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How does shadow banking wealth management product affect bank performance under government capital injection?

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1. Introduction

Background:

* Why the shadow banking activities involved by banks?

- The ratio of shadow banking to commercial banks' total financial assets was rising from approximately 52% in 1990s to 200% in 2007. (Panetti, 2014)
- The collapse of shadow banking in 2007 to 2008 played a critical role in undermining the regulated banking sector, and in bringing about the financial crisis (Gennaioli et al. 2013).
- Offer rate of return well above regulated deposit interest rate and are often used to fund investments in sectors where bank credit is restricted (Plantin, 2015).
• Financial institutions received a government aggregate infusion of $125 billion on October 14, 2008 (Bayazitova and Shivdasani, 2012).

• Capital enhances a bank’s survival probability (Allen et al, 2011).

• A growing body of literature examines capital affecting bank performance during a financial crisis. Our study focuses on one related issue: bank efficiency gain/loss from shadow banking activities and bankruptcy prediction under government capital injections.
There are at least two reasons where a thorough understanding of WMPs is essential.

- Actively managed by banks, a part of the shadow banking system in China, few are recorded on banks’ balance sheets.
- Issuance of Chinese WMPs has grown rapidly in recent years, around 17-19%. It does represent a part of the shadow bank activities that have been particularly important at some point in time (Perry and Weltewitz, 2015).
Bank performance

Two key issues that concern bank managers:

• **Bank interest margin**, as a proxy for the **efficiency** (Saunders and Schumacher, 2000).

• **Bank survival** related to **default risk** is central for banks and regulators in banking stability (Berger and Bouwman, 2013)
Purpose of the paper

We develop a contingent claim model to examine how shadow banking wealth management products (WMPs) affect a bank’s performance (efficiency, default risk) under government capital injection.
Contributions to the literature

• 1) the growing literature linking bank interest margin and WMPs, particularly a deeper justification about the collapse of shadow banking in 2007 to 2008.

• 2) an alternative explanation of deteriorating bank interest margins by focusing on WMPs.

• 3) an alternative explanation of the viewpoint from Pozsar et al., 2013.

  (the link between the regular banking and the shadow banking may create higher contagion and systemic risks, which in turn may affect banking stability.)
Framework of paper

- Section 1: introduction
- Section 2: literature review
- Section 3: basic structure of the proposed model
- Section 4: derives model solution and comparative static analysis
- Section 5: numerical analysis
- Section 6: conclusion
2. Related literature: three related strands

• 1) regular banks with shadow banking activities:

  # Pozsar et al. (2013): features of shadow banks, economic roles, relation to traditional banks.
  # Jeffers and Baicu (2013): interconnections between affect the stability of the financial system.
  # Li and Lin (2016): bank interest margin management when the bank conducts regular
    lending and shadow-banking entrusted lending activities under capital regulation.

  **Our focus**: bank interest margin management aspects of shadow-banking WMPs
2. Related literature: three related strands

- 2) interest margin:
  - #Wong (1997): is positively related to the bank’s market power, credit risk, and interest rate risk.
  - #While Williams (2007): negative relationship between credit risk and bank interest margin.
  - #Hawtrey and Liang (2008): negative impact of managerial efficiency on bank interest margins.
  - #Ewijk (2012): an explanation for the decline in bank interest margins in many developed countries.
  - **Our focus:** effects of shadow banking activities on bank interest margin under government capital injection that these papers are silent on.
2. Related literature: three related strands

- 3) government capital injection:
  - #Bayazitova and Shivdasani (2012): less stable funding mixes more likely receive government capital infusions.
  - # Chang and Chen (2016): interactions between government capital injections and credit risk transfers.
  - # Chen and Lin (2016): impacts on bank interest margin, bank default risk, and borrower default risk from government’s capital injection.
  - **Our focus:** commingling of regular banking with shadow banking under government capital injection, and in particular, the emphasis we put on the interconnections between the two systems in the context of bank interest margin management.
3. Model framework

Our model proceeds in the following main assumptions to capture all the real-life dimensions of bank valuation and regulation:

• Except the loan market faced by the bank, perfectly competitive markets are assumed for all financial assets.

• Financial markets are assumed to be complete.

• Investors and regulators are risk-neutral.

• The Federal Deposit Insurance Corporation (FDIC) plays both the roles of insurer and receiver for administering and resolving failing banks.

• We only focus on direct government capital injection.
3. Model framework

- a. Equity valuation
- b. Efficiency gain from shadow banking
- c. Default risk
3.1 Equity valuation

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Simplified balance-sheet and shadow banking activities at $t = 0$.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>Liabilities</td>
</tr>
<tr>
<td>Balance-sheet activities:</td>
<td></td>
</tr>
<tr>
<td>Loan</td>
<td>$L$</td>
</tr>
<tr>
<td>liquid asset</td>
<td>$B$</td>
</tr>
<tr>
<td>Shadow banking activities:</td>
<td></td>
</tr>
<tr>
<td>risky asset</td>
<td>$\alpha W$</td>
</tr>
<tr>
<td>liquid asset</td>
<td>$(1 - \alpha)W$</td>
</tr>
<tr>
<td>Notes: $\theta &gt; 0$, and $0 &lt; \alpha &lt; 1.$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>product</td>
</tr>
</tbody>
</table>
3.1 Equity valuation

Consider a bank that makes decisions in a single period horizon with two dates, 0 and 1, the bank, at has the following balance sheet:

\[ L + B = D + K + \theta K \]  

where

- \( L \): risky loans
- \( B \): liquid assets
- \( D \): deposits
- \( R \): government capital injections
- \( K \): capital
- \( \theta \): parameter

(1)
3.1 Equity valuation

- The bank’s loans mature at $t = 1$.
- Equity capital with government capital injections $(1 + \theta) \text{held by the bank is tied by regulation to be fixed proportion of its deposits}$ $(l + \theta) K \geq D$ (Wong, 1997).

  when the capital constraints binding, Eq.(1) can be expressed as

$L + B = (1 + \theta)K (1/Q + 1)$

In addition to balance-sheet activities, at $t = \theta$, the bank also holds an amount of WMPs $W > 0$. 
3.1 Equity valuation

\[(1+\theta)K = L + B + \alpha W + (1-\alpha) W - D - W\]  \hspace{1cm} (2)

\[L = L(R_L)\]

where

\[W \text{ WMPs} \hspace{1cm} \alpha \text{ risky assets in WMPs} \hspace{1cm} \theta \text{ loan rate chosen by bank}\]

This paper takes a path-dependent barrier option approach to the market valuation of equity in a bank.

The default can occur at any time before the maturity date. Bank equity can be priced as a down-and-out call (DOC) option.

When the value of the bank’s assets is less than the strike price, the value of the bank’s equity is zero.
3.1 Equity valuation

The market value of the bank’s underlying assets follows a geometric Brownian motion of the form:

\[ dV = \mu V dt + \sigma V dM \]  \hspace{1cm} (3)

where

\[ V = (1 + R_L) L + \alpha (1 + R_w) W \]

\( V \): the value of the asset portfolio

\( R_L \): constant market rate of WMPs

\( R_w \): constant market rate of WMPs return
3.1 Equity valuation

The market value of the bank’s equity $S$:

$$S = SC - DIC$$

(4)

where

$SC = VN(d_1) - Ze^{-\delta} N(d_2)$, as the market value of the bank’s assets and present value of the net-obligation payments using the standard call option view of the bank.

$DIC = V(H/V)^{2n} N(a_1) - Ze^{-\delta} (H/V)^{2n-2} N(a_2)$, down-and-in call activated only if the barrier is breached.

$H = \beta Z$ : the knock-out value of the bank. $\beta$ is the barrier-to-debt ratio, and $N(\cdot)$ is the standard normal cumulative distribution function.
3.2 Efficiency gain from shadow banking activities

- variance of the bank return (Ronn and Verma 1986):

\[ \sigma_S = \frac{\partial S}{\partial V} = \sigma \]

(5)

- efficiency gain from WMPs can be measured by the differential (Ergungor, 2005):

\[ \Delta RV = RW(WW) - RV(OW) \]

(6)

where

\[ RV(WW) = \frac{S(W > 0)}{\sigma_S(W > 0)} \]

\[ RV(OW) = \frac{S(W = 0)}{\sigma_S(W = 0)} \]

\( \Delta RV > 0 \) can be explained as efficiency gain from involving the shadow banking activities, whereas \( \Delta RV < 0 \) can be explained as deficiency.
3. 3 Default risk

- The framework offers a very useful measure for predicting bankruptcy.
- Probability of default (risk-neutral):

\[ P_S = N(h_1) + e^{h_2}(1 - N(h_3)) \] (7)

where

\[ h_1 = \frac{1}{\sigma} (\ln \frac{\beta Z}{V} - \delta + \frac{\sigma^2}{2}) \]
\[ h_2 = \frac{2}{\sigma^2} (\delta - \frac{\sigma^2}{2}) \ln \frac{\beta Z}{V} \]
\[ h_3 = -\frac{1}{\sigma} (\ln \frac{\beta Z}{V} + \delta - \frac{\sigma^2}{2}) \]
3. 3 Default risk

- It is important to note that we use our measure of default risk to examine the relation between default risk and equity returns rather than price.
4. Solution and result

The first-order condition for the equity maximization are:

\[
\frac{\partial S}{\partial R_L} = \frac{\partial SC}{\partial R_L} - \frac{\partial DIC}{\partial R_L} = 0 \tag{8}
\]

Eq. (8) determines the optimal loan rate, thus the optimal bank interest margin, proxy efficiency of the banking intermediation.
4.1 Increases in **risky investment** from WMPs funding:

\[
\frac{\partial R_L}{\partial \alpha} = - \frac{\partial^2 S}{\partial R_L \partial \alpha} / \frac{\partial^2 S}{\partial R_L^2}
\]

(9)

\[
\frac{dP_s}{d\alpha} = \frac{\partial P_s}{\partial \alpha} + \frac{\partial P_s}{\partial R_L} \frac{\partial R_L}{\partial \alpha}
\]

(10)
4.2 Increases in WMPs

\[
\frac{\partial R_L}{\partial W} = -\frac{\partial^2 S}{\partial R_L \partial W} / \frac{\partial^2 S}{\partial R_L^2}
\] (11)

\[
\frac{\partial \Delta RV}{\partial W} = \frac{\partial \Delta RV}{\partial W} + \frac{\partial \Delta RV}{\partial R_L} \frac{\partial R_L}{\partial W}
\] (12)

\[
\frac{\partial P_S}{\partial W} = \frac{\partial P_S}{\partial W} + \frac{\partial P_S}{\partial R_L} \frac{\partial R_L}{\partial W}
\] (13)
4.3 Increases in government **capital injection**

\[ \frac{\partial R_L}{\partial \theta} = - \frac{\partial^2 S}{\partial R_L \partial \theta} / \partial R_L^2 \]  

(14)

\[ \frac{\partial P_S}{\partial \theta} = \frac{\partial P_S}{\partial \theta} + \frac{\partial P}{\partial R_L} \frac{\partial R_L}{\partial \theta} \]  

(15)
5. Numerical results

Result 1. An increase in bank investment funded by the shadow banking WMPs leads to increase bank loan portfolio at a reduced margin.

![Table 2: Responsiveness of bank interest margin to allocated coefficient.](image)
Result 2. An increase in the bank investment funded by the shadow banking WMPs increases the default risk in the bank’s equity returns.
Table 4
Responsiveness of bank interest margin to WMPs.

<table>
<thead>
<tr>
<th>$W$</th>
<th>$(R, %)$</th>
<th>4.50, 200</th>
<th>4.60, 199</th>
<th>4.70, 197</th>
<th>4.80, 194</th>
<th>4.90, 190</th>
<th>5.00, 185</th>
<th>5.10, 179</th>
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<tbody>
<tr>
<td></td>
<td>$(L, %)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>30</td>
<td>38.0025</td>
<td>38.0140</td>
<td>37.8954</td>
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<td>37.7256</td>
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<td>37.7432</td>
<td>37.2251</td>
<td>36.5722</td>
<td></td>
</tr>
</tbody>
</table>

Result 3. Increases in WMPs decrease the bank interest margin.
Result 4. Increases in WMPs increase the bank’s efficiency gain from shadow banking involvement.
Result 5. Increases in WMPs increase the default risk in the bank’s equity returns.
Result 6. Increases in the capital injection by the government increase the bank interest margin, and decrease the default risk in the bank’s equity returns.
Results 7. Higher government capital injection has a significant effect on a bank’s survival likelihood in particular during a financial crisis.
6. Conclusions

- 1) Increases in WMPs increase bank loan portfolio at a reduced interest margin. WMPs hurt the bank to decrease its probability of survival.

- 2) Increases in the government’s capital injection decrease bank loan portfolio at an increased margin. Government capital injection helps the bank to increase its probability of survival particularly during a severely financial crisis.

- 3) We suggest that shadow credit intermediation should be regulated.

- 4) Our suggestion contributes to the growing literature on explaining the collapse of shadow banking in 2007 to 2008.

- 5) Several results are derived that should be of interest to investors, analysts, and policy makers.