When credit expansions become troublesome: the story of investor sentiments

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Credit growth and GDP growth are imperfectly correlated

YoY GDP growth (left) and credit growth (right)
Correlation: 0.32

Note: GDP is real GDP, credit is total credit to the non-financial business sector from the flow of funds, deflated with the GDP deflator. All data are for the United States. Sample period: 1960Q1 to 2020Q4.
Understanding the drivers of credit dynamics is important

Credit booms predict financial crises, which cause deep recessions (Jordà, Schularick, and Taylor (2011)).

But not all credit booms are alike (Gorton and Ordoñez (2020)):

- **Bad** credit booms are followed by a bust (e.g. Japan in the 1980s, US during the late 1990s)
- **Good** credit booms are not (e.g. US or Europe during the 1980s)

Popular narrative: expectations as drivers of credit cycles (e.g. Mishkin (2008))

- "Wrong" expectations → bad credit boom
- "Correct" expectations → good credit boom
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Can non-fundamental shocks cause credit cycles?

1. **Macroeconomic model of credit-demand driven boom-bust cycles**
   Key elements:
   - long-term debt & default risk
   - noisy signals about future fundamentals

   $\Rightarrow$ noise shocks cause leverage-driven booms, followed by debt overhang-driven bust.

2. **Empirical investigation of the effects of noise shocks**
   In line with the model:
   - News and noise shocks lead to leverage-driven credit booms
   - Noise shocks lead to credit busts with slow deleveraging and persistently elevated default rates
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**Credit and asset prices booms:**
Schularick and Taylor (2012), Jordà et al. (2011), Krishnamurthy and Muir (2017), Gorton and Ordoñez (2020), ...

**Expectations as drivers of fluctuations:**

**Long-term debt and macroeconomic dynamics:**
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Outline

1 Introduction
2 Model
3 Empirics
4 Conclusion
Outline

1. Introduction

2. Model
   - Setup
   - Discussion of the assumptions
   - Characterization

3. Empirics

4. Conclusion
How can noise-driven asset price fluctuations affect credit?
A simple model.

The economy:

- Three periods, $t = 1, 2, 3$.
- Three risk-neutral agents: workers, firms, and entrepreneurs.
- Worker and firm problems are standard.
- Two assets: capital $K$ and defaultable long-term debt $B$.
- Two sources of uncertainty: aggregate (news) shocks to productivity $Z$ and idiosyncratic capital quality shocks $A$ to entrepreneurs.
Flow of funds – agents

Workers → Firms

Firms → Entrepreneurs

Workers → Output → Firms → Capital → Entrepreneurs

Firms → Labor → Workers

Entrepreneurs → Output → Firms → Labor → Workers
Flow of funds – financial frictions

- Workers
- Firms
- Entrepreneurs
- Long-term loans
- Loan repayment or default
- Labor
- Output
- Capital
- Output

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Investor sentiments
Jan 2024
Flow of funds – balance sheets

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Workers

Firms

Entrepreneurs

Long-term loans

Loan repayment or default

Labor

Output

Capital

Output

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Flow of funds – shocks

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Workers

Firms

Entrepreneurs

Aggregate productivity (news) shocks

Idiosyncratic capital quality shocks

Loan repayment or default

Long-term loans
Timing of aggregate shocks

Period 1 productivity:
\[ Z_1 = 1 \]

Signal about period 2 productivity:
\[ S_1 = a_1 + e_1 \]

News shock:
\[ a_1 \sim N(0, \sigma_a^2) \]

Noise shock:
\[ e_1 \sim N(0, \sigma_e^2) \]

Period 2 productivity:
\[ Z_2 = Z_1 + a_1 \]

Period 3 productivity:
\[ Z_3 = Z_2 \]
Entrepreneur problem pt. 1

**Investment:** Entrepreneurs invest into capital $k_{it}$, which they rent to firms at rate $r^K(Z_t)$.

**Capital quality shocks:** At the beginning of the period, there is an idiosyncratic shock $A_{it} \sim U(A, \bar{A})$ to the capital stock of entrepreneurs.

**Long-term debt:** Entrepreneurs borrow long-term $b_{it}$ at a state-contingent price $Q_{it}$. They have outstanding long-term debt $b_{it-1}$, which is rolled over at the market price $Q_{it}$. All debt matures in $t = 3$.

**Equity issuance:** Entrepreneurs consume $c_{it}^F$. This can be negative, which we interpret as equity issuance.

**Default:** Entrepreneurs can default, in which case creditors receive nothing and their capital is lost. They optimally do so below a cut-off $A^*_{it}$ for the idiosyncratic shock.
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Entrepreneur problem pt. 2

The problem of an entrepreneur in period 2 is

\[ X_{i2}(k_{i1}, b_{i1}, A_{i2}; S_2) = \max_{c_{i2}^F, k_{i2}, b_{i2}} c_{i2}^F + \beta^F E_2 \left[ \max(X_{i3}(k_{i2}, b_{i2}, A_{i3}; S_3), 0) \right], \]

subject to the budget constraint:

\[ c_{i2}^F + k_{i2} = (r_2^K + A_{i2} + 1)k_{i1} - \mu b_{i1} + Q_2(k_{i2}, b_{i2}; S_{2+}) (b_{i2} - (1 - \mu)b_{i1}). \]

Higher \( \mu \), shorter debt maturity.

The continuation value function is

\[ X_{i3}(k_{i2}, b_{i2}, A_{i3}; S_3) = c_{i3}^F = (r_3^K (Z_3) + A_{i3} + 1)k_{i2} - b_{i2}. \]

The period 1 problem looks similar, adding the signal as an aggregate state.
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The period 1 problem looks similar, adding the signal as an aggregate state.
Mutual fund

Workers own and invest in a safe claim $D_t$ in a mutual fund, holding the portfolio of defaultable loans $\int_i b_{it} di$.

They earn a gross return $\int_i (1 - F(A_{it}^*)) b_{it-1} di - D_{t-1}$.

They set state-contingent prices $Q_t(k_{it}, b_{it}; S_{t+})$, such that they break even in expectation. $S_{t+}$ is the end of period aggregate state vector.

It’s straightforward to add a financial friction to the intermediary sector. We do this in the paper.
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Discussion of the assumptions

Long-term debt

- A large share of firms’ debt is long-term, see e.g. Gomes et al. (2016).
- This fact matters both for leverage dynamics at the firm level and aggregate dynamics, see e.g. DeMarzo and He (2016), Kuehn and Schmid (2014), Gomes, Jermann, and Schmid (2016), Jungherr and Schott (2021).

Endogenous default

- Default risk is important for leverage dynamics and credit spreads, see e.g. H. Chen (2010) or L. Chen, Collin-Dufresne, and Goldstein (2009).

Risk-neutral agents and fixed labour supply

- Labour supply and household preferences matter for the propagation of news shocks, see e.g. Jaimovich and Rebelo (2009), Schmitt-Grohé and Uribe (2012), or Görtz, Gunn, et al. (2022).
- We shut these effects down to focus on the interaction between credit supply and credit demand frictions.
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Signal extraction problem

The noise representation has an alternative news representation with a news shock $\nu_1$ and a surprise shock $\Delta_2$ (Chahrour and Jurado (2018)).

The solution to the signal extraction problem yields

$$
\nu_1 = E[Z_2|S_1] = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2} \quad S_1 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2} (a_1 + e_1). \quad (1)
$$

Kalman gain

Both news and noise shocks raise expected productivity.

The surprise shock in period 2 is

$$
\Delta_2 = \frac{\sigma_e^2}{\sigma_a^2 + \sigma_e^2} a_1 - \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2} e_1. \quad (2)
$$

News shocks lead to a positive, noise shocks to a negative surprise.
Signal extraction problem

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Entrepreneurs and the credit demand curve

In period 2, debt FOC:

\[ Q_2(k_2, b_2; S_{2+}) + \frac{\partial Q_2(k_2, b_2; S_{2+})}{\partial b_2} (b_2 - (1 - \mu)b_1) = \beta^F (1 - F(A_3^*)) \]

Bond revenue

Bond revenue change

Default-adjusted repayment

(3)

The default threshold in period 3, \( A_3^*(k_2, b_2, Z_3) \), is

\[ A_3^* = \frac{b_2}{k_2} - (r_3^K(Z_3) + 1) \]

(4)

Notice that the default threshold is linear in leverage \( b_2/k_2 \).
Entrepreneurs and the credit demand curve

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Loan pricing and the credit supply curve

If no credit supply frictions, the bond price is a function of the default probability of the firm:

\[
Q_2(k_2, b_2; S_{2+}) = 1 - F(A^*_3) = \frac{\bar{A} - A^*_3}{\bar{A} - A}.
\]

This implies that the bond price derivatives are

\[
\frac{\partial Q_2(k_2, b_2; S_{2+})}{\partial k_2} = -f(A^*_3) \frac{\partial A^*_3}{\partial k_2} = \frac{1}{\bar{A} - A} \frac{b_2}{k_2} \frac{1}{k_2} > 0 \tag{5}
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Note that the impact of investment on the bond price is increasing in leverage \(b_2/k_2\).
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Note that the impact of investment on the bond price is increasing in leverage \( b_2/k_2 \).
Analytical discussion of the key mechanism

Plugging credit demand and credit supply together and defining leverage \( \omega_2 \equiv \frac{b_2}{k_2} \), we get for the optimal leverage policy:

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\omega_2 = \frac{1 - \beta^F}{2 - \beta^F} \left( \bar{A} + 1 + r_3^K(Z_3) \right) + \frac{1 - \beta^F}{2 - \beta^F} \frac{k_1}{k_2} (1 - \mu) \omega_1
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Target leverage \( \omega_2^* \)\hspace{1cm}\hspace{1cm} Downward leverage persistence

Thus,

- Leverage is increasing in (expected) future productivity \( Z_3 \)
- Leverage is increasing in lagged leverage \( \omega_1 \)
- Leverage is declining in the investment rate \( \frac{k_2}{k_1} \)
- Longer debt maturity, more leverage persistence

As the default probability is linear in leverage, it has the same properties.
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- Leverage is declining in the investment rate $\frac{k_2}{k_1}$
- Longer debt maturity, more leverage persistence

As the default probability is linear in leverage, it has the same properties.
Analytical discussion of the key mechanism

1. **Leverage-fuelled credit boom**
   - Both a noise and a news shock raise expected productivity growth.
   - As leverage is increasing in expected future productivity, both shocks raise leverage.

2. **Credit bust with slow deleveraging and elevated default rates**
   - A positive noise shock in period 1 leads to a negative surprise shock to productivity growth in period 2.
   - Target leverage falls.
   - Because of downward leverage persistence, entrepreneurs do not adjust leverage to the target level.
   - Leverage is higher, default rates are higher and investment (see the paper) is lower relative to the case without a noise shock.
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Outline

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2. Model
3. Empirics
4. Conclusion
Outline

1. Introduction

2. Model

3. Empirics
   - Identifying noise shocks
   - Specification of the local projections
   - Noise shocks and credit to non-financial corporations

4. Conclusion
Identification assumptions

Based on Forni, Gambetti, Lippi, and Sala (2017a) and Forni, Gambetti, Lippi, and Sala (2017b)

3 key identification assumptions

1. potential output is driven by a news shock
2. investors observe a noisy signal about the news shock
3. the noise does not affect potential output

The econometrician cannot infer news shock from data available at time of the shock

BUT:

The econometrician can infer news and noise shocks ex post, as noise shocks are unrelated to past, current and future potential output
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BUT:

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Recovering noise shocks from the data

We use quarterly data for the US, 1960Q1-2020Q4.

First, we estimate a VAR in log-levels with (in that order)
- potential output (from the BEA) per capita
- the 3-month treasury bill rate (to proxy for short rates)
- the Moody’s AAA corporate bond yield (to proxy for risk premiums)
- stock prices (S&P 500)
- real GDP (to proxy for the business cycle) per capita

to recover reduced-form residuals.

Second, we apply a simple Cholesky scheme to recover signal shocks and surprise shocks.

Third, we identify noise shocks and true news shocks as a dynamic rotation of the signal shocks and the surprise shocks, with the identification assumptions as above.
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Standardized units; dashed-line marks one standard deviation; grey areas mark NBER recessions. The blue text denotes the timing of the five largest positive noise shocks; the red text the timing of the five largest negative noise shocks.
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Validating noise shocks


\[
Y_{t+h} = \alpha^h + \sum_{s=1}^{S} \beta_s^h sh\hat{ock}_{t-s} + \sum_{s=1}^{S} \rho_s^h Y_{t-s}
\]

\[
+ \sum_{s=0}^{S} \Gamma_s^{h,1} X_{t-s}^1 + \sum_{s=1}^{S} \Gamma_s^{h,2} X_{t-s}^2 + \theta^h t + \varepsilon_{t+h}
\]

- \( Y_{t+h}, h \in [0, H] \) is the outcome of interest \( h \) periods ahead
- \( sh\hat{ock}_t \) is the shock of interest, estimated in the first stage
- \( X_{t-s} \) is a vector of control variables (same as in the VAR): 3-month Treasury rate and the Moody’s AAA corporate bond yield (in \( X^1 \)); dividends, stock prices, the other shock and real GDP (in \( X^2 \))
Effect of shocks on potential output & stock prices

LP IRF in blue, VAR IRF in red
Confidence levels: 90 percent (light shading) 68 percent (dark shading)
standard errors correct for autocorrelation of the residuals using a Newey-West estimator. All data are for the United States. Time period: 1960Q1-2020Q4.
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Total credit

**Note:** Data: sum of loans to non-financial corporate business (FL104123005.Q) and debt securities to non-financial corporate business (FL104122005.Q) from the Financial Accounts of the United States. All data are for the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Robustness

- Dividends as fundamental
- BAA yield as expectation
- Extending the sample to 1950Q1
- Stopping the sample in 2006Q4
- Adding credit to the VAR
- GDP ordered second in the VAR
- Adding Jurado et al. (2015)-uncertainty to the VAR
**BAA-AAA corporate bond spread**

*Note:* Data: difference between the Moody’s BAA corporate bond spread (BAA) and the Moody’s AAA corporate bond spread (AAA). Source: FRED. All data are for the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Real effects

Note: Data: real GDP (GDPC1) from FRED. All data are for the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Outline

1. Introduction
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Conclusion

We study the expectational noise shocks as a potential driver of credit cycles, in a model and in the data.

In the model, credit boom-bust cycles are due to credit demand frictions that arise because of defaultable long-term debt.

In the data, a noise shock that is unrelated to fundamentals leads to a boom-bust cycle in credit and default rates, consistent with the data.
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Outline

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- Extension: state-dependent transmission
  - More on the model
  - More on the identification of noise shocks
  - Bonds vs Loans
  - Alternative leverage definitions
  - Additional variables
State-dependent transmission

Question:
What is the role of credit supply frictions in the transmission of noise shocks?

Theory:
- High risk premiums **amplify** the effects of credit supply frictions, as leverage is counter-cyclical (e.g. Akinci and Queralto (2022), Akinci, Benigno, et al. (2020)).
- High risk premiums **mute** the effects of credit demand frictions, as firms leverage less if credit is more costly.
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- High risk premiums *mute* the effects of credit demand frictions, as firms leverage less if credit is more costly.
Model extension: adding a frictional banking sector

Workers Bankers Firms Entrepreneurs
Assets Liabilities Assets Liabilities Assets Liabilities
Deposits Equity Long-term loans Deposits Equity Capital Long-term loans Equity

Deposits
Deposit repayment

Long-term loans
Loan repayment or default

Output

Aggregate productivity (news) shocks

Idiosyncratic capital quality shocks

Output
Output
Output

Labor
Output

Deposits

Capital
Loan pricing with credit supply frictions

With credit supply frictions, the bond price is a function of the default probability of the firm and an endogenous aggregate wedge that depends on the balance sheet constraint of the banking sector:

\[ Q_2(k_2, b_2; S_{2+}) = 1 - F(A_3^*) = \psi_2 \frac{\bar{A}_3 - A_3^*}{A - A}. \]

The wedge is

\[ \psi_2 = \beta^l \frac{1 + \mu^l}{\mu^l \psi + \beta^l (1 + \mu^l)}, \]

which is decreasing in the multiplier \( \mu^l \) on the banks’ financial constraint.
Loan pricing with credit supply frictions

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\[ Q_2(k_2, b_2; S_{2+}) = 1 - F(A_3^*) = \psi_2 \frac{\overline{A} - A_3^*}{A - \overline{A}}. \]

The wedge is

\[ \psi_2 = \beta' \frac{1 + \mu'}{\mu' \psi + \beta'(1 + \mu')}, \]

which is decreasing in the multiplier \( \mu' \) on the banks’ financial constraint.
Optimal leverage with credit supply frictions

With credit supply frictions, the optimal choice of entrepreneurs’ leverage is

$$
\omega_2 = \frac{\psi_2 - \beta^F}{2\psi_2 - \beta^F} \left(\bar{A} + 1 + r^K(Z_3)\right) \omega^*_2 + \frac{\psi_2 - \beta^F}{2\psi_2 - \beta^F} \frac{k_1}{k_2} (1 - \mu) \omega_1
$$

As \(\frac{\psi_2 - \beta^F}{2\psi_2 - \beta^F}\) is increasing in \(\psi_2\) for the relevant range of values \(\psi_2 \in [\beta^F, 1]\), higher financial constraints (i.e. a lower \(\psi_2\)) weaken the credit demand channel and the debt overhang channel.

Instead, because \(\psi_2\) is pro-cyclical, there is a novel credit supply channel.
State dependent transmission

**Figure:** States of high and low credit spreads

*Note:* Data: difference between the Moody’s AAA credit spread (AAA) and the 10-year treasury constant maturity rate (DGS10). Data source: FRED. All data are for the United States. Time period: 1960Q1-2020Q4. The spread is detrended with a linear trend. The state is computed according to the smoothing function $\frac{\exp(-\gamma X)}{1 + \exp(-\gamma X)}$ with $\gamma = 10$. 
Non-financial debt: more amplification during times of low risk premiums

Note: Data: sum of loans to non-financial corporate business (FL104123005.Q) and debt securities to non-financial corporate business (FL104122005.Q) from the Financial Accounts of the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 percent confidence intervals.
Real effects are stronger during times of low credit spreads

Note: Data: real GDP (GDPC1) from FRED. All data are for the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 percent confidence intervals.
Unobserved Component Model

We decompose credit into a trend, a drift (not shown) and a cycle:

\[ \text{credit}_t = \text{trend}_t + \text{cycle}_t \]  

(10)

The credit cycle is driven by exogenously identified stock price noise shocks \( \text{noise}_t \) and other shocks \( \epsilon_{\text{cycle},t} \):

\[ \text{cycle}_t = \phi(L)\text{cycle}_{t-1} + \alpha_t \text{noise}_t + \epsilon_{\text{cycle},t} \]  

(11)

The impact of stock price noise shocks on the credit cycle is allowed to vary over time, according to

\[ \alpha_t = \alpha_{t-1} + u_{\alpha,t} \]  

(12)

The credit cycle feeds into GDP growth with a lag:

\[ \Delta \text{GDP}_t = \beta_0 + \beta_1 \Delta \text{GDP}_{t-1} + \beta_{2,t} \text{cycle}_{t-1} + u_{\text{GDP},t} \]  

(13)
Note: Estimates from the unobserved component model. The confidence bands represent the 16th and 84th percentiles of the corresponding posterior densities. All data are for the United States. Time period: 1960Q1 to 2020Q4.
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Worker problem

Workers supply labor $L$ inelastically at wage $W_t$. They lend in the form of short-term debt $D_t$ at a rate $R^D_t$. They consume $C_t$.

The problem of a worker in period 2 is

$$V_2 = \max_{C_2, D_2} C_2 + E_2 [V_3],$$

subject to

$$C_2 + D_2 = W_2 L + R^D_1 D_1,$$

$$V_3 = C_3 = W_3 L + R^D_2 D_2.$$
Firm problem

Firms rent capital $K_{t-1}$ from entrepreneurs at rate $r^K_t$ and hire labor from workers at rate $W_t$.

They produce output with technology $Y_t = Z_t K_{t-1}^\alpha L_t^{1-\alpha}$.

The problem of a firm is

$$\max_{K_{t-1}, L_t} Z_t K_{t-1}^\alpha L_t^{1-\alpha} - W_t L_t - r^K_t K_{t-1}. \quad (14)$$
The solution to the worker problem yields $R_1^D = R_2^D = 1$.

Optimal choice of inputs yields a wage $W_t = (1 - \alpha)Z_tK_{t-1}^\alpha L^{-\alpha}$ and a return on capital $r_t^K = \alpha Z_tK_{t-1}^{\alpha-1} L^{1-\alpha}$ for $t = 1, 2, 3$. 
We set the model up in a way such that despite the presence of idiosyncratic shocks, there is no heterogeneity.

This implies that we can consider representative workers, firms, and entrepreneurs.

The aggregate resource constraint is

\[ C_t + C^F_t + K_t = \left( Z_2((1 - F(A^*_t))K_{t-1})^\alpha L^{1-\alpha} + (1 - F(A^*_t))K_{t-1} \right). \]
A credit boom in period 1

Combining credit supply and credit demand equations:

\[
(1 - \beta^F) E_1 \left[ Q_2(k_2, b_2; S_{2+}) (1 - F(A_2^*)) \right] = -\frac{\partial Q_1(k_1, b_1; S_{1+})}{\partial b_1} (b_1 - b_0),
\]

where

\[
\frac{\partial Q_1(k_1, b_1; S_{1+})}{\partial b_1} = -\frac{1}{A - A} E_1 \left[ Q_2 \frac{1}{k_1} \right]
\]

\[
+ E_1 \left[ \frac{A - A^*_2}{A - A} \left( \frac{\partial Q_2 \partial k_2}{\partial k_2 \partial b_1} + \frac{\partial Q_2 \partial b_2}{\partial b_2 \partial b_1} \right) \right].
\]  

(15)

Fall in expected default risk -> rise in wedge between valuation of cash flows -> firm takes on more default risk and leverage at the margin.

Effect stronger the smaller \(b_1 - b_0\).
A credit bust in period 2

\[
(1 - \beta^F) (1 - F(A_3^*)) = -\frac{\partial Q_2(k_2, b_2; S_{2+})}{\partial b_2} (b_2 - b_1),
\]

where

\[
\frac{\partial Q_2(k_2, b_2; S_{2+})}{\partial b_2} = -\frac{1}{\bar{A} - \underline{A} k_2} \frac{1}{k_2}
\]

Rise in expected default risk. Extreme case: \(b_2 = b_1\). Firm does not internalize that investment and debt reduction reduces default risk at the margin.

Reduces default risk too little: underinvestment, excessive leverage and excessive default.

Issue more severe the higher \(b_1\) (i.e. the stronger was the credit boom), because bond price more sensitive to default risk.
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Resulting time series of dividend shocks

![Dividend shock graph](image)

Standardized units

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Jan 2024
News and noise shocks jointly

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St.dev.</th>
<th>Autocorr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise (stocks)</td>
<td>0.00</td>
<td>1.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Fund. (stocks)</td>
<td>-0.00</td>
<td>0.99</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

**Table: Summary statistics**

<table>
<thead>
<tr>
<th></th>
<th>Noise (stocks)</th>
<th>Fund. (stocks)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-0.01</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Table: Correlation of shocks**
# Events coinciding with noise shocks

<table>
<thead>
<tr>
<th>Positive noise shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971Q3 Nixon rally (NY Times)</td>
</tr>
<tr>
<td>1980Q1 Inflation hedge (NY Times)</td>
</tr>
<tr>
<td>1987Q3 Run-up to 1987 stock market crash (WSJ)</td>
</tr>
<tr>
<td>1999Q3 Peak of the dot-com bubble</td>
</tr>
<tr>
<td>2009Q2 Great recession ends</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative noise shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962Q2 Kennedy slide (WSJ)</td>
</tr>
<tr>
<td>1974Q3 Nixon resignation (WSJ)</td>
</tr>
<tr>
<td>1987Q4 1987 stock market crash (WSJ)</td>
</tr>
<tr>
<td>2008Q4 US financial market meltdown</td>
</tr>
<tr>
<td>2009Q1 US financial market meltdown</td>
</tr>
</tbody>
</table>

Table: Largest 5 positive and negative noise shocks and coinciding events
Decomposition of stock price into components

Data: S&P500 (in blue). The red line is the noise bubble component, the yellow line the difference between the noise bubble component and the data. All data are for the United States. Time period: 1960Q1-2020Q4.
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The bank lending channel

Note: loans to non-financial corporate business (FL104123005.Q) from the Financial Accounts of the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.

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The bond market channel

Note: Data: debt securities to non-financial corporate business (FL104122005.Q) from the Financial Accounts of the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Non-financial loans: no differences in amplification

Note: Data: loans to non-financial corporate business (FL104123005.Q) from the Financial Accounts of the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 percent confidence intervals.
Non-financial bonds: only amplification during times of low risk premiums

Note: Data: debt securities to non-financial corporate business (FL104122005.Q) from the Financial Accounts of the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 percent confidence intervals.
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The bank lending channel: loans/commercial bank assets

Note: Data: loans to non-financial corporate business (FL104123005.Q) from the Financial Accounts of the United States, divided by total assets of commercial banks (FA763164103.Q) from the Financial Accounts of the United States. Series are cumulated. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.

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The bank lending channel: bank leverage

**News Shock**

**Noise Shock**

Note: Data: inverse ratio of total financial assets of broker-dealers (FA764068005.Q) to corporate equities as a liability of broker-dealers (FA763164103.Q) from the Financial Accounts of the United States. Series are cumulated. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.

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The bank lending channel: commercial bank equity

Note: Data: equity as a liability of commercial banks (FA763164103.Q) from the Financial Accounts of the United States. Series are cumulated. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
The bank lending channel: commercial bank assets

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Note: Data: assets of commercial banks (FA763164103.Q) from the Financial Accounts of the United States. Series are cumulated. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Commercial bank market leverage, Compustat

**News Shock**

**Noise Shock**

Quarters

Quarters
Broker-dealer book leverage, Flow of Funds

![Chart showing News Shock and Noise Shock over quarters]

Quarters

0.1
0.05
0
-0.05
-0.1
-0.15

0.1
0.05
0
-0.05
-0.1
-0.15
Broker-dealer book leverage, Compustat

News Shock

Noise Shock

Quarters

Quarters
Broker-dealer market leverage, Compustat

News Shock

Noise Shock

Quarters

Quarters
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Credit-to-GDP ratio

**Note:** Data: sum of loans to non-financial corporate business (FL104123005.Q) and debt securities to non-financial corporate business (FL104122005.Q) from the Financial Accounts of the United States. All data are for the United States. Time period: 1960Q1 to 2020Q4. The shaded areas correspond to the 90 (bright shading) and 68 (dark shading) percent confidence intervals.
Cyclically adjusted Price Earnings Ratio (CAPE)

![Graphs showing News Shock and Noise Shock over quarters](image-url)
Consumption

News Shock

Noise Shock

%

Quarters

%
Investment

News Shock

Noise Shock

%

Quarters

%
News Shock

Noise Shock

% vs Quarters
Inflation

News Shock

Noise Shock

Percent (%) vs. Quarters

5 10 15 20 25 30

5 10 15 20 25 30
SLOOS, higher demand

![Graphs showing News Shock and Noise Shock over quarters.](Image)
SLOOS, banks tightening

News Shock

Noise Shock

Quarters

%
Business loan delinquency rate

News Shock

Noise Shock

Quarters

Quarters
AAA-10Y spread (liquidity premium)
Excess bond premium (risk premium)
10Y-3M treasury spread (term premium)
GZ spread (risk premium)