Uncertainty, Financial Frictions, and Investment Dynamics

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The Great Recession and the subsequent slow recovery has heightened interest towards two non-traditional drivers of the cycle:

- Financial shocks: Disruptions in the credit market intermediation process (Gilchrist Zakrajšek 2012);

Financial disruptions lead to high uncertainty. Spikes in uncertainty lead to higher financial risk. Stock and Watson (2012):

- Correlation between Gilchrist & Zakrajšek EBP and Baker et al policy uncertainty instruments: 0.79;
- They conclude that: ...these two sets of instruments do not seem to be identifying distinct shocks.

Correlation = 0.61
Investment-uncertainty nexus motivated by investment irreversibility and associated “real options” mechanism.

Uncertainty fluctuations can influence macroeconomic outcomes through financial market frictions.

- Standard debt contract: Payoff from holding a risky bond is a concave function of the (stochastic) project return.
- Mean-preserving spread in the distribution of shocks:
  - expected defaults ↑ ⇒ credit spreads ↑ ⇒ cost of capital ↑ ⇒ I ↓
Uncertainty fluctuations can influence macroeconomic outcomes through financial market frictions.

Arellano et al. (2012); Christiano et al. (2014)

Standard debt contract: Payoff from holding a risky bond is a concave function of the (stochastic) project return.

Mean-preserving spread in the distribution of shocks:
  - expected defaults ↑ ⇒ credit spreads ↑ ⇒ cost of capital ↑ ⇒ I ↓
Analyze the interaction between uncertainty and investment in the context of imperfect financial markets and irreversibility.

Provide new micro- and macro-level empirical evidence on the link between uncertainty, investment, and credit spreads.

Embed a costly reversible investment framework in a GE model with frictions in both the debt and equity markets.
Use information from the stock market to infer fluctuations in uncertainty:

- **Cross section**: 11,303 U.S. nonfinancial corporations
- **Sample period**: July 1, 1963 to September 30, 2012

Use a standard asset pricing framework to purge uncertainty proxy of forecastable variation.
Factor model of asset returns:

\[(R_{itd} - r_{td}^*) = \alpha_i + \beta_i' \mathbf{f}_{td} + u_{itd}\]

- **Risk factors**: market excess return, SMB, HML, MOM

- **Firm-level idiosyncratic uncertainty**:

\[\sigma_{it} = \sqrt{\frac{1}{D_t} \sum_{d=1}^{D_t} (\hat{u}_{itd} - \bar{u}_{it})^2}; \quad \bar{u}_{it} = \frac{1}{D_t} \sum_{d=1}^{D_t} \hat{u}_{itd}\]
Firm-Level Analysis


- Credit spread regression:

  \[
  \log s_{it}[k] = \beta_1 \log \sigma_{it} + \beta_2 R^E_{it} + \beta_4 \log[D/E]_{i,t-1} + \epsilon_{it}[k]
  \]

- Investment regression:

  \[
  \log[I/K]_{it} = \beta_1 \log \sigma_{it} + \beta_2 \log s_{it} + \theta \log Z_{it} + \eta_i + \lambda_t + \epsilon_{it}
  \]
## Uncertainty & Credit Spreads

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tr>
<td>( \log \sigma_{it} )</td>
<td>0.730</td>
<td>0.459</td>
<td>0.484</td>
<td>0.216</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.046)</td>
<td>(0.049)</td>
<td>(0.021)</td>
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<tr>
<td>( R_{it}^E )</td>
<td>-0.095</td>
<td>-0.112</td>
<td>-0.109</td>
<td>-0.053</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.025)</td>
<td>(0.024)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>([\Pi/A]_{it})</td>
<td>-4.100</td>
<td>-1.835</td>
<td>-1.500</td>
<td>-1.318</td>
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<tr>
<td></td>
<td>(0.698)</td>
<td>(0.502)</td>
<td>(0.475)</td>
<td>(0.385)</td>
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<tr>
<td>( \log[D/E]_{i,t-1} )</td>
<td>0.212</td>
<td>0.056</td>
<td>0.049</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.011)</td>
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<tr>
<td>Adj. ( R^2 )</td>
<td>0.474</td>
<td>0.641</td>
<td>0.648</td>
<td>0.797</td>
</tr>
<tr>
<td>( p )-value: credit rating effects</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>( p )-value: industry effects</td>
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<td>-</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>( p )-value: time effects</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.000</td>
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</tbody>
</table>

**NOTE:** Robust clustered standard errors in parentheses.
<table>
<thead>
<tr>
<th>Explanatory Variable</th>
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<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \log \sigma_{it} )</td>
<td>-0.169</td>
<td>-0.081</td>
<td>-0.157</td>
<td>-0.036</td>
<td>0.022</td>
<td>-0.062</td>
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<td>(0.036)</td>
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<td>(0.034)</td>
<td>(0.035)</td>
<td>(0.033)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>( \log s_{it} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.206</td>
<td>-0.172</td>
<td>-0.152</td>
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<tr>
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<td></td>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>( \log [Y/K]_{it} )</td>
<td>0.558</td>
<td>-</td>
<td>-</td>
<td>0.535</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.046)</td>
<td></td>
<td></td>
<td>(0.045)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log [\Pi/K]_{it} )</td>
<td>-</td>
<td>1.166</td>
<td>-</td>
<td>-</td>
<td>1.075</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.086)</td>
<td></td>
<td></td>
<td>(0.088)</td>
<td></td>
</tr>
<tr>
<td>( \log Q_{i,t-1} )</td>
<td>-</td>
<td>-</td>
<td>0.715</td>
<td>-</td>
<td>-</td>
<td>0.645</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.040)</td>
<td></td>
<td></td>
<td>(0.041)</td>
</tr>
<tr>
<td>( R^2 ) (within)</td>
<td>0.325</td>
<td>0.307</td>
<td>0.297</td>
<td>0.349</td>
<td>0.323</td>
<td>0.310</td>
</tr>
</tbody>
</table>

**Note:** Robust clustered standard errors in parentheses.
Use a SVAR to trace out the impact of uncertainty and financial shocks on the macroeconomy.

Dynamic volatility model:

\[ \log \sigma_{it} = \gamma_i + \delta_i t + \rho \log \sigma_{i,t-1} + v_t + \epsilon_{it} \]

- Benchmark uncertainty estimate: \( \hat{v}_t, t = 1, \ldots, T \).
- Cross section: 11,303 nonfinancial firms
NOTE: Credit spread is the (nonfinancial) 10-year BBB-Treasury spread.
SVAR Analysis

- 8-variable VAR(4) system:
  - $i_t = \log$ of real business fixed investment
  - $c_t^D = \log$ of real PCE on durable goods
  - $c_t^N = \log$ of real PCE on nondurable goods & services
  - $y_t = \log$ of real GDP
  - $p_t = \log$ of the GDP price deflator
  - $\hat{v}_t = \text{economic uncertainty}$
  - $s_t = 10$-year BBB-Treasury corporate bond spread
  - $m_t = \text{effective (nominal) federal funds rate}$

- Implications of two types of shocks:
  - **Uncertainty**: orthogonalized innovations in $\hat{v}_t$
  - **Financial**: orthogonalized innovations in $s_t$

- **Identification Scheme I**: $(i_t, c_t^D, c_t^N, y_t, p_t, \hat{v}_t, s_t, m_t)$
- **Identification Scheme II**: $(i_t, c_t^D, c_t^N, y_t, p_t, s_t, \hat{v}_t, m_t)$
IMPLICATIONS OF AN UNCERTAINTY SHOCK
Identification scheme I

- Business fixed investment
- PCE - durables
- PCE - nondurables & services
- GDP
- Uncertainty
- Credit spread
Implications of a Financial Shock
Identification scheme I

**Business fixed investment**

**PCE - durables**

**PCE - nondurables & services**

**GDP**

**Uncertainty**

**Credit spread**
IMPLICATIONS OF AN UNCERTAINTY SHOCK
Identification scheme II

- Business fixed investment
- PCE - durables
- PCE - nondurables & services
- GDP
- Uncertainty
- Credit spread

Graphs showing the impact of an uncertainty shock on various economic indicators.
Implications of a Financial Shock
Identification scheme II

- Business fixed investment
- PCE - durables
- PCE - nondurables & services
- GDP
- Uncertainty
- Credit spread
Questions:

- Are results robust to alternative measures of uncertainty?
- Are results robust to alternative methods of identification?
Alternative measures of uncertainty:

- **RVOL**: Realized volatility computed using daily weighted total market return.
- **VXO**: Option-implied volatility on S&P100 stock price index.
- **DISP** (Bachmann, Elstner, and Sims, 2013): Forecast disagreement from the Business Outlook Survey measured as the cross-sectional standard deviation of forecast errors.
- **BBD** (Baker, Bloom, and Davis, 2012): Weighted sum of news index, temporary tax code provisions set to expire, and dispersion of SPF for CPI and G.
## Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>EBP</th>
<th>RVOL</th>
<th>IVOL</th>
<th>DISP</th>
<th>BBD</th>
<th>VXO</th>
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</thead>
<tbody>
<tr>
<td>EBP</td>
<td>1</td>
<td>0.56</td>
<td>0.36</td>
<td>0.26</td>
<td>0.43</td>
<td>0.58</td>
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<td>RVOL</td>
<td>1</td>
<td>0.75</td>
<td>0.11</td>
<td>0.47</td>
<td>0.84</td>
<td></td>
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<tr>
<td>IVOL</td>
<td>1</td>
<td>0.04</td>
<td>0.29</td>
<td>-0.01</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>DISP</td>
<td>1</td>
<td></td>
<td></td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.49</td>
</tr>
<tr>
<td>VXO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### Notes:
The sample ranges from 1985:M1 to 2011:M12 for all variables but VXO for which the sample starts in 1986:M1.
Identification procedure:

- Use Excess Bond Premium to measure financial conditions – removes variation in credit spreads associated with default risk.
- Identification uncertainty versus financial shocks using penalty function approach (Caldera et al 2012)
  - An uncertainty shock is a shock that maximizes the response of the uncertainty proxy (e.g. IVOL) for up to 3 months;
  - A financial shock is a shock that maximizes the response of the EBP for up to 3 months and is orthogonal to an uncertainty shock.
Fluctuations in idiosyncratic uncertainty can have a large effect on aggregate investment.
The impact of uncertainty on investment occurs largely through changes in credit spreads.
Financial shocks have a strong effect on aggregate investment, irrespective of the level of uncertainty.
**Heterogeneous firms**: use DRS technology to produce final-good output and accumulate capital.

- Production subject to persistent aggregate and idiosyncratic productivity shocks.
- Volatility of idiosyncratic productivity shocks is time varying.

**Capital adjustment frictions**:
- fixed costs
- partial irreversibility $\Rightarrow$ purchase price of capital $>$ sale price

**Financial frictions**:
- Strategic default and debt renegotiation.
- Issuance costs in equity markets.
The household earns a competitive real market wage $w$ by working $h$ hours and saves by purchasing bonds and equity shares of firms in the economy.

Household preferences:

$$u(c, h) = \log c - \zeta h$$
Production function:

\[ y = (az)^{(1-\alpha)\chi} (k^\alpha h^{1-\alpha})^\chi - F_0 k \]

- \( a \) = aggregate technology shock
- \( z \) = idiosyncratic technology shock
- \( \chi \) = degree of DRS in production
- \( F_0 \) = fixed operating costs

Profits are linear in \( a \) and \( z \):

\[ \pi(a, z, w, k) = \max_{h \geq 0} \left\{ (az)^{(1-\alpha)\chi} (k^\alpha h^{1-\alpha})^\chi - F_0 k - wh \right\} \]

\[ = az\psi(w) k^\gamma - F_0 k \]
**Technology Shocks**

- **Aggregate technology shock**:
  \[
  \log a' = \rho_a \log a + \log \epsilon'_a; \quad \epsilon'_a \sim N(-0.5\omega^2_a, \omega^2_a)
  \]

- **Idiosyncratic technology shock**: $N$-state Markov chain process with time-varying volatility
  \[
  \log \sigma'_z = (1 - \rho_\sigma) \log \tilde{\sigma}_z + \rho_\sigma \log \sigma_z + \epsilon'_\sigma; \quad \epsilon'_\sigma \sim N(-0.5\omega^2_\sigma, \omega^2_\sigma)
  \]

  - Fluctuations in $\sigma_z$ do not affect the conditional expectation of $z'$.
  - An increase in $\sigma_z$ represent a mean-preserving spread of $z'$.
Nonconvex capital adjustment costs:
Abel & Eberly (1994,1996); Caballero et al. (1995); Cooper & Haltiwanger (2006)

\[
g(k', k) = F_k k + (p^+ \times 1[k' \geq (1 - \delta)k]
+ p^- \times 1[k' \leq (1 - \delta)k]) \left[k' - (1 - \delta)k\right]
\]

- \( F_k \) = fixed investment adjustment costs
- \( p^+ \) = purchase price of capital
- \( p^- \) = liquidation price of capital
- \( p^- / p^+ < 1 \Rightarrow \text{capital specificity} \)

Liquidation price of capital \( p^- \):

\[
\log p^- = (1 - \rho_{p^-}) \log \tilde{p}^- + \rho_{p^-} \log p^- + \epsilon'_{p^-}
\]

- \( \log \epsilon'_{p^-} \sim N(-0.5\omega^2_{p^-}, \omega^2_{p^-}) = \text{capital liquidity shock} \)
Financial Distortions

- Moral hazard and limited liability in credit markets.
- Issuance costs in equity markets.

Implications:
- Full set of capital structure choices (debt, equity, internal funds).
- Strategic default and debt renegotiation.
Net Worth

- Net worth is the sum of net profits and the market value of undepreciated capital less the face value of debt:

\[ n' = a' z_j'(\sigma)\psi(w(s'))k'^\gamma - F_0 k' + p^{−'}(1 - \delta)k' - b' \]

- Aggregate state: \( s = [a, \sigma, p^−, \mu] \)
- The value of capital follows a stochastic process and entails a discount in the amount of \( 1 - p^{−'}/p^+ \).
Endogenous Default

- Limited liability: lower bound on net worth $\tilde{n}$
- Default threshold for the idiosyncratic technology shock:

$$z^D(k', b'; s') \equiv \frac{\tilde{n} + b' + F_0 k' - p'^{-}(1 - \delta) k'}{a' \psi(w') k' \gamma}$$

- Set of default states:

$$\mathcal{D} = \{j \mid j \in \{1, \ldots, N\} \text{ and } z'_j(\sigma) \leq z^D(k', b'; s')\}$$

- Default occurs if and only if $z'_j(\sigma) \in \mathcal{D}$. 
With limited liability, the amount of renegotiated debt must be consistent with $\bar{n}$:

$$b^R \leq \bar{b}(k', z'_j(\sigma); s') \equiv a' z'_j(\sigma) \psi(w') k'^\gamma - F_o k' + p'^{'}(1 - \delta)k'$$

No bargaining power for firm implies the maximum recovery in equilibrium:

$$b^R = \bar{b}(k', z'_j(\sigma); s')$$

Bond market distortions:

Townsend (1979)
- Bankruptcy costs: $\xi(1 - \delta)k'$; $0 < \xi < 1$
- Recovery rate in the case of default:

\[ \mathcal{R}(k', b', z'_j(\sigma); s') = \frac{\bar{b}(k', z'_j(\sigma), s')}{b'} - \xi(1 - \delta) \frac{k'}{b'} \]

- Bond pricing formula:

\[
q_i^B(k', b'; s') = \mathbb{E} \left\{ m(s, s') \left[ 1 + \sum_{j \in \mathcal{D}} p_{i,j} [\mathcal{R}(k', b', z'_j(\sigma); s') - 1] \right] \middle| s \right\}
\]
Dividends:

\[ d \equiv a z_i (\sigma - 1) \psi(w) k^\gamma - F_o k - \nu g(k', k) - b + q_i B b' + e \]

- \( e \) = value of newly issued shares if positive
  (share repurchases otherwise)
- \( \nu = \{0, 1\} \): investment action/inaction status
- Minimum dividend constraint: \( d \geq \bar{d} \geq 0 \)
  
  Fama & French (2005); Leary & Michaely (2011)

Equity market distortions:

Gomes (2001); Cooley & Quadrini (2001); Hennessy & Whited (2007)

- Dilution costs: \( \bar{\varphi}(e) \equiv e + \varphi \max\{e, 0\}; \quad 0 < \varphi < 1 \)
Net liquid asset position:

\[ x \equiv a z_i(\sigma_{-1})\psi(w)k^\gamma - F_0k - b = n - p^-(1 - \delta)k \]

Dividends can be expressed as:

\[ d = x - \nu g(k', k) + q_b^B b' + e \]

Value of the firm: \( v_i(k, x; s) \)
Firm’s Problem

- Recursive problem formulation:

\[
v_i(k, x; s) = \min_{\phi} \max_{d, e, \nu, k', b'} \left\{ d + \phi(d - d) - \bar{\phi}(e) + \eta \mathbb{E} \left[ m(s, s') \right] \right. \\
\left. \times \sum_{j=1}^{N} p_{i,j} \max \left\{ v_j(k', x_j'(\sigma); s'), v_j(k', x_j^R(\sigma); s') \right\} \bigg| s \right\}
\]

s.t. dividend & bond pricing eqns. & \( s' = \Gamma(s) \)

- \( \eta = \) exogenous survival probability
- \( v_j(k', x_j^R(\sigma); s') = \) continuation value in the case of default
**Optimal Capital Structure**

- FOC: equity issuance:

\[ 1 + \phi = 1 + \varphi \times 1(e > 0) \]

- FOC: bond issuance:

\[
q^B_i(k', b'; s) + q^B_{i,b}(k', b'; s)b' = \\
\eta \mathbb{E} \left[ m(s, s') \sum_{j \in D^c} p_{i,j} \left( \frac{1 + \varphi \times 1(e' > 0)}{1 + \varphi \times 1(e > 0)} \right) \bigg| s \right]
\]
Tobin’s Q:

\[ q_i^K(k', b'; s) = \eta \frac{\partial}{\partial k'} \mathbb{E} \left[ m(s, s') \sum_{j=1}^{N} p_{i,j} \max \{ v_j(k', x_j^R(\sigma); s'), v_j(k', x_j^R(\sigma); s') \} \right] \]

FOC: capital (assuming \( \nu = 1 \)):

\[ (1 + \phi) \left[ g_{k'}(k', k) - q_{i,k'}^B(k', b'; s) \right] = q_i^K(k', b'; s). \]

Firm may find it optimal to delay (dis)investment:

\[ q_i^{K-} = \lim_{k' \uparrow (1-\delta)k} (1 + \phi) \left[ g_{k'}(k', k) - q_{i,k'}^B(k', b'; s)b' \right] \]

\[ q_i^{K+} = \lim_{k' \downarrow (1-\delta)k} (1 + \phi) \left[ g_{k'}(k', k) - q_{i,k'}^B(k', b'; s)b' \right] \]
Generalized $(S, s)$ policy rule:

- If $q_i^K((1 - \delta)k, b'; s) \not\in [q_i^{K-}, q_i^{K+}]$ then
  
  $$g_{k'}(k', k) = q_i^{B}(k', b'; s)b' + \frac{1}{1 + \phi}q_i^K(k', b'; s)$$

- If $q_i^K((1 - \delta)k, b'; s) \in [q_i^{K-}, q_i^{K+}]$ then $k' = (1 - \delta)k$

Sufficient conditions for action/inaction decision:

$$v_i(k, x; s) = \max \{ v_i(k, x; s|\nu = 1), v_i(k, x; s|\nu = 0) \}.$$
(S, s) INVESTMENT POLICY FUNCTION
Partial irreversibility only
Partial irreversibility and fixed adjustment costs
Household’s problem:

\[ W(s) = \max_{b',s',c,h} \{ u(c, h) + \beta \mathbb{E}[W(s') | s] \} \]

subject to a budget constraint,

\[ c + \int (q^B b' + p_s s') \mu(dz, dk, dx) = wh \]

\[ + \int [\tilde{R}^b + (d + \tilde{p}_s) s] \mu(dz, dk, dx) + \int F_0 k \mu(dz, dk, dx) \]

Consistency between firm and household problems.
Goods and labor markets clear.
**Aggregation**

- $\mu = \text{joint distribution of } z \in Z, k \in K, \text{ and } x \in X$
- Law of motion of $\mu$:

$$
\mu'(Z, K, X) = \\
\int 1[\left(z'_j(\sigma), k'_i(k, x; s), \tilde{x}_i(k, x, z'_j(\sigma); s, s')\right) \in Z \times K \times X] p_{i,j} \mu(dz, dk, dx)
$$

- $\tilde{x}_i(k, x, z'_j(\sigma); s, s') = \text{post-renegotiation value of net liquid assets}$

- **Solution method for GE models with heterogeneous agents:**
  
  *Krusell & Smith (1998); Khan & Thomas (2008)*

  - Agents use only a finite number of moments of $\mu$ to forecast equilibrium prices ($u_c(s)$ and $w(s)$).
<table>
<thead>
<tr>
<th><strong>Key Parameter Values</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Production and capital accumulation</strong></td>
</tr>
<tr>
<td>Fixed costs of production ( (F_o) ) &amp; 0.05</td>
</tr>
<tr>
<td>Fixed costs of investment ( (F_k) ) &amp; 0.01</td>
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<tr>
<td>Purchase price of capital ( (p^+) ) &amp; 1.00</td>
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<tr>
<td><strong>Financial markets</strong></td>
</tr>
<tr>
<td>Survival probability ( (\eta) ) &amp; 0.95</td>
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<tr>
<td>Bankruptcy costs ( (\xi) ) &amp; 0.10</td>
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<tr>
<td>Equity issuance costs ( (\varphi) ) &amp; 0.12</td>
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<td><strong>Representative household</strong></td>
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<td>Discount factor ( (\beta) ) &amp; 0.99</td>
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<tr>
<td><strong>Exogenous shocks</strong></td>
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<tr>
<td>Persistence of the idiosyncratic technology shock process &amp; 0.80</td>
</tr>
<tr>
<td>Steady-state level of idiosyncratic uncertainty ( (\tilde{\sigma}_z) ) &amp; 0.15</td>
</tr>
<tr>
<td>Persistence of the idiosyncratic uncertainty process ( (\rho_\sigma) ) &amp; 0.90</td>
</tr>
<tr>
<td>Volatility of innovations of the idiosyncratic uncertainty process ( (\omega_\sigma) ) &amp; 0.04</td>
</tr>
<tr>
<td>Steady-state liquidation value of capital ( (\tilde{p}^-) ) &amp; 0.50</td>
</tr>
<tr>
<td>Persistence of the liquidation value of capital process ( (\rho_{p^-}) ) &amp; 0.98</td>
</tr>
<tr>
<td>Volatility of innovations of the liquidation value of capital process ( (\omega_{p^-}) ) &amp; 0.015</td>
</tr>
</tbody>
</table>
Impact of an Uncertainty Shock

- Output
- Consumption
- Investment
- Hours worked
- Capital
- Debt
- Risk-free rate
- Credit spread
IMPACT OF A CAPITAL LIQUIDITY SHOCK
Conditional on the Type of Shock

<table>
<thead>
<tr>
<th>Selected Correlations</th>
<th>Technology</th>
<th>Uncertainty</th>
<th>Liquidity</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corr($S, Y$)</td>
<td>0.927</td>
<td>-0.811</td>
<td>-0.938</td>
<td>-0.457</td>
</tr>
<tr>
<td>Corr($S, I$)</td>
<td>0.626</td>
<td>-0.515</td>
<td>-0.577</td>
<td>-0.531</td>
</tr>
<tr>
<td>Corr($S, C$)</td>
<td>0.916</td>
<td>-0.368</td>
<td>-0.816</td>
<td>-0.498</td>
</tr>
<tr>
<td>Corr(STD($S$), $Y$)</td>
<td>0.933</td>
<td>-0.832</td>
<td>-0.950</td>
<td>-0.245</td>
</tr>
</tbody>
</table>

**NOTE:** All variables are expressed in deviations from their respective steady-state values.
Fluctuations in idiosyncratic uncertainty can have a large effect on aggregate investment.

The impact of uncertainty on investment occurs largely through changes in credit spreads.

Financial shocks have a strong effect on aggregate investment, irrespective of the level of uncertainty.

The presence of financial market frictions significantly amplifies the response of investment and output to uncertainty and capital liquidity shocks.