Economics of Regulation:
Credit Rationing and Excess Liquidity

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# Table of Contents

1. Introduction
2. Model
3. Pictorial brief
4. Empirical results
5. Future Research
Main contents - Liquidity

- Liquid asset and liquidity: ambiguity between the precautionary level and the excessive one,
- Compound lotteries: equivalent simple lotteries, (1) consisting of the constituent simple lotteries (2) on the one hand, and a single simple lottery whose probabilities are given by (3) on the other hand,
- Credit rationing: An excess demand for commercial loans at the ruling commercial loan rate (Jaffee-Modigliani, 1969).

3 stages: Liquid asset, liquidity, credit rationing
Main contents - Credit rationing

- Aggregation problem in equilibrium credit rationing modelling - Some credit rationing (credit rationed or sufficient funding) is mixed in a sense of funding level. Nash eq. in no credit rationing (first-best optimum investment) and low investment (first-best case for everybody) (Piketty, 1997; Geanakoplos, 2014; Stiglitz-Weiss, 1981),

- Some credit rationing (credit rationed or sufficient funding) done by individuals and commercial banks in the same problem.

How we can insert the problem of individuals to one of commercial banks as a regulator?
Table of Contents

1. Introduction

2. Model
   - An individual’s problem
   - Necessary condition for credit rationing
   - A commercial bank’s problem
   - Excess liquidity
   - Compound concern in Credit rationing
   - Incomplete structural representation
   - Comparing different lotteries

3. Pictorial brief

4. Empirical results
An individual’s problem

If the individual borrows the amount $B$, and the interest is $\hat{r}$, then we say the individual defaults on his loan if the return $R$ plus the collateral $C$ is insufficient to pay back the promised amount,

$$C + R \leq B(1 + \hat{r})$$  \hspace{1cm} (1)

Claim that consumption and investment don’t stand in parallel. If the agent consume more, his utility increases. However, if the agent invest more, the satisfaction is not directly analogous to uncertain return on investment.
We assume that agents consider initial investment $I$ satisfies fixed investment scale $Z_1 > I > Z_0 > 0$. Most investors can have pledgeable investment $Z_0$.

A model considers a risk-neutral agent (entrepreneur in Holmstrom-Tirole, 2011) with an investment opportunity that is worth $Z_1$ to him. It is not self-financing in case of a positive net present value, $Z_1 > I$, because most investors can get a pledgeable $Z_0$ so the risk-taking agent should pay shortfall $I - Z_0 > 0$ converting the market value of their other existing assets.

The portfolio can go forward if and only if the pledgeable income exceeds the portfolio’s net financing, $I - \bar{A}$, that is when

$$A \geq \bar{A} \equiv I - Z_0 > 0 \quad (2)$$
Credit rationing (Holmstrom-Tirole, 2011)

Let $A$ be the maximum amount of capital that the agent can commit to the project either personally or through the commercial bank. A lower bound $\bar{A}$ on the amount of assets that the commercial bank or the agent needs to have in order to attract external funds. A commercial bank with less capital than $\bar{A}$ will be credit rationed. $A > I$ is in the situation that no external funds are needed.

**Necessary conditions for credit rationing (Holmstrom-Tirole, 2011)**

1. a positive rent $Z_1 - Z_0 > 0$. If $Z_1 = Z_0$, then all projects with positive net present value ($Z_1 > I$) are also self financing ($Z_0 > I$) and hence can move forward.

2. the agent is capital poor in case of $A < (Z_1 - Z_0)$, the agent has enough capital up front to pay for the ex post rents earned and therefore all projects with positive net present value can go forward.
A commercial bank’s a fixed reserve scale

Remark that "capital poor" is in case of $A < (Z_1 - Z_0)$

$$\equiv 1 < \frac{(Z_1 - Z_0)}{A}$$

where $A$ is defined as the maximum in capital in a sense of a portfolio and $(Z_1 - Z_0)$ is a positive rent.

A commercial bank controls individuals by interest rate on loans like mortgage interest rate. In a regulatory aim, we assume that the agent deposit savings to demand deposit in the precautionary aim.
Excess liquidity, instrument from Micro to Macro

- **Excess liquidity**: holdings of precautionary (↔ inflationary potential) reserves in the country having a contraction in the supply of credit by banks because of poorly developed interbank market.

**Excess Liquidity (EL) = Excess Cash + Excess Reserves (ER)**

- Reserves (R) < Demand Deposit (DD),

  \[ ER = (DD - R) + (R - RR) \]

  \[ \text{Level } 1^{th} \text{ to } 10^{th} \]

- Reserves (R) > Demand Deposit (DD) (precautionary reserves), \( ER = R - RR \)

  \( RR \div DD \) (Level 1\(^{st}\) to 10\(^{th}\), according to \( RR \div DD \div 10 \))

- Reserves (R) > Demand Deposit (DD), \( RR/DD > 1 \) (**excess liquidity**)
### Compound concern in Credit rationing

**Example: Akerlof’s used car market for lemons**

Suppose there are only two qualities, good cars ("peaches") and bad cars ("lemons"), worth 5000 dollars and 1000 dollars, respectively. The buyer knows that half the cars are peaches and half are lemons. If she offers 5000 dollars, the sellers of either type surely accept, but the expected value of the car will only be equal to 3000 dollars (1000 dollars with 50% probability and 5000 dollars with 50% probability), so she will make expected losses of 2000 dollars...
when beliefs are formed enoughly to affect on decision procedures

Preferences can only depend on the consequences \((c_1, c_2, ..., c_n)\)
Degenerated lotteries are also equivalent.

**Compound lotteries**

Compound Lotteries \((L_1, ..., L_k; a_1, ..., a_k)\) (MWG, session 6B) is the risk alternative that yields the simple lottery \(l_k\) with probability \(a_k\) for \(k = 1, ..., K\), given \(K\) simple lotteries \(l_k = (p_{1k}^k, ..., p_{Nk}^k)\), \(k = 1, ..., K\) and probabilities \(a_k \geq 0\) with \(\sum_k a_k = 1\).
Utility function in incomplete structural representation

- (example 1, multi-valued prediction, Jovanovic, 1989, discrete form game) $u$ is latent variable, $\theta$ is a parameter in the payoff matrix, $S$ is the set of (pure) strategies, and $G(u \mid \theta)$ is the set of Nash equilibrium (pure) strategy profiles for given $u$ and $\theta$.

- solution for multiple equilibria: sub-correspondence? rationalizability? samples converge (ergodicity) and obey classical limit theorems? Why $\theta$ is given?
Initially we consider decisions when the number of possible outcomes or "states" is finite. A regulator (decision maker) then indicates the choice structure $\theta$ to each state.

Let $L_\theta$ be the consequence in complete structure $\theta$.

Let $1_{\theta}(L)$ be the indicator that the individual assigns to this complete structure $\theta$, where $1_{\theta} : L \rightarrow \{0, 1\}$ defined as

$1_{\theta}(L) := 1 \text{ if } L \in \theta, 0 \text{ if } L \notin \theta$ then the uncertain outcome or "prospect" is the $2 \times \theta$ vector:

$\left( L_\theta; 1_{\theta}(L) \right) = ((L_1, \ldots, L_\theta); (1_{\theta}(L), \ldots, 1_{\theta}(L)))$. \hspace{1cm} (4)

Under the axiom of choice on two uncertain outcomes, there exists a continuous utility function $U(L_\theta; 1_{\theta}(L))$ over prospects.
Utility function in incomplete structural representation

- Given a structural parameter $\theta \in \Theta$ and the realization $u \in U$ of an unobservable random variable, the model predicts a nonsingleton set, denoted $G(u \mid \theta)$, of values for the outcome variable, that is $G(u \mid \theta)$ is a subset of the (finite) outcome space $S$.

- The question (Epstein-Kaido-Seo, 2016) is on how the realized outcome $s$ is selected from $G(u \mid \theta)$.

- The object of interest is $\theta$. 
Utility function in incomplete structural representation

- Considering the set of all lotteries or prospects over the fixed outcome levels $L_1 < L_2 < L_3$, which can be represented by the set of all choice structure triples of the form $\Theta = (\theta_1, \theta_2, \theta_3)$, we can represent these lotteries by the points in the unit triangle in the $(\theta_1, \theta_3)$ plane.

- Since upward movements in the triangle increase $\theta_3$, the risky movements are all northwest movements.

- For $\theta_3 > 1$, it’s possible but we assume there is limit of cognition as of $0 < \theta_3 \leq 1$ by a regulator.

- The value is revealed when preference structure $u$ is corresponding $\theta$-parametric choice structure $\Theta$:

$$G(u \mid \theta_1 + \theta_3) \in \triangle(S), G(u \mid \theta_2) \notin \triangle(S).$$ (5)
Utility function in incomplete structural representation

Let’s say we assume that we have three points (lotteries, probabilities). If a lottery is utility-representable, a lottery is $\theta$-parametric structural which is complete in the choice structure.

$$P_{\theta} = \left\{ P \in \Delta(S^\infty) : P = \int_{U^\infty} P_u dm_\theta(u^\infty) \right\}, \quad (6)$$

If the preference of a lottery is not revealed in the $\theta$-parametric structure, we get certain decision procedure which is not interesting for a rational agent who is afford to get risk-taking outcome:

$$P_{\theta c} = 0. \quad (7)$$

$G(u \mid \theta_1 + \theta_3) \in \Delta(S)$,
$G(u \mid \theta_2) \notin \Delta(S)$ in the case of certain second outcome.

Again, there is possibility of $G(u \mid \theta_3) \notin \Delta(S)$ in the extreme case of risky preference on uncertain third outcome.
Utility function in incomplete structural representation

- (Compound convergences in this model)
  Assume that $u^\infty$ jointly follows a parametric compound convergence $m_\theta^\infty$, the i.i.d. product of the compound convergence

$$m_{\theta_1+\theta_3} \equiv \left\{ \frac{Z_1^1 - Z_0^3}{A^1}, \frac{Z_1^1 - Z_0^3}{A^3} \right\} \in \triangle,$$  \hspace{1cm} (8)

defined as "redlining in credit rationing" on $U$.

- Markets play allocational.
- Redlining: the group of borrowers who can not obtain credit with a given supply of loanable funds.
- Financial autarky: savings and investment express the supply and demand of loanable funds.
Comparing different lotteries

Lotteries, degenerated at the same portion in a von Neumann-Morgenstern utility function

- Preferences can only depend on the consequences \( (c_1, c_2, \ldots, c_n) \) and their respective probabilities \( (p_1, p_2, \ldots, p_n) \)
- A utility function \( F(c_1, c_2, \ldots, c_n; p_1, p_2, \ldots, p_n) \) (by attaching numbers to indifference curves, where a curve corresponding to a higher level of preference gets a bigger number)
- The indifference map

\[
EU(L) = p_1 u(c_1) + p_2 u(c_2) + \ldots + p_n u(c_n) \tag{9}
\]

Where \( F(=\text{constant}) \) exists by the indifference map consisted by contours.

\[
EU(L) = 1_{\theta} \cdot G(u \mid (\theta_1 + \theta_3)) + 1_{\theta} \cdot G(u \mid \theta_2). \tag{10}
\]
Table of Contents

1 Introduction

2 Model

3 Pictorial brief
   - Incomplete structural triangle
   - Independence axiom?
   - Free to Subgame?

4 Empirical results

5 Future Research
Compound convergences in incomplete structural triangle

Framework of risk preference in the Machina Triangle

Excess Liquidity (EL)
- \( R > DD \)
- \( RR/DD > 1 \)

Certain outcome
- DD index
- DD-R/R
- RR-R/R

Uncertain outcome
- DD index
- DD-R/DD
- RR index
- RR-R/R

From rectangle to triangle
Excess Liquidity in incomplete structural triangle

Figure 5. Remoted prospects from the origin point
Binary choice in uncertainty
1) Independence Axiom (Von Neumann and Morgenstern, 1944)

The preference relation $\succeq$ on the space of simple lotteries $I$ satisfies the independence axiom if for all $L, L', L'' \in I$ and $a \in (0, 1)$, we have $L \succeq L'$ if and only if $aL + (1 - a)L'' \succeq aL' + (1 - a)L''$

The agent should choose the first lottery ($L$) than the second lottery ($L'$) regardless of the third one ($L''$).

Example 1) There are three outcomes: "a trip to New-york," "eating a New york styled bagle," and "staying in the office." Suppose that you prefer the first lottery to the second one and the second one to third one. The choice to select the second lottery is rational if you anticipate that you cannot travel to New-york. However, the independence axiom forces you to prefer the first lottery to the second one (Machina Paradox in section 6.B MWG)
2) Preferential consequentialism (Vergopoulos, 2011)

The agent firstly recognizes the endogenous event \((E)\), regardless of the preferred act \(g\) in the exogenous event \((E^c)\), he will choose the preferred set \(f\) in the endogenous event \((E)\): \(f \sim_E g\).

Example 2) You are invited for a dinner \((E)\). You were supposed to drink a Beer \((g)\) in case of staying at home \((E^c)\). However, you decide to carry a Wine \((f)\) for an invitation of dinner \((E)\).

3-1) Savage’s Sure Thing Principle (STP) (Savage 1954; Aumann, Hart)

For any event \(E \subset \Omega\) and any acts \(f, g, h, k \in B(\Omega)\),
\[
f_{E} h \leq_0 g_{E} h \iff f_{E} k \leq_0 g_{E} k\]
where \(\leq_0\) is an optimal ex ante choice in the backward induction.
Table of Contents

1 Introduction
2 Model
3 Pictorial brief
4 Empirical results
   ■ Comparision: Jordan and Lebanon
   ■ Jordan
   ■ Lebanon
5 Future Research
Case comparison: MENA (Middle East and North Africa) countries

Which country can be better?

2. complementary economic information about village I and village II, reference: world bank data.

<table>
<thead>
<tr>
<th></th>
<th>Village I</th>
<th>Village II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (total)</td>
<td>7,416,083</td>
<td>5,612,096</td>
</tr>
<tr>
<td>GDP (millions, Current USD)</td>
<td>3,587</td>
<td>4,573</td>
</tr>
<tr>
<td>GDP per capita (Current USD)</td>
<td>4,830</td>
<td>8,148</td>
</tr>
<tr>
<td>commercial bank branches per 100,000 adults</td>
<td>19,85</td>
<td>29,84</td>
</tr>
<tr>
<td>Domestic credit to private sector (% of GDP)</td>
<td>70</td>
<td>103</td>
</tr>
<tr>
<td>Bank nonperforming loans to gross loans (%)</td>
<td>5.6</td>
<td>4</td>
</tr>
<tr>
<td>Bank capital to asset (%)</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Outside Liquidity in domestic currency, liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>currency issued</td>
<td>5,886</td>
<td>400</td>
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<tr>
<td>required reserve</td>
<td>2,053</td>
<td>19,200</td>
</tr>
<tr>
<td>excess reserve</td>
<td>1,981</td>
<td>44,400</td>
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<tr>
<td>reserve money</td>
<td>9,920</td>
<td>64,000</td>
</tr>
<tr>
<td>demand deposit, commercial banks</td>
<td>12,684</td>
<td>3,028</td>
</tr>
<tr>
<td>excess liquidity</td>
<td>R &lt; DD</td>
<td>DD &lt; R</td>
</tr>
</tbody>
</table>

| Inside Liquidity |
| overnight deposit window rate | 2.75 | 2.75 |
| credit rationed A | -10,631 | 60,972 |
| domestic credit to private sector by banks to GDP (%) | 70 | 99.2 |
| net commercial bank lending and other private credits | 250 | -43 |

Table 3. Selected Liquid Characteristics in 2014.
Application to MENA countries: Jordan
6.1. Village I (Jordan)

<table>
<thead>
<tr>
<th>Year</th>
<th>DD-RR/R</th>
<th>R-RR/RR, Precautionary Reserves</th>
<th>RR/DD, RR index (1-11th)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>-35%</td>
<td>567%, certain outcome</td>
<td>23%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1994</td>
<td>-37%</td>
<td>567%, certain outcome</td>
<td>24%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1995</td>
<td>-38%</td>
<td>567%, certain outcome</td>
<td>24%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1996</td>
<td>-36%</td>
<td>567%, certain outcome</td>
<td>24%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1997</td>
<td>-41%</td>
<td>614%, certain outcome</td>
<td>24%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1998</td>
<td>-33%</td>
<td>614%, certain outcome</td>
<td>21%, 3rd (below 30%)</td>
</tr>
<tr>
<td>1999</td>
<td>-38%</td>
<td>614%, certain outcome</td>
<td>23%, 3rd (below 30%)</td>
</tr>
<tr>
<td>2000</td>
<td>-29%</td>
<td>900%, certain outcome</td>
<td>14%, 2nd (below 20%)</td>
</tr>
<tr>
<td>2001</td>
<td>-15%</td>
<td>1150%, certain outcome</td>
<td>9%, 1st (below 10%)</td>
</tr>
<tr>
<td>2002</td>
<td>1%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2003</td>
<td>2%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2004</td>
<td>27%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2005</td>
<td>23%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2006</td>
<td>12%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2007</td>
<td>9%</td>
<td>92%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2008</td>
<td>0%</td>
<td>91%, certain outcome</td>
<td>1st (below 10%)</td>
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<tr>
<td>2009</td>
<td>12%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2010</td>
<td>15%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2011</td>
<td>20%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
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<tr>
<td>2012</td>
<td>30%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2013</td>
<td>28%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2014</td>
<td>22%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
<tr>
<td>2015</td>
<td>25%</td>
<td>93%, uncertain outcome</td>
<td>11th (over 100%)</td>
</tr>
</tbody>
</table>

Identification symbols: DD (Demand Deposit), RR (Required Reserves), R (Reserve), BL = Excess Liquidity
Application to MENA countries: Lebanon
Table of Contents

1. Introduction
2. Model
3. Pictorial brief
4. Empirical results
5. Future Research