University of Warwick

EC331: Research in Applied Economics, Presentation 1

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

Presenter: Parley Yang   Date of Presentation: 16.01.2018

Outline for this presentation:

- Introduction and Motivation
  - Why Negative Interest Rates?
  - Why Japan?
  - Why Bank-Credit Model?
- Bank-Credit Model
  - Aim
  - Basic Settings
  - Result and Example

Outline for the next presentation:

- Bank-Credit Model
  - Advance Variations
- Macroeconomic Implications
  - Settings
  - Result and Example
- Evaluations on the models
- Conclusion and Future Extensions

Note: This slide and additional documents for this presentation can be found at the following website: parleyyang.wordpress.com/documents-for-rae-dissertation/

I thank Dr Alex Karalis Isaac for his supervision and support in the relevant fields.

I also thank Dr Gianna Boero, Dr Julia Brettschneider, Prof Jonathan Cave, Dr Natalie Chen, Dr Nicholas Jackson, Dr Piotr Jelonek, and Prof Herakles Polemarchakis for their generous and professional advice to my works.

Introduction and Motivation: Why Negative Interest Rates (NIRs)?

Empirical (on Japan) and Theoretical Views asking for Negative Interest Rates

Svensson (2006, pp.1,3,8) described that, Japan faced a Zero Lower Bound (ZLB) in the late-1990s, which prevented Bank of Japan (BOJ) from setting its interest rate at its optimal level. (Also see Figure 1 at the website.)

Goodfriend (2016) derived the need for certain level of Negative natural real interest rates. By Fisher Equation and the boundedness of $\mathbb{E}[\pi]$, one can show that the policy-induced real interest rates being bounded due to ZLB.

Theoretical Views opposing Negative Interest Rates

Keynes (1937, p.207) described the liquidity trap as follows:

> [If the interest rate is lower than a certain level] ... everyone prefers cash to holding a debt which yields so low interest rate. In this event the monetary authority would have lost effective control over the interest rate. (1)

A modern approach to describe the similar concept of liquidity trap and ZLB was provided by Schmitt-Grohé & Uribe (2009, pp.89-92) which formulises (1) as:

$$\lim_{M\to\infty} \frac{\frac{\partial u(c,M)}{\partial M}}{\frac{\partial u(c,M)}{\partial c}} = 0 \quad \forall c > 0 \tag{2}$$

where c is consumption, M is money, u is the household utility function.

Schmitt-Grohé & Uribe (2009, p.89) then claimed that (2) leads to "money demand approaches infinity as the nominal interest rate vanishes".

Introduction and Motivation: Why Japan? And Why Bank-Credit Model?

Why Japan?

- This economy is currently under a Negative Interest Rate;
- model-specific, e.g. the Value-at-Risk model from Adrian & Shin (2010) may not be used to describe Japanese banks;
- lack of papers on Japanese banking (Berger, Molyneux, and Wilson, 2014, p.905);
- personal research interest (Yang, 2017; Yang and Hui, 2016a; Yang and Hui, 2016b).

Why Microeconomic Foundation?

- Story behind numbers;
- "[macroeconomic] specifications underlying the microeconomic studies cited by a calibrator conflict with those of the macroeconomic model being 'calibrated '. " (Ljungqvist and Sargent, 2012, p.xxviii)

Why not adapt existing Macroeconomic models?

Let us review the Schmitt-Grohé & Uribe (2009) paper, which inherits Benhabib et al. (2001) and Woodford (2003) on solving a dynamic macroeconomic model with Taylor Rule[a]. Ambiguous assumptions as follows:

Taylor Rule holds for all possible rates of inflation. (pp.92-93) (3)

For the household-side utility maximisation, the household-side budget constraint is the same function for any nominal interest rate. (pp.89-90, 95-97) (4)

(3) means that central bank can set any Negative Interest Rates (NIRs), which certainly conflicts with ZLB and liquidity trap, thus self-conflicts with its own settings for ZLB, e.g.(2).

(4) effectively assumes that households face a budget constraint with the policy-induced negative interest rate, which is inconsistent with the reality in Japan. (See Figure 2 at the website.)

The lesson from Schmitt-Grohé & Uribe (2009) warns my paper not to conduct the macroeconomic analysis directly without any support from the microeconomic mechanism on NIR.

[a] Originated from Taylor (1993).

Bank-Credit Model: Aim and Basic Settings

Aim of this paper: Assess whether NIR boosts consumption and investment in Japan, by considering the commercial bank's credit issuing decisions.

Aim of this Bank-Credit Model: Show NIR damages bank profits,[1] which further leads the bank to a dilemma between choosing to lend to riskier borrowers or to retain cash.[2] Eventually, the bank may have to decrease the total lendings.

Definition 1: Classification of Central Bank interest rate (i%) as follows:

Interest Rate Interval	$(-\infty, i_E)$	$[i_E, 0)$	$[0, i_P]$	(i_P, ∞)
Name	Impossible NIR	Effective NIR	Near zero positive interest rate	Strictly positive interest rate

(Note: This definition is motivated by the speech given by Nessén (2016).)

Throughout this presentation, we put $i_P = 0.1$ and $i_E = -20$ for simplicity, and we set the timing as a two-period economy, with periods $t = 1$ and $t = 2$. Suppose that the rate cut happens at $t = 1$, which cuts interest rate from $i^{(0)} \in [0, i_P]$ to $i^{(1)} \in [-i_E, 0)$, and interest rate does not change thereafter. [Note: Modification of time period may be made in the next presentation, when macroeconomic models being adapted.]

Assumption 1: There is only one central bank and one commercial bank in the economy. The commercial bank (hereafter "the bank") has the balance sheet as shown in Figure 3 (b) at the website.

The above assumption is set based on the Japanese Credit Network analysis done by Masi et al. (2011), which suggests that many Japanese firms have connections with only one or two commercial banks.

[1] This is suggested empirically by Nakano (2016, pp.98-101, 137, 178), and Barwell (2016, pp.43-46).

[2] The mechanism that central bank lowers interest rate leads to commercial banks lending to riskier borrowers has been tested to be true, econometrically by Jiménez et al. (2008).

Bank-Credit Model: Basic Settings (Continued)

Given a policy-induced interest rate x, we use the following function i_c to summarise the empirical interest rate setting behaviour of the commercial banks to their depositors.

Definition 2: A differentiable function $i_c : [i_E, +\infty) \to [0, +\infty)$ is said to be a customer-side interest rate function if it satisfies the following conditions:

$$i_c(x) < x \quad \text{whenever} \quad x \geq i_P \tag{5}$$

$$i_c'(x) \geq 0 \quad \forall x \in [i_E, +\infty) \tag{6}$$

An example of the above function is illustrated in Appendix 1 at the website.

The following assumption marks the foundation of this paper's analysis. Notice that, Appendix 2 at the website defines, using rigorous mathematical construction and expressions, the following terminologies and symbols.

Assumption 2: The bank chooses the strategy which maximises its expected utility. That is: given the bank's utility function U, given a finite set of strategies $\{S_1, ..., S_n\}$ with their associated Probability Functions $\{\mathbb{P}_1, ..., \mathbb{P}_n\}$ and random variables $\{X_1, ..., X_n\}$. The bank chooses the strategy S^* where $S^* \in \text{argmax}_{j \in \{1,...,n\}} \mathbb{E}_{X_j}[U(S_j)]$.

The above assumption implicitly assumes some basic microeconomic settings including perfect information, consistency of choices, perfect rational behaviour, and perfect homogeneity between a bank manager's subjective view to another. After all, this is set to enable the decision being modelled mathematically without inconsistent random shocks.

Note: there are some definitions, assumptions, lemmas, corollaries (from the definitions and assumptions), and their proofs for analytical purposes that being skipped due to page limit, please refer to Appendix 2 and Appendix 3 at the website if interested.

Bank-Credit Model: Result and Example

Theorem 1: Consider some utility functions U, and some finite set of possible strategies $\{S_1, ..., S_n\}$ with their associated Probability Functions $\{\mathbb{P}_1, ..., \mathbb{P}_n\}$, random variables $\{X_1^{(0)}, ..., X_n^{(0)}\}$, and the chosen strategy $\overline{S}$. After the rate cut from $i^{(0)}$ to $i^{(1)}$, the strategies $\{S_1, ..., S_n\}$ correspond to $\{X_1^{(1)}, ..., X_n^{(1)}\}$; then the new chosen strategy $\widehat{S}$ has the property $card(\Omega_{\widehat{S}}) < card(\Omega_{\overline{S}})$.

Since the above theorem is only claiming existence, it is easily proved numerically by an example. Details of settings and calculations are written at Appendix 4 at the website.

Proposed Theorem: (to be clarified and proved in the next presentation) With some conditions on parameters, especially by bounding functions U and i_c, and scalars i_{A_2} and i_{A_3}, Theorem 1 can be generalised to be for every utility function and every (possibly infinite) set of possible strategies.

To see the economic meaning of the above theorems, a lemma is needed to support.

Lemma 1: Given two strategies $\overline{S}$ and $\widehat{S}$. Write $\overline{A_2}$ and $\overline{A_3}$ to be the A_2 and A_3 induced by $\overline{S}$, $\widehat{A_2}$ and $\widehat{A_3}$ to be the A_2 and A_3 induced by $\widehat{S}$. Then $[\widehat{A_2} + \widehat{A_3} < \overline{A_2} + \overline{A_3}] \Leftrightarrow [card(\Omega_{\widehat{S}}) < card(\Omega_{\overline{S}})]$.

Finally, we finish this model by concluding the following corollary.

Corollary 1: The rate cut from a near zero positive interest rate to an effective NIR in some cases reduce the total lendings. Moreover, if the proposed theorem is true, then, whenever conditions on parameters are satisfied, the rate cut (as mentioned in the previous sentence) always reduce the total lendings.

Note: Proofs of the Lemma 1 and Corollary 1 are available at Appendix 3 at the website.