Credit and Banking[1]

Abstract

This topic will investigate selected issues related to the credit and banking aspects of the economy with money. At the macro level, we will ask how the presence of credit (in addition to money) affects the aggregate demand dynamics and its implications for how monetary authority should conduct its policy. At the micro level, we will look at the issue of bank runs and deposit insurance.
Keywords: Credit, Bank runs

1 Introduction

Over the last two topics, we have devoted most of our time discussing the theory of aggregate supply, the objective being to understand whether changes in aggregate demand can influence real output. We have downplayed the details of aggregate demand side intentionally, to keep the models tractable. It is now time to fill in some of these details.

First of all, the aggregate demand is certainly a function of more than the amount of money being printed (high-powered money, or M0). You have learned elsewhere that money in economics means much more than just cash. In particular, commercial banks, by taking deposits from individuals and lending out to businesses, play an important role in generating money in a broader sense, which we shall collectively refer to as credit. Understanding whether credit matters for monetary policy is our first objective.

Commercial banks' business is largely based on trust on the part of depositors. Any commercial bank, no matter how strong it is financially, can go bankrupt overnight if all depositors decide to withdraw their money simultaneously. Thailand painfully witnessed how big the problem can be during the 1997 crisis. We will look at the interactions between banks and depositors from microeconomic lens, and investigate if government has any role to play in reducing the chance of bank runs. If central banks want their monetary policy to affect the aggregate demand efficiently, they will certainly want the banking system to be sound!

2 Credit, Money and Aggregate Demand

The material in this section is drawn from Bernanke and Blinder (1988). The structure of the model is based on the standard IS-LM. The standard LM analysis comprises money and bonds as the only two assets available in the economy. In this model, we draw a distinction between bonds and loans. The former may be thought of as auction-market credit whilst the latter is customer-market credit. We assume that the two assets are not perfectly substitutable, so the demand for each type of credit will depend on the interest rates of both types.

Let us start from the loan market equilibrium. Specifically, let the loan demand be given by

$$: L^d = L(\underset{-}{\rho}, \underset{+}{i}, \underset{+}{y})$$

[1] Lecture note by Dr. Phurichai Rungcharoenkitkul (2010)

where ρ is the rate of interest on loans, i is the rate of interest on bonds, and y is the level of output. Higher loan interest rate will lower the demand from consumers, whilst a higher bond interest rate will raise the demand for loans (as they are imperfect substitutes). Higher income boosts demand for loans for transaction purposes. To understand the supply of loans, one requires some basic understanding of the bank balance sheet. The asset side includes bonds B^b, loans L^s, and reserve R. The liability side has deposits D. A portion τ of deposits will be required by authority to be kept as reserve. The bank may decide to keep more reserve than required, in which case there will be an excess reserve E. Thus we have

$$\begin{aligned} &B^b + L^s + R = D \\ &B^b + L^s + E + \tau D = D \\ &B^b + L^s + E = (1-\tau)D \end{aligned}$$

Now, the bank must decide how to organize its portfolio of assets which is backed by deposits. How much to hold in bonds, loans and reserve as a proportion 'free' deposits $(1-\tau)D$? Let the desired proportion of loans be a function of the interest rates for loans and bonds, assuming the bank is seeking higher yields from its investment.

$$L^s = \lambda(\underset{+}{\rho}, \underset{-}{i})D(1-\tau)$$

Equating the demand and supply for loans gives us the loan market equilibrium:

$$L(\rho, i, y) = \lambda(\rho, i)D(1-\tau) \qquad (1)$$

Similar conditions can be established for bonds and excess reserve.

Next, let us construct a standard LM curve. The analogy of money supply in this model is the magnitude of deposit D. The size of D will be determined amongst other things by the total reserve R, which the central bank can control directly via open market operations (we will discuss in details the actual practice of this in topic 6, but for the moment, if you are interested, take a look at Walsh's book [Wa] in reading list, chapter 9 "Monetary-Policy Operating Procedures"). To see this, assume that the desired proportion of excess reserve is just a function of interest rate on bonds:

$$E = \varepsilon(\underset{-}{i})D(1-\tau)$$

We could invert this, to find the supply of deposit (how many deposit accounts banks want to put on their book) for any given R set by the central bank:

$$\begin{aligned} R &= \varepsilon(i)D(1-\tau) + D\tau \\ &= D[\varepsilon(i)(1-\tau) + \tau] \\ D &= [\varepsilon(i)(1-\tau) + \tau]^{-1} R \end{aligned}$$

Let the demand for deposit $D\left(\underset{-}{i}, \underset{+}{y}\right)$ depend on interest rate and income (via transaction motives) as usual, we will then have an LM curve relationship being

$$D(i, y) = \left[\varepsilon(i)(1-\tau) + \tau\right]^{-1} R \qquad (2)$$

The coefficient is sometimes referred to as the money multiplier, as it measures the extent to which total reserve magnifies the size of total deposits.

Finally, we keep the IS relationship simple:

$$y = Y\left(\underset{-}{i}, \underset{-}{\rho}\right) \qquad (3)$$

The solution will be determined by the IS-LM intersection point. The first objective is to derive a relationship analogous to the IS curve. We do this by combining equations (1) and (2), which implies a reduced-form

$$\rho = \phi(i, y, R) \qquad (4)$$

Exercise 1: Suppose that money multiplier does not vary too much with i, prove that

$$\phi_1 > 0, \quad \phi_2 > 0, \quad \text{and } \phi_3 < 0$$

Substitute (4) into (3) to get the output expression

$$y = Y\left(i, \phi(i, y, R)\right) \qquad (5)$$

Exercise 2: Draw a curve depicting the relationship between i and y according to equation (5). Call this the CC curve, for credit-commodity. On the same diagram, draw a curve depicting the same relationship as implied by equation (2). This is the LM curve.

This model adds the credit feature to the IS-LM analysis: in particular, now the credit supply λ and credit demand $L(,,)$ functions both shift the CC curve. We can draw qualitative implications of this model for policy problem by considering the impact of different types of shocks on the output.

TABLE 1—EFFECTS OF SHOCKS ON OBSERVABLE VARIABLES

Rise in:	(1) Income	(2) Money	(3) Credit	(4) Interest Rate[a]
Bank Reserves	+	+	+	−
Money Demand	−	+	−	+
Credit Supply	+	+	+	+
Credit Demand	−	−	+	−
Commodity Demand	+	+	+	+

[a] On bonds.

TABLE 2—SIMPLE CORRELATIONS OF GROWTH RATES OF GNP WITH GROWTH RATES OF FINANCIAL AGGREGATES, 1973–85[a,b]

Period	With Money	With Credit
1953:1–1973:4	.51,.37	.17,.11
1974:1–1979:3	.50,.54	.50,.51
1979:4–1985:4	.11,.34	.38,.47

[a] Growth rates are first differences of natural logarithms.

[b] Correlations in nominal terms come first; correlations in real terms come second.

3 Bank Runs

Smooth and efficient operation of commercial banks is crucial for the working of the real economy. We all witnessed how failures of Thai banks in 1997 had contributed to the eventual scale and depth of the economic meltdown. The welfare loss caused by bank runs is largely associated with interruptions to productive investment projects which need financing from banks.

In general, the banking business generates economic values by transforming illiquid assets into liquid ones, i.e. by allowing those without liquidity need to earn a high returns in the long-run, whilst providing liquidity with reasonable returns to the others who need it in the short-run. However, precisely because of this liquidity service, a bank may have put depositors in a strategic setting: one is likely to withdraw early and demand liquidity if everyone else is doing the same, and hence jeopardizing the solvency of the bank. We now seek to formalize this intuition by considering an explicit model of bank runs, due to Diamond and Dybvig (1983).

3.1 The Model

Production Technology

We seek to describe, in simplest terms, the notion of short-term liquidity need versus the returns from long-term investment. Accordingly, let the production technology be characterized by 3 stages or periods. In period T=0, each agent is endowed with 1 unit of goods, and invests the endowment. If the production is uninterrupted, it will yield returns R>1 in period T=2. If production is interrupted in period T=1, the agent gets back the scrap value equal to her endowment 1.

Types and Preferences

There are 2 types of agents. Type 1, or the impatient type, only cares about consumption in period 1. These agents require liquidity, and need to withdraw from the investment. Therefore this type of agents will have a utility function given by $u(c_1)$, where c_1 is the consumption in period 1. On the other hand, type 2 agents do not have any liquidity problem, and care equally about consumption in both periods. Assume that their utility function is given by $u(c_1 + c_2)$, implying that consumption in period 1 is a perfect substitute for consumption in period 2. Let t be the fraction of type-1 agents.

Information Structure

At T=0, nobody knows her own type, but everybody knows the proportion t. In period 1, each agent finds out her type, i.e. whether she has liquidity need. Types are private information, and cannot be easily verified by others.

$$
\begin{array}{ccc}
T = 0 & T = 1 & T = 2 \\
-1 & \begin{cases} 0 \\ 1 \end{cases} & \begin{array}{c} R \\ 0, \end{array}
\end{array}
$$

3.2 Banks, Allocation and Risk Sharing

We now describe different possible allocations in this economy.

3.2.1 Autarky

If an agent can only rely on own resource, she will invest everything in period 0, withdraw everything in period T=1 if she turns out to be the impatient type, and saves everything otherwise. Thus, given the production technology, the expected utility of this agent is given by

$$E(u) = tu(1) + (1-t)u(R)$$

3.2.2 Competitive Equilibrium

Before types are revealed in period 1, agents may decide to get together in period 0 to buy and sell units of commodities to be delivered in periods 1 and 2. In finance, this is nothing but transactions in forward markets, i.e. prices are agreed and money is exchanged today, for goods to be delivered tomorrow. In economics, we refer to this type of transactions as trade on ‘claims’.[2] Recall that a competitive equilibrium is one where (a) all agents maximize utility/profit, (b) agents are price takers, and (c) the economy’s resource constraint is respected and market clears.

Exercise 3: Show that in the competitive equilibrium, (a) the period-0 price of period-1 goods is 1 (b) the period-1 price of period-2 goods is 1/R, and (c) the period-0 price of period-2 goods is 1/R.

Note that under these equilibrium prices, the consumption allocation is no different from that under autarky, hence agents yield the same utility. There is therefore no private incentives for agents to conduct trade in this environment. In welfare terms, the competitive allocation is no better than the no-trade allocation.

The autarky allocation is inefficient from the agents’ point of view in the sense that it involves risk that agents would like to insure against, but they cannot. If you are lucky and turn out to be the patient type, you get R, otherwise you get 1, and nothing in between is available. This stems largely from the inability to verify types. If types can be easily verified, then in period 0, agents can contract on contingent claims, such that the patient type agrees to allocate some consumption to the impatient. In that case, ex ante the consumption pattern will be smoother, and expected utility higher for risk-averse agents.

3.2.3 Social Planner Allocation

To get an idea of what is the best possible outcome, let us make a strong assumption that there exists a benevolent social planner, who is able to observe all agents’ types in period 1. This would allow the planner to be able to allocate consumption away from the patient to the impatient type, and raise ex ante expected utility. Economists also refer to such transfer as ‘risk sharing’, as it is essentially an insurance programme.

Note that clearly the planner will not allocate any consumption to the impatient type in period T=2, as it is of no value to them. Next, note that the planner will never want to allocate any consumption to the patient type in period T=1. This is because the utility function of the patient type weighs consumption in periods 1 and 2 equally ($u(c_1 + c_2)$), but it is always productively more efficient to wait till period T=2 and let the production process be completed (as R>1). Denoting the consumption allocated to each impatient agent in period T=1 by c_1 and the consumption allocated to the patient type in period 2 by c_2, the social welfare function is given by

$$tu(c_1) + (1-t)u(c_2) \qquad (1)$$

In period 1, there is a fraction t of agents who are impatient, and the planner will need to give out tc_1 units of goods in period 1, which is also the amount of investment liquidation required. What

[2] Generally, agents can even trade on claims contingent on realizations of random events. E.g. you may agree to pay your friend some money, in exchange for promises that if it rains tomorrow, your friend will deliver you an umbrella. An important result in microeconomics is that, if there exists a competitive market for every contingent claim that agents conceivably want to trade on, then a competitive equilibrium is Pareto efficient (Arrow-Debreu result). In the current application, agents cannot transact on claims contingent on type, because types can only be observed privately and cannot be verified. The best they could do is to trade on uncontingent future claims.

is left remains in the production process which will yield return R, so the total available resource for the patient type in period 2 is $(1-t)c_2 = (1-tc_1)R$, which can be rewritten as

$$tc_1 + (1-t)\frac{c_2}{R} = 1 \qquad (2)$$

The first-order condition (i.e. maximizing equation (1) w.r.t (2)) defines the optimal risk-sharing solution, and is given by

$$u'\left(c_1^*\right) = Ru'\left(\frac{\left(1-tc_1^*\right)}{1-t}R\right) \qquad (3)$$

Exercise 4: Under what conditions, will $c_1^* > 1$ and $c_2^* < R$?

3.2.4 Banks' Allocation

Banks offer deposit contracts that provide reasonable returns even if depositors may decide to withdraw early due to short-run liquidity need. The commercial banking business is therefore a promising candidate for a decentralized form of risk-sharing.[3] Unfortunately, as we shall see, this function as a liquidity provider is also what makes banks susceptible to bank runs.

Let the deposit contract offered by a bank specify that each deposit withdrawal in period 1 will be paid r_1. In period 2, all the bank's assets will be liquidated, and distributed equally to remaining depositors. Let f be the fraction of depositors who withdraw in period 1.

In period 1, the bank faces total withdrawal equal to fr_1. If the withdrawal does not exceed the total resource available at the bank (i.e. $fr_1 < 1$), then the payoff to each withdrawing agent in period 1 is equal to the full return

$$V_1 = \frac{fr_1}{f} = r_1$$

and the payoff to the withholding agent in period 2 is equal to the residual investment times return:

$$V_2 = \left(\frac{1-fr_1}{1-f}\right)R$$

On the other hand, if withdrawal in period 1 is excessive, for example if there is a bank runs, and $fr_1 > 1$, then all withdrawing agents will get a split share of all assets in period 1, whilst the withholding agents get nothing in period 2:

[3] Commercial banks cannot and do not make an attempt to verify the liquidity needs of their clients and depositors.

$$V_1 = \frac{1}{f}$$

$$V_2 = 0$$

The decision whether to withdraw is completely free for agents to choose. Even the patient type can withdraw in period 1 if she so wishes. One may readily recognize the game theoretic aspect of the problem here; if a sufficient number of depositors is expected to withdraw, no value of r_1 will be persuasive enough for one to wait until period 2.

Let us now check follow a more formal route, and establish the set of Nash equilibria. Let us start with a set of beliefs, and verify if they can be supported as a Nash equilibrium. Consider the following 2 cases.

Case 1: A Good Equilibrium

Let depositors withdraw according to their liquidity need, so that only the patient type withdraws in period 1. In this case, $f = t$. Furthermore, let the bank sets $r_1 = c_1^*$, the consumption that mimics the social planner solution. Then we have

$$V_1 = c_1^*$$

$$V_2 = \left(\frac{1 - tc_1^*}{1 - t} \right) R = c_2^*$$

It is easy to check that this set of payoff is consistent with a Nash equilibrium. The impatient will no doubt withdraw in period 1 as she has liquidity need. The patient will not want to withdraw in period 1 given this set of belief, as $c_1^* < c_2^*$, hence indeed $f = t$. This decentralized outcome perfectly replicates the optimal risk-sharing solution under social planner problem.

Case 2: Bank Runs Equilibrium

Consider another set of belief, where all agents withdraw so that $f = 1$, and let $r_1 > 1$, so that we have an excessive withdrawal. Then

$$V_1 = 1$$

$$V_2 = 0$$

which will induce the patient type to withdraw in period 1, confirming that this is also a Nash equilibrium.

The key point is that bank runs can only be ruled out as a possible Nash equilibrium only if $r_1 = 1$. But under that scenario, banks would be providing no risk-sharing service to the economy! Agents could replicate the same allocation under autarky. As soon as banks add values in terms of allowing risk-sharing in the economy by providing deposit contracts, they necessarily expose themselves to bank runs.

Numerous solutions have been proposed to reduce the risk of bank runs. The Diamond-Dybvig framework can be used to analyse the policy implications of convertibility suspension, and government deposit insurance scheme for instance. See the paper for the details!