Modelling the “Animal Spirits” of Bank’s Lending Behaviour

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Introduction

- In the traditional banking literature, banks are often treated as a passive intermediary that channels fund from ultimate lender to ultimate borrower (Bernanke et al 1999)

- In reality however, the role of banks goes beyond a passive intermediary that merely allocates financial resource from lenders to borrowers.

  - In the presence of fractional banking system, it functions as an active credit creator. The creation of loan simultaneously creates deposit, which ultimately add to the broad money stock (M3).
Introduction

- Another important aspect, which is overlooked in the traditional banking literature, is the role of bank’s lending attitude (Asanuma, 2012).
  - An optimistic attitude in the banking sector collectively lowers the lending standard and prompt banks to collectively over-lend to a particular sector such as real estate, which potentially leads to the development of credit bubble.
  - A collectively pessimistic banking system not only hinders economic growth but also render expansionary monetary policy ineffective.
Introduction

Source: Koo (2011)
Introduction

The wave of optimism and pessimism, which potentially influences behaviour of economic agents such as bankers, is referred to as the “animal spirits” by Keynes (1936) in chapter 12 in his General Theory.

- **Self-fulfilling**: an optimistic/pessimistic sentiment will bring forth a positive/negative outcome to the market, which further reinforces the optimistic/pessimistic sentiment.
- **Contagion**: sentiment spreads and it eventually leads to herding amongst agents.
Introduction

- In recent years there is a surge of literature that attempts to integrate “animal spirits” into financial and macroeconomic modelling.
  - Lux (1995) proposes a seminal work that examines the relationship between investors’ sentiment and asset price bubble and crash by applying the stochastic aggregation method.
  - De Grauwe (2010) develops a DSGE model that is augmented by agent’s cognitive limitations.
  - Asanuma (2012) examines how bank’s lending attitude affects economic growth in an agent-based setting, where there is a monopolistic bank and multiple borrowers.
Introduction

- The main purpose of this paper is to propose a model that examines:
  - how the “animal spirit”, i.e. the contagious waves of optimism and pessimism affect banks’ lending behaviour, which ultimately contributes to the boom-bust of the credit cycle?
  - What is the consequence of “animal-spirit” type herding on the real side of business fluctuations?
Model Description

The balance sheet of a commercial bank

- In this paper we focus on the linkage between the loan and the reserve on the asset side in terms of loan-to-reserve ratio, according to Taylor (2004): 
  \[ L^S = \lambda^S T_c \]

- The loan-to-reserve ratio reflects not only banker’s lending attitude but also the amount of debt accumulation
Model Description

- Suppose that there are $2N$ banks in the economy, of which $n_+$ is the number of optimists and $n_-$ are the number of pessimists.

- Average Opinion Index: $x = \frac{n_+ - n_-}{2N} = \frac{n}{N} \in [-1, 1]$
  - When $x = 0$, there are equal number of optimistic and pessimistic banks; when $x = \pm 1$, it implies that all the banks are optimistic or pessimistic.
We assume that only optimistic banks make loans:

\[ L^s = Rn_+ \lambda_+ = RN(1 + x)\lambda_+ = \frac{T_c}{2} (1 + x)\lambda_+ \]

The variable \( x \) and \( \lambda_+ \) are of our main interest. In a parsimonious setting, we assume that:

i. When \( x > 0 \), the optimistic banks expand their balance sheet;

ii. when \( x < 0 \), they contract their balance sheet;

iii. when \( x = 0 \), the balance sheet position of optimistic banks remain unchanged.

Hence we have:

\[ \dot{\lambda}_+ = \gamma x \]  (5)
Model Description

- What is the dynamics of average opinion ($x$)?
- Adopting Lux (1995), the law of motion for $x$ is given by:

$$\dot{x} = (1 - x)p_{+-} - (1 + x)p_{-+}$$

where:

$$p_{+-} = v \cdot \exp(s)$$
$$p_{-+} = v \cdot \exp(-s)$$

In the context of our model, the opinion formation index ($s$) is given by:

$$s = s(x, \lambda_+, d) = a_1 x + a_2 \lambda_+ + d$$
Model Description

The Switching Function

![Graph of the switching function with opinion formation index (s) on the x-axis and a curve indicating the function's behavior.]}
Model Description

“"It is not a case of choosing those [faces] that, to the best of one’s judgment, are really the prettiest, nor even those that average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees.”

(Keynes 1936)
Model Description

Our first 2D system

\[ \dot{\lambda}_+ = \gamma x \]
\[ \dot{x} = v \left[ (1 - x) \exp(s(x, \lambda_+, d)) - (1 + x) \exp(-s(x, \lambda_+, d)) \right] \]

- By setting the LHS = 0 we can derive the unique equilibrium \((\lambda_+^*, x^*) = (d/(-a_2), 0)\). We assume that \(d > 0\) and \(a_2 < 0\).
  - \(d\) is the financial condition index. It captures the equilibrium level of loan-to-reserve ratio, given certain value of \(a_2\)
  - \(a_2\) can be interpreted as the debt tolerance parameter.
Model Description

- The Jacobian of the system is derived as:
  \[ J = \begin{pmatrix} 0 & \gamma \\ 2\nu a_2 & 2\nu(a_1 - 1) \end{pmatrix} \]

- The Trace of \( J \), \( \text{Tr}(J) = 2\nu(a_1 - 1) \), and the determinant of \( J \), \( \text{Det}(J) = -2\nu a_2 \gamma \). The determinant of the Jacobian, \( \text{Det}(J) \) is always positive give that \( a_2 < 0 \). As for \( \text{Tr}(J) \), When \( 0 < a_1 < 1 \), in other words when the herding effect is weak, \( \text{Tr}(J) < 0 \), the system is stable; however, when \( a_1 > 1 \) (when the herding effect is strong), \( \text{Tr}(J) < 0 \), the system is unstable.
Model Description

Introducing a real sector
\[
\dot{y} = \sigma (y^d - y) \\
y^d = y_0^d + k L^s
\]

Hence:
\[
\dot{y} = \sigma \left( y_0^d + k \frac{T_c}{2} (1 + x) \lambda_+ - y \right)
\]

Furthermore:
\[
\dot{\lambda}_+ = \gamma_1 x + \gamma_2 \dot{y} \\
s(x, \lambda_+, y^d - y, d) = a_1 x + a_2 \lambda_+ + a_3 (y^d - y) + d
\]
Model Description

Introducing a real sector

\[ \dot{\lambda}_+ = \gamma_1 x + \gamma_2 \dot{y} \]
\[ \dot{y} = \sigma_1 (y_0^d + \kappa (1 + x) \lambda_+ - y) + \sigma_2 x \]
\[ \dot{x} = \nu [(1 - x) \exp(s(.)) - (1 + x) \exp(-s(.))] \]

Where: \( s(x, \lambda_+, y, d) = a_1 x + a_2 \lambda_+ + a_3 (y^d - y) + d \)

Again, by setting the LHS = 0 we can easily derive that the equilibrium of the system is given by \( (\lambda_+^*, y^*, x^*) = (-d/a_2, y_0^d + \kappa d/(-a_2), 0) \).
Model Description

The feedback loops

Self-reinforcing Herding Effect

\( s \) increases

Positive Feedback

\( x > 0 \) (optimism)
\( x \) increases
\( x \) decreases
\( x < 0 \) (pessimism)

loan-to-reserve ratio increases

credit supply (\( L \)) increases

\( d \)
\( Y \) increases

output gap (\( y - \hat{y} \)) increases

\( s \) decreases

Negative Feedback (due to accumulation of debt)

Sydney Agent Seminar
Model Description

A representative run of the system (instability scenario)
Model Description

A representative run of the system (stability scenario)
Model Description

Some basic sensitivity analysis

- $a_1 = 0.3$
  - Output vs. time
  - $a_1 = 0.8$
  - Output vs. time
  - $a_1 = 1.3$
  - Output vs. time

- $a_2 = -0.02$
  - Output vs. time
  - $a_2 = -0.12$
  - Output vs. time
  - $a_2 = -0.22$
  - Output vs. time

- $a_3 = 0.5$
  - Output vs. time
  - $a_3 = 1$
  - Output vs. time
  - $a_3 = 1.5$
  - Output vs. time
Some thoughts about extending the model

- Derive the Jacobian of the 3D system and apply Routh-Hurwitz condition to find the stability conditions
- Adding some stochastic component
- Introducing a price dynamics that captures the interaction between fundamentalists and a chartists (speculator)
Concluding remarks

- What we have found?
  - i. Sentiment contagion (herding) amongst banks plays an important role in propagating the cycle
  - ii. Other opinion formation parameters (debt tolerance and respond to change in output gap) also play some role

- Future works:
  - i. More realistic banker’s behaviour
  - ii. Integrating a banking sector into the recently developed Dynamic Stochastic General Disequilibrium (DSGD) Model of real-financial interaction (Charpe et al, 2012)
Questions?

Thank you for your comments 😊
Reference


