EC331 Research in Applied Economics, Presentation 2

Does the negative interest rate boost consumption and investment in Japan? — An insight from a Bank-Credit Model

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27th Feburary 2018

Acknowledgement

I thank Dr Alex Karalis Isaac for his supervision and support in the relevant fields.
I thank Prof Herakles Polemarchakis for his wonderful teaching at the Warwick Economics module EC9B3: Topics in Macroeconomics and International Economics, and support in the relevant fields.
I also thank Dr Pablo Beker, Dr Gianna Boero, Dr Julia Brettschneider, Prof Jonathan Cave, Dr Natalie Chen, Dr Nicholas Jackson, and Dr Piotr Jelonek for their generous and professional advice to my works.

Resources

Materials including slides for presentations 1 and 2 can be found at: parleyyang.wordpress.com/documents-for-rae-dissertation/

Recall last presentation and outline for this presentation

In presentation 1:

- Motivation.
  - →Why Japan? Why Negative Interest Rates? Why Bank-Credit Model?
- Bank-Credit Model.
  - →Aim and settings centring at the Commercial Bank.
  - →Alex-Jeremy-Bank Story and one of the results.

In this presentation:

- Bank-Credit Model with Macroeconomic elements.
  - →General Settings and Individual's Utility Maximisation Problem (UMP).
  - →An enhanced version of the Commercial Bank's Balance Sheet accounting.
- Mathematics in solving the problems and Sample Result.
- Further Steps and Extension.
- Conclusion at current stage and Evaluation.

Introduction to the Macroeconomic elements

Note on the content:

This is a selection of materials from my model. Please contact me if you wish to know more.

Recall aim of the model:

Assess whether the negative interest rate boosts consumption and investment, by considering the commercial bank's credit issuing decisions.

- Assumption on general settings.

  $\rightarrow$Consider the economy with two institutions, two types of individuals, and two periods — period 1 and period 2.

  $\rightarrow$The first institution is Government-and-Central-Bank, the second institution is a commercial bank ($ComB$).

- Assumptions on credit network, goods market, production, and investment.
- Assumption on types of individuals.

  $\rightarrow$Ordinary Farmer (OF): able to deposit and borrow, but unable to invest.

  $\rightarrow$Entrepreneurial Farmer (EF): able to deposit, borrow, and invest.

Individual Settings

- Assumption on individual's utility functions.

$$u_j : \mathbb{R}_{\geq 0} \to \mathbb{R}, \quad C_{t;j} \mapsto u_j(C_{t;j}) \tag{1}$$

$$\text{such that} \quad u_j \in C^2(\mathbb{R}_{>0}, \mathbb{R}) \tag{2}$$

$$\forall x \in \mathbb{R}_{>0}, \quad u_j'(x) \geq 0 \quad \text{and} \quad u_j''(x) \leq 0 \tag{3}$$

- Assumption on weather-associated risk.

  $\to$Let weather at period 2 be a binary outcome for each farmer's land.

  $\to$Write X_j to be the weather on the land of the farmer j at period 2.

  $\to$One outcome is good, write as $X_j = G_j$, with probability $p_j \in (0, 1)$.

  $\to$The other outcome is bad, write as $X_j = NG_j$, with the remaining probability $1 - p_j$.

  $\to$Assume the weather on each land is pairwise independent.

- Assumptions on common knowledge, consumption functions, and production functions.

Individual's UMP and Commercial Bank (General)

- Every individual j faces utility maximisation problem (UMP) at period 1 as

$$\max_{C_{1;j}\geq 0 \text{ and } C_{2;j}\geq 0} \left\{ \mathbb{E}\Big[u_j(C_{1;j}) + \beta_j u_j(C_{2;j}) \Big] \right\} \tag{4}$$

subject to

$$C_{1;j}P_1 \leq F_{1;j}P_1 + B_j - I_j \tag{5}$$

$$C_{2;j}P_2 \begin{cases} = 0 & \text{if } F_{2;j}(NG_j, I_j)P_2 \leq B_j(i_{\#}+1) \text{ and } X_j = NG_j \\ \leq F_{2;j}(X_j, I_j)P_2 - B_j(i_{\#}+1) & \text{otherwise} \end{cases} \tag{6}$$

where

$$i_{\#} = \begin{cases} i_{b;j}, & \text{if } B_j > 0 \\ i_{d;j}, & \text{if } B_j \leq 0 \end{cases} \tag{7}$$

- Underlining implication: $F_{2;j}(G_j, I_j)P_2 \geq B_j(i_{\#}+1)$
- Key Assumptions to the Commercial Bank: utility function u_{ComB}, legal constraints, and balance sheet.

Commercial Bank (Accounting Principle of Balance Sheet)

Balance Sheet of the commercial bank for this paper

Assets	Liabilities
Cash and cash equivalent (A_0)	Deposits from customers (L_0)
Government Bonds and equivalent (A_1)	
Lendings (A_2)	Equity (L_1)

$\forall X \in \{L_0, L_1, A_0, A_1, A_2\}$, write the value of X at period 1 before the rate cut as $X(0)$, and after the rate cut as $X(1)$. Write the value of X at period 2 as $X(2)$.

$$\forall t \in \{0,1\}, \quad A_0(2) = (1-c)A_0(t) + \sum_{j=1}^{m+n}(i_{d;j})B_j \mathbb{1}[B_j \leq 0] \tag{8}$$

$$\forall t \in \{0,1\}, \quad A_1(2) = (1+i_{c:1})A_1(t) \tag{9}$$

$$\forall t \in \{0,1\}, \quad A_2(t) = \sum_{j=1}^{m+n} B_j \mathbb{1}[B_j > 0] \tag{10}$$

$$A_2(2) = \sum_{j=1}^{m+n}\left(\left((1+i_{b;j})B_j(1-\mathbb{1}[Default_j]) + F_{2;j}(NG_j, I_j)P_2\mathbb{1}[Default_j]\right)\mathbb{1}[B_j > 0]\right) \tag{11}$$

$$\forall t \in \{0,1,2\}, \quad L_0(t) = \sum_{j=1}^{m+n} -B_j \mathbb{1}[B_j \leq 0] \tag{12}$$

Mathematics in solving the problems, and a Sample Result

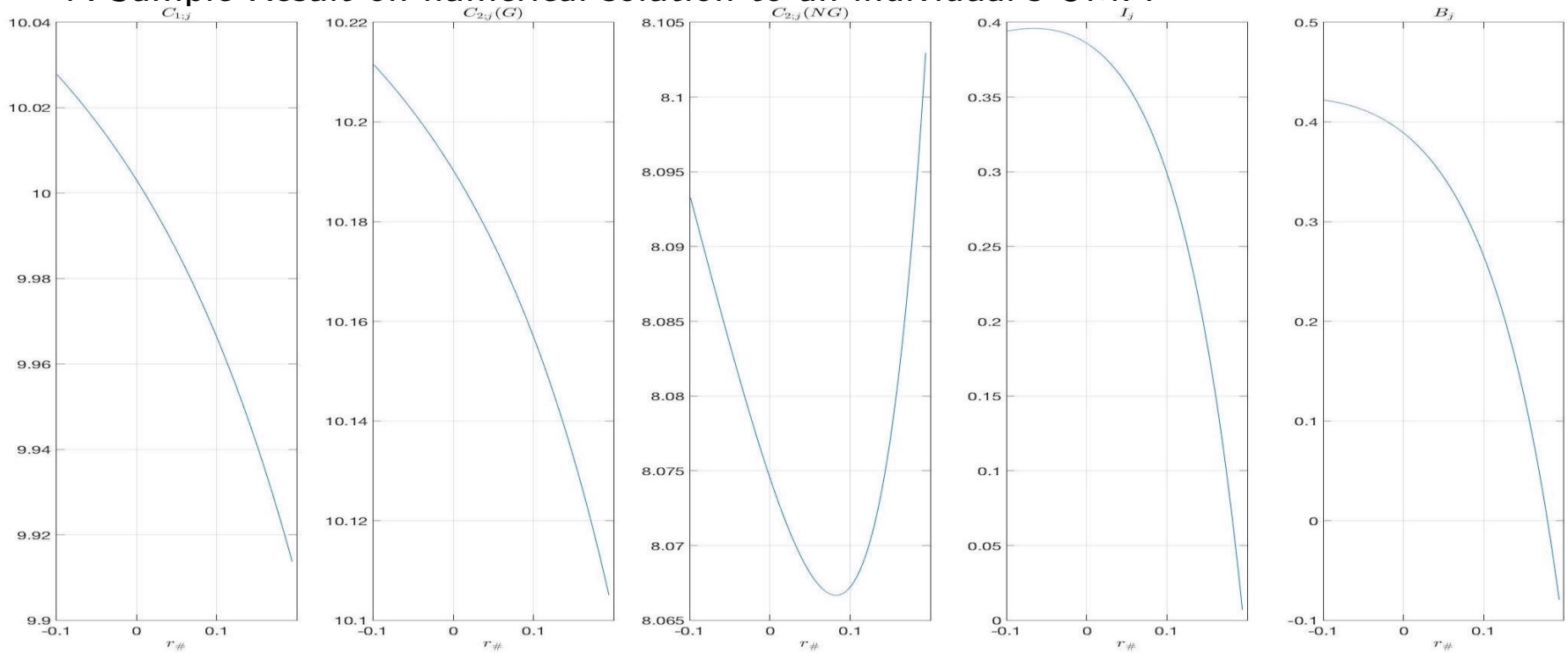
- Theoretical Mathematics: $(\mathbb{R}^n, d)$ metric space and their topological extensions. Convexity, concavity, higher order Fréchet derivatives.
- Practical Trials.

  $\rightarrow$Linear utility function & any production function: almost **no interior maximiser**.

  $\rightarrow$Any utility function & linear production function: some does not have interior maximisers, some may yield $card(M) = \infty$, i.e. **infinitely many maximisers**.

  $\rightarrow$Quadratic utility function & linear production function: **some maximisers are explicit.**

  $\rightarrow$Log / power utility function & log / power production function: **nearly all have unique maximisers**, but some maximisers hardly have explicit solutions within one page.
- A Sample Result on numerical solution to an individual's UMP.



Further Steps and Extension

- Further steps. (Ordered in a decreasing priority. Some less prioritised items may be done in my postgraduate research.)

  $\rightarrow$**Dynamic**: generalise the time periods from 2 to $T \geq 3$, or ∞.

  $\rightarrow$**Policy**: observe the behaviour of functions if the inflation changes exogenously after the rate cut. Observe also the impact of "helicopter-money"styled consumption boost, then to interpret the contemporary Japanese macroeconomic phenomena.

  $\rightarrow$**Expectation**: set a proper expectation for the futures, e.g. stochastic expectation on prices with uncertainty.

  $\rightarrow$**General Equilibrium**: generalise the price of banana and land to be endogenous, meanwhile ensure the system is solvable. Generalise the number of goods to $N \geq 2$.

  $\rightarrow$Adjusting towards a **DSGE structure**, e.g. make changes in probability distributions, broader the General Equilibrium to include international trade.

- Extension.

  $\rightarrow$**Microeconomic Extensions**: information disparities, degree of competitions amongst commercial banks, and risk-taking financial institutions.

  $\rightarrow$**Econometric Verifications**: Japanese commercial banks' balance sheet data, and macroeconomic data compared to the model.

Conclusion at the current stage and Evaluation

- Conclusion at current stage.

  →Without any further assumption, answer to the topic question is **uncertain**.

  - If I assume (restrict) the coefficients and functions to be such that the commercial bank faces a substantial drop in profit after the rate cut,
  - then the result can be proved as a **clear NO**, i.e. negative interest rate does not boost consumption and investment in Japan.

- Evaluation: Robustness and Deficiency.

  →Potential critique: use of functional and topological analyses overkill the problem. **But rigorous mathematical proofs ensure robustness.**

  →Reliance on some microeconomic assumptions, e.g. separable utility functions over time. (**The same problem amongst some current literature.**)

  →Until full conversion to a DSGE structure, this paper is not on a publishable level, thus may not be a strong policy recommendation. (**Vice versa.**)

- Evaluation: Strength and Summary.

  →**High quality analyses** demonstrating excellent knowledge on relevant literature, accurate and rigorous mathematical foundation.

  →**Original work** which brings new concepts to the dynamic macroeconomic models, e.g. using different interest rates with some preserving Zero Lower Bound.

  →Provides **theoretical basement** for further empirical works.