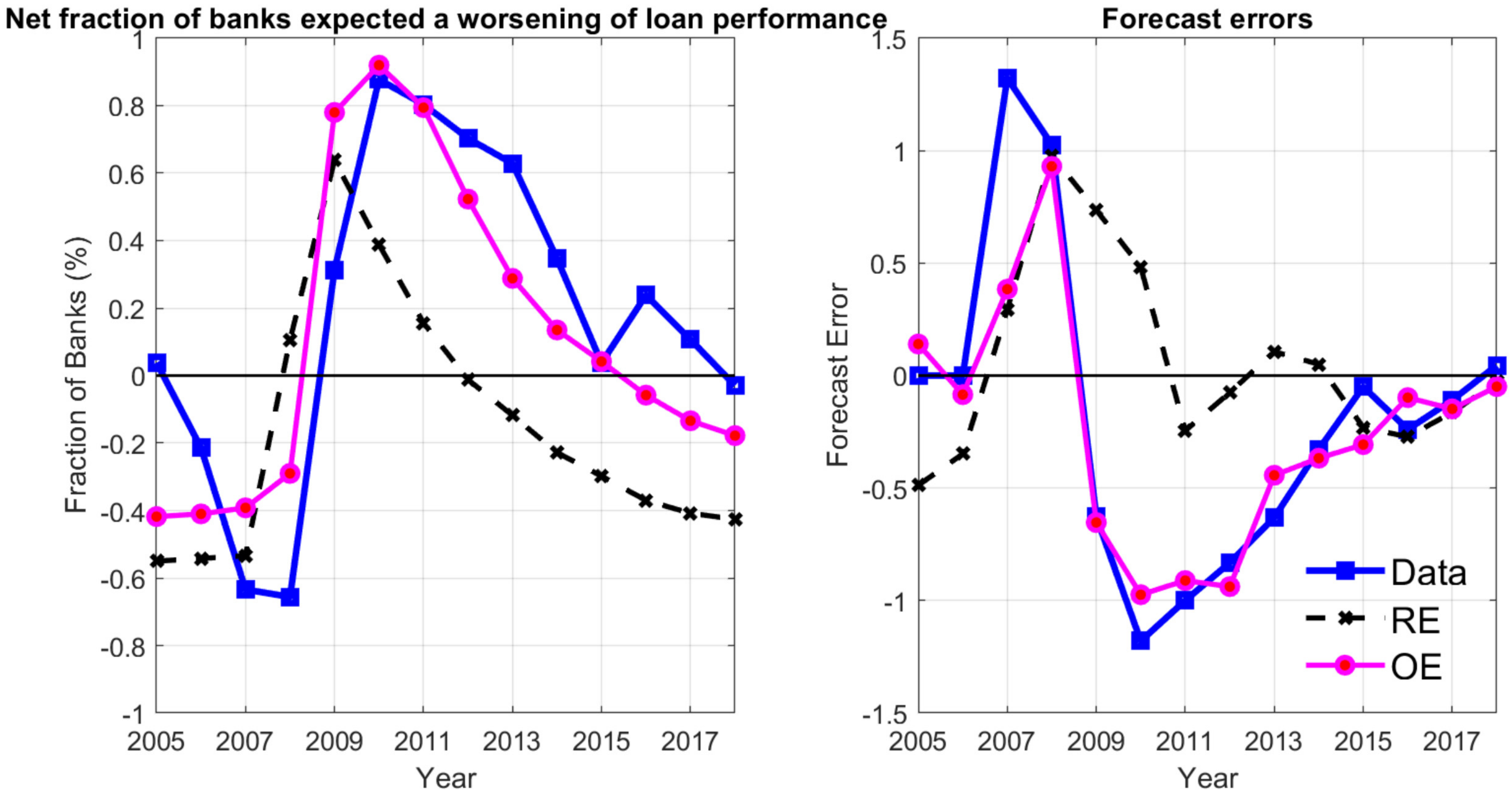
Figure: IRF to a Temporary Increase in Disaster Probability



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

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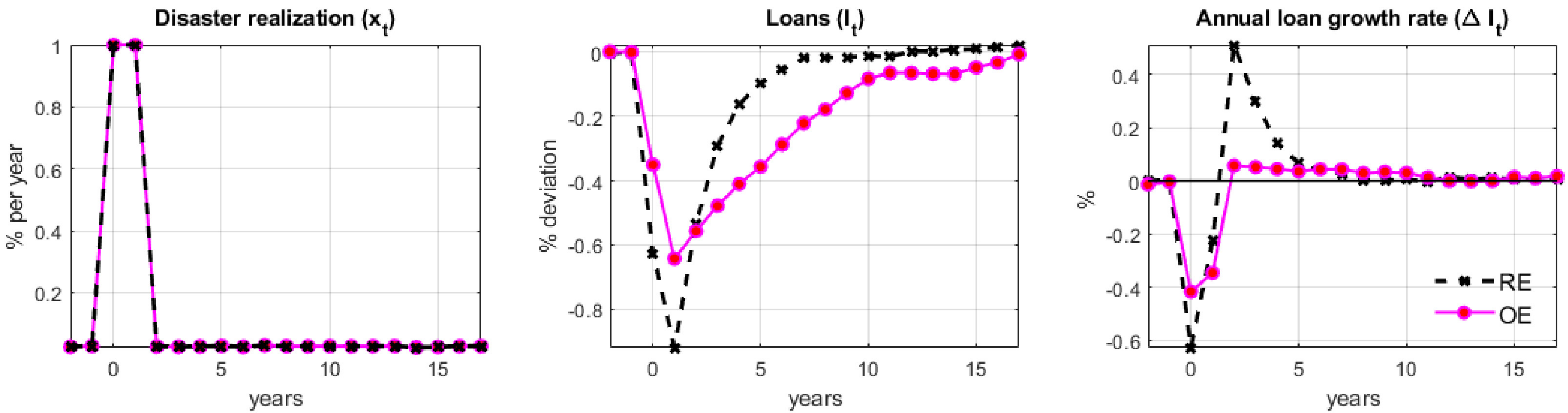
Figure: Disaster in the Model



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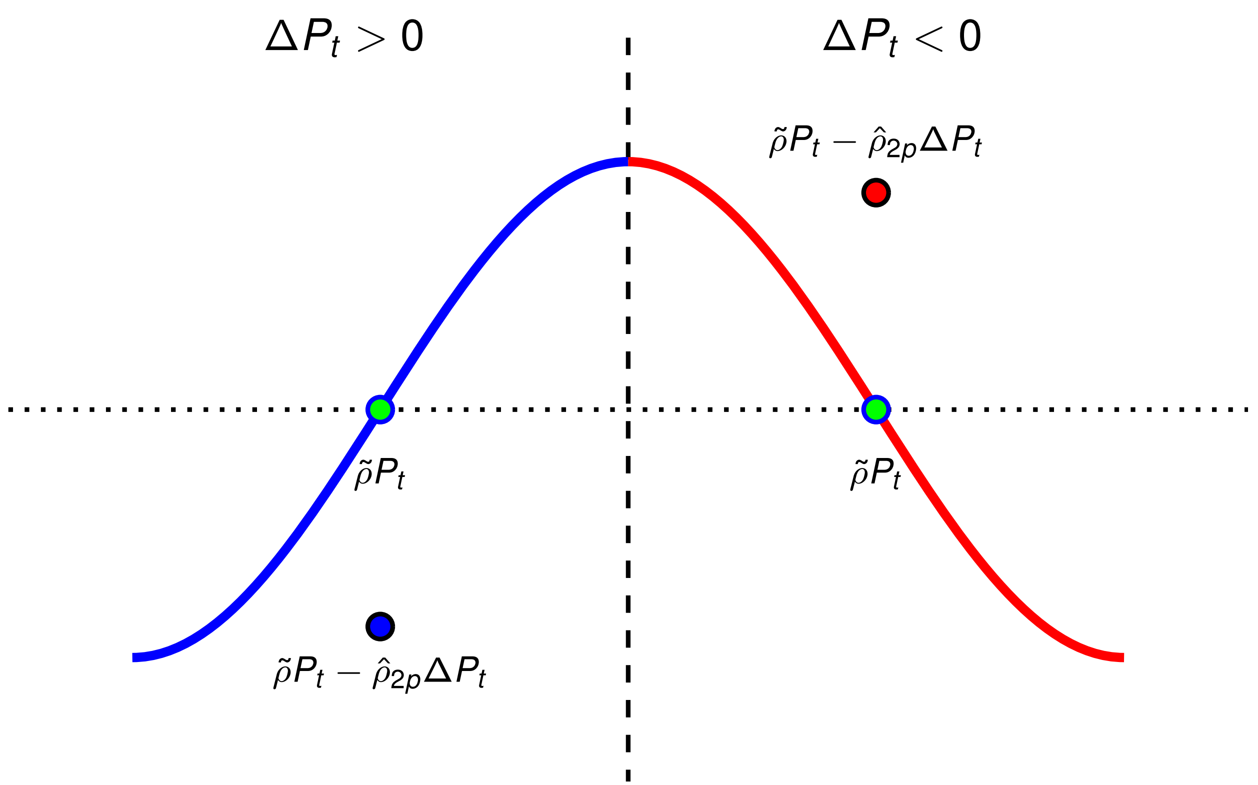
OE: AR(2) or AR(1) with higher persistence?

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



- Over-extrapolation under AR(1)
- Over-extrapolation under AR(2), with $\Delta P_t > 0$ and $\hat{\rho}_{2p} > 0 \Longrightarrow$ at the end of a boom
- Over-extrapolation under AR(2), with $\Delta P_t < 0$ and $\hat{\rho}_{2p} > 0 \Longrightarrow$ at the end of a crisis

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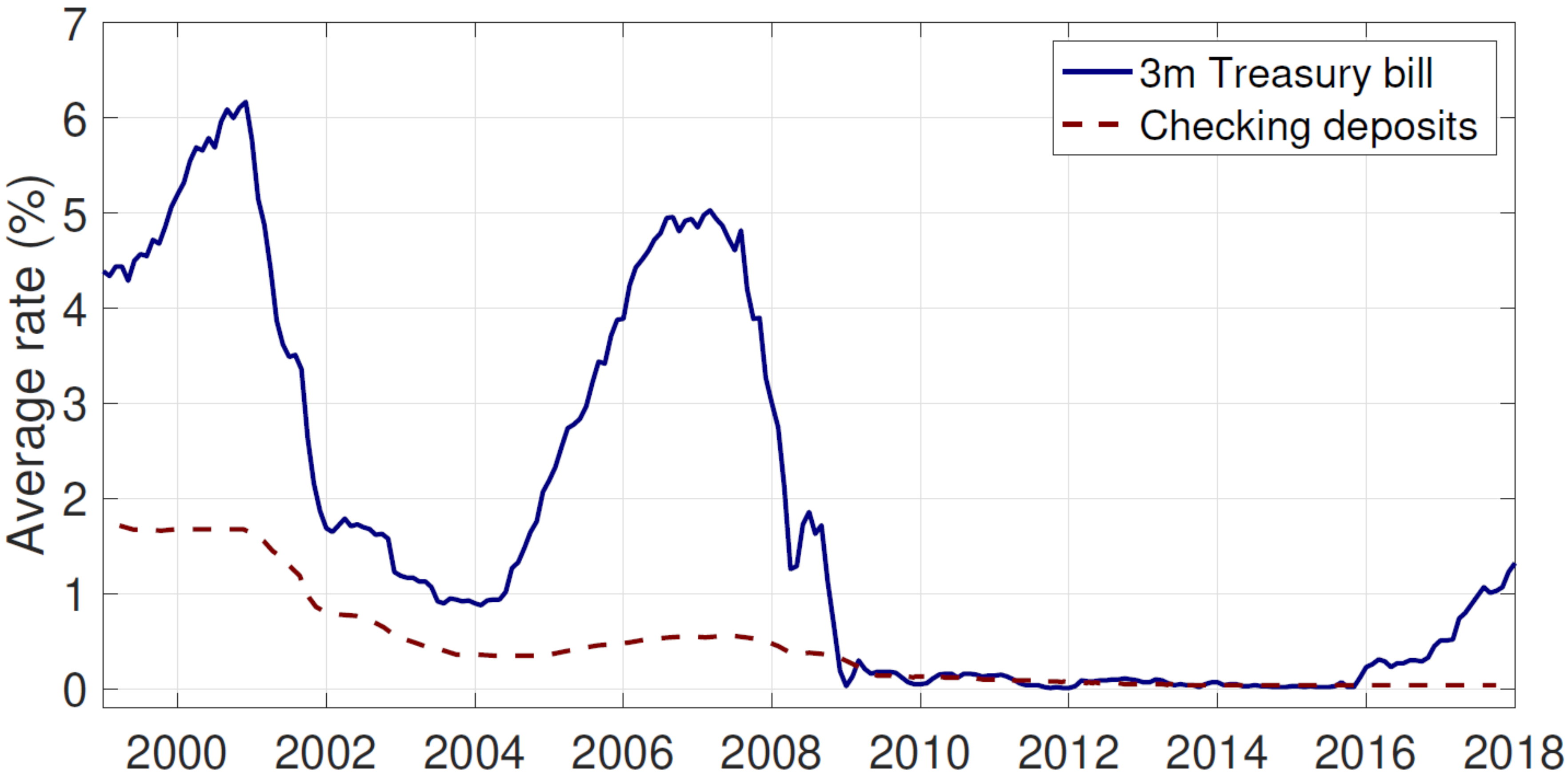
Figure: Rates on Deposits



Sources: Gomes, Grotteria and Wachter (2020)