Which Financial Shocks Drive the Business Cycle?

Jonathan Goldberg
Federal Reserve Board
(joint with Andrea Ajello & Ander Perez-Orive - Federal Reserve Board)

AEA 2019

January 5, 2019

Disclaimer: The views expressed here are of the authors, and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System, or of anyone else associated with the Federal Reserve System.
Asset prices driven by discount rates

- Cochrane 2010; Gilchrist and Zakrajsek 2012

Underlying mechanisms

- Intermediaries’ risk-bearing capacity (e.g. He and Krishnamurthy 2013), sentiment or behavioral (Shiller 2014), liquidity and liquidity risk (Acharya and Pedersen 2005), heterogeneous beliefs,...

This paper: Can shocks to investor demand for corporate debt drive business cycles?
This paper: Can shocks to investor demand for corporate debt drive business cycles?

Monetary DSGE with rich corporate finance structure

- Long-term nominal debt
- Strategic default
- Match debt flows, default rates, idiosyncratic volatility, credit spreads
- Study how corporate finance frictions propagate shocks to debt demand
What are Corporate Debt Preference Shocks?

Financial and agency frictions at intermediaries


Sentiment or behavioral


Liquidity and liquidity risk

- Acharya and Pedersen (2005) and Lin, Wang, and Wu (2011)

Safety, flight to quality, knightian uncertainty

- Krishnamurthy and Vissing-Jorgensen (2012)

Household-level idiosyncratic risk

- Constantinides and Duffie (1996)

Heterogeneous preferences or beliefs


Regulatory shocks and regulatory uncertainty

- Danielsson, Shin, and Zigrand (2004), Baker, Bloom, and Davis (2016)
Why Focus on Corporate Debt?

Relevant for mechanisms driving discount rates

- Highly intermediated (He Kelly Manela 2017; Haddad and Muir 2018)
- Relatively illiquid (He and Xiong 2012; Bao Pan Wang 2011)
- More exposed to downside risk (Geanakoplos 2009; Gennaioli Shleifer and Vishny 2012; Gourio 2012)

Economically relevant

- Major source of external finance for corporations
- Credit spreads have substantial predictive power for business cycles
  - Important info is risk premium not expected defaults (Gilchrist Zakrajsek 2012)
- In contrast, stock prices do not have robust predictive power for aggregate activity (Fama 1981; Campbell 1999; Lopez-Salido Stein Zakrajsek 2015)
- Net debt issuance is cyclical and negatively correlated with net equity issuance
Focus on Corporate Debt

Two types of debt demand shocks

- Demand for corporate debt
- Demand for long-term debt (corporate or government)
- Do these shocks affect economic activity through very different mechanisms?
Credit market sentiment shocks matter significantly for the business cycle

- Explain 20% of GDP, 40% of investment and hours
Credit market sentiment shocks matter significantly for the business cycle

- Explain 20% of GDP, 40% of investment and hours

Corporate debt preference shock dominates term premium shock
Main Insights

Credit market sentiment shocks matter significantly for the business cycle

- Explain 20% of GDP, 40% of investment and hours

Corporate debt preference shock dominates term premium shock

Importance of debt maturity (I): rollover channel stronger with short-term debt

Importance of debt maturity (II): debt deflation stronger with longer term debt

Results hold when including risk shocks (shocks to supply of corporate bonds)
Main Insights

Credit market sentiment shocks matter significantly for the business cycle

- Explain 20% of GDP, 40% of investment and hours

Corporate debt preference shock dominates term premium shock

Importance of debt maturity (I): rollover channel stronger with short-term debt

Importance of debt maturity (II): debt deflation stronger with longer term debt
Main Insights

Credit market sentiment shocks matter significantly for the business cycle

- Explain 20% of GDP, 40% of investment and hours

Corporate debt preference shock dominates term premium shock

Importance of debt maturity (I): rollover channel stronger with short-term debt

Importance of debt maturity (II): debt deflation stronger with longer term debt

Results hold when including risk shocks (shocks to supply of corporate bonds)
**Model: Agents, Frictions and Shocks**

**Households**
- Shocks to investors’ preference for:
  - corporate bonds $\rightarrow$ excess bond premium $\phi_t^B$
  - long-term bonds (Treasury & corporate bonds) $\rightarrow$ term premium $\phi_t^{TP}$
- Akin to money-in-utility approach (Sidrauski 1976, Krishnamurthy and Vissing Jorgensen 2012, Fisher 2015)

**Entrepreneurs**
- Buy capital and rent it out. Issue defaultable debt.
- Firm-specific capital quality shock with time-varying volatility $\sigma_{z,t}$ (risk shock)

**Final Goods Producers**
**Intermediate Capital Goods Producers** (Rotemberg price and wage rigidities)
**Capital Producers** (Investment adjustment costs)
**Monetary Policy Authority** (Taylor rule)
Model: The Household–Preferences

\[ U_t = \frac{C_t^{1-\psi}}{1-\psi} + \phi_{TP} u(Q_{TB}^T B_t) + (\phi_B^T + \phi_{TP}) u(Q_{TB}^T B_t). \]

Household owns and derives utility from

- Treasury bonds \((TB_t)\) with price \(Q_{TB}^T\)
- Corporate bonds \((B_t)\) with price \(Q_{TB}^T\)

Demand shocks for corporate bonds \((\phi_B^T)\) and long-term bonds \((\phi_{TP})\)

Not shown:

- Habits (Campbell-Cochrane (1999))
- Disutility of labor with constant Frisch elasticity
Asset-class-specific SDFs

Treasury bonds:

\[
SDF_{t,t+1}^{TB} = \frac{1}{1 - \frac{1}{C_t^{-\psi}}(\phi_t^{TP})(Q_t^{TB}TB_t)^{-\kappa}} \frac{C_{t+1}^{-\psi}}{C_t^{-\psi}}
\]

Corporate bonds:

\[
SDF_{t,t+1}^{B} = \frac{1}{1 - \frac{1}{C_t^{-\psi}}(\phi_t^{B} + \phi_t^{TP})(Q_t^{B}B_t)^{-\kappa}} \frac{C_{t+1}^{-\psi}}{C_t^{-\psi}}
\]
Model: The Household-Asset Pricing

Treasury bond price:

\[ Q_{t}^{TB} = \beta E_t[SDF_{t,t+1}^{TB}(c + \lambda + (1 - \lambda) Q_{t+1}^{TB})] \]

\[ \text{yield}_{t}^{TB,\frac{1}{\lambda}} = \frac{c + \lambda}{Q_{t}^{TB}} - \lambda \]
Treasury bond price:

\[
Q_t^{TB} = \beta E_t[SDF_{t,t+1}^{TB}(c + \lambda + (1 - \lambda)Q_{t+1}^{TB})]
\]

\[
yield_t^{TB, \frac{1}{\lambda}} = \frac{c + \lambda}{Q_t^{TB}} - \lambda
\]

Corporate debt price:

\[
Q_t^B = \beta E_t[SDF_{t,t+1}^B(((1 - \Phi(z_{t+1}^*)))(c + \lambda + (1 - \lambda)Q_{t+1}^B) + \Phi(z_{t+1}^*)rc_{t+1}))]
\]

\[
yield_t^B, \frac{1}{\lambda} = \frac{c + \lambda}{Q_t^B} - \lambda
\]


**Model: The Household-Asset Pricing**

Treasury bond price:

\[
Q_t^{TB} = \beta E_t \left[ SDF_{t,t+1}^{TB} (c + \lambda + (1 - \lambda) Q_{t+1}^{TB}) \right]
\]

\[
\text{yield}_t^{TB, \frac{1}{\lambda}} = \frac{c + \lambda}{Q_t^{TB}} - \lambda
\]

Corporate debt price:

\[
Q_t^B = \beta E_t \left[ SDF_{t,t+1}^B \left( (1 - \Phi(z_{t+1}^*)) (c + \lambda + (1 - \lambda) Q_{t+1}^B) + \Phi(z_{t+1}^*) rc_{t+1} \right) \right]
\]

\[
\text{yield}_t^B, \frac{1}{\lambda} = \frac{c + \lambda}{Q_t^B} - \lambda
\]

Corporate spread:

\[
Spread_t = \text{yield}_t^B - \text{yield}_t^{TB}
\]
Classic trade-off: Tax advantage of debt vs. costs of financial distress
Classic trade-off: Tax advantage of debt vs. costs of financial distress

Idiosyncratic productivity/capital quality shock $z_{t,e}$
  - Endogenous default threshold $z_t^*$
  - Risk shocks CMR (2014)
  - $z_{t,e}$ log normal with std dev $\sigma_{z,t}$
**Model: Entrepreneurs – Bond Supply**

- Classic trade-off: Tax advantage of debt vs. costs of financial distress

- Idiosyncratic productivity/capital quality shock $z_{t,e}$
  - Endogenous default threshold $z_t^*$
  - Risk shocks CMR (2014)
  - $z_{t,e}$ log normal with std dev $\sigma_{z,t}$

- Long-term nominal debt
Classic trade-off: Tax advantage of debt vs. costs of financial distress

Idiosyncratic productivity/capital quality shock $z_{t,e}$
- Endogenous default threshold $z_t^*$
- Risk shocks CMR (2014)
- $z_{t,e}$ log normal with std dev $\sigma_{z,t}$

Long-term nominal debt

Debt and dividend adjustment costs
Strategic default choice:

\[ J(B_{t-1}/\pi_t, \overline{K}_{t-1}, z_t, S_t) = \]

\[
\max[0, \Pi_t(z_t) - \left\{ (1 - \tau)c + \left[ 1 - \tau(1 - Q_t^B)\lambda \right] \right\} \frac{B_{t-1}}{\pi_t} + V(B_{t-1}/\pi_t, S_t)],
\]

where the value of continuation for firm shareholders is

\[
V(B_{t-1}/\pi_t, S_t) = \max_{B_t, \overline{K}_t} Q_t^B \Delta B_t - v(B_t) - Q_t^k \overline{K}_t
\]

\[
+ E_t[\beta SDF_{t,t+1} \int_0^\infty J(B_t, \overline{K}_t, z_{t+1}, S_{t+1}) d\Phi(z_{t+1})]
\]
MODEL SOLUTION AND ESTIMATION

- FOCs solved using first-order perturbation methods
- State-space model estimated via Bayesian methods
**Observable Variables**

- Sample: 1982Q1 to 2017Q4.
- Standard real (CEE/SW) variables (per capita GDP, C, Inv, Real Wage growths, Hours, FFR, Inflation);
- Financial variables [measured with error (*)]
  - Non-farm Business Debt Repurchases (*)
    \[ DRP_t = -\frac{(B_t - B_{t-1})}{GDP_t} \]
  - Baa corporate bond spread (*)
    \[ Spread_t = yield_t^B - yield_t^{TB, \frac{1}{\lambda}} \]
  - Term spread (*)
    \[ TS_t = yield_t^{TB, \frac{1}{\lambda}} - yield_t^{TB, 1} \]
  - Default Rate of Corporate Bonds
    \[ DR_t = \sum_{i=0}^{3} \Phi(z_{t-i}^*) \]
  - Idiosyncratic Volatility of Stock Returns (*)
    \[ Vol_t = \sigma_{z,t} \]
## Comparison of Financial Observables

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt Repurchases</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Baa corporate bond spread</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Term spread</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Default Rate of Corporate Bonds</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Idiosyncratic Volatility of Stock Returns</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock Market</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
Exogenous shocks to be identified:

- Macro Shocks: TFP, MP, Price and Wage Mark-up, Intertemporal Pref Shock, Government spending
- Corporate Credit Supply Shock: Risk Shock (CMR)
- Portfolio Preference Shocks: Corporate Bond and Long Maturity Bond preference shock.
Exogenous shocks to be identified:

- Macro Shocks: TFP, MP, Price and Wage Mark-up, Intertemporal Pref Shock, Government spending
- Corporate Credit Supply Shock: Risk Shock (CMR)
- Portfolio Preference Shocks: Corporate Bond and Long Maturity Bond preference shock.

Identification strategy:

- Risk shocks (or bond supply shock) mapped into de-trended idiosyncratic excess return volatility, as one possible driver of corporate defaults.
- Asset preference shocks (or bond demand shock) allow for independent (residual) variation of demand for debt.
### Variance Decomposition

<table>
<thead>
<tr>
<th></th>
<th>mp</th>
<th>gam</th>
<th>p</th>
<th>w</th>
<th>bet</th>
<th>g</th>
<th>tp</th>
<th>b</th>
<th>sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>9</td>
<td>21</td>
<td>25</td>
<td>5</td>
<td>9</td>
<td>9</td>
<td>3</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Investment</td>
<td>10</td>
<td>10</td>
<td>31</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td>Consumption</td>
<td>1</td>
<td>30</td>
<td>2</td>
<td>1</td>
<td>56</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Hours</td>
<td>4</td>
<td>3</td>
<td>35</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>39</td>
<td>1</td>
</tr>
<tr>
<td>Inflation</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>Fed Funds Rate</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>Corporate Bond Spread</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Term Premium</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>62</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Idiosyncratic Stock Return Vol</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>Excess Stock Returns</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>63</td>
<td>8</td>
</tr>
<tr>
<td>Excess Bond Returns</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>43</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Equity Payouts</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>Default Rate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>79</td>
</tr>
<tr>
<td>Debt Repurchases</td>
<td>1</td>
<td>29</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>21</td>
<td>0</td>
</tr>
</tbody>
</table>
HISTORICAL SHOCK DECOMPOSITION: GDP

GDP Growth Historical Shock Decomposition

- GDP
- Bond Preference Shock
- Other Shocks and Initial Conditions


0.04 0.03 0.02 0.01 0 0 -0.01 -0.02 -0.03 -0.04
HISTORICAL SHOCK DECOMPOSITION: INVESTMENT

Investment Historical Shock Decomposition

- Investment
- Bond Preference Shock
- Other Shocks and Initial Conditions


Y-axis: 0.1, 0.08, 0.06, 0.04, 0.02, 0, -0.02, -0.04, -0.06, -0.08, -0.1
Historical Shock Decomposition: Debt Flows

Debt Repurchase Historical Shock Decomposition

- Debt Repurchases
- Bond Preference Shock
- Other Shocks and Initial Conditions


Values: -8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8
Model Implied EBP vs Data

Note: The Data (ebp) series is the standardized Ex. Notes.
IRFs: Term Premium Shock

Term Premium Shock

GDP (% dev. f. SS)

C (% dev. f. SS)

I (% dev. f. SS)

Default Rate (p.p. dev. f. SS)

Excess Stock Return (p.p. dev. f. SS)

Excess Corporate Bond Return (p.p. dev. f. SS)

Fed Funds Rate (p.p. dev. f. SS)

Corporate Bond Spread (p.p. dev. f. SS)

Debt Repurchases (% dev. f. SS)

Equity Payouts (% dev. f. SS)

Term Spread (% dev f. SS)

Inflation (p.p. dev f. SS)
IRFs: Role of Debt Maturity

Debt Preference Shock

- GDP (% dev f. SS)
- C (% dev f. SS)
- I (% dev f. SS)
- Default Rate (p.p. dev f. SS)
- Excess Stock Return (p.p. dev f. SS)
- Excess Corporate Bond Return (p.p. dev f. SS)
- Fed Funds Rate (p.p. dev f. SS)
- Corporate Bond Spread (p.p. dev f. SS)
- Debt Repurchases (% dev f. SS)
- Equity Payouts (% dev f. SS)
- Term Spread (% dev f. SS)
- Inflation (p.p. dev f SS)
IRFs: Debt Deflation

Price Markup Shock

GDP (% dev f. SS) vs. C (% dev f. SS) vs. I (% dev f. SS) vs. Default Rate (p.p. dev f. SS)

Excess Stock Return (p.p. dev f. SS) vs. Excess Corporate Bond Return (p.p. dev f. SS) vs. Fed Funds Rate (p.p. dev f. SS) vs. Corporate Bond Spread (p.p. dev f. SS)

Debt Repurchases (% dev f. SS) vs. Equity Payouts (% dev f. SS) vs. Term Spread (% dev f SS) vs. Inflation (p.p. dev f SS)
**Conclusion**

- Propose framework for studying role of risk premia in macroeconomic dynamics.
- Framework addresses two key empirical findings
  - Credit spreads have substantial predictive power for business cycles, and predictive power comes from variation in premia not default losses; in contrast, stock prices do not have robust predictive power
  - Net debt issuance is cyclical and negatively correlated with net equity issuance
- Contribution
  - Develop monetary dynamic general equilibrium model in which firms optimally choose investment, debt, equity issuance, taking into account expected default losses and fluctuations in risk premia
  - Estimate model to match asset prices, financing flows, and macro variables
- Next Steps
  - Explore implications of asset demand elasticity further.
  - Explore alternative shock structures (treasury preference shocks, equity preference shock?)
Model: Value of Corporate Debt

- Constraint to maximization problem – HH Euler equation for corporate debt:

\[
Q^B_t B_t = E_t \left[ \beta SDF^B_{t,t+1} \left( (1 - \Phi(z^*_t))(c + \lambda + (1 - \lambda)Q^B_{t+1}) \frac{B_t}{\pi_{t+1}} + \right. \right. \\
\left. \left. \xi \left( \int_{z_{min}}^{z^*_t} \Pi^p_{t+1}(z_{t+1}) d\Phi(z) \right. \right. \\
\left. \left. + \Phi(z^*_t)(V(B_t/\pi_{t+1}, S_{t+1}) + (1 - \lambda)Q^B_{t+1} \frac{B_t}{\pi_{t+1}}) \right) \right] 
\]
Constraint to maximization problem – HH Euler equation for corporate debt:

\[
Q^B_t B_t = E_t \left[ \beta SDF^B_{t,t+1} \left[ (1 - \Phi(z_{t+1}^*)) (c + \lambda + (1 - \lambda) Q^B_{t+1}) \frac{B_t}{\pi_{t+1}} + \zeta \left( \int_{z_{min}}^{z_{t+1}} \Pi_{t+1}^{pt} (z_{t+1}) d\Phi(z) \right. \right. \\
\left. \left. + \Phi(z_{t+1}^*) (V(B_t / \pi_{t+1}, S_{t+1}) + (1 - \lambda) Q^B_{t+1} \frac{B_t}{\pi_{t+1}}) \right) \right] \right]
\]
Model Solution and Estimation

- FOCs solved using (first-order) perturbation methods
- State-space model estimated via Bayesian methods

**Observation equation:**

\[ Y_t = C + BX_t + \eta_{t}^{meas} \]

- \( Y_t \), vector of observables,
- \( C \), constant terms
- \( B \), loadings on state variables \( X_t \)

**State-transition equation:**

\[ X_t = \mu_X + \Phi X_{t-1} + \Sigma \varepsilon_t \]

- \( X_t \), vector of state variables,
- \([\mu, \Phi, \Sigma]\) solution to DSGE model
- \( \varepsilon_t \), structural shocks to the economy.