The views expressed are those of the authors and not of the Bank of Canada, the Federal Reserve Bank of Minneapolis or the Federal Reserve System.
Motivation

- Regulatory discussions during the financial crisis:
  - insufficient capitalization of banks;
  - bank dividend payouts (Acharya, Gujral, Kulkarni and Shin 2011);

- Basel III capital regulations include:
  - Capital conservation buffer (2.5%) + min. capital requirement (4.5%).
  - Distribution of earnings will be restricted if the buffer is drawn down.
Objective and Issues with Existing Macro-Banking Models

- Our goal: Analysis of macroeconomic implications of minimum capital requirement and conservation buffer in Basel III.

- To do so, we need a model environment whereby over-payment of dividends and executive bonuses naturally arise.

- Existing macro-banking models typically have
  - no outside equity issuance, and/or
  - manager’s incentive perfectly aligned with shareholders’ interests.

- For today, focus on analyzing an equilibrium without capital regulations to discuss why they may be necessary.
Our Paper

- A macro-banking model featuring a manager who controls the bank and:
  1. issues outside equity and dividends (time inconsistency problem);
  2. is impatient; and
  3. faces moral hazard through limited liability.

- These elements allow us to analyze capitalization and risk taking of banks simultaneously.
Main Results

- Under-capitalization due to time-inconsistency problem. Time inconsistency problems exist because of:
  - Reoptimization of dividend payment, and
  - Dilution of existing equities.

- Excessive leverage by banks due to moral hazard.

- Need for both capital conservation buffer and minimum capital requirement.
Bank Manager’s Problem with Implicit Loans

- Time-inconsistency issue
  
  \[ V(n) = \max_{\{c,z,y,e,m\}} \{ u(c) + \chi V(f(y)) \} \]

  subject to
  
  \[ c + z + y = n + \alpha m \]
  
  \[ m = e \beta \Omega(f(y)) \].

- In equilibrium,
  
  \[ \Omega(n) = z(n) + \beta [1 - e(n)] \Omega(f(y(n))) \].

- Bonus incentive
  
  \[ c \leq \psi z \]

- Anti-dilution protection
  
  \[ e \leq \frac{m}{(n - \gamma c - z) + m} \]
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Markov Perfect Equilibrium

**Generalized Euler Equation:**

\[ u_c = \frac{\chi (1 - \alpha) f_y}{1 + \alpha \beta \gamma \psi f_y z'_n - \alpha \beta f_y} u'_c. \]

- Knowing that tomorrow’s manager will have his own interests, today’s manager takes it into account through \( z'_n \equiv \frac{\partial z'}{\partial n'} \).

- GEE collapses to a usual Euler equation when \( \alpha = 0 \): \( u_c = \chi f_y u'_c \).

- The manager considers the “cost” of increasing \( y \) through

\[ \Omega (f (y)) = -\psi \gamma z (f (y)) + f (y). \]
Under-Capitalization in MPE (Steady State)

- Markov Perfect Equilibrium:

\[ f^\text{ME}_y = \frac{1}{\chi (1 - \alpha) + \alpha \beta (-\gamma \psi z'_n + 1)} \]

- Commitment Equilibrium:

\[ f^\text{CM}_y = \frac{1}{\chi (1 - \alpha) + \alpha \beta} \]

- Social Planner

\[ f^\text{SP}_y = \frac{1}{\beta} \]

- Insufficient capitalization if \( z'_n > 0 \).

\[ y^\text{SP} > y^\text{CM} > y^\text{ME} \]
Numerical Results (Steady State)

- Functional forms: \( u(c) = \log(c) \), \( f(y) = y^\nu \).
- Parameter values:

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \beta )</th>
<th>( \gamma )</th>
<th>( \chi )</th>
<th>( \psi )</th>
<th>( \nu )</th>
</tr>
</thead>
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<td>0.98</td>
<td>0.99</td>
<td>0.5</td>
<td>0.9</td>
<td>1.0</td>
<td>0.9</td>
</tr>
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</table>

- Results: \( z'_n = 0.036 > 0 \). Thus, \( y^{CM} > y^{ME} \).

| Commitment Equilibrium vs Markov Perfect Equilibrium |
|---|---|---|---|---|---|
| \( y \) | \( z \) | \( \Omega \) | \( z/\Omega \) | \( m/\Omega \) |
| Commitment | 0.31 | 0.035 | 0.33 | 0.10 | 0.09 |
| Markov Perfect | 0.26 | 0.034 | 0.28 | 0.12 | 0.11 |
Model with Loan, Deposit and Default

\[
V(n; \Omega) = \max_{\{c, z, y, \ell, d, e, m\}} \left\{ u(c) + \chi \int_{\eta^*(d, y)} V(F(d, y, \eta') ; \Omega) G(d\eta') + \chi V G(\eta^*(d, y)) \right\}
\]

subject to

\[
c + z + y = n + \alpha m
\]

Budget Constraint

\[
\ell = d + y
\]

Balance Sheet

\[
m = e \beta \int_{\eta^*(d, y)} \Omega(F(\ell, y, \eta')) dG(\eta')
\]

Equity Issuance

\[
c \leq \psi z
\]

Compensation Constraint

\[
e = \frac{m}{(n - \gamma c - z) + m}
\]

Dilution Constraint

\[
F(d, y, \eta') = R(d + y)^{1-\nu} \eta' - \left[ R_d + h(d) \right] \cdot d
\]

Loan Return

\[
\eta^*(d, y) \text{ given by } F(d, y, \eta' = \eta^*) = 0
\]

Default Threshold
The model simplifies to...

\[ V(n) = \max_{z,y} \left\{ u(\psi z) + \chi \int_{\eta^* (\hat{d}(z,y,n), y)} V \left( F \left( \hat{d}(z,y,n), y, \eta' \right) \right) G(d\eta') \right. \]
\[ + \left. \chi \int_{\eta^* (\hat{d}(z,y,n), y)} V \left( \eta^* (\hat{d}(z,y,n), y) \right) \right\} \]

- Deposit, \( \hat{d} \), is determined through the bud. const. given \((z,y,n)\):

\[ [1 + \psi - \alpha (1 + \gamma \psi)] z + y = (1 - \alpha) n + \alpha \beta \int_{\eta^* (\hat{d}, y)} F \left( \hat{d}, y, \eta' \right) G \left( d\eta' \right) \]
\[ - \alpha \beta \gamma \psi \int_{\eta^* (\hat{d}, y)} z \left( F \left( \hat{d}, y, \eta' \right) \right) G \left( d\eta' \right) \]
Optimality conditions

\[ [z] \]

\[ \psi u_c + \chi \left[ \int_{\eta_* (\hat{d}, y)} V'_n F_d G (d \eta') + [V - V(0)] G (\eta_*) \eta_* d \right] \hat{d}_z = 0 \]

\[ [y] \]

\[ \int_{\eta_* (\hat{d}, y)} V'_n \left( F_d \hat{d}_y + F_y \right) G (d \eta') + [V - V(0)] G (\eta_*) \left[ \eta_* d \hat{d}_y + \eta_* y \right] = 0 \]

[envelope]

\[ V_n (n) = \chi \left[ \int_{\eta_* (\hat{d}, y)} V'_n F_d G (d \eta') + [V - V(0)] G (\eta_*) \eta_* d \right] \hat{d}_n \]
Generalized Euler Equations

\[ y \]
\[
\psi u_c \frac{\hat{d}_y}{\hat{d}_z} = \chi \int_{\eta^*_*(d,y)} \frac{\psi (1 - \alpha)}{1 + \psi - \alpha (1 + \gamma \psi)} u'_c F_y G(d\eta') - \chi [V - V(0)] G(\eta^*_*) \eta^*_{*y} 
\]

\[ z \]
\[
\psi u_c = \chi \left[ - \int_{\eta^*_*(d,y)} V'_n F_d G(d\eta') + [V(0) - V] G(\eta^*_*) \eta^*_{*d} \right] \hat{d}_z 
\]
\[ 0 = \psi \, u_c \cdot \frac{1}{1+\psi-\alpha(1+\gamma \psi)} \{ \]

\[ -1 \]

\[ + \alpha \beta \int_{\eta_*}(d, y) (1 - \gamma \psi z_n') F_y G(d \eta') \]

\[ + \alpha \beta \gamma \psi z(0) G(\eta_*) \eta_{*y} \} \]

\[ + \chi \int_{\eta_*}(d, y) \frac{\psi(1-\alpha)}{1+\psi-\alpha(1+\gamma \psi)} u_c' F_y G(d \eta') \]

\[ + \chi [ V(0) - \underline{V} ] G(\eta_*) \eta_{*y} \]

- direct loss in consumption from \( y \uparrow \)
- gain in equity valuation from more loans
- gain in equity valuation from lower default
- gain in future (consumption) from more loans
- gain in continuation value from lower default
Two State Example

Suppose $\eta' \in \{0, 1\}$ and $h = \kappa \cdot (\ell - y)$. Let $p_1 = \Pr(\eta' = 1)$.

Long-surviving bankers’ leverage and capital can be ordered as

\[
\text{leverage}^{ME} > \text{leverage}^{CM} > \text{leverage}^{SP},
\]

\[
y^{ME} < y^{CM} < y^{SP}.
\]
Proof (Step 1)

- Compare a Markovian manager and a committed manager.

- Regardless of com. tech., \( \ell(y) \) is the same under moral hazard.

\[
D\ell F(\ell(y), y, 1) = 0.
\]

- DRS implies \( d\ell(y)/dy < 1 \) and leverage is decreasing in \( y \).

- Again, \( y^{ME} < y^{CM} \) due to time inconsistency. Hence,

\[\text{leverage}^{ME} > \text{leverage}^{CM}.\]
Proof (Step 2)

- Compare a committed banker and the social planner.

- Only the banker is protected by limited liability.

- Solutions to $d$ and $\ell$ satisfy $d^{CM} > d^{SP}$ and $\ell^{CM} < \ell^{SP}$:

$$d^{CM} = \frac{p_1^{-1} [\chi (1 - \alpha) + \alpha \beta]^{-1} - R_d}{2\kappa} > \frac{\beta^{-1} - R_d}{2\kappa} = d^{SP},$$

$$\ell^{CM} = \left[ [\chi (1 - \alpha) + \alpha \beta] p_1 (1 - \gamma) R \right]^{1/\gamma} < \left[ \beta p_1 (1 - \gamma) R \right]^{1/\gamma} = \ell^{SP}$$

- This implies that $y^{CM} < y^{SP}$. As a result,

$$\text{leverage}^{CM} > \text{leverage}^{SP},$$
Conclusion

- Time inconsistency problem regarding outside equity issuance leads bankers to pay excessive dividends and accumulate insufficient capital.

- Moral hazard problem leads to too much borrowing and thus excessive leverage of banks.

- Minimum capital requirement alone may not be adequate to promote capital accumulation. Capital conservation buffer may be an effective policy instrument.

What’s next?

- Global solution (non-steady-state analysis).
- Quantitative analysis of capital regulations.
- Markovian evolution of banking industry.
- Aggregate shocks.
- General equilibrium.
Equity Issuance by Banks in Canada

Big 6 Common Share Issuance and Redemption

- Issuance
- Redemption
- Net Issuance
Dividend Payout by Banks in Canada

Big 6 Bank Common Share Dividend-to-Book Value Ratio

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Financial Institution Dynamics and Capital Regulations