Financial Frictions and Credit Spreads

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Modelling Challenges

• Considerable work underway to incorporate a role for financial frictions
  – the financial crisis highlighted this as a weakness of DSGE models
  – Understood here to represent a cost that gives rise to a spread between borrowing and lending rates. A wedge exists (i.e., due to asymmetric information) between borrowers and savers, and there are intermediation costs financial institutions must absorb
May be representative of theoretical spread in this study.

Taylor & Williams 2009

‘staple’ of many term structure studies.
Selected Spreads: view II

![Graph showing selected spreads from 2003 to 2009](image)

Legend:
- Blue line: 10 year vs 3 months
- Red line: Fed funds vs 3 month
- Green line: Libor-OIS
- Purple line: Prime rate vs M2 yield
Modelling Challenges

• The ‘canonical’ model (Woodford 2003) has been seen as not ideally suited to handling capital market imperfections
  – In general, the weaknesses of the New Keynesian paradigm are well-known (Goodhart 2008, Tovar 2008, Chari et.al. 2009)
  – But...its either the best we have or it may be more fruitful to ‘repair’ it rather than discard it completely
    • Provides a ‘disciplined’ way of thinking about interactions of key macroeconomic variables
Focus of the Study

• Spreads play a central role in the transmissions mechanism
  – Bernanke and Gertler (1989, 1995)
    • The economy is ‘interest sensitive’, that is, there exists a “credit channel”
      – May operate through balance sheets or bank lending behaviour
      – We don’t take a stand on one versus the other although focus is on the latter in this study

• Walsh (2009)“...factors that generate movements in spreads, or the degree to which these movements reflect inefficient fluctuations that call for policy responses” still eludes us
  – In particular why are spreads subject to sharp movements and why can they be so volatile?
  – Do they really matter (in a crisis): NO Chari. et.al. 2008); YES (Cohen-Cole e.al.2008)
Overview of the Approach of the Paper

• Credit frictions model of Curdia & Woodford (2009, 2009a) is starting point
  – NOTE: has changed in its various incarnations
• The model is adapted to the concerns of this study, namely attempting to replicate movements and volatility in spreads
  – Agents are heterogeneous, intermediation is ‘inefficient’ or costly
  – Actual U.S. time series are used for exogenous factors (e.g., TFP shocks, government spending)
  – We try to replicate movements in selected spreads
  – We explore the impact of two types of monetary policies
    • QUANTITATIVE EASING: varying the amount of aggregate reserves to influence the spread between the fed funds rate and the interest rate on reserves (liabilities of the Fed’s balance sheet)
    • CREDIT EASING: debt-financed fiscal policy (asset composition of the Fed’s balance sheet)
MODEL: Households I

- 2 types of households
  - \( b \) more impatient than \( s \)
  - \( b \) borrows, \( s \) saves
  - Remain the same type form one period to the next with prob. \([\delta, 1-\delta]\)
- Borrowing is done ONLY via intermediary
  - One period contracts (riskless) + households can insure against various risks
  - Necessary because
    - 1. heterogeneity of households; 2. credit frictions; 3. risk sharing
    - Represents a ‘key’ source of financial frictions
- Lifetime utility function
  \[
  \sum_{t=0}^{\infty} \beta^t \{ U^{c_t(i)}[c_t(i)] - V^{r_t(i)}[h_t(i)] \}
  \]
- Household \( i \)’s (net) wealth
  \[
  A_t(i) = [B_{t-1}(i)]^d (1 + i^d_{t-1}) + [B_{t-1}(i)]^{-1} (1 + i^b_{t-1}) + D_{t}^{int}(i) + T_t(i)
  \]
  Deposit and borrowing rates (riskless)
- Budget constraint
  \[
  B_t(i) = A_t(i) - P_t c_t(i) + W_t h_t(i) + D_t(i) + T_t^g(i)
  \]
MODEL: Households II

- $B_t(i)$ is the budget constraint
- Lifetime utility is maximized subject to $A_t(i)$ & $B_t(i)$
- Euler equation governs labour supply
  \[ w_t \lambda_t^{\tau_t(i)} = V_h^{\tau_t(i)} [h_t^{\tau_t(i)}] \]
- Optimal consumption for borrower (b), saver (s)
  \[ \lambda_t^b = \beta \frac{1 + i_t^b}{\Pi_{t+1}} \{ [\delta + (1 - \delta)\pi_t^b] \lambda_{t+1}^b + (1 - \delta)\pi_t^s \lambda_{t+1}^s \} \]
  \[ \lambda_t^s = \beta \frac{1 + i_t^s}{\Pi_{t+1}} \{ [1 - \delta] \pi_t^b \lambda_{t+1}^b + [\delta + (1 - \delta)\pi_t^s] \lambda_{t+1}^s \} \]

- Probability of being type $b$ or $s$
- Inflation
MODEL: Financial Intermediaries

- Perfectly competitive
- *Intermediation costs are non-linear (convex function)*
- Interest rates are given, determine supply of loans to maximize profits
- Leads to a functional form that describes spread
- *Intermediation costs create a spread & changes, NOT increased risk*

- ‘Technolog[ies]’
  \[ d_t = b_t + \Phi(b_t) \rightarrow d_t = b_t + \Phi(b_t - \bar{b}) \]

  Real deposit, real credit

- Spread
  \[ 1 + i_t^b = (1 + \omega_t)(1 + i_t^d) \]

- Equilibri[a]n
  \[ \omega_t = \Phi'(b_t) \]

  Benchmark/Modified
MODEL: Firms & Government

• Firms
  – A single good
  – Perfectly competitive price takers
  – Isoelastic production function (subject to a TFP (i.e., productivity) shock [ TFP is exogenous]

• Government
  – Budget is balanced every period [spending and transfers are exogenously given]
MODEL: Monetary Policy

- A ‘Taylor’ type rule
  - Contemporaneous
  - The ‘policy rate’ is the deposit rate
  - CB makes optimal policy projections that asymptotically approaches the s.s. (Svensson & Tetlow 2005)

- Model closed with 2 market clearing conditions

- Policy rule
  \[ i_t^d = \bar{I}^d \left( \frac{\Pi_t}{\bar{\Pi}} \right)^{\gamma_{\pi}} \left( \frac{Y_t}{\bar{Y}} \right)^{\gamma_y}, \quad \gamma_{\pi}, \gamma_y \geq 0 \]

- Goods & labour markets
  \[ Y_t = \pi_b c_t^b + \pi_s c_t^s + G_t + \Phi(b_t) \]
  \[ h_t = \pi_b h_t^b + \pi_s h_t^s \]
Evolution of $b$

- **Aggregate over all borrowers**

\[
\int_{B_t} A_t(i)di = -\delta_{t-1} b_{t-1}(1+i_{t-1}^b) + \pi_b D_t^{\text{int}} + (1-\delta)\pi_b A_t \quad \text{where} \quad A_t = P_{t-1}[d_{t-1}(1+i_{t-1}^d)-b_{t-1}(1+i_{t-1}^b)] + D_t^{\text{int}}
\]

- **Aggregate budget constraints**

\[
P_t b_t = -\int_{B_t} A_t(i)di + \pi_b (P_t c_t^b - W_t h_t^b - D_t - T_t^g)
\]

- **Substitution yields debt dynamics:**

\[
b_t = \pi_b \pi_s [(c_t^b - c_t^s) - w_t (h_t^b - h_t^s)] - \pi_b \Phi(b_t)
\]

\[
\{c_t^b, c_t^s, h_t^b, h_t^s, b_t, \gamma_t, h_t\}
\]

\text{QUANTITIES}

\[
+ \frac{\delta(1+i_{t-1}^d)}{\Pi_t} [b_{t-1} + \pi_b \Phi(b_{t-1}) + \pi_s b_{t-1} \omega_{t-1}]
\]

\{\pi^d, \Pi_t, \omega_t, w_t\}

\text{PRICES}

\[
\{Z_t, g_t, \tau_t\}
\]

\text{EXOGENOUS}
Calibration - Baseline

- $\eta = 51.6$ (Curdia-Woodford)
- $\delta = 0.9$
- $\pi_b = \pi_s = 0.5$
- $\beta / i^d = 4\%$
- $\phi^s = 1$, $\phi^b / h$ for both types the same in s.s.
- $\omega = 2\%$ in s.s.
- Debt/GDP = 80% in s.s.
- $Y, Z = 1$ in s.s.

$U^c(c_t^c) = \frac{\theta^c(c_t^c)^{1-\delta}}{1-\frac{1}{\sigma^c}}$, $\sigma^c > 0$

$V^c(h_t^c) = \frac{\theta^c(h_t^c)^{1+\nu}}{1+\nu}$, $\nu \geq 0$

$\Phi(b_t) = \varphi b_t^\eta$, $\eta > 1$

\begin{table}[h]
\centering
\begin{tabular}{lcc}
\hline
Parameter & Value 1 & Value 2 \\
\hline
$\alpha$ & 0.75 & 0.9512 \\
$\nu$ & 0.1 & 0.25 \\
$\sigma^b$ & 31.0475 & 2.3074 \\
$\sigma^s$ & 1.7088 & 1.2177 \\
$\phi^b$ & 0.5 & 1 \\
$\phi^s$ & 0.5 & 0.3 \\
\hline
\end{tabular}
\caption{List of Parameters}
\end{table}

‘Conventional’ TR coeffs
<table>
<thead>
<tr>
<th>( \eta )</th>
<th>8</th>
<th>16.6</th>
<th>21.6</th>
<th>24</th>
<th>31.6</th>
<th>36.6</th>
<th>41.6</th>
<th>46.6</th>
<th>51.6</th>
<th>56.6</th>
<th>61.6</th>
<th>66.6</th>
<th>71.6</th>
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</thead>
<tbody>
<tr>
<td>( \phi )</td>
<td>0.0119</td>
<td>0.0391</td>
<td>0.0918</td>
<td>0.1412</td>
<td>0.5845</td>
<td>1.5401</td>
<td>4.1351</td>
<td>11.2652</td>
<td>\textbf{31.0475}</td>
<td>86.3794</td>
<td>242.2122</td>
<td>683.6796</td>
<td>1940.7</td>
</tr>
<tr>
<td>( \phi_b )</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>\textbf{1.2177}</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
<td>1.2177</td>
</tr>
<tr>
<td>( \theta_b )</td>
<td>2.307</td>
<td>2.3072</td>
<td>2.3073</td>
<td>2.3073</td>
<td>2.3073</td>
<td>2.3073</td>
<td>2.3073</td>
<td>2.3073</td>
<td>\textbf{2.3074}</td>
<td>2.3074</td>
<td>2.3074</td>
<td>2.3074</td>
<td>2.3074</td>
</tr>
<tr>
<td>( \theta_s )</td>
<td>1.7071</td>
<td>1.7081</td>
<td>1.7083</td>
<td>1.7084</td>
<td>1.7086</td>
<td>1.7086</td>
<td>1.7087</td>
<td>1.7087</td>
<td>\textbf{1.7088}</td>
<td>1.7088</td>
<td>1.7088</td>
<td>1.7088</td>
<td>1.7088</td>
</tr>
<tr>
<td>( \beta )</td>
<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
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<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
<td>0.9512</td>
</tr>
</tbody>
</table>
\{Z_t, g_t, \tau_t \}
Results

• Solution is numerical to non-linear equations
  – Allow 200 periods [years] to converge (happens much faster
  – Implies 1600 equations
• What TFP?
• Role of exogenous ‘drivers’
• Simulated spreads: what they look like
• Model assessment: a bird’s eye view
• Impact of ‘unconventional’ monetary policies
Which TFP?
The role of Specific Shocks I

Figure 4: Benchmark Model with Only TFP

Figure 5: Benchmark Model with All Except TFP
The Role of Specific Shocks II

Figure 6: Benchmark Model with Only $g$

Figure 7: Benchmark Model with Only $\tau$
Simulation I: Benchmark

Long-term Govt bond less 3 month Tbill

![Graph showing simulated and actual data over time]

- Simulated
- Actual
## Simple test I

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>Std error</th>
<th>Z-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-.004</td>
<td>.005</td>
<td>-.83</td>
<td>.41</td>
</tr>
<tr>
<td>omega</td>
<td>.94</td>
<td>.24</td>
<td>3.95</td>
<td>.00</td>
</tr>
</tbody>
</table>

\[ \text{Eta} = 51.6 \]
Simple test Ia

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>Std error</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>.001</td>
<td>.002</td>
<td>9.06</td>
<td>.00</td>
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<tr>
<td>omega</td>
<td>.57</td>
<td>.27</td>
<td>2.07</td>
<td>.04</td>
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</tbody>
</table>

Eta = 2
Simulation II: Benchmark

3 month less fed funds rate

Simulated
Actual
## Simple test II

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Error</th>
<th>t-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.013</td>
<td>0.013</td>
<td>-4.26</td>
<td>0.00</td>
</tr>
<tr>
<td>Omega</td>
<td>0.43</td>
<td>0.15</td>
<td>2.80</td>
<td>0.01</td>
</tr>
</tbody>
</table>

$\text{Eta} = 51.6$
Simulation III: Benchmark

Prime rate less M2 yield

Simulated Actual
Simple Test III

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff</th>
<th>Std error</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>.06</td>
<td>.01</td>
<td>12.15</td>
<td>.00</td>
</tr>
<tr>
<td>Omega</td>
<td>-1.24</td>
<td>.26</td>
<td>-4.73</td>
<td>.00</td>
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</table>

Etta = 51.6
Simulations vs Facts I

<table>
<thead>
<tr>
<th>Standard Dev of Inflation</th>
<th>ACF (1)</th>
<th>H-P filtered PCE inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen TFP = .0099</td>
<td>.28</td>
<td>.34</td>
</tr>
<tr>
<td>FM TFP = .006</td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>FMLP = .0058</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>FMU = .0059</td>
<td>.30</td>
<td></td>
</tr>
</tbody>
</table>
## Simulations vs Facts II

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Omega (bench) eta=2</th>
<th>Omega (bench) eta = 51.6</th>
<th>Omega (10 yr LESS 3 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>.00</td>
<td>.02</td>
<td>.02 ('03-'09)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.014 ('34-'09)</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.0159</td>
<td>.0150</td>
<td>.013</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.019</td>
</tr>
<tr>
<td>AC (1)</td>
<td>.22</td>
<td>.29</td>
<td>.22*</td>
</tr>
<tr>
<td>AC (2)</td>
<td>-.25</td>
<td>-.23</td>
<td>-.14</td>
</tr>
<tr>
<td>AC (3)</td>
<td>-.37</td>
<td>-.41</td>
<td>.06</td>
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<tr>
<td>AC (4)</td>
<td>-.34</td>
<td>-.35</td>
<td>.14</td>
</tr>
<tr>
<td>AC (5)</td>
<td>.15</td>
<td>.10</td>
<td>-.03</td>
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</tbody>
</table>

* 1st difference
Varieties of Omegas

Benchmarks cases vs Modified cases

OMEGA (benchmark) eta = 2
OMEGA (benchmark) eta = 51.6
OMEGA (modified) eta = 2
OMEGA (modified) eta = 51.6
Debt Dynamics

steady state = 0.8
Convexity

steady state = 0.8

- \( b \) (modified) \( \eta = 2 \)
- \( b \) (modified) \( \eta = 51.6 \)
- \( b \) (benchmark) \( \eta = 51.6 \)
Inflation

Steady state = 1
Comparing Inflation

PCE inflation
Simulated inflation (eta=51.6), TFP from Chen
# Sources of Changes in the Spread

<table>
<thead>
<tr>
<th>Source</th>
<th>( \omega^{\eta=51.6} )</th>
<th>( \omega^{\eta=51.6} \mid \omega_j )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \omega_g )</td>
<td>-0.06 (.70)</td>
<td>( \omega_g, \omega_{TFP} ) -0.26 (.08) 0.60 (.00)</td>
</tr>
<tr>
<td>( \omega_t )</td>
<td>0.81 (.00)</td>
<td>( \omega_g, \omega_t ) -0.05 (.73) 0.96 (.00)</td>
</tr>
<tr>
<td>( \omega_{TFP} )</td>
<td>0.88 (.00)</td>
<td>( \omega_{TFP}, \omega_t ) 0.46 (.00) 0.98 (.00)</td>
</tr>
</tbody>
</table>

\[
\omega^{\eta=51.6} = 0.02 \ (0.00) + 1.16 \ (0.39) * \omega_t + 1.46 \ (0.87) * \omega_g + 0.89 \ (0.21) * \omega_{TFP}
\]

* = 1%, + = 10%

p-values in parenthesis
‘Unconventional’ Monetary Policies

• Credit easing
  – Central bank does NOT incur the same intermediation costs (passed on in the GVT budget)

• Quantitative easing
  – An increase in the monetary base (i.e., bank reserves)

• For C.E. add a new element to $b$
  $$b_t = L_t + L_t^{cb}$$
  Zero in s.s.

• Profit max as before but s.t.
  $$s.t. \quad d_t = L_t + \Phi(L_t)$$

• Where
  $$\Phi(L_t) = \varphi L_t^n$$

• For Q.E. Augment intermediation
  $$R_t^{cb} + d_t = b_t + \Phi(b_t)$$
Dynamics of Unconventional MP

• Credit Easing

\[ b_t = \pi_b \pi_s [(c_t^b - c_t^s) - w_t (h_t^b - h_t^s)] - \pi_b \Phi(b_t - L_t^{cb}) \]
\[ + \frac{\delta(1 + i_t^{cb})}{\Pi_t} [b_{t-1} + \pi_b \Phi(b_{t-1} L_t^{cb}) + \pi_s b_t \omega_{t-1}] \]
\[ + \frac{\pi_b (1 + i_t^{cb}) L_t^{cb}}{\Pi_t} (\omega_{t-1} + 1 - \delta) \]

• Quantitative Easing

\[ b_t = \pi_b \pi_s [(c_t^b - c_t^s) - w_t (h_t^b - h_t^s)] - \pi_b \Phi(b_t) \]
\[ + \frac{\delta(1 + i_t^{cb})}{\Pi_t} [b_{t-1} + \pi_b \Phi(b_{t-1}) + \pi_s b_t \omega_{t-1} - \pi_b R_{t-1}^{cb}] \]
IRFs: CE vs QE

CE: 1% increase CB s.s. credit, $L^{cb} = 0.01\bar{b}$

QE: 1% of s.s. Credit $R^{cb} = 0.01\bar{b}$
Accum. IRFs: CE vs QE

$R^b = 0.01b$
What’s next?

• Simulations
  – Change inflation target
  – Relax perfect substitutability of government debt & deposits
  – Relax the ‘costless’ CE easing policy assumption
  – Consider other kinds of ‘financial shocks’

• Empirical
  – Many ways to proceed but...
Conclusions

• A highly level of convexity is needed to match sharp movements and volatility in the spread
  – a less non-linear intermediation costs function would lead to conditions as in the Great Moderation
  – A challenge is to link this type of phenomenon to how intermediation costs are actually determined
• Credit easing when its a ‘free lunch’ to the CB can reduce the spread
• QE is less effective and actually leads to a rise in the spread. This appears to describe the early days of the crisis in the fall of 2007