Modelling the “Animal Spirits” of Bank’s Lending Behaviour
(incomplete, preliminary version)

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Abstract

The idea that animal spirits amplify the business cycle is the central insights that Keynes elaborates in his General Theory. In particular, the collective waves of optimism and pessimism of bankers play an important role in the formation of credit cycle. In this paper we construct a model and analyses how the animal spirits of banks affect their lending behaviour, which contributes to the boom and bust of credit bubble and amplifies business cycle. We adopt Lux (1995) framework to model the herding of banks. The model has a particular emphasis on fractional reserve banking mechanism and it is capable of generating endogenous credit cycle and capturing the pro-cyclical bank lending activities observed in empirical literature. The boom phrases trigger banks’ optimism thus banks collectively make excessive lending into a particular area, thus reinforce the credit bubble. Eventually the bubble collapses due to banks over-leverage.

Keywords: animal spirits; contagion; pro-cyclical credit cycle; financial fragility

JEL classifications: TBA

1 Introduction

“Banks are much more social creature than most people think. Understanding banks is not about brute facts. The values on a balance sheet are dependent upon confidence, and when an institution is in trouble those values are quite different from the figures when the institution is thought to be doing well. So value is dependent on confidence,

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The recent financial crisis in 2007 has revived an interest of studying the role of financial factors such as banking and financial market speculation in amplifying business cycles in the real sector. In the traditional banking literature that attempts to address this real-financial interaction problem, the commercial bank is often modelled as a passive intermediary that channel funds from the ultimate borrower to the ultimate lender. Bernanke et al (1999) is one of the most influential amongst this string of literature, where they examine the role of asymmetric information between borrowers and lenders (to be continued).

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. As many Post-Keynesian literature points out, the creation of loan simultaneously creates deposit, which creates endogenous money, and deposit is part of the broad money (M3) (Taylor, 2004). In other words, the banks behaviour is not a passive reflection of the conditions of the economy, but is in itself an important factor that influences the economy via creating endogenous money.

Another important aspect, which is overlooked in the traditional banking literature, is the role of banks 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. Eventually the bubble bursts due to factors such as an unsustainable level of debt (Kindleberger, 1989). On the contrary, a collective pessimistic banking system not only hinders economic growth but also render expansionary monetary policy ineffective, as we have observed in the recent financial crisis. In the aftermath of the crisis, the money base has grown triple times due to three rounds of Quantitative Easing (QE), however, it has virtually no effect on the growth of broad money due to an inactive and pessimistic banking sector (Koo, 2011).

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, in which he claims that: most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits: of a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities. The animal spirits has two important characteristics. First, it is self-fulfilling: an optimistic/pessimistic sentiment will bring forth a positive/negative outcome to the market, which further reinforces the optimistic/pessimistic sentiment. Second, it is contagious: sentiment spreads and it eventually leads to herding amongst agents. The herding behaviour in financial market is well-documented in empirical literature (Haiss, 2005). Surprisingly, there is also notable amount of literature that finds empirical evidence of herding amongst banks, particularly in the context of US and Japan.

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. Franke (2010) and Charpe et al (2012) apply the Lux model to macroeconomic modelling. De Grauwe (2010) develops a DSGE model that is augmented
by agents cognitive limitations. More recently, Asanuma (2012) examines how banks lending attitude affects economic growth in an agent-based setting, where there is a monopolistic bank and multiple borrowers. The main purpose of this paper is to analyse 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; and what is the consequence on the real side of business fluctuations? We adopt Lux (1995) framework to model banks opinion formation dynamics. There are several features that distinguish this paper from the existing literature. First, compared to the literature of real-financial interaction such as Charpe et al (2012) that looks at financial market, we examine the role of banks other than financial market in real-financial interaction; second, compared to the traditional banking literature, we emphasis on banks role in credit creation rather than financial intermediation; and third, compared to Asanuma (2012) where there is only one single bank, we model the behaviour of multiple banks and take into account of contagious effect of animal spirits amongst the bankers.

The rest of the paper is organized as follows

2 Model Description

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2.1 The Baseline Model

To address the first question proposed in the previous section, we consider the following baseline model. We categorize banks into two groups, i.e. the optimistic banks and the pessimistic banks. Formally, suppose that there are $2N$ banks in the economy, of which $n_+$ is the number of optimists and $n_-$ are the number of pessimists, thus $n_+ + n_- = 2N$. Following Lux (1995), we focus on the difference in the size of the two groups by defining the index $x$ where:

$$x = (n_+ - n_-)/2N \quad (1)$$

The index $x$ essentially captures the average opinion of banks. When $x = 0$, there are equal number of optimistic and pessimistic banks. When $x = 1$, it implies that all the banks are optimistic or pessimistic. Taylor (2004) proposes a simple way of modeling banks lending behavior where the level of bank credit is proportional to their base of unborrowed reserves, as is specified in the following equation:

$$L^s = \lambda^s T_c \quad (2)$$

where $L^s$ is the level of aggregate credit supply, $\lambda^s$ is the loan-to-reserve ratio of banks, and $T_c$ is the level of unborrowed reserves.

However, given that there are two groups of banks in our model, and each group has
different loan-to-reserve ratios. Therefore we modify the equation to:

\[ L^s = R(n_+ \lambda_+ + n_- \lambda_-) \tag{3} \]

where \( R \) is the unit reserve of each bank. It is assumed that each bank holds the same amount of reserves \( (T_c = 2NR) \). \( \lambda_+ \) and \( \lambda_- \) are the loan-to-reserve ratio of optimistic and pessimistic banks respectively. For simplicity lets assume that \( \lambda_- = 0 \), which indicates that the pessimistic banks are completely inactive. Hence we have:

\[ L^s = Rn_+ \lambda_+ = RN(1 + x)\lambda_+ = (T_c/2)(1 + x)\lambda_+ \tag{4} \]

In equation (4), the aggregate unborrowed reserve \( T_c \) is assumed to be exogenous. The variable \( x \) and \( \lambda_+ \) are of our main interest, which are assumed to be endogenous. First lets consider the law of motion for \( \lambda_+ \). For simplicity, we assume that the rate of change of \( \lambda_+ \) is purely determined by the average opinion \( x \). When \( x > 0 \), the optimistic banks expand their balance sheet even further at a speed \( \gamma \); when \( x < 0 \), they contract their balance sheet position at the same speed \( \gamma \), when \( x = 0 \), the balance sheet position of optimistic banks remain unchanged. Hence the law of motion for \( \lambda_+ \) is assumed to take the following form:

\[ \dot{\lambda}_+ = \gamma x \tag{5} \]

Second, we model the law of motion of \( x \) according to Lux (1995). Let \( p_{+-} \) be the transition probability that a pessimistic bank becomes an optimistic one, and likewise for \( p_{-+} \). The change in \( x \) depends on the size of each group multiplied by their transition probability:

\[ \dot{x} = (1-x)p_{+-} - (1+x)p_{-+} \tag{6} \]

![Figure 1: the switching function](image)
“It is not a case of choosing those [faces] that, to the best of ones 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)

We assume that there are three factors that affect the transitional probability: the bankers average opinion \( x \), which captures the contagion effect (herding); the loan-to-reserve ratio of the optimistic banks \( \lambda_+ \); and a general financial condition index \( d \) that is assumed to be a constant. Specifically we compose a switching index \( s \), which is simply a linear combination of the three factors:

\[
s(x, \lambda_+, d) = a_1 x + a_2 \lambda_+ + d
\]

An increase in \( s \) is assumed to increase the probability that the pessimistic banks become optimistic ones, and vice versa. Furthermore, if we assume that the relative changes of \( p_{+-} \) and \( p_{-+} \) in response to changes in \( s \) are linear and symmetric, the probability can be written as:

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

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

Given the above assumptions, our first dynamic system is given by the following equations:

\[
\dot{\lambda}_+ = \gamma x
\]

\[
\dot{x} = v[(1 - x) \exp(s(x, \lambda_+, d)) - (1 + x) \exp(-s(x, \lambda_+, d))]
\]

By setting the LHS = 0 we can derive the unique equilibrium \((\lambda^*, x^*) = (d/(-a_2), 0)\). Given that the loan-to-reserve ratio of a bank has to be positive, we have to make an assumption that \( d > 0 \) and \( a_2 < 0 \). The economic justification is that, first, the accumulation of debt and an increasing leverage of banks, reflected in an increasing loan-to-reserve ratio \( \lambda_+ \), always has a negative effect on the opinion formation index \( s \). Second, the financial condition index here determines the equilibrium loan-to-reserve ratio of the optimistic banks given certain level of \( a_2 \). It has to be positive since \( \lambda_+ \) has to be positive.

The Jacobian \( J \) of system is derived as:

\[
\begin{pmatrix}
0 & \gamma \\
2va_2 & 2v(a_1 - 1)
\end{pmatrix}
\]

In the above Jacobian \( J \), \( Tr(J) = 2v(a_1 - 1) \), and \( Det(J) = -2va_2\gamma \). The \( Det(J) \) is always positive give that \( a_2 < 0 \). As for \( Tr(J) \), When \( 0 < a_1 < 1 \), in other words when the herding effect is weak, \( Tr(J) < 0 \), the system is stable; however, when \( a_1 > 1 \) (when the herding effect is strong), \( Tr(J) < 0 \), the system is unstable.
2.2 Introducing a Real Sector

A more important object of the paper is to examine how the animal spirits influences fluctuations of the real economy through banking sector. To achieve this, we introduce a real sector of output dynamics by adopting Blanchard (1981)\(^1\), where he proposed that:

\[
\dot{y} = \sigma(y^d - y) \tag{12}
\]

where \(y\) is the output; \(y^d\) is the aggregate demand; \(\sigma\) is the speed of adjustment.

In the context of this paper, we assume that the aggregate demand \(y^d\) is determined by an autonomous component \(y_0^d\) and the availability of credit \(L^*\):

\[
y^d = y_0^d + kL^* \tag{13}
\]

Substituting (4) and (13) into (12) we get:

\[
\dot{y} = \sigma(y_0^d + k(T_c/2)(1 + x)\lambda_+ - y) \tag{14}
\]

Here we also make two modifications over the original model after we introduce this real sector. First, the output gap \(y^d - y\) now enters the opinion formation index \(s\); second, regarding the behaviour of the optimistic banks, We assume that the loan-to-reserve ratio of optimistic banks \(\lambda_+\) adjusts not only by the average opinion \(x\) but also by the change of real output:

\[
\dot{\lambda}_+ = \gamma_1 x + \gamma_2\dot{y} \tag{15}
\]

where \(\gamma_1\) captures the speed of adjustment regarding average opinion \(x\) and \(\gamma_2\) captures the speed of adjustment regarding change of output \(y^d - y\).

Hence our new system with a real sector can be written as:

\[
\begin{align*}
\dot{\lambda}_+ &= \gamma_1 x + \gamma_2\dot{y} \tag{16} \\
\dot{y} &= \sigma(y_0^d + k(T_c/2)(1 + x)\lambda_+ - y) \tag{17} \\
\dot{x} &= v[(1 - x)\exp(s(x,\lambda_+,y^d - y,d) - (1 + x)\exp(-s(x,\lambda_+,y^d - y,d))]
\end{align*}
\]

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

Again, by setting the \(LHS = 0\) we can easily derive that the equilibrium of the system (16)-(18) is given by \((\lambda^*_+, y^*, x^*) = (d/(-a_2), y_0^d + k(T_c/2)d/(-a_2), 0)\). The Jacobian of this system is derived as:

\[
\begin{pmatrix}
? & ? & ? \\
? & ? & ? \\
? & ? & ?
\end{pmatrix}
\]

The limit cycle system (16)-(18) essentially captures what figure 4 depicts. When the index \(x\) is positive, it leads to an increase of leverage of optimistic banks, thus increases

\(^1\)In the original Blanchard (1981) paper, the aggregate demand is determined by stock price via Tobin’s \(q\).
the credit supply. This is accompanied by an increase of aggregate demand, thus raises output. When bankers sentiment becomes more optimistic, and output gap increases, this reinforces the increase of x, thus forms the positive feedback loop. However, this does not last forever. The increase of bankers leverage means an accumulation of debt, which has a negative impact on the opinion formation index s. At the beginning, the positive feedback outweighs the negative feedback. Up to a certain point when debt accumulation becomes significantly large, the system turns reverses.

Figure 3: A representative run of the system: instability scenario

2.3 Analysis of the behavioural parameters

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3 Conclusion

The modern fractional reserve banking system is inherently unstable due to its role in credit creation. Kindleberger (1981), in his famous book of the history of financial crisis, points out that manias, bubble, and crashes are not simply caused by credit expansion. Yet nearly all manias are associated with credit expansions. In addition, the idea that animal spirits amplify the business cycle is the central insights that Keynes elaborates in his General Theory. One of the key contributions of this paper is the explicit modelling of how the animal spirit of bankers is transmitted to the real economy via credit creation under fractional reserve system. The model presented in previous section is parsimonious. Yet it shows us in what situation the credit expansion engenders boom-bust of credit cycle. It indicates that three factors, i.e. animal spirit herding, tolerance toward debt, and bankers speed of reaction toward change in real output, reflected in the parameters in the opinion formation index have destabilizing effect on the real economy. When these parameters are relatively small, the economy tends to converge toward a stable equilibrium path; when these parameters get larger, the equilibriums become unstable. A small shock will lead the system to persistent fluctuation in the form of limit cycles. On the policy side, we recommend that it is important to curb excess herding amongst banks, which causes credit cycle and amplifies business cycle on the real economy. Yet the result presented in this paper is still far from reality. Our research has several limitations. First, for the sake of parsimony, our assumption over bankers behaviour is simple. Second, we have yet to take into account of other important speculative variables such as interest rate and asset price. Third, we need a more detailed picture of macroeconomy that incorporates inflation, unemployment, and etc. This can be done by
incorporating our banking model into the recently emerging DSGD type model developed by Charpe et al (2012). These topics need to be further examined in future research to make this model useful under a real world setting.

References


