Risk Shocks

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Finding

• Countercyclical fluctuations in the cross-sectional variance of a technology shock, when inserted into an otherwise standard macro model, can account for a substantial portion of economic fluctuations.
  – Complements theory findings of Bloom (2009) and Bloom, Floetotto and Jaimovich (2009) which describe another way that increased cross-sectional dispersion can generate business cycles.

• ‘Otherwise standard model’:
  – A DSGE model, as in Christiano-Eichenbaum-Evans or Smets-Wouters
  – Financial frictions along the line suggested by BGG.
Outline

• Rough description of the model.

• Summary of Bayesian estimation of the model.

• Explanation of the basic finding of the analysis.
Standard Model

Firms

Market for Physical Capital

Labor market

household

\[ K_{t+1} = (1 - \delta)K_t + G(\zeta, I_t, I_{t-1}) \]

Marginal efficiency of investment shock
Standard Model with BGG

Examples:
1. Large proportion of firm start-ups end in failure
2. Even famously successful entrepreneurs (Gates, Jobs) had failures (Traf-O-Data, NeXT computer)
3. Wars over standards (e.g., Betamax versus VHS).

\[ K \to \omega K, \quad \omega \sim F(\cdot, \sigma_t) \]
Standard Model with BGG

- Firms
  - $K \to \omega K, \omega \sim F(\cdot, \sigma_t)$

- Labor market
  - $L$ to firms

- Household

- Entrepreneurs

Observed by entrepreneur, but supplier of funds must pay monitoring cost to see it.
Standard Model with BGG

Firms

Labor market

household

Entrepreneurs

Risk shock

$K \to \omega K, \omega \sim F(\cdot, \sigma_t)$
Standard Model with BGG

Firms

Labor market

Capital Producers

Entrepreneurs

Entrepreneurs sell their $\omega K$ to capital producers

$K_{t+1} = (1 - \delta)K_t + G(\zeta_{t,t}, I_t, I_{t-1})$

$K \rightarrow \omega K, \quad \omega \sim F(\cdot, \sigma_t)$
Standard Model with BGG

\[ K \rightarrow \omega K, \ \omega \sim F(\cdot, \sigma_t) \]

Entrepreneurial net worth now established:

\[ = \text{value of capital} + \text{earnings from capital} - \text{repayment of bank loans} \]
Standard Model with BGG

\[ K \rightarrow \omega K, \ \omega \sim F(\cdot, \sigma_t) \]

- Firms
- Labor market
- Capital Producers
- Entrepreneurs
- household
- banks

Entrepreneur receives standard debt contract.
End of period $t$: Using net worth and loans, entrepreneur purchases new, end-of-period stock of capital from capital goods producers. Entrepreneur observes idiosyncratic disturbance to its newly purchased capital.

After realization of period $t+1$ shocks, entrepreneur supplies capital services to rental market.

Entrepreneur pays off debt to bank, determines current net worth.

Entrepreneur sells undepreciated capital to capital producers.

Entrepreneur goes to bank for another loan.
Determination of Standard Debt Contract

Interest rate

‘Menu’ of loan contracts supplied by competitive financial system

Entrepreneur indifference curve

Loan amount
Economic Impact of Risk Shock

lognormal distribution:
20 percent jump in standard deviation

- Larger number of entrepreneurs in left tail problem for lender
- Interest rate on loans to entrepreneur increases
- Entrepreneur borrows less
- Entrepreneur buys less capital, investment drops, economy tanks
Five Adjustments to Standard DSGE Model for CSV Financial Frictions

• Drop: household intertemporal equation for capital.

• Add: equations that characterize the loan contract –
  – Zero profit condition for suppliers of funds.
  – Efficiency condition associated with entrepreneurial choice of contract.

• Add: Law of motion for entrepreneurial net worth (source of accelerator and Fisher debt-deflation effects).

• Introduce: bankruptcy costs in the resource constraint.
Risk Shocks

• We assume risk has a first order autoregressive representation:

\[ \hat{\sigma}_t = \rho_1 \hat{\sigma}_{t-1} + \text{iid, univariate innovation to } \hat{\sigma}_t \]

• We assume that agents receive early information about movements in the innovation (‘news’).
Risk Shock and News

• Assume

\[ \hat{\sigma}_t = \rho_1 \hat{\sigma}_{t-1} + u_t \]

iid, univariate innovation to \( \hat{\sigma}_t \)

• Agents have advance information about pieces of \( u_t \)

\[ u_t = \xi_t^0 + \xi_{t-1}^1 + \ldots + \xi_{t-8}^8 \]

‘signals’ or ‘news’

\[ \xi_{t-i}^i \sim \text{iid, } E(\xi_{t-i}^i)^2 = \sigma_i^2 \]

\[ \xi_{t-i}^i \sim \text{piece of } u_t \text{ observed at time } t - i \]
Monetary Policy

• Nominal rate of interest function of:
  – Anticipated level of inflation.
  – Slowly moving inflation target.
  – Deviation of output growth from ss path.
  – Monetary policy shock.
12 Shocks

- Trend stationary and unit root technology shock.

- Marginal Efficiency of investment shock (perturbs capital accumulation equation)

\[ \bar{K}_{t+1} = (1 - \delta) \bar{K}_t + G(\zeta_{i,t}, I_t, I_{t-1}) \]

- Monetary policy shock.

- Equity shock.

- Risk shock.

- 6 other shocks.
Estimation

• Use standard macro data: consumption, investment, employment, inflation, GDP, price of investment goods, wages, Federal Funds Rate.

• Also some financial variables: BAA - 10 yr Tbond spreads, value of DOW, credit to nonfinancial business, 10 yr Tbond – Funds rate.

• Data: 1985Q1-2010Q2
Results

• Risk shock most important shock for business cycles.

• Quantitative measures of importance.

• Why are they important?

• What shock do they displace, and why?
Role of the Risk Shock in Macro and Financial Variables

Risk shock closely identified with interest rate premium.

Notes: The grey solid line represents the (two-sided) fitted data. The dotted black line is the model simulations.
Percent Variance in Business Cycle Frequencies Accounted for by Risk Shock

<table>
<thead>
<tr>
<th>variable</th>
<th>$\text{Risk, } \sigma_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>62</td>
</tr>
<tr>
<td>Investment</td>
<td>73</td>
</tr>
<tr>
<td>Consumption</td>
<td>16</td>
</tr>
<tr>
<td>Credit</td>
<td>64</td>
</tr>
<tr>
<td><strong>Premium (Z – R)</strong></td>
<td><strong>95</strong></td>
</tr>
<tr>
<td>Equity</td>
<td>69</td>
</tr>
<tr>
<td>$R^{10 \text{ year}} - R^{1 \text{ quarter}}$</td>
<td>56</td>
</tr>
</tbody>
</table>

Note: ‘business cycle frequencies means’ Hodrick-Prescott filtered data.
Why Risk Shock is so Important

• A. Our econometric estimator ‘thinks’ risk spread $\sim$ risk shock.

• B. In the data: the risk spread is strongly negatively correlated with output.

• C. In the model: bad risk shock generates a response that resembles a recession

• A+B+C suggests risk shock important.
The risk spread is significantly negatively correlated with output and leads a little.

Notes: Risk spread is measured by the difference between the yield on the lowest rated corporate bond (Baa) and the highest rated corporate bond (Aaa). Bond data were obtained from the St. Louis Fed website. GDP data were obtained from Balke and Gordon (1986). Filtered output data were scaled so that their standard deviation coincide with that of the spread data.
Surprising, from RBC perspective

Figure 3: Dynamic Responses to Unanticipated and Anticipated Components of Risk Shock

Looks like a business cycle
Figure 3: Dynamic Responses to Unanticipated and Anticipated Components of Risk Shock

A: interest rate spread (Annual Basis Points)
B: credit
C: investment
D: output
E: net worth
F: consumption
G: inflation (APR)

- response to unanticipated risk shock, $\xi_{0,0}$
- response to anticipated risk shock, $\xi_{8,0}$
What Shock Does the Risk Shock Displace, and why?

• The risk shock mainly crowds out the marginal efficiency of investment.
  – But, it also crowds out other shocks.

• Compare estimation results between our model and model with no financial frictions or financial shocks (CEE).
Baseline model mostly ‘steals’ explanatory power from m.e.i., but also from other shocks:

big drop in marginal efficiency of investment

<table>
<thead>
<tr>
<th>Shock</th>
<th>Risk (σ_t)</th>
<th>Equity (γ_t)</th>
<th>M.E.I. (ζ_{I,t})</th>
<th>Technol. (ε_t, μ_{Z,t})</th>
<th>Markup (λ_{f,t})</th>
<th>M.P. (ε_t)</th>
<th>Demand (ζ_{C,t})</th>
<th>Exog.Spend. (g_t)</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline model</td>
<td>62</td>
<td>0</td>
<td>13</td>
<td>2</td>
<td>12</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>CEE</td>
<td>[–]</td>
<td>[–]</td>
<td>[39]</td>
<td>[18]</td>
<td>[31]</td>
<td>[4]</td>
<td>[3]</td>
<td>[5]</td>
<td>[-]</td>
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</tbody>
</table>
Baseline model mostly ‘steals’ explanatory power from m.e.i., but also from other shocks:

technology goes from small to tiny

<table>
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<tr>
<th>Variance Decomposition of GDP at Business Cycle Frequency (in percent)</th>
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<tr>
<td>-------------------</td>
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<tr>
<td>Baseline model</td>
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<tr>
<td>CEE</td>
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</table>
Why does Risk Crowd out Marginal Efficiency of Investment?

Price of capital

Demand shifters:
- risk shock, $\sigma_t$;

Supply shifter:
- marginal efficiency of investment, $\zeta_{i,t}$

Quantity of capital
• Marginal efficiency of investment shock can account well for the surge in investment and output in the 1990s, as long as the stock market is not included in the analysis.

• When the stock market is included, then explanatory power shifts to financial market shocks.

• When we drop ‘financial data’ – slope of term structure, interest rate spread, stock market, credit growth:
  
  – Hard to differentiate risk shock view from marginal efficiency of investment view.
Figure 6: Dynamic Responses to Two Shocks

A: interest rate spread (Annual Basis Points)

B: credit

C: investment

D: output

E: net worth

F: consumption

G: inflation (APR)

- unanticipated risk shock, $\xi_{0,0}$
- innovation in marginal efficiency of investment, $\zeta_{t}$
Challenge for Intertemporal Shocks

• CKM argue that risk shocks (actually, any intertemporal shock) cannot be important in business cycles.

• Idea: a shock that hurts the intertemporal margin induces substitution away from investment to other margins, such as consumption and leisure.

• CKM argument has some appeal in RBC model.
  – Although, argument fails when marginal utility of consumption increasing in labor.

• Not valid in New Keynesian models.
Closer Look at RBC Mechanism

- In RBC model, jump in risk discourages investment.

- Reduction in investment demand would, unless replaced by other demand, lead to wasteful underutilization of resources.

- RBC model avoids this through drop in current price of goods relative to future price of goods, i.e., real interest rate.

- Real interest rate decline induces surge in demand, partially offsetting drop in investment.

- This mechanism does not necessarily work in NK model because real rate not fully market determined there.

\[
\frac{1 + R_t}{1 + \pi_t} \leftarrow \frac{1 + \pi_t^e}{1 + \pi_{t+1}^e}
\]

Controlled by central bank

Sluggish due to wage/price frictions, anticipated behavior of future monetary policy.
Message #1: rise in C requires a very sharp drop in real rate, something that does not occur under ‘normal monetary policy’
Message #2:
a bigger cut in the interest rate than implied under inflation targeting would be an improvement
Policy

• The discussion of the CKM critique included a policy experiment....

• How should the monetary authority respond to a jump in interest rate spreads?
  – Depends on why the spread jumped.
  – If the jump is because of an increase in risk (uncertainty), then cut policy rate more than simple Taylor rule would dictate.
Conclusion

• Incorporating financial frictions and financial data changes inference about the sources of shocks:
  – risk shock.

• Interesting to explore mechanisms that make risk shock endogenous.

• Models with financial frictions can be used to ask interesting policy questions:
  – When there is an increase in risk spreads, how should monetary policy respond?
Comparison with Bloom (2009)

• Return of entrepreneur $i$ at time $t$:

$$ r_{i,t+1} = \log(1 + R_{t+1}^k) + \log \omega_{it}, \quad \log \omega_{it} \sim \text{Normal with variance}, \sigma_t $$

• Go to CRSP data set, 1985 – 2010

$$ 1 + R_t^k = \frac{1}{N_t} \sum_{i=0}^{N_t} \exp(r_{it}) $$

$$ \hat{\sigma}_t = \left( \frac{1}{N_t} \sum_{i=0}^{N_t} [r_{it} - \log(1 + R_t^k)]^2 \right)^{1/2} $$
Figure 11: CRSP-based Measure of Uncertainty and Risk

- Cross-sectional standard deviation of firm-level CRSP stock returns
- Risk shock

Smoothed estimate of the risk shock