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
Mechanisms:

- 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 $\uparrow \Rightarrow$ credit spreads $\uparrow \Rightarrow$ cost of capital $\uparrow \Rightarrow I \downarrow$
Standard Debt Contract

![Graph showing the standard debt contract](image-url)
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.
Firm-Level Analysis


Credit spread regression:

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

Investment regression:

\[ \log[I/K]_{it} = \beta_1 \log \sigma_{it} + \beta_2 \log s_{it} + \theta \log Z_{it} + \eta_i + \lambda_t + \epsilon_{it} \]
### Table: Explanatory Variable Coefficients

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<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>
</tr>
<tr>
<td>$R^E_{it}$</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>
</tr>
<tr>
<td></td>
<td>(0.698)</td>
<td>(0.502)</td>
<td>(0.475)</td>
<td>(0.385)</td>
</tr>
<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>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.474</td>
<td>0.641</td>
<td>0.648</td>
<td>0.797</td>
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<tr>
<td>$p$-value: credit rating effects</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$p$-value: industry effects</td>
<td>-</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$p$-value: time effects</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Note:** Robust clustered standard errors in parentheses.
## Uncertainty, Credit Spreads & Investment

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>(1)</th>
<th>(2)</th>
<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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<tr>
<td></td>
<td>(0.036)</td>
<td>(0.034)</td>
<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>
<td></td>
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<td></td>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>( \log \left[ \frac{Y}{K} \right]_{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 \left[ \frac{\Pi}{K} \right]_{it} )</td>
<td>-</td>
<td>1.166</td>
<td>-</td>
<td>-</td>
<td>1.075</td>
<td>-</td>
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<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:

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

- Benchmark uncertainty estimate: \( \hat{\nu}_t, t = 1, \ldots, T \).
- Cross section: 11,303 nonfinancial firms
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
- **Sample period:** 1963:Q3–2012:Q3
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
  - \( \hat{v}_t \): economic uncertainty
  - \( s_t \): 10-year BBB-Treasury corporate bond spread
  - \( m_t \): 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: \((i_t, c_t^D, c_t^N, y_t, p_t, s_t, \hat{v}_t, m_t)\)
8-variable VAR(4) system:
- $i_t = \text{log of real business fixed investment}$
- $c_t^D = \text{log of real PCE on durable goods}$
- $c_t^N = \text{log of real PCE on nondurable goods & services}$
- $y_t = \text{log of real GDP}$
- $p_t = \text{log of the GDP price deflator}$
- $\hat{v}_t = \text{economic uncertainty}$
- $s_t = \text{10-year BBB-Treasury corporate bond spread}$
- $m_t = \text{effective (nominal) federal funds rate}$

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**: $(i_t, c_t^D, c_t^N, y_t, p_t, s_t, \hat{v}_t, m_t)$
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 $\hat{v}_t$
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- **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
IMPLICATIONS OF A FINANCIAL SHOCK
Identification scheme I
Implications of an Uncertainty Shock
Identification scheme II

Business fixed investment

PCE - durables

PCE - nondurables & services

GDP

Uncertainty

Credit spread
IMPLICATIONS OF A FINANCIAL SHOCK

Identification scheme II

![Graphs showing the implications of a financial shock on various economic indicators.](image-url)
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>
</tr>
</thead>
<tbody>
<tr>
<td>EBP</td>
<td>1.00</td>
<td>0.56</td>
<td>0.36</td>
<td>0.26</td>
<td>0.43</td>
<td>0.58</td>
</tr>
<tr>
<td>RVOL</td>
<td>1.00</td>
<td>0.75</td>
<td>0.11</td>
<td>0.47</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>IVOL</td>
<td>1.00</td>
<td>0.04</td>
<td>0.29</td>
<td>0.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISP</td>
<td>1.00</td>
<td>1.00</td>
<td>-0.01</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBD</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VXO</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></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.**
### Stylized facts:
- 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.

**Implications:** Financial frictions are an important part of the transmission mechanism through which fluctuations in uncertainty are propagated to the real economy.
Summary of Empirical Evidence

Stylized facts:
- 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.

Implications: Financial frictions are an important part of the transmission mechanism through which fluctuations in uncertainty are propagated to the real economy.
**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.
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 \( z \):

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

$$y = (az)^{(1-\alpha)\chi}(k^\alpha h^{1-\alpha})^{\chi} - F_0k$$

- $a =$ aggregate technology shock
- $z =$ idiosyncratic technology shock
- $\chi =$ degree of DRS in production
- $F_o =$ fixed operating costs

- Profits are linear in $a$ and $z$:

$$\pi(a, z, w, k) = \max_{h \geq 0} \left\{(az)^{(1-\alpha)\chi}(k^\alpha h^{1-\alpha})^{\chi} - F_0k - wh\right\}$$

$$= az\psi(w)k^\gamma - F_0k$$
Aggregate technology shock:

$$\log a' = \rho_a \log a + \log \epsilon'_a; \quad \epsilon'_a \sim N(-0.5\omega_a^2, \omega_a^2)$$

Idiosyncratic technology shock: $N$-state Markov chain process with time-varying volatility

$$\log \sigma'_z = (1 - \rho_\sigma) \log \bar{\sigma}_z + \rho_\sigma \log \sigma_z + \epsilon'_\sigma; \quad \epsilon'_\sigma \sim N(-0.5\omega_\sigma^2, \omega_\sigma^2)$$

- Fluctuations in $\sigma_z$ do not affect the conditional expectation of $z'$.
- An increase in $\sigma_z$ represent a mean-preserving spread of $z'$. 
Technology Shocks

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

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

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

- \( F_k = \) 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 \( p^- \):

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

- \( \log \epsilon'_{p^-} \sim N(-0.5\omega^2_{p^-}, \omega^2_{p^-}) = \text{capital liquidity shock} \)
Nonconvex capital adjustment costs:
Abel & Eberly (1994,1996); Caballero et al. (1995); Cooper & Haltiwanger (2006)

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

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

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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.
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 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 \( 1 - p^{-'}/p^{+} \).
Limited liability: lower bound on net worth $\bar{n}$

Default threshold for the idiosyncratic technology shock:

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

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 $z'_j(\sigma) \in \mathcal{D}$.
Endogenous Default

- Limited liability: lower bound on net worth $\bar{n}$
- Default threshold for the idiosyncratic technology shock:
  \[
  z^D(k', b'; s') \equiv \bar{n} + b' + F_0 k' - p'(1 - \delta) k' \\
  a' \psi(w') k' \gamma
  \]
- Set of default states:
  \[
  D = \{ j \mid j \in \{1, \ldots, N\} \text{ and } z'_j(\sigma) \leq z^D(k', b'; s') \}
  \]
  - Default occurs if and only if $z'_j(\sigma) \in D$. 
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: $\xi(1 - \delta) k'$; $0 < \xi < 1$
With limited liability, the amount of renegotiated debt must be consistent with $\bar{n}$:

$$b^R \leq \bar{b}(k', z_j'(\sigma); s') \equiv a' z_j'(\sigma) \psi(w') k'^{\gamma} - F_0 k' + p^{\prime -}(1 - \delta) k'$$

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: $\xi(1 - \delta) k'$; $0 < \xi < 1$
Bond Financing

- Recovery rate in the case of default:

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

- Bond pricing formula:

\[
q^B_i(k', b'; s') = \mathbb{E} \left\{ m(s, s') \left[ 1 + \sum_{j \in \mathcal{D}} p_{i,j} \left[ R(k', b', z'_j(\sigma); s') - 1 \right] \right] \right\}
\]
Bond Financing

- **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:**

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

\[ d \equiv a z_i (\sigma - 1) \psi(w) k^\gamma - F_0 k - \nu g(k', k) - b + q_i^B b' + e \]

- \( e \) = 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: \( \bar{\varphi}(e) \equiv e + \varphi \max\{e, 0\}; \quad 0 < \varphi < 1 \)
Dividends:

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

- \( e \) = value of newly issued shares if positive
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- Minimum dividend constraint: \( d \geq \bar{d} \geq 0 \)

Fama & French (2005); Leary & Michaely (2011)

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

- **Dilution costs:** \( \varphi(e) \equiv e + \varphi \max\{e, 0\}; \quad 0 < \varphi < 1 \)
### Key Parameter Values

<table>
<thead>
<tr>
<th>Production and capital accumulation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed costs of production ($F_o$)</td>
<td>0.05</td>
</tr>
<tr>
<td>Fixed costs of investment ($F_k$)</td>
<td>0.01</td>
</tr>
<tr>
<td>Purchase price of capital ($p^+$)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial markets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival probability ($\eta$)</td>
<td>0.95</td>
</tr>
<tr>
<td>Bankruptcy costs ($\xi$)</td>
<td>0.10</td>
</tr>
<tr>
<td>Equity issuance costs ($\varphi$)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Representative household</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Discount factor ($\beta$)</td>
<td>0.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exogenous shocks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistence of the idiosyncratic technology shock process</td>
<td>0.80</td>
</tr>
<tr>
<td>Steady-state level of idiosyncratic uncertainty ($\tilde{\sigma}_z$)</td>
<td>0.15</td>
</tr>
<tr>
<td>Persistence of the idiosyncratic uncertainty process ($\rho_\sigma$)</td>
<td>0.90</td>
</tr>
<tr>
<td>Volatility of innovations of the idiosyncratic uncertainty process ($\omega_\sigma$)</td>
<td>0.04</td>
</tr>
<tr>
<td>Steady-state liquidation value of capital ($\tilde{p}^-$)</td>
<td>0.50</td>
</tr>
<tr>
<td>Persistence of the liquidation value of capital process ($\rho_{p^-}$)</td>
<td>0.98</td>
</tr>
<tr>
<td>Volatility of innovations of the liquidation value of capital process ($\omega_{p^-}$)</td>
<td>0.015</td>
</tr>
</tbody>
</table>
IMPACT OF AN UNCERTAINTY SHOCK
IMPACT OF A CAPITAL LIQUIDITY SHOCK

Output

Consumption

Investment

Hours worked

Capital

Debt

Risk-free rate

Credit spread

Output

Consumption

Investment

Hours worked

Capital

Debt

Risk-free rate

Credit spread

0 10 20 30 40

-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
0.1
Percent
w/ FF
w/o FF

0 10 20 30 40

-0.2
-0.1
0.0
0.1
Percent

0 10 20 30 40

0.0
0.2
0.4
0.6
0.8
1.0
Percentage points
Risk-free rate

0 10 20 30 40

-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
Percentage points
Credit spread

0 10 20 30 40

-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
Percentage points
Credit spread

0 10 20 30 40
Fluctuations in idiosyncratic uncertainty can have a large effect on aggregate investment.

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

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