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 with BGG

$K \rightarrow \omega K, \ \omega \sim F(\cdot, \sigma_t)$

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).
Standard Model with BGG

- Firms
  - Labor market
  - Household
  - Entrepreneurs

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

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

Firms

Labor market

household

Entrepreneurs

Risk shock

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

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

Entrepreneurs sell their \( \omega K \) to capital producers

\[ K_{t+1} = (1 - \delta)K_t + G(\zeta_{t,t}, I_t, I_{t-1}) \]
Entrepreneurial net worth now established….

= value of capital + earnings from capital
  - repayment of bank loans
Standard Model with BGG

Entrepreneur receives standard debt contract.

\[ K \to \omega K, \quad \omega \sim F(\cdot, \sigma_t) \]
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.


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

• We assume risk has a first order autoregressive representation:

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

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

• Assume

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

i.d.d., univariate innovation to \( \hat{\sigma}_t \)

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

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

'signals' or 'news'

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

\[ \xi_{t-i} \sim \text{piece of } u_t \text{ observed at time } t - i \]
News on Risk Shocks Versus News on Other Shocks

<table>
<thead>
<tr>
<th>Model</th>
<th>Marginal Likelihood</th>
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<tbody>
<tr>
<td>DSGE Baseline</td>
<td>4493.85</td>
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<tr>
<td>DSGE without Signals</td>
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<td>DSGE with Signals on Monetary Policy and No</td>
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<td>Signals on Risk Shock ($\sigma$)</td>
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<tr>
<td>DSGE with Signals on Technology Shocks and No Signals on Risk Shock</td>
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</table>
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)
  \[ \tilde{K}_{t+1} = (1 - \delta)\tilde{K}_t + G(\zeta_{i,t}, I_t, I_{t-1}) \]
- 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?
Risk shock closely identified with interest rate premium.

Role of the Risk Shock in Macro and Financial Variables:

A. GDP growth (y-o-y %)

B. Equity (log-level)

C. Premium

D. Credit growth (y-o-y %)

E. Slope ($R^\text{Long}_i - R^{\text{short}}_i$)
<table>
<thead>
<tr>
<th>variable</th>
<th>( Risk, \sigma_t )</th>
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<td>GDP</td>
<td>62</td>
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<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>Premium ((Z - R))</td>
<td>95</td>
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<tr>
<td>Equity</td>
<td>69</td>
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<tr>
<td>( R^{10 \text{ year}} - R^{1 \text{ quarter}} )</td>
<td>56</td>
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Note: ‘business cycle frequencies means’ Hodrick-Prescott filtered data.

Risk shock closely identified with interest rate premium.
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)

- Blue line: response to unanticipated risk shock, $\zeta_{0,0}$
- Green line: response to anticipated risk shock, $\zeta_{8,0}$
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>Variance Decomposition of GDP at Business Cycle Frequency (in percent)</th>
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<td>shock</td>
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<td>12</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0</td>
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<tr>
<td>CEE</td>
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<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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Technology goes from small to tiny
Why does Risk Crowd out Marginal Efficiency of Investment?

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

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

Price of capital vs. 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, $\xi_{1}$
Is There Independent Evidence for Risk Shocks?

• Cross-sectional standard deviation of rate of return on equity in CRSP rises in recessions (Bloom, 2009).

• This observation played no role in the construction or estimation of the model.

• Compute the model’s best guess (Kalman Smoother) about the cross-sectional standard deviation of equity returns, and compare with data.
Cross-sectional standard deviation is countercyclical
How well does the model predict these data?
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?