Banks and macro Part 1

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Lecture note for ECON 4335 The Economics of Banking

1 Introduction

The purpose of this lecture note is twofold. The first is to provide some factual background information about the banking system. The second is to provide a link between the macro and micro-based models in the reading list and the statistical aggregates that appear in the national accounts.

Sections 2-4 are background information mainly. Some of it may seem elementary and obvious, but it may still be worthwhile to reflect a little about things we think we know. The remaining sections will contain three related models of increasing complexity. Only the first one is contained in this installment. The remaining sections will be made available as soon as possible, and we will come to these models in lecture 10. In the models we take seriously that banks deal with fiat money or should we say electronic money.

2 What do banks do?

The defining characteristics of banks are

1. They take deposits from the general public (households and firms).
2. They accept deposits that the depositors are allowed to withdraw at any time without notice (demand deposits).
3. They extend loans to households and firms. The loans cannot be reclaimed before a certain period has elapsed.

In other words, banks "lend long and borrow short" or they carry out "maturity transformation". Depending on how they are regulated, banks may do many other things too, but we shall focus on the core activities and activities that follow as consequence of these.

Bank deposits are money in the sense that they are commonly accepted means of payment. A transfer between bank accounts is in most transactions

Table 1: Bank balance sheet

Assets		Liabilities	
Loans to the public	L	Deposits from the public	D
Bonds and bills	B	Loans from other banks	$\tilde{L}_b$
Loans to other banks	L_b	Loans from the central bank	L_{cb}
Deposits at the central bank	D_{cb}		
Total assets		Total liabilities	
		Equity	

accepted as equivalent to an exchange of the official currency (bank notes and coins). Having demand deposits in a bank is equivalent to having bank notes. Hence, the stock of money in the hands of the general public is usually defined as the sum of their holdings of currency and of bank deposits.

Table 1 shows the items that one expects to find on the balance sheet of any bank. On the asset side are loans to the general public, loans to other banks, deposits at the central bank, currency and bonds and bills. The liabilities are deposits from the general public, loans from other banks and loans from the central bank. The difference between assets and liabilities is of course the bank's equity or net worth, which belongs to the bank's shareholders. The balance sheet may contain other items, for example bonds issued by the bank itself or, if the law permits, shares in other companies. For a typical bank the deposits will dominate on the liability side and the loans on the asset side.

Banks as financial intermediaries

If firms or governments want to borrow, they can sell bonds or bills directly to investors instead of going through banks. Why not dispense with the middle man? The answer has four key-words: Liquidity, diversification, screening and monitoring.

By definition one financial instrument is more liquid than another if it can be changed into common means of payment, more rapidly, with lower cost, less effort and less uncertainty about price. Bonds and bills are on all these criteria less liquid than bank deposits. People like liquidity. Hence, they will buy bonds only if the expected return on bonds is higher than the interest rate on deposits. In other words, the interest rate on bonds must include an (il)liquidity premium.

Furthermore, banks pool the deposits of many investors and are therefore able to diversify their investments (spread their loans) to a degree that would be impossible for individuals without incurring prohibitive administrative costs. Thus, even in the absence of deposit insurance, bank deposits contain less credit risk than the best portfolios of bonds and bills that individuals can assemble on their own. This conclusion is reinforced when we think of that someone has to to screen borrowers for their ability and willingness to pay and monitor their behavior until the loan is repaid. Banks can keep down the costs of these activities by acting as a monitoring and screening agent for a large number of

investors.

Banks are not the only institutions that can keep down the costs of diversification, monitoring and screening. Mutual funds, buy-out firms and similar institutions can do the same. However, mutual fund managers and banks have different incentives. In banks the owners of equity are first in line to take losses due to poor screening or monitoring. In mutual funds the customers are first in line. The merits of bank financing versus market financing is a subject for the micro part of ECON4335. What is important from the the macro point of view is that if banks suddenly reduce their lending, we cannot expect market financing to replace it. Households and small and medium sized firms are particularly dependent on bank financing. Issuing tradable bonds or commercial paper requires fixed costs. For investors there are fixed costs for every issuer they consider. Hence, for small issues it is impossible to create a liquid and competitive market.

Bonds and bills

By bonds and bills we mean marketable loans that can eventually be spread on many investors. Conventionally those with more than one year to maturity are called bonds, those with shorter maturity bills or certificates. Most often the interest rate is fixed for the whole duration, but it can also be more or less adjustable. In the present note we assume that interest rates are adjustable in order to avoid having to account for capital gains and losses. This is not important for our conclusions. Banks often issue bonds or bills to finance loans with fixed interest rates or just to make sure they have some more stable financing. Central banks typically use treasury bills for their open market operations in domestic currency. Recently they have also bought fixed interest rate bonds in attempts to bring down long-run interest rates. This is one example of what is now called unconventional monetary policy. Until quite recently virtually every textbook in macroeconomics treated this as the normal central bank procedure.

Norges Bank instead of using T-bills has created its own instruments F-loans and F-deposits. Both have fixed maturity and fixed interest rates and are sold in auctions where only banks can participate. F-loans are used to increase the liquidity of the banking sector and F-deposits to reduce the liquidity. This shows up as changes in the level of demand deposits banks have at the central bank. The arrangement means that Norges Bank do not need to hold bills or bonds in kroner from other sectors in order to carry out normal market operations.

Banks as creators of money

It is important to understand that the way banks create liquidity is by lending. Loans create deposits and leave more cash in the hands of the public.

Suppose ABC bank lends 10 million kroner to a builder. The ten million are then credited to the builder's account in the bank. This means the money supply to the general public has suddenly increased by 10 million kroner. In the

bank's balance sheet L on the asset side and D on the liability side have both increased by 10 billion kroner. The builder may draw on his account to pay a saw-mill say 4 million kroner for materials. If the mill has an account in the same bank as the builder, the sums in the bank's balance sheet stay the same. The only change is that the distribution of D on different names has changed.

If the mill has its account in another bank, say Bank 123. then Bank ABC needs to settle the transaction with Bank123. Suppose both banks have accounts in the central bank and that ABC has more than 4 million in deposits there. Then it can transfer the 4 million from its own account in the central bank to the account of Bank123. The latter will then credit this to the account of the saw mill. This reduces both assets and liabilities on the balance sheet of ABC bank with 4 million kroner. On its asset side deposits at the central bank are down 4 million and on its liability side deposits from the general public are down 4 million. For Bank123 it is the opposite, both assets and liabilities increase with 4 million kroner. The consolidated balance sheet of the whole banking sector does not change at all. The bank deposits of the general public are still 10 million higher than before the builder got his loan.

There is another, and often better, way to settle the transfer to the saw-mill. The two banks can agree that ABC Bank borrows the 4 million from Bank123[1]. The balance sheet consequences of the payment to the saw mill is then for ABC Bank that 4 million of liabilities are moved from "deposits from non-financial firms" to "deposits from other banks" (interbank loans). For Bank 123 liabilities are increased with 4 million in deposits from non-financial firms, while assets are increased with 4 million in deposits in other banks. Again the consolidated balance sheet of the whole banking sector - where interbank loans are netted out - does not change at all.

The importance of this example is that it shows that banks can expand credit and increase the money supply without any need for central bank involvement. Banks create money by lending to the general public. When a bank gives a loan it also creates a corresponding deposit that "finances" the loan. If the deposit is moved to another bank, the bank needs to refinance the loan. However, as long as none of those who are later in the chain of transfers decide to change their deposits into official currency, the money needed for financing the loan is available somewhere in the bank sector.

In contrast, consider what happens if people come to ABC bank with 1 000 kroner notes they have had "under the mattress". Deposits are increased but only by the same amount as the reduction in notes in circulation among the general public. The public commands neither more, nor less of commonly accepted means of payment. The money supply does not increase. Extra liquidity is not created. Banks can always place the extra money as deposits in the central bank. New deposits does not automatically create new loans.

The idea that deposits are needed before one can lend derives from a time when deposits and loans were gold or silver and the idea was obsolete even

[1] A third possibility is that ABC-bank in advance happened to have a deposit with 123 that it could draw on.

before deposits became just bits in computers.

Note the important role of the interbank loans in the example. If there were no interbank market ABC bank had to make sure that it had sufficient reserves at the central bank before it extended the loan.

The need for buffers

Bank lending creates money. This has been the message so far. However, the deposits of a bank are accepted as means of payments and attractive investment objects only if the risk that the bank will default on its obligations is perceived to be negligible. Hence, banks need to make sure that they are solid and liquid all the time. Solidity requires that the bank has sufficient equity capital to meet variations in loan losses without going broke. More lending means higher potential loan losses and, hence, the need for more equity. This demand is reinforced by capital adequacy requirements set by the government. Lending creates deposits but not equity. (Capital adequacy regulations are a central topic in the micro part of ECON4335).

In the long run banks can only stay solid if they set interest rates on loans that are sufficiently high to cover losses that occur due to borrowers who default. The agency problems that this gives rise to has a prominent place in the micro literature on banking and of course also in ECON4335. Moral hazard and adverse selections are keywords. Banks also have to take account of the facts that entreprenuers tend to be overoptimistic about their projects and that indivuals have problems with some self-control. We shall see later that these information and agency problems are important for the role of banks in business cycles and in the transmission of monetary policy.

Liquidity in this context means that the bank must be able to meet unexpectedly high withdrawals of deposits. If the bank has sufficient equity capital and is deemed solid, it can expect great help from the interbank market. However, banks will always need some additional buffers in the form of highly liquid assets. Traditional banking models used to assume that banks keep a share of their customer deposits in reserve as deposits in the central bank. Some countries also have compulsory reserve requirements of that kind. Loans may finance themselves, but they cannot finance reserves at the central bank on top of that. We need to discuss liquidity buffers further, but then we first have to look more closely at how central banks and the interbank market work.

3 What do central banks do?

The bank of banks

While ordinary banks deal with the general public, central banks receive demand deposits from and lends to ordinary banks. All big banks have accounts with the central bank. They settle the claims they have on each other by transferring money between their accounts in the central bank. These are the defining

Table 2: Central bank balance sheet

Assets		Liabilities	
Bonds, bills	B_{cb}	Currency held by the public	CY_p
Loans to banks	L_b	Currency held by banks	CY_b
		Deposits from banks	D_{cb}
Total assets		Total liabilities	
		Equity (Net assets)	

Table 3: Norges Bank

Balance Sheet 2011[a]. Billion NOK.			
Assets		Liabilities	
Abroad[b]	316	Abroad	23
- Gold and SDRs	14		
- Bank deposits	17	In Norway	231
- Bonds and bills	154	Notes and coins	
- Loans	28	- in banks	12
- Equity	91	- elsewhere	43
- Others	13	Deposits	
		- from banks	92
In Norway	25	- from government	82
- Loans to banks	25	Other debts	2
Total assets	341	Total liabilities	229
		Net assets	112
Sum	341	Sum	341

Source: Statistics Norway.

[a] Financial assets and liabilities only. Government pension fund global not included.
[b] Foreign exchange reserves.

characteristics.

In addition to being the "bank of banks" the central bank of a country typically has a monopoly on issuing bank notes and coins in the official currency and it manages the country's official foreign exchange reserves. It may also provide other banking services to the government. One example is that in some countries (Norway among them) the central government has its main bank account at the central bank. Direct lending from central bank to government is prohibited in an increasing number of countries. Most of them still allow the CB to buy government debt in the second-hand market.

Table 2 shows the items one expects to find on the balance sheets of a typical central bank, while table 3 shows a balance sheet for Norges Bank.

Small banks usually settle their transactions with other banks through bigger banks. (About 20 banks settle the transactions in Norges Bank. The others go

through one of the 20, about 100 through DnB, which in this respect acts as their "central bank").

Targets and instruments

The central bank influences the rest of the economy through interest rates and other conditions on its deposit and loan accounts and through open market operations. The latter means purchases and sales of bonds, bills and other securities or derivatives from securities. Open market operations can involve both domestic and foreign currency. As everyone knows and as we shall say more about later, the way the CB uses these instruments can have strong effects on economic aggregates and also on income distribution. Therefore, the ultimate goal for CBs should be the welfare of the population, not to maximize profits.

Protecting the value of money has always been a main task of central banks. Today this is often made operational as an inflation target, which is what we will have in mind in the sequel. Central banks are also expected to contribute to other goals such as high employment and financial stability. As the bank of banks and the main hub of the national payments system central banks have an obvious interest in the stability of the banking system.

Today the interest rate is generally regarded as the main policy instrument of central banks. However, not long ago almost all textbooks treated the quantity of money as the main instrument. As we shall see these two cannot be used independently. With several goals and a limited set of instruments there are bound to be conflicts between the different goals. Usually the goal of safeguarding the value of money will take precedence.

Since central banks mainly deal with banks and not directly with the general public, banks are the main channel for the transmission of monetary policy to the real economy. Banks decide to what extent changes in the interest rates set by central banks will be passed on to deposits and loans and whether they should lead to changed credit limits for firms and households. New practices and disturbances in the banking system can by themselves have macroeconomic effect and may require action from the central bank.

If the central bank lends to a bank, this creates deposits at the central bank in the same way as loans from ordinary banks create deposits in ordinary banks. The difference is that for each currency there is only one central bank so the deposits cannot be moved anywhere else. First the loan is credited to the borrowing bank's account at the central bank. Payments from bank to bank do not change the total deposits at the central banks, only the distribution between the banks that have accounts there. Whether the central bank lends directly to the banks or buys bonds or bills in the open market does not matter. Unavoidably the payments end up as deposits in the central bank.

If a bank needs more cash or bank notes it can always get that by drawing on its account in the central bank. This means that the central bank does not have full control over the level of deposits. However, in principle it has full control over the sum of deposits at the central bank and currency outside of the central bank. This sum is called the quantity of central bank money. Since any change

Table 4: Balance sheet. Norwegian banks 2008.
Percent of total assets, branches of foreign banks not included.

Assets		Liabilities and equity	
Cash and deposits	11,6	Deposits from	
Securities (current)	11,6	-customers	38,5
Loans to non-financials	59,4	-domestic financials	4,5
Other lending	11,3	-foreign financials	12,9
Loan loss provisions	-0,3	Norges Bank	1,8
Fixed assets and others	6,4	Other deposits/loans	4,5
		Certificates	5,4
		Bond debt	19,0
		Other liabilities	5,5
		Subordinated loans	2,5
		Equity	5,4
Total assets	100	Total	100

on the liability side of the CB balance sheet must be reflected in an equal change on the asset side, the quantity of central bank money cannot change without the central bank being active. Hence, the central bank can effectively determine the amount of deposits it has if it can predict accurately the levels of currency holdings by the banks and the general public.

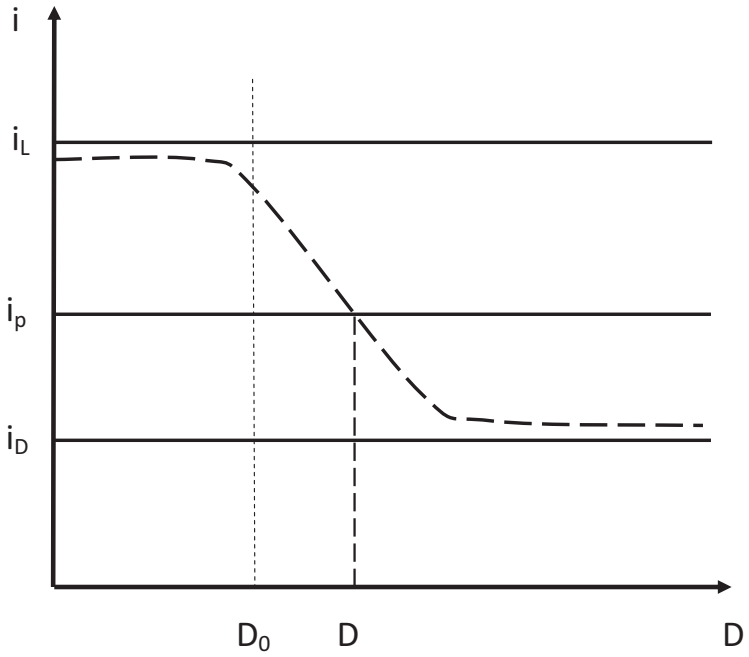
By lending sufficiently the central bank can ensure that there is enough central bank money available at the end of the day that all payments can be settled without any bank in the negative provided that the interbank market distributes the money to those banks that need it. In order to help the settlement process and reduce the reliance on the interbank market central banks usually also offer open credit lines to banks. This is short-run credit primarily meant for use within the day, and perhaps overnight, but it can be rolled over. Banks get a "credit card" in addition to their "debit card". The two accounts are often called the central bank's standing facilities.

It is considered good central bank practice to demand that the banks back their loans with good collateral in the form of bills or bonds from solid issuers (this is the practice in Norway now). The collateral protects the central bank against loss. Importantly, it also makes it more difficult for reckless banks to expand their own lending.

The corridor and the policy rate

The central bank decides the overnight interest rate on the two standing facilities. These define a corridor that the overnight rate in the interbank market has to stay within as in Figure 1. If the overnight interbank rate is below the deposit rate, no bank will want to lend in the interbank market. Hence, the interbank rate can never fall below the deposit rate. If the interbank rate is above the lending rate, all banks will want to borrow to their limit in the central bank,

Figure 1:



and, if there is a surplus, lend it in the interbank market. If the borrowing limits of all banks are sufficiently high, the interbank rate cannot rise above the central bank's lending rate.

In countries which target inflation there is always a key policy interest rate that is set by a high level body: a central bank board or a monetary policy committee. Its level is reconsidered at fixed intervals. The rates on the two standing facilities are adjusted together with the policy rate. Within this framework there are at least three ways to implement the interest rate decision:

1. Set the bottom of the corridor equal to the desired level of the policy rate. Make sure that there is always plenty of reserves available for the banks. Then hope for the banks to redistribute liquidity through the interbank market until every bank ends up at night with positive deposits in the central bank. If the redistribution works, the result will be that the overnight rate ends at the bottom of the corridor, where it was wanted.

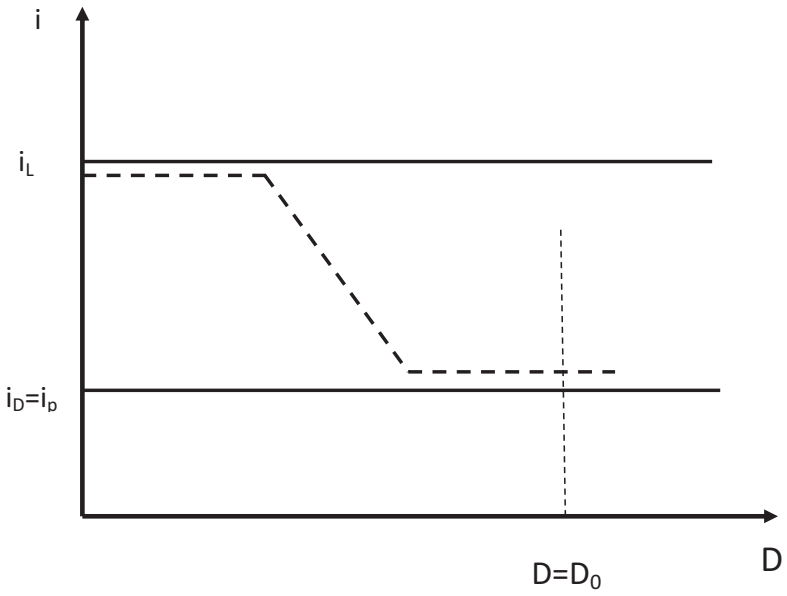
2. Set the bounds such that the desired policy rate is in the middle of the corridor. Between the upper and the lower bounds the banks demand for loans from the central bank will be a falling function of the interest rate. The reason is that banks will be uncertain about whether at the end of the day they will end up as depositors or borrowers. The closer the interbank rate is to the upper bound, the smaller is the loss that is incurred if it turns out that the bank did not manage to borrow enough from the interbank market. When the bank is risk averse this means that it will reduce its borrowing when the interbank rate is high. The central bank then exploits the falling demand curve to fine-tune until the overnight rate is reasonably close to the policy rate. The fine-tuning is done by open market operations, usually "repos". (This means the bank buys a bond or bill for a fixed price and promise to sell it back at a fixed price at some future date. The difference between the two prices then determines an implicit interest rate. This is very similar to lending against collateral).

3. This is the converse of alternative 1. CB supplies so little liquidity that banks always are forced to borrow. Set the lending rate equal to the desired policy rate.

The last alternative has to my knowledge not been used together with inflation targeting. Alternative 2 is close to the standard practice of ECB and Fed. Alternative 1 describes the standard practice of Norges Bank. The disadvantage of alternative 2 is that the fine tuning is costly and cumbersome. A disadvantage of alternative 1 is weak incentives for banks with excess liquidity to lend to other banks.

Note that in alternative 2 the central bank supplies the amount of central bank money that the banks and the general public demand at the given interest rate. When the policy rate is decided there is no freedom to set the money supply. In alternative 1 there is a lower limit for the money supply, but no upper limit. During the recent crisis years CBs which usually practice system

Figure 2:



2 have in effect moved closer to system 1 and "oversupplied" banks with credit hoping that this will induce banks to lend more. This is part of what is called unconventional monetary policy.

4 Managing liquidity risk

As we have already touched upon, a bank has to be prepared in case its customer deposits decline faster than loans are repaid. It is then important to remember that the money does not disappear in thin air. There are three possibilities:

1. Deposits in other banks increase.
2. People change their deposits into bank notes in the official currency.
3. People change their krone deposits into foreign currency deposits.

The first may sound as if people are losing faith in one particular bank, the second as if they are losing faith in the banking system as a whole, and the third as if they are loosing faith in the central bank's ability to protect the value of money. More often the reasons will be structural changes in the economy, the arrival of new competitors and other things that have nothing to do with a loss of faith in the institutions. If case 1 occurs, the problem can in principle be solved by the banks lending to each other. Case 2 can in principle be solved

the same way provided that the central bank lends to the other banks a sum that is equal to the increase in currency in circulation. We may regard bank notes as proof of an anonymous deposit at the central bank. Losing deposits to the central bank is very much like losing deposits to another bank. Case 3 will be discussed in section in the second part of the notes together with other open-economy issues.

The first priority for a bank that wants to be able to honor its deposits in all circumstances, is to have enough equity capital that its solvency will not be questioned. The next priority is to have liquid assets and credit lines available in case of unusually high withdrawals. For a bank the most liquid assets of all is deposits at the central bank. Short term loans to other solid banks are also highly liquid. Bonds and bills, especially those issued by governments, are much more liquid than bank loans. Bonds and bills can also be used as collateral for loans.

The interbank market

The main role of the interbank market is to redistribute the deposits at the central bank according to the needs of the different banks. It is a market for unsecured loans of short duration, down to one night. The gross payment flows between banks during a day are large compared to the stock of deposits. The amounts that banks have in their accounts with the central bank change quickly during the day and it is hard to predict how much will stay there overnight. Hence, the banks need to adjust their positions quickly and often. The pressure on time is highest just before the market closes for the day. There is no time for arranging collateral. The market depends on trust. Transparency is low since trade is decentralized and individual trades not made public. What helps the market is that normally the risk is close to zero that a bank shall fail during the short periods that the loans are for. Banks can also analyze their potential borrowers and decide credit limits in advance. To avoid to be squeezed at closing time banks often borrow interbank at a longer maturity (say a few weeks) and place the proceeds as demand deposits in other banks to be drawn upon when needed.

We explained in section 3 how the central bank can make the overnight interest rate in the interbank market equal to the desired policy rate. There we neglected default risk. If there is even a small probability of default, the bank in question will have to pay a premium over the policy rate. Recent experience has shown that this premium can be quite high even for banks which seem above average solid judged from their capital adequacy and the quality of their loan portfolio.

In normal times the interbank market is an excellent vehicle for hindering that movements of deposits from bank to bank become a liquidity problem for the banks on the losing side. The other side of the coin is that interbank loans like other deposits can leave quickly. Banks are more professional and less loyal than ordinary depositors. If a bank lends long-term on the basis of short-term loans from the interbank market, it faces more liquidity risk than if the financing

is from ordinary depositors.

The interbank market is part of a broader money market where institutions with large deposits participate. An obvious alternative to borrowing from another bank is to lure over large depositors from other banks. The interbank market is international.

Interbank markets can dry up almost completely as they did after the bankruptcy of Lehman Brothers i 2008. Suppose bank Z has borrowed heavily in the interbank market.Then it incurs some loan losses and other banks start to think that default by Z is a possibility, although unlikely. The other banks will then demand a higher interest rate for lending to Z. For them it is not enough to get compensated for the expected loss on the loan to bank Z. Default means that the whole claim on bank Z, not just the amount that corresponds to the loan-loss may be frozen for a long time while the administrators sort out who gets what. The lending bank then lose liquidity and questions about its own solidity may arise. In this way a small risk of default may lead to a substatial rise in the interbank borrowing rates that are offered to Z. If Z refinance its interbank debt at these higher rates, the likelihod of Z defaulting increases. It is easy to see how this can spiral out of control. The result can be that bank Z actually defaults, perhaps immediately. More often the bank is sold to new owners with more capital.

During old-fashioned bank runs ordinary people lined up at bank offices in order to get their accounts converted to bank notes. Today this rarely happens. Instead the run starts in the interbank market and ends there. It is banks that run on banks.

The large volumes in the interbank market means that if one bank fails, other banks may have large losses. The lack of transparency of the market, means that for other banks it is hard to know which banks sit on thesse losses. This means that defaults can be contagious, especially if big banks default.

Implications for balance sheets

As already indicated banks have three alternative ways of preparing for large withdrawals. 1) Deposits at the central bank, 2) Deposits at other banks, 3) Bonds and bills that can be sold in liquid markets and/or used as collateral at the central bank. Suppose the central bank operates a corridor system with the policy rate in the middle. Consider the pros and cons of each alternative the way a banker might do:

1. Deposits at the CB are 100 per cent liquid, but interest rates are low.

2. Other banks pay at least the policy rate. As long as they do not default, their deposits are 100 per cent liquid. If the others default, then at least we end up in good company. Besides, if we are losing deposits, it is more likely that they are gaining.

3. If the credit risk is the same, bonds tend to pay higher interest rates than bank deposits. Unfortunately this is because they are less liquid. Luckily,

this does not matter so much for us, since we can repo them at the policy rate. If our deficit is passing quickly, or if we have to wait for the repo, we can also get along by "drawing our credit card" with the bonds as collateral. This is costly, but the liquidity premium we collect all the time can easily pay for some short spells of borrowing.

It seems obvious that alternatives 2 and 3 are better than 1 from the point of view of individual banks at normal times. If it is difficult to find solid banks and solid issuers of bonds and bills the answer could be different. The figures in table 3 show that at least for Norwegian banks deposits in other banks and bonds and bills are more important quantitatively than deposits at the central bank. An indication that there is no fixed proportion between deposits from the public and deposits held in reserve at the central bank, is this: From 31/12 1996 to 31/12 2006 deposits from the general public in Norwegian banks more than doubled from 481 to 1098 billion kroner. On both days the deposits at the central bank were 24 billion kroner. Deposits grew quite steadily over the period. In between deposits at the central bank varied a lot. This is consistent with the view that in normal times demand for reserves at the central bank is more related to expected transaction volumes than to the stock of deposits.

Funding costs

The interbank rates form the basis for setting the interest rate on loans and deposits in banks. Banks are almost always active in the interbank market and hence alternative uses of funds can always be measured against the interbank rate. Statistics on interbank rates are published daily although their relyability is being questioned. When calculating the cost of extending a new loan banks start from the interbank rate, then add something to cover expected loan losses and perhaps a risk premium on top of that. Finally the bank would factor in that it needs to keep more equity and this requires a higher expected return than interbank loans.

Similarly, to calculate the gain from a deposits, the bank would start from the interbank rate and then subtract the extra costs of keeping the higher level of liquidity.

5 Model 1: Banking in sunshine

Throughout this section we assume that all banks are rock solid. Hence, banks lend to each other freely in the overnight interbank market. The interbank rate is equal to the central bank's policy rate. If competition in the market is perfect, this will force banks to pay the same interest rate on deposits as they pay in the interbank market. Payment services and administration of the accounts the customers will have to pay for through fees. In practice deposit rates are usually below the interbank rate by some margin. This may be due to monopolistic competition in the market for deposits or, in a less cozy environment, the cost

Table 5: Sectoral balance sheets in model 1

Instrument	Government	Central bank	Banks	Firms and households	Sum
Deposits at CB		-D_{cb}	D_{cb}		0
Loans from CB		L_{cb}	$-L_{cb}$		0
Deposits at banks			$-D$	D	0
Loans from banks			L	$-L$	0
T-bills	$-B$	B_{cb}	B_b	B_h	0
Real capital				QK	QK
Sum=Net assets	W_g	W_{cb}	W_b	W_p	QK

of being ready to handle large withdrawals of deposits with a more difficult interbank market. We return to this in the second part of the notes.

Similarly, perfect competition in the market for loans will force the interest rate on loans with no default risk close to the interbank rate, while administrative costs will be covered by fees. Loans with default risk will of course require a higher interest rate. As a first approximation we may assume that large and well-diversified banks behave as if they are risk neutral. Interest rates will then be equal to the interbank rate plus the expected cost of default per krone lent. For regulatory and other reasons more lending to risky borrowers increase banks´ need for equity capital. Because equity holders demand a return that is higher than the interbank rate, this cost has to be added to the interbank rate.

In this section we model the links between the central bank, the ordinary banks and the real economy. The model is among the simplest one can think of. The economy is closed. Banks are rock solid with more than enough equity. All markets are competitive. Payments are made with cards and nobody holds bank notes and coins. Interest rates on all financial assets follow the central bank's policy rate one for one. We look at a relatively short period and we should think of wages and prices of consumer goods as set before this period starts. The central bank determines the policy rate at the start of the period. The model features six assets: Bank deposits D, Bank loans L, Central bank deposits D_{cb}, Central bank loansL_{cb}, Treasury bills B, and real capital K. There are four institutional sectors: Government (subscript g), Central bank (cb), Banks (b) and the remainder, which is households and non-bank firms (p), called the general public below. Behind the scenes there is an efficient interbank market, but this is netted out of the aggregates we study. Table 5 gives an overview of the structure of the asset markets in the economy. The entries are nominal values of the holdings of the different sectors at the end of a period. Liabilities have a minus in front, assets an invisible plus. Q is the price of capital goods. W is used as symbol for wealth or net worth. When we need to make explicit which time period we refer to, we do that with the time argument as in the example $D(t)$ which denotes the amount of deposits at the end of period t.

Definitional relations These are useful to write down before we model the behavior of the different sectors. Corresponding to the columns in 5 we have the *balance sheet equations* for the four sectors. They define the net worth of each sector as the difference between its assets and liabilities:

$$Q(t)K(t) + D(t) + B_p(t) - L(t) = W_p(t) \tag{1}$$

$$-B(t) = W_g(t) \tag{2}$$

$$L(t) + B_b(t) + D_{cb}(t) - D(t) - L_{cb}(t) \quad = \quad W_b(t) \tag{3}$$

$$B_{cb}(t) + L_{cb}(t) - D_{cb}(t) = W_{cb}(t) \tag{4}$$

Except for the last one, the rows in table 5 sum to zero. This is because One sector's *financial* asset is always the liability of another. The government's bond debt is equal to the bond holdings of the other three sectors.

$$B(t) = B_p(t) + B_b(t) + B_{cb}(t) \tag{5}$$

If we add together equations (1) - (4) taking account of (5), we find that the total wealth is equal to the value of the stock of productive capital.

$$W(t) = W_p(t) + W_g(t) + W_b(t) + W_c(t) = Q(t)K(t) \tag{6}$$

Wealth accumulates (or decumulates) over time. Changes in wealth over time come from two sources, savings and capital gains / losses. The latter are changes in the value of assets and liabilities that one owns. We have assumed that all the financial assets have variable interest rates so their prices do not change. The only asset where there can be capital gains is then real capital. As a further simplification we assume that the only sector that saves is the general public. Hence, we treat W_b, W_{cb} and W_g as constants. The wealth of the general public then accumulates according to

$$W_p(t) = W_p(t-1) + S(t) + [Q(t) - Q(t-1)]\, K(t-1) \tag{7}$$

Where the last term is the capital gains. The stock of productive capital accumulates according to

$$K(t) = K(t-1) + I(t) \tag{8}$$

Since the economy is closed

$$S(t) = Q(t)I(t) \tag{9}$$

Flow of funds: Often we are more interested in the flows of new loans and new deposits than in their levels. Define the difference operator Δ as $\Delta X(t) =$

$X(t) - X(t-1)$. For the general public the funds aquired during period t are $S(t) + \Delta L(t)$. These have to end up in one of the three available instruments. Hence,

$$S(t) + \Delta L(t) = Q(t)\Delta K(t) + \Delta D(t) + \Delta B_p(t) \tag{10}$$

This is the same as we get if we take take the difference between the balance sheets for period t and period $t-1$ the for the general public and apply the accumulation equation (7). Since we have assumed that the general public is the only sector that saves and invests in this economy, savings on the left and investment on the right cancel, and we are left with

- for the general public:

$$\Delta D(t) + \Delta B_p(t) - \Delta L(t) = 0 \tag{11}$$

The same procedure for the other sectors yields

- for the government:

$$\Delta B(t) = 0 \tag{12}$$

- for banks:

$$\Delta L(t) + \Delta B_b(t) + \Delta D_{cb}(t) - \Delta D(t) - \Delta L_{cb}(t) = 0 \tag{13}$$

- for the central bank:

$$\Delta L_{cb}(t) + \Delta B_{cb}(t) - \Delta D_{cb}(t) = 0 \tag{14}$$

The flow-of-funds equations say that for all sectors the sum of financial assets bought and sold must be zero. Rember that this is a special case that is due to the assumption that all saving and real investment takes place in one sector.

Bank behavior We start by assuming that all bank lending is to finance new investment in real capital and that the bank finances a share $0 < \lambda \leq 1$ of the value of the investments:

$$\Delta L(t) = \lambda Q(t) I(t) \tag{15}$$

One interpretation is that firms want to borrow to finance the whole investment, but that the bank is not be willing to go that far - perhaps because of problems related to moral hazard. Another interpretation may be that $1 - \lambda$ is the share of the investment that investors on average are able to finance with equity and the share λ then remains to be financed through banks. Banks take the deposits they get from the general public and demand liquidity reserves in the form of T-bills and deposits at the central bank in proportion to the amount of deposits

$$B_b(t) = \delta_b D(t) \tag{16}$$

$$D_{cb}(t) = \delta_{cb} D(t) \tag{17}$$

where $1 > \delta_b \geq 0$and $1 > \delta_{cb} \geq 0$ are the proportionality factors. The central bank accomodates the demand for reseves, since if it did not, the interest rate would change.

Relation to real sector This goes through the interest rate, which is also the rate of return that investors in physical capital are requiring. One unit of capital bought at the end of period t can be used in production of consumption goods in period $t+1$ and then yields the marginal product $F'_K(K(t), N(t+1))$, F being a production function with standard neo-classical properties. After the unit of capital has been used, it can be resold for $Q(t+1)$. The value of one unit of capital today is the discounted value of what you can get for it next period:

$$Q(t) = \frac{F'_K(K(t), N(t+1)) + Q(t+1)}{1 + i(t)} \tag{18}$$

For given values of $N(t+1)$ and $Q(t+1)$, $Q(t)$ then depends negatively on $i(t)$. The level of investment is determined by the intersection of the price $Q(t)$ and the supply curve of investment goods at t. The production function for investment goods is $I = G(Z, N_I(t)$ with constant return, Z a fixed factor and $N_I$labor input. With the wage rate $w(t)$ given and normalized to one we then get a supply curve for investment goods

$$I(t) = H(Q(t)/w(t)) \tag{19}$$

that is increasing in $Q(t)$.

There is also a connection to the real economy through consumption. To make it simple we shall just use the Euler equation for consumption:

$$C_t = C_{t+1}/[\beta(1+i)]^\sigma \tag{20}$$

and take C_{t+1} as given. This completes the model[2].

The solution

The model can be solved step by step:

- $i(t)$ is set by the CB
- $Q(t)$ follows from arbitrage between real capital and other investments, $C(t)$ from Euler equation
- $I(t)$ follows from the supply function for investment goods
- $S(t)$ follows from the definitional relation $S = QI$
- $\Delta L(t)$ follows from banking practice as $\lambda Q(t)I(t)$
- $\Delta D(t)$ can then found from the flow-of-funds equation for the general public (11), $\Delta D = \Delta L - \Delta B_p$,

[2]The reader may ask what mechanism that makes savings equal to investment. This is quite simple. National income is the value of the output of the two industries. The output of the consumption goods industry is equal to consumption. Savings is national income minus consumption, and must then be equal to the output of investment goods.

if we substitute for ΔB_p from the equilibrium condition for the bond market. Since $\Delta B = 0$ this reads $\Delta B_p = -\Delta B_b = -\delta_b \Delta D$. The equation we then get is

$$\Delta D = \Delta L + \delta_b \Delta D = \lambda Q I + \delta_b \Delta D$$

which has the solution

$$\Delta D = \frac{1}{1-\delta_b} \lambda Q I \tag{21}$$

The multiplier here takes account of that not only does more loans increase the deposits directly, they also require the banks to buy bills from the general public to have in reserves.

- when equation (21) is inserted in the flow of funds equation for banks (13) we find that the central bank has to lend

$$\Delta L_{cb} = \frac{\delta_{cb}}{1-\delta_b} \lambda Q I \tag{22}$$

to the ordinary banks in order that they can satisfy their demand for deposits. This is necessary for the policy rate to stay at the level decided by the board.

Note that in the model it is the demand for loans that determines the level of bank deposits, not the other way around.

Effects of exogenous events

If the central bank reduces the interest rate, model 1 says the reduction will be passed on unchanged to housholds and firms. Both $I(t)$ and $C(t)$ will go up. More investment means the banks lend more This creates more bank deposits, and forces the central bank to lend more to the banks.

The effects on consumption and investment do not depend on the three parameters that characterize the banks loan supply and reserve demand. If banks change their behavior in these areas it has no effect on aggregate demand for goods and services. Banks' demand for liquid reserves does nothing to dampen credit growth. The same would the case for compulsory reserve requirements.

More investment demand, for instance because a higher $Q(t+1)$ is expected , sends bank lending up (and deposits up). The central bank is forced to lend more to the banks if the interest rate decision is maintained. However, higher investment now and even more expected for next period, means higher employment in both years and a risk for inflation driven by wage increases. Hence, the central bank should raise the interest rate. This reduces both consumption and investment now. If the interest rate succeeds to bring total employment back to where it would otherwise have been, consumption must be down and investment up relative to before. This means less credit growth and less lending from the central bank than if i had been constant. However, a monetary policy guided by an inflation target does not stop the credit growth, only weakens it.

Getting further In Model 1 the banking sector does not really matter for the transmission of monetary policy. Nor is it able to make significant troubble for the real economy. Credit supply is remarkably elastic. If there is demand for bank loans, this can be accomodated by the banks. The loans and the accompanying reserve needs can be financed mainly - perhaps close to 100 per cent - by the deposits that the loans themselves create.

The severe macroeconomic consequences of banking crises and the inability of expansionary monetary policies to bring economic activity back to normal levels quickly suggests that banks actually matter a lot and can make serious troubble. Interbank rates that occasionally rise far above policy rates point in the same direction.

To get towards realism we have to drop some of the assumptions that are behind model. Points to consider are:

1. Default risk for borrowers from banks
2. Default risks for banks themselves
3. Capital adequacy constraint that are binding for banks
4. Capital costs of firms that depend on the source of financing
5. Screening and rationing of loan applicants

An extended model that attempts to take care of these points will be presented in the next sction.

Question 1 Suppose that equation (14) in model 1 is replaced by either $\Delta L(t) = \lambda I(t)$ or $\Delta L(t) = \lambda(Q(t)I(t) + \Delta Q(t)(K(t-1)$. Interpret the three expressions and compare the effect of a given increase in Q(t) on bank lending in the three cases. Does the alternatives matter for the level of $I(t)$?