Risk Shocks

Lawrence Christiano (Northwestern University), Roberto Motto (ECB) and Massimo Rostagno (ECB)

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Finding

• Countercyclical fluctuations in the cross-sectional variance of a type of technology shock, when inserted into a widely-used business cycle model, can account for a substantial portion of economic fluctuations.

• Model used in analysis:
  – 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.

• Explanation of the basic results.

• Comparison with Bloom (2009)
  – Evaluation of findings using CRSP stock return data.
The Standard Model includes the following components:

- **Labor market**: A market for labor denoted by $L$.
- **Household**: A component representing household activities, denoted by $L$.
- **Firms**: A central entity mediating transactions, denoted by $K$.
- **Market for Physical Capital**: A market for physical capital, denoted by $K$.

The relationship between these components can be described by the following equation:

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

This equation describes the marginal efficiency of investment shock, indicating how changes in the market for physical capital are influenced by investment decisions and other economic factors.
Standard Model with BGG

Firms

Labor market

household

Entrepreneurs
Standard Model with BGG

Firms

Labor market

household

Entrepreneurs

$L$ → $K$

$\gamma_k$, $\alpha_t$
Standard Model with BGG

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

Examples:
1. Large proportion of firm start-ups end in failure

\[ K \to \omega K, \ \omega \sim F(\cdot, \sigma_t) \]
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2. Even famously successful entrepreneurs (Gates, Jobs) had failures (Traf-O-Data, NeXT computer)
Standard Model with BGG

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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

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

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

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

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

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

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

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

Entrepreneur receives standard debt contract.
Standard Model with BGG

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Entrepreneur receives standard debt contract.
Economic Impact of Risk Shock
Economic Impact of Risk Shock

lognormal distribution:
20 percent jump in standard deviation

density

idosyncratic shock
Economic Impact of Risk Shock

lognormal distribution:
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Larger number of entrepreneurs in left tail problem for lender
Economic Impact of Risk Shock

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Interest rate on loans to entrepreneur increases
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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
Risk Shocks

• We assume risk has a first order autoregressive representation:

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

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

• Standard information assumption:
  – Agents become aware of \( u_t \) when it’s realized.

• We assume that agents receive early information about \( u_t \) (‘news’).
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.
12 Shocks

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- Marginal Efficiency of investment shock (perturbs capital accumulation equation)
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\bar{K}_{t+1} = (1 - \delta)\bar{K}_t + G(\zeta_{i,t}, I_t, I_{t-1})
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- Monetary policy shock.
- Equity shock.
12 Shocks

• Trend stationary and unit root technology shock.

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

• Monetary policy shock.

• Equity shock.

• Risk shock.
12 Shocks

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• Monetary policy shock.

• Equity shock.

• Risk shock.

• 6 other shocks.
Inference

• 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?

• Some Direct Evidence on Risk Shocks.
Figure 5: The Role of the Risk Shock in Selected Variables

a. GDP growth *(year-on-year %)*

Solid line: data when all shocks are fed to model.
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Dashed line: data when only disturbances to risk are fed to model.

a. GDP growth \( (\text{year-on-year \%}) \)
Figure 5: The Role of the Risk Shock in Selected Variables

a. GDP growth *(year-on-year %)*

b. Equity *(log-level)*

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Figure 5: The Role of the Risk Shock in Selected Variables

a. GDP growth (*year-on-year %*)

b. Equity (*log-level*)

c. Credit growth (*year-on-year %*)

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Figure 5: The Role of the Risk Shock in Selected Variables

a. GDP growth (year-on-year %)
b. Equity (log-level)
c. Credit growth (year-on-year %)
d. Credit spread (p.p. per annum)

Solid line: data when all shocks are fed to model.

Dashed line: data when only disturbances to risk are fed to model.
Percent Variance in Business Cycle Frequencies Accounted for by Risk Shock

<table>
<thead>
<tr>
<th>variable</th>
<th>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>Premium ($Z - R$)</td>
<td>95</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

• In the model:
  
  – jump in risk, $\sigma_t$, generates a response that resembles a recession
Looks like a business cycle
Figure 3: Dynamic Responses to Unanticipated and Anticipated Components of Risk Shock

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Looks like a business cycle
Surprising, from RBC perspective

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

Looks like a business cycle
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 ‘normal monetary policy’ would be an improvement.
What Shock Does the Risk Shock Displace, and why?

• The risk shock mainly crowds out the marginal efficiency of investment.
Why does Risk Crowd out Marginal Efficiency of Investment?

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

Price of capital vs. Quantity of capital
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.
Comparison with Bloom (2009)

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

$$r_{i,t+1} = \log(1 + R_{t+1}^k) + \log \omega_{it}, \; \log \omega_{it} \sim \text{Normal with variance, } \sigma_t$$
Comparison with Bloom (2009)

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• Go to CRSP data set, 1985 – 2010
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$$\hat{\sigma}_t = \left( \frac{1}{N_t} \sum_{i=0}^{N_t} [r_{it} - \log(1 + R_t^k)]^2 \right)^{1/2}$$

CRSP measure of uncertainty

$$1 + R_t^k = \frac{1}{N_t} \sum_{i=0}^{N_t} \exp(r_{it})$$
Comparison with Bloom (2009)

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log, idiosyncratic shock
Figure 11: CRSP-based Measure of Uncertainty and Risk

Cross-sectional standard deviation of firm-level CRSP stock returns, as in Bloom (2009)
Figure 11: CRSP-based Measure of Uncertainty and Risk

Smoothed estimate of the risk shock
CRSP Data

- What do they say about the assumed temporal independence of idiosyncratic shocks?
  
  - Data consistent with very small autocorrelation of shocks.
Top panel: distribution of first order autocorrelation of idiosyncratic shocks for 17,757 firms in the data set.
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Bottom panel: what the distribution would be if in fact the autocorrelation is zero in each firm.
Conclusion

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

• Evaluated model by looking at implications for data not in the estimation sample:

  – Measure of loan delinquency rates.
  – Out-of-sample forecasts.
  – Firm-level stock return data in CRSP.