Liquidity and Discipline. Bank Due Diligence over the Business Cycle

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Motivation

- Banks perform fundamental functions in the economy:
  - intermediate liquidity between savers and borrowers;
  - perform due diligence and information production on loans.
- Banks' access to liquidity is a primary determinant of their intermediation activity.
  - During the Great Recession and the European sovereign debt crisis, tight liquidity constraints acted as a transmission mechanism of the crises (Acharya and Mora, 2015).
  - In the years preceding the Great Recession, easy access to funding liquidity promoted a major growth of bank lending (Bernanke, 2009).

Motivation

- Banks produce a wealth of information that certifies banks' financial status to bank supervisors and financiers, shaping their access to liquidity.
- Like banks' access to liquidity, banks' due diligence effort appears to exhibit pronounced variation over the business cycle.
- Empirical studies find that booming liquidity may indeed dilute banks' incentives to undertake due diligence on loans, while banks appear to step up their due diligence effort during contractions (Ruckes, 2004; Dell'Ariccia and Marquez, 2006; Lisowsky et al., 2017).

This paper

- Key questions
  - What role does banks' due diligence play in business cycle transmission?
  - How does banks' due diligence interact with banks' access to funding liquidity over the business cycle?
- Empirical evidence on banks' due diligence activities on U.S. banks in syndicated loan market over 1996-2015:
  - i) Due diligence is higher when banks have lower access to wholesale liquidity market.
  - ii) Banks perform more careful due diligence during recessions than in normal times.
  - iii) Lower access to interbank liquidity during a recession furtherly boosts due diligence effort.

This paper

- We build a DSGE model with bank intermediation.
  - Banks face constraints when gathering retail and wholesale liquidity.
  - As in previous studies (e.g., Gertler and Kiyotaki, 2010), collateral constraints stem from the risk that banks default strategically on their obligations to financiers.
  - Key departure from previous studies: building on micro-banking literature (e.g., Diamond and Rajan, 2005) loans are informationally sensitive and banks perform ongoing due diligence on loan portfolios.
  - This costly due diligence affects the loan recovery value expected by bank supervisors and financiers in the event of bank default, impacting on the value of loans pledgeable by banks in liquidity markets.
- Two main mechanisms drive banks' due diligence effort over the business cycle:
  - Tighter wholesale and retail liquidity access strengthens due diligence incentive *(liquidity channel)*.
  - Lower value of assessed loan portfolios reduces effectiveness of bank due diligence *(information productivity channel)*.

Preview of results

- We perturb the economy with funding liquidity (wholesale collateral and regulatory) shocks and quality of loan portfolios shocks.
- Banks' due diligence responds countercyclically to all shocks.
  - Liquidity channel outweighs information productivity channel.
- Due diligence response attenuates liquidity shocks but moderately amplifies loan quality shocks.
- Variance decomposition: due diligence reduces output variance by 11% after liquidity shocks; increases it by 1.3% after loan quality shocks.

Preview of results (cont.)

- Role of lending experience in banks' due diligence activities
  - Lending experience directly attenuates the impact of negative shocks, but also dilutes banks' due diligence incentives.
  - It may weaken the stabilizing role of due diligence following liquidity contractions.
- Government's credit policies may dilute stabilizing effects of banks' due diligence in short run. They recover stabilizing effects in the medium run.

Empirical setting

- We hand-match granular loan-level data from the U.S. syndicated loan market with bank-level data.
- Due diligence in U.S. syndicated loans market (Sufi, 2007; Ivashina, 2009).
  - The "lead arranger" establishes a relationship with the borrowing firm and negotiates terms of the loan.
  - The lead arranger then invites "participant" lenders to fund part of the loan.
  - To ensure due diligence, the lead arranger retains a large share of the loan.
- Data
  - DealScan: syndicated loans extended by 199 banks to 5,408 firms over the 1996-2015.
  - Call Reports: data on bank-level information (balance sheets and access to interbank market liquidity).

Empirical model

Key variables in empirical analysis:

- *Lead share*: loan share of bank b in loan l at time (quarter) t, which proxies for the bank's bank's due diligence effort.
- *shock*: a dummy equal to one if period t is a NBER recession or if bank is hit by restrictive regulatory (FDIC) shock.
- *interbank:* a proxy for the bank's participation in, and access to, the wholesale liquidity market:
  - cash and balances due from depository institutions
  - loans and federal funds sold to a depository institution.
- $X_{b,t}$ and $X_{l,t}$: controls for characteristics of the bank, of the loan, and of the borrowing firm (i.e., degree of informational opaqueness of the borrowing firm and lending experience).

Empirical results

Summary of empirical results:

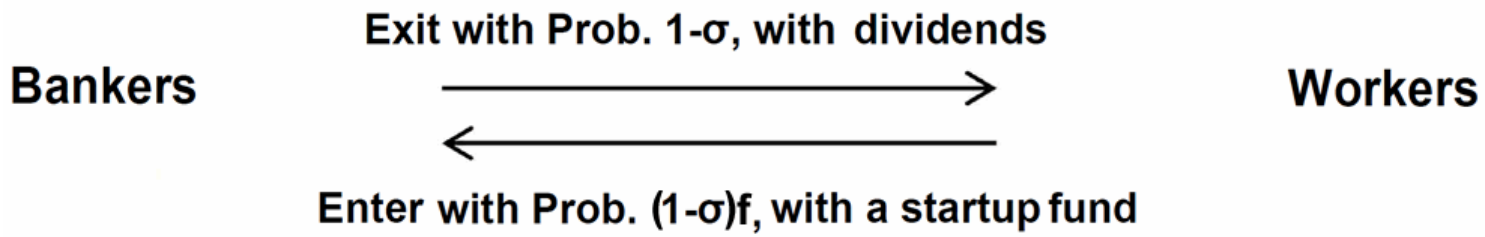
- Main findings
  - Banks perform more due diligence during contractions.
  - Banks perform more due diligence when they have difficult access to wholesale liquidity, especially during recessions.
  - Banks perform less due diligence when they have stronger lending experience with firms.
  - Restrictive regulatory shocks: banks with difficult access to wholesale liquidity perform more due diligence than banks with easy access.

The model

- The environment builds on broad macro-banking literature (e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011).
- Players
  - Representative households
  - Firms: final goods producers and capital producers
  - Banks
  - Government

Households

- Representative household composed by workers and bankers.
  - Workers supply labor for wage income. Employed in goods production or in banking activities (loan officers).
  - Bankers operate banks and bring dividend distributions to households.



$$\max_{\{C_t, D_t, H_t, L_t\}_{t\geq 0}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_t - h_C C_{t-1}\right) - k_H \frac{H_t^{1+\varphi}}{1+\varphi} - k_L \frac{L_t^{1+\tau}}{1+\tau} \right],$$

$$\text{s.t.} \quad C_t + D_t + T_t = R_{t-1}^D D_{t-1} + W_t^H H_t + W_t^L L_t + \Pi_t.$$

Firms - Final goods producers

- Continuum of firms of unit mass located on continuum of islands.
- Constant returns to scale technology with capital and labor used to produce output. Capital not mobile, labor perfectly mobile across firms and islands.

$$Y_t = A_t K_t^{\alpha} H_t^{1-\alpha}.$$

- Every period t a fraction π^i of islands receive the opportunity to invest. Only firms on these investing islands can acquire new capital.
  - Arrival of investment opportunities i.i.d. across time and across islands.
  - A simple way to introduce liquidity needs by firms.
- Firms on investing (non-investing) islands issue state-contingent securities X_t^i (X_t^n), at a market price $Q_t^{X,i}$ ($Q_t^{X,n}$), to banks.
- Each firm security constitutes a claim to the future returns of a unit of present capital.

Capital producers - Capital accumulation

- Firms on investing islands acquire capital from capital goods producers who operate in a national market.
- Capital producers choose their investment to maximize the expected present value of profits given by the value of new capital sold to firms in investing islands minus the cost of investment.
- Capital good producers incur an adjustment cost $F\left(\frac{I_t}{I_{t-1}}\right)$

$$Q_t^{X,i} = 1 + F\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} F'\left(\frac{I_t}{I_{t-1}}\right) - E_t \Lambda_{t,t+1} \left(\frac{I_{t+1}}{I_t}\right)^2 F'\left(\frac{I_{t+1}}{I_t}\right)$$

Banks

- Banks intermediate liquidity and perform ongoing due diligence on their claims on borrowing firms.
  - Banks raise retail liquidity (deposits) and wholesale liquidity (interbank) and make loans to final goods producers located on the same island.
  - Banks choose the amount of information they produce about their claims on borrowing firms. Through information production and due diligence, banks can raise the pledgeable recovery value of these claims.
- Timing within a period t
  - Aggregate shocks are realized
  - Banks decide deposits (d_t) from households and government bond holdings (b_t).
  - Shocks to investment opportunities occur in the islands.
  - Banks choose interbank position (m_t^h), holdings of firm shares (x_t^h) and amount of labor to employ in due diligence activities (l_t^h), $h \in (i, n)$.

Banks - Optimization problem

$$V_{t-1}(\cdot) = E_{t-1}\Lambda_{t-1,t}\left[\sum_h \pi^h(1-\sigma)n_t^h + \right.$$
$$\left. + \max_{d_t, b_t, m_t^h, x_t^h, l_t^h} \sum_h \pi^h \sigma V_t(d_t, b_t, m_t^h, x_t^h, l_t^h)\right]$$

s.t.

(Flow of Funds) $\quad Q_t^{X,h} x_t^h + Q_t^B b_t = n_t^h + d_t + m_t^h - W_t^L l_t^h \quad \left[\lambda_t^h\right]$

(Capital) $\quad R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \mathcal{P}(\cdot) Q_t^{X,h} x_t^h \quad \left[\mu_t^h\right]$

(Interbank) $\quad R_t^M m_t^h \leq \chi_t Q_t^B b_t \quad \left[\gamma_t^h\right]$

Banks' constraints in liquidity markets

- Resource constraint:

$$Q_t^{X,h} x_t^h + Q_t^B b_t = n_t^h + d_t + m_t^h - W_t^L l_t^h,$$

where banks' net worth at time t is the gross payoff from assets funded at $t-1$, net of borrowing costs:

$$n_t^h = [Z_t + (1-\delta) Q_t^{X,h}] \psi_t x_{t-1} + \psi_t^{B_g} b_{t-1} - R_{t-1}^D d_{t-1} - R_{t-1}^M m_{t-1}.$$

- Collateral (capital) constraint:

$$R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \mathcal{P}(Q_t^{X,h} x_t^h, l_t^h) Q_t^{X,h} x_t^h,$$

where $\mathcal{P}(\cdot) Q_t^{X,h} x_t^h$ is the recovery value of firm shares in the event of default and, hence, captures their pledgeable value.

- Bank due diligence (l_t^h) raises the pledgeability of loans (x_t^h).
- Interbank (collateral) constraint:

$$R_t^M m_t^h \leq \chi_t Q_t^B b_t.$$

Due diligence function

- The recoverable portion of the portfolio of firm shares (henceforth, the "due diligence function") is

$$\mathcal{P}(Q_t^{X,h} x_t^h, I_t^h) = \zeta \left(\frac{I_t^h}{Q_t^{X,h} x_t^h} \right)^{1-\phi}.$$

- This is a standard increasing and concave function of the labor of loan officers in due diligence, per unit of firm shares. $\zeta > 0$ is a parameter capturing the effectiveness of due diligence.
- The recovery value of firm shares is then a constant-returns-to-scale function

$$\mathcal{P}(Q_t^{X,h} x_t^h, I_t^h) Q_t^{X,h} x_t^h = \zeta (Q_t^{X,h} x_t^h)^{\phi} (I_t^h)^{1-\phi}.$$

Endogenizing banks' due diligence function

- Diamond and Rajan (2001, 2005) relate the loan values pledgeable by banks to the liquidation skills acquired by banks through their information accumulation on loans.
- Heterogeneity in the banking sector between investing and non-investing islands: liquidation market for banks' claims on firms that is characterized by trading frictions.
- The specificity of bank claims on firms requires that, if a bank defaults strategically, only banks in the same island type can reuse the liquidated firm shares.
- For example, only banks that have dealt with the same capital investment opportunities of the defaulting bank could recognize and understand the firms' capital that backs the liquidated project loans.
- Trading frictions prevent from identifying buyers from the same island type and banks in default are randomly matched with potential buyers.

Endogenizing banks' due diligence function

- Due diligence and information acquisition mitigate trading frictions and allow banks to identify suitable buyers of project loans in the event of default, raising the pledgeable recovery value of loans.
- The expected recovery value of the firm shares of a defaulting bank from an investing island is

$$\mathcal{P}(\mathcal{S}_t^i, \mathcal{M}^i, \mathcal{M}^n) Q_t^{X,i} x_t^i = \frac{\mathcal{S}_t^i \mathcal{M}^i}{\mathcal{M}^i + \mathcal{M}^n} Q_t^{X,i} x_t^i,$$

  where $\mathcal{P}(\cdot)$ is the probability of being matched with a bank (buyer) from an investing island.
- Banks' search intensity in the liquidation market is increasing in the information acquired by loan officers on firm shares (Cavalcanti and Wallace, 1999; Araujo and Minetti, 2007):

$$\mathcal{S}_t^i = \zeta^i \left(\frac{I_t^i}{Q_t^{X,i} x_t^i} \right)^{1-\phi},$$

  where $\zeta^i = \zeta / \pi^i$.

Banks' choice of due diligence

$$I_t^h = \underbrace{\left[\frac{\zeta(1-\phi)}{W_t^L}\right]^{\frac{1}{\phi}}}_{\text{Resource drain}} \underbrace{\left[\frac{\mu_t^h}{\lambda_t^h}\right]^{\frac{1}{\phi}}}_{\substack{\text{Liquidity} \\ \text{channel}}} \underbrace{\left[Q_t^{X,h} x_t^h\right]}_{\substack{\text{Information productivity} \\ \text{channel}}}$$

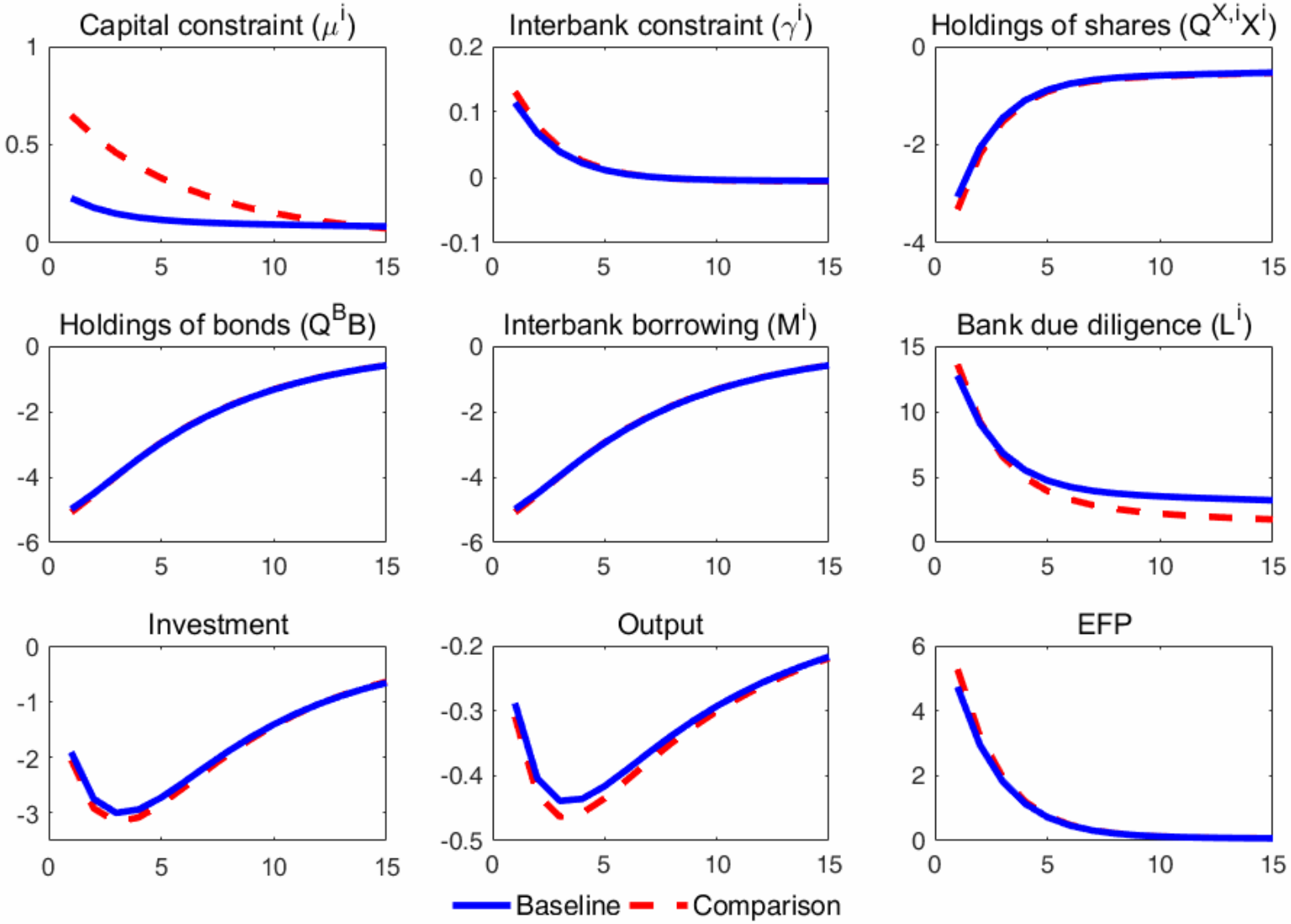
- Higher wage (W_t^L) for loan officers reduces due diligence incentive.
- Tighter capital constraint (higher μ_t^h / λ_t^h) increases due diligence incentive.
- Lower value of loans ($Q_t^{X,h} x_t^h$) reduces due diligence incentive.

Bank liquidity shocks - Bond value shock

$$n_t^h = [Z_t + (1-\delta)Q_t^{X,h}]\psi_t x_{t-1} + \psi_t^{B_g} b_{t-1} - R_{t-1}^D d_{t-1} - R_{t-1}^M m_{t-1}$$

- Negative shock to bond value following an AR(1) process, $\psi_t^{B_g}$, that exogenously lowers the value of government bonds (the standard error of the shock is set to obtain a drop of bank capital equal to 3% of the GDP).
  - Tightens both the capital constraint and the interbank constraint.
- Compare our model with alternative scenario where there is a tax to depress due diligence in investing islands.

Bank liquidity shocks - Bond value shock



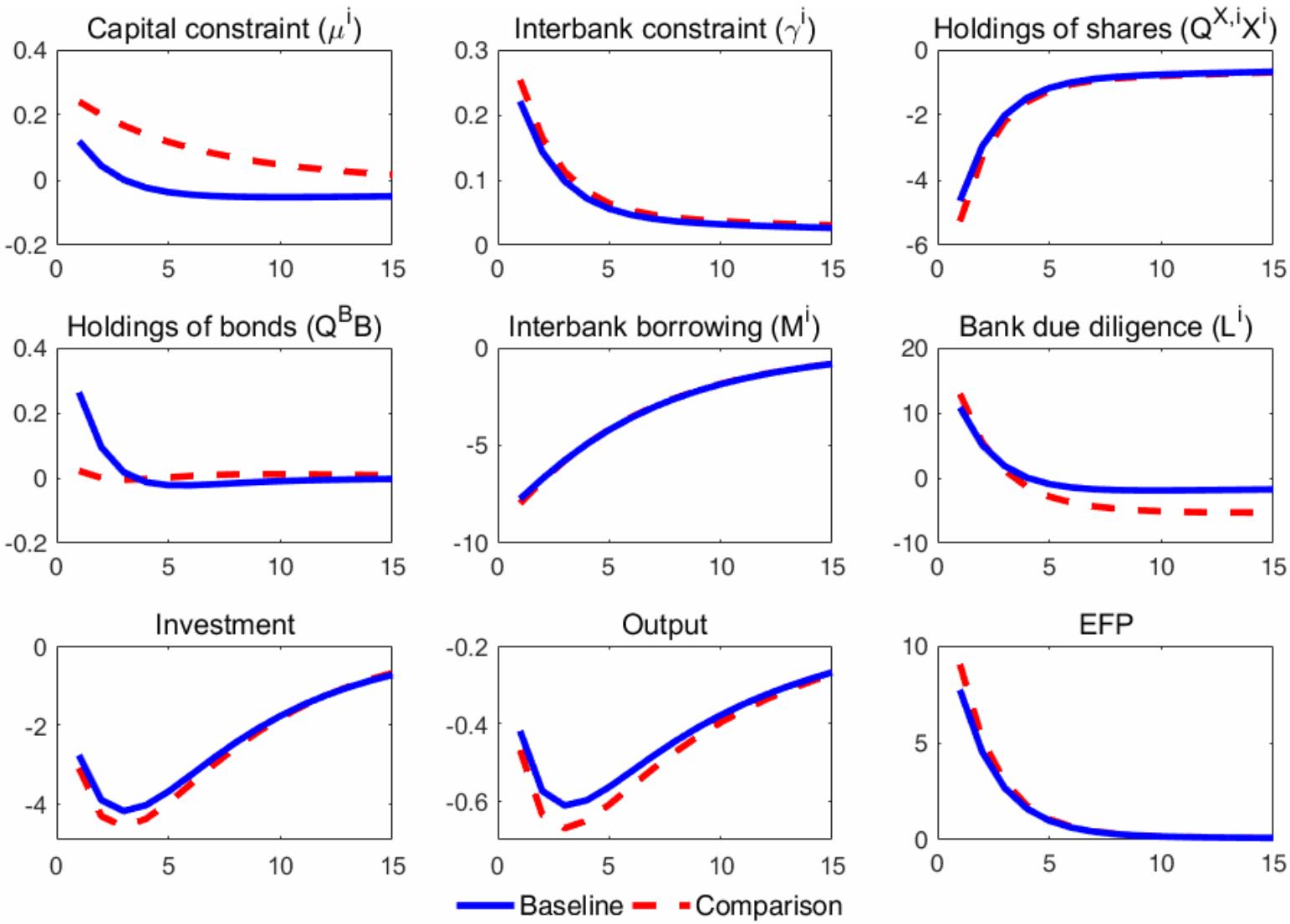
Forces that contribute to bank due diligence response

Bank liquidity shocks - Regulatory shock

$$R_t^M m_t^h \leq \chi_t Q_t^B b_t$$

- Exogenous tightening of regulation in the interbank market, i.e., reduction in the interbank LTV χ_t (the standard deviation of the shock is set to obtain a decrease of the interbank rate of around 2%, like that observed after the 2011 change in the FDIC regulation).
  - Directly tightens the interbank constraint.

Bank liquidity shocks - Regulatory shock



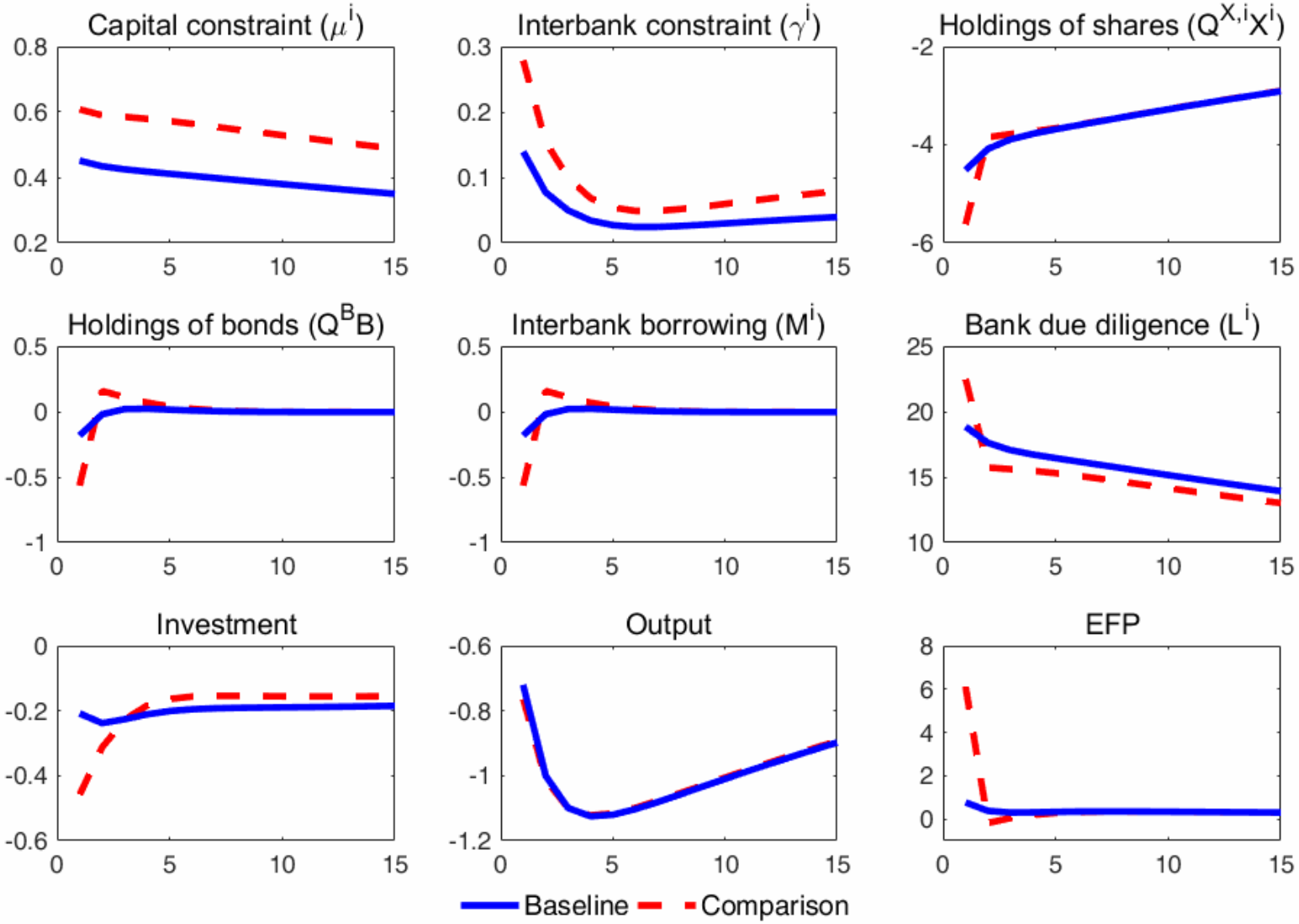
Forces that contribute to bank due diligence response

Loan quality/Net worth shocks - Capital quality shock

$$n_t^h = [Z_t + (1-\delta)Q_t^{X,h}]\psi_t x_{t-1} + \psi_t^{B_g} b_{t-1} - R_{t-1}^D d_{t-1} - R_{t-1}^M m_{t-1}$$

- Exogenous decline in loan (capital) quality (ψ_t), intended to capture a drop in the value of capital assets and, hence, in the value of firm shares held by banks.

Loan quality/Net worth shocks - Capital quality shock



Forces that contribute to bank due diligence response

Quantitative assessment

- Loan haircut $(1 - \mathcal{P}(\cdot))$ reduction implied by the countercyclical due diligence is 4.39% over a one-year horizon.
- The response predicted by the model appears in the ballpark of the empirical estimates by Mora (2015) and Ivashina (2009).
- A key prediction of our model is that due diligence mitigates the effects on output of liquidity shocks while magnifying those of capital quality shocks.
- Variance decomposition of output and investment.

Due diligence and macroeconomic volatility

Variance decomposition (% difference)

		Capital quality	Bond value	Regulatory
Baseline minus Comparison	Y_t	1.29%	−2.8%	−8.1%
Baseline minus Comparison	I_t	29.2%	4.6%	−2.8%

Extensions - Lending experience

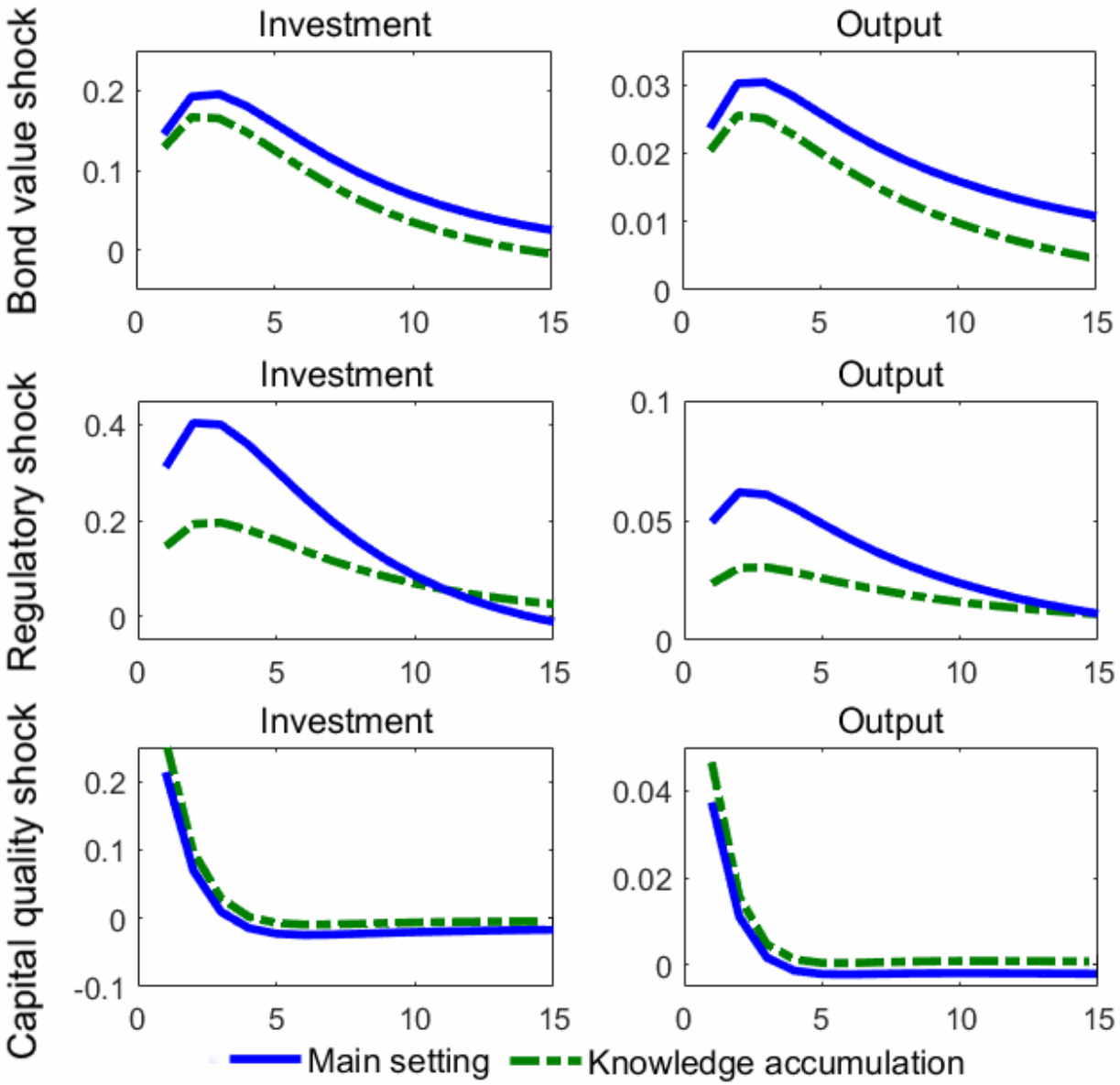
- Lending experience accumulated by banks during credit relationships can influence banks' ability and incentives to perform loan due diligence (Ongena and Smith, 2001; Sette and Gobbi, 2015).
- Lending experience facilitates the process of recovery and liquidation of project loans in the event of default.
- Lending experience: habits in the Cobb-Douglas function for the recovery value of firm shares:

$$\mathcal{P}(Q_t^{X,h}x_t^h, I_t^h, s_{t-1})Q_t^{X,h}x_t^h = \zeta[Q_t^{X,h}(x_t^h + h_x s_{t-1})]^{\phi}(I_t^h)^{1-\phi},$$

where

$$s_{t-1} = \rho_s s_{t-2} + (1-\rho_s)x_{t-1}.$$

Lending experience



Credit policies

- We consider three types of credit policy implemented by the government:
  - Liquidity provision in the interbank market
  - Equity injections
  - Direct lending to firms.

Liquidity provision in the interbank market

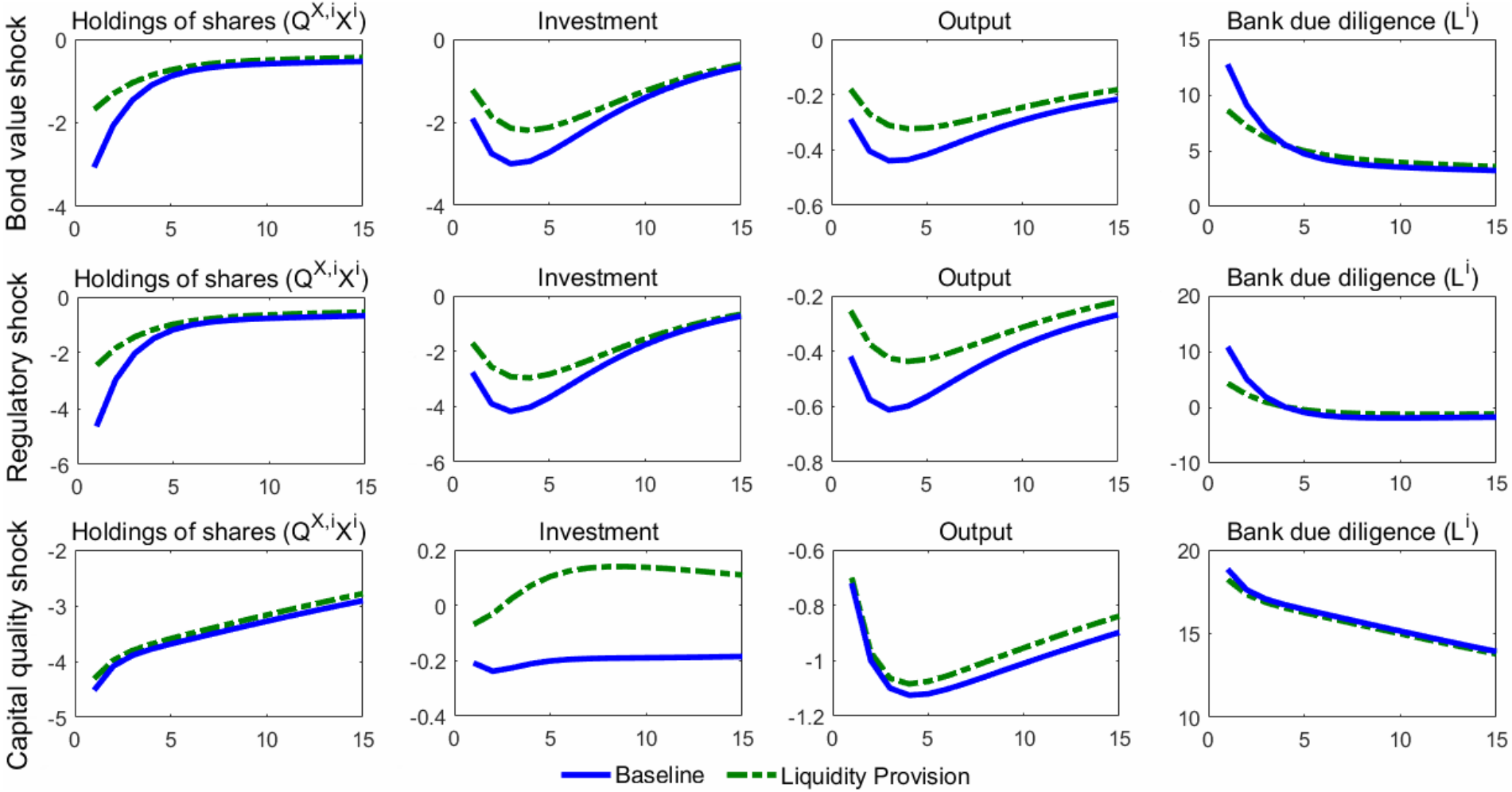
- The government provides uncollateralized liquidity to banks that borrow in the interbank market.
- Liquidity provision $m^i_{G,t}$ is a fraction Φ_t of total interbank borrowing

$$m^i_{G,t} = \Phi_t m^i_t$$

  - The government has to sustain a deadweight loss of ϱ_L for each unit supplied (e.g., reflecting administrative costs).
- Feedback rule: liquidity provision when credit spreads widens:

$$\Phi_t = \upsilon \left[\left(E_t R^{K,ii'}_{t+1} - R^D_t \right) - \left(R^{K,ii'} - R^D \right) \right]$$

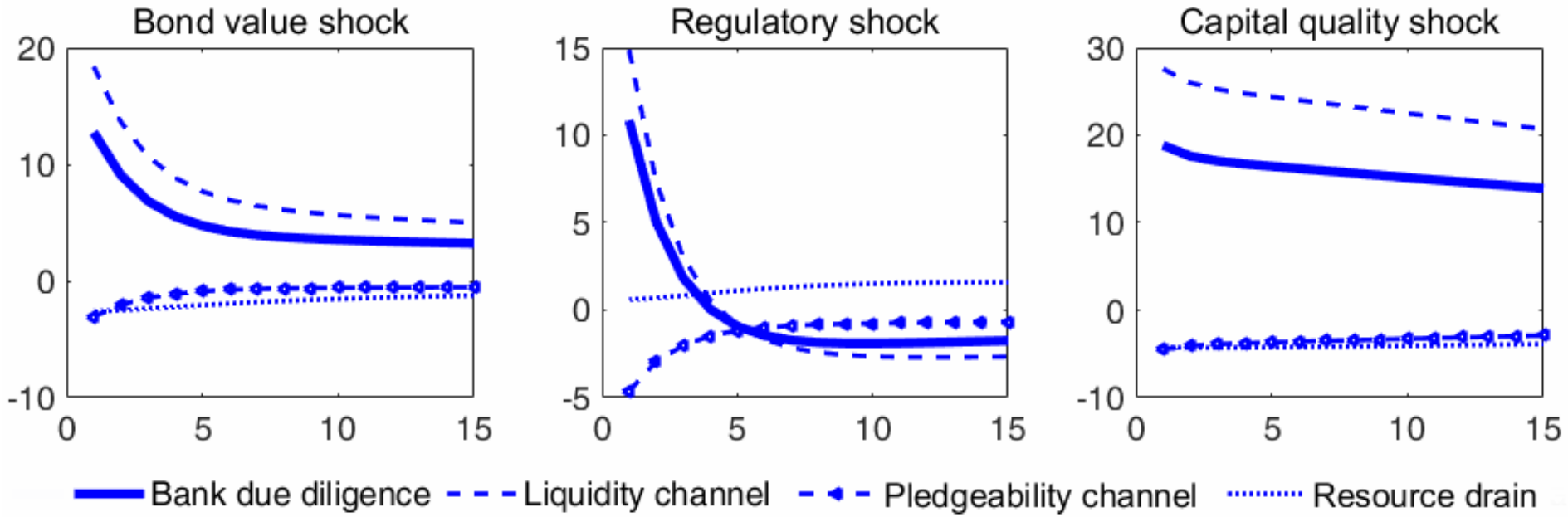
Liquidity provision in the interbank market



Conclusion

- Role of due diligence in the business cycle.
- Interaction between due diligence-funding liquidity.
- Motivational evidence from bank-level U.S. data.
- Two major channels in interaction due diligence-funding liquidity
  - Tighter wholesale liquidity access strengthens bank due diligence incentive;
  - Lower value of loans reduces effectiveness of bank due diligence.
- Due diligence overall countercyclical, but attenuator or amplifier depending on origin of shocks.
- Stabilizing effects of credit policies may be weaker in the short-run.

Forces that contribute to bank due diligence response



Bond value shock

Regulatory shock

Loan quality shock