Banks, monetary policy and aggregate demand

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October 3, 2014

Contents

Abstract

Lecture note for ECON4335 Unfinished. 3/10 2014

0.1 Introduction

Banks deal with money and money today is either intrinsically worthless pieces of paper or numbers stored on computer disks. Commodity money is a thing of the past, except perhaps inside certain prisons and in most banking models in economics. In the most studied of these, the Diamond -Dybvig model, deposits are consumption goods and you get consumption goods in return. of Models with commodity money are useful for discussing many aspects of banking. Still a course in the economics of banking should have a at least a small part that recognizes that banks deal with money. Banks are a central part of the transmission mechanism that brings the force of monetary policy from the central bank over to the real economy. The first part of this lecture note describes the interaction between banks and central banks. Then we present a couple of models of the transmission mechanism. We also discuss briefly how the banking system can be a source of disturbances to the real economy.

The exposition is held at an elementary level. Some will find that they know much of the material from earlier courses. That is fine. There are enough challenges in the other readings in the macro part of the course. The ambition with the present paper is just to make sure that we also cover the basics including some institutional facts. Institutions in this area vary somewhat from country to country. For obvious reasons we will use Norges Bank as example quite often, but the US Federal Reserve and the European Central Bank (ECB) will also be mentioned.

0.2 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.

Bank deposits are money in the sense that they are commonly accepted means of payment. A transfer between bank accounts is in most transactions 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 bank deposits[1].

Table 1 shows the composition of the balance sheet of Norwegian banks in one year. Loans to non-financials were the dominating asset. Deposits from non-financials were lower, but still the largest single item on the liability side.. We

[1] A distinction is made between narrow money, $M1$, and broad money, $M2$. $M1$ includes only currency and demand deposits and is money proper. $M2$ also includes time deposits in the quantity of money.

Table 1: Balance sheet. Norwegian banks 2008.
Percent of total assets, branches of foreign banks not included.

Assets		Liabilities and equity	
Currency and deposits	11,6	Deposits from	
Securities (current)	11,6	non-financials	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

Table 2: 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}	Equity net worth	$L + B + D_{cb} - D - Lcb$
Total assets		Total liabilities	
		Equity	

also note that there is considerable amounts of lending and borrowing going on between banks both within Norway and internationally. The difference between assets and liabilities is of course the bank's equity or net worth, which belongs to the bank's shareholders.
In the sequel we shall work with a simplified balance sheet like the one in Table 2 . The balance is for a closed economy, which explains that loans between banks are the same on both sides.

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 ()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 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 tradeable 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. 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 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 sawmill 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 ABC 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[2]. 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 before deposits became just bits in computers.

Note the important role of the interbank loans in the example. If there were

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

no interbank market ABC bank had to make sure that it had sufficient reserves at the central bank before it extended the loan[3].

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 entrepreneurs tend to be overoptimistic about their projects and that individuals may have problems with 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.

Staying liquid 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 help from the interbank market. However,prudent banks will always want 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.

0.3 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 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

[3] In the Diamond-Dybvig model a consumer who reclaims his deposits before he needs it destroys a long-term investment. Moving numbers in a computer does not have the same destructive effect.

Table 3: 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 4: 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.

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 3 shows the items one expects to find on the balance sheets of a typical central bank, while table 4 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").

Setting interest rates

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.

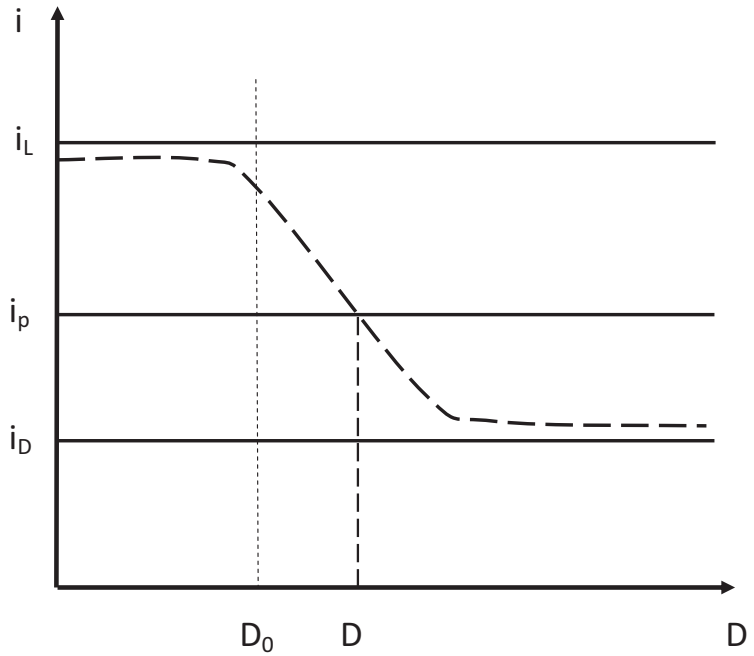
Since central banks mainly deal with banks and not directly with the general public, banks are the main channel for the transmission of monetary policy to the real economy. Banks decide to what extent changes in the interest rates set by central banks will be passed on to deposits and loans and whether 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 become deposits in the central bank. usually "repos". (This means the bank buys a bond or bill for a fixed price and promise to sell them 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).

A bank can always choose to convert its deposits in the CB to the official currency (bank notes and coins). 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 (M_0). Since any change 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.

In order to help the settlement process central banks usually also offer open credit lines to banks. This is short-run credit primarily meant for use within

Figure 1:



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, i_D and i_L. Naturally $i_L > i_D$ always and i_L is often called the "penalty rate". The two interest rates 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, 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.

between the upper and the lower bounds the demand for loans from the central bank will be a falling function of the interest rate, see Tobin (1982). Inside the corridor interbank loans offer better interest rates for both borrowers and lenders than the the standing facilities of the central bank. Hence, banks

would prefer to have zero deposits and zero "credit card debt" in the CB at the end of the day. However, with new transactions coming in all the time, banks have limited control over their positions. Banks will be uncertain about whether at the end of the day they will end up as depositors or borrowers in the CB. f it turns out that a bank borrowed too much, it will have a loss equal to the difference between the interbank rate and the deposit rate. If it borrowed too little, it will have a similar loss equal to the difference between between the interbank rate and the penalty rate.the The higher the interbank rate is, the smaller is the eventual loss from borrowing too little, and the greater is the loss from borrowing too much. Hence, a bank minimizing expected losses will choose to borrow less in the interbank market when the interbank rate is higher. On average this means lower deposits in the CB. It follows from this reasoning that if the interbank rate is in the middle of the corridor, banks should use each of the standing facilities half the time.

In practice banks seldom use their "credit card" overnight. One reason may be fear of getting stigmatized. If others get to know, they may think that the bank has difficulties in getting loans from other banks. If people start to believe that, the belief will become true. This fear acts as a fixed cost of borrowing that moves the demand curve for deposits at the central bank to the right as shown in Tobin (). Fear of exhausting the credit limit may have the same effect.

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.In the framework we have described there are three ways the CB can implement the interest rate decision:

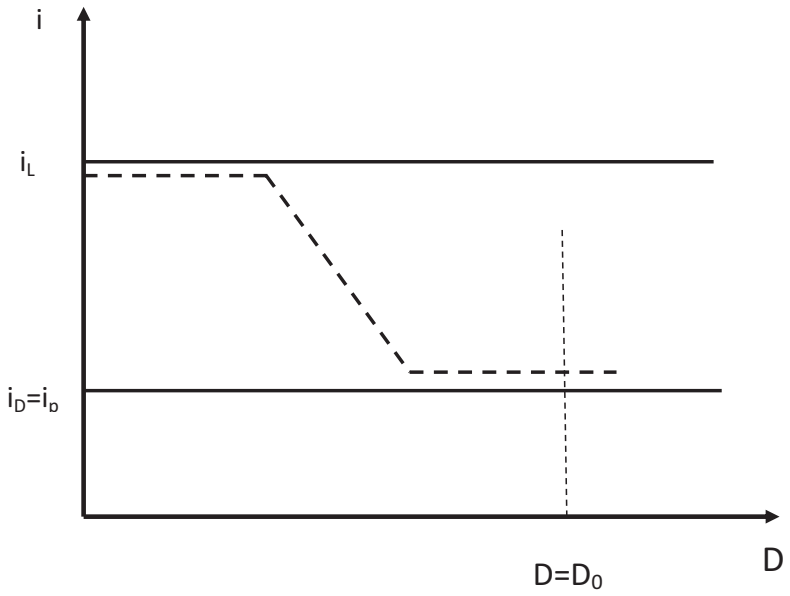
1. The central bank sets the three interest rates in such a way that the policy rate is in the interior of the corridor as illustrated in figure 1x. It then uses open market operations to adjust the supply of reserves central bank money until the overnight rate in the market is reasonably close to the policy rate. The fine-tuning is done by open market operations.

2. The central bank sets the deposit rate equal to the policy rate as illustrated in figure 0.3.Then it makes sure that there is always more than enough reserves available for the banks.

3. This is the converse of alternative 2 Set the lending rate equal to the desired policy rate. CB supplies so little liquidity that banks always are forced to borrow.

. Alternative 1 resembles the standard practice of ECB and Fed, Alternative 2 describes that of Norges Bank. Alternative 3 was used by Norges Bank around 1990, but there seems to be few other examples. In alternative 3 there is no stigma related to borrowing. The disadvantage of alternative 1 is that it requires daily fine tuning through market operations. This is is costly and cumbersome. The disadvantage of alternative 2 is weak incentives for banks with excess liquidity to lend to other banks. Conversely, in alternative 3 there is little incentive to borrow from other banks. Easy credit from the central bank may in turn increase the risk of reckless lending.

We mentioned above that in principle the central bank can decide the quantity of central bank money. However, with alternative 1 this freedom is used



to keep the overnight interbank rate on target. There is only one choice to make, the level of the interest rate. In alternative 2 there is a lower limit for the money supply, but no upper limit. The CB can choose how much money to supply in excess of what is necessary to keep the overnight rate equal to the target. Hence, the central bank has more freedom in this case. Whether that freedom is useful depends on how the interbank market works. During the recent crisis years ECB, which usually practice system 1 has moved closer to system 2 by "oversupplying" banks with credit hoping that this will induce banks to lend more. This is part of what is called unconventional monetary policy.

Box 2 summarizes some facts about the use of Norges Bank's facilities in 2013. The figures confirm that banks try to avoid borrowing overnight. Low use of this facility is also a sign that Norges Bank supplied sufficient CB money to keep the market interest rate close to the policy rate. However, the banks had registered enough collateral to borrow a lot overnight if they needed. Note the enormous volume of transactions. This means that the system has to handle large movements of deposits every day, and normally it works smoothly. In 2013 as usual there was no instance when a bank were unable to pay on time.

Box

Settlement at Norges bank 2013

- 22 banks settled their claims at Norges bank, ca 100 at DnB
- Turnover 200 billion NOK per day, over 500 billion on busiest days

Use of standing facilities:

- deposits were 34 billion NOK on average over the year
- within-day loans were used by between 4 and 18 banks every day
- on busiest day more than 50 billion was borrowed within day
- overnight loans were used 8 times (days times banks)
- registered collateral and credit limit varied between 200 and 300 billion NOK
- for comparison
- bank deposits ca 1 700 billion NOK

Sources: Årsrapport for norges Banks oppgjørssystem 2013 og SSB

0.4 Model 1: Transmission without friction

In first year macro the transmission of monetary policy was direct and simple. There was only one interest rate and this was set by the central bank. Nominal interest rates affected real rates since there was an element of nominal rigidity in wages and prices. Monetary policy affects the real economy through the well known effects on consumption and investment demand and possibly on labor supply. On consumption and labor supply there are wealth effects, income effects and intertemporal substitution effects. Investment is affected through the cost of capital.

In this section we take a closer look at the simplifications that are behind the the assumption of a singlee interest rate. The discussion will be structured around the balance sheets of the different sectors of the economy. First, however we sketch the real side of the model. We go on to look at how saving and investment affect the financial balances over time.

While the neo-Wicksellians of today tell us to focus on the interest rates, the monetarists saw the quantity of money as the key variable. Other schools have have pointed to the volume of credit. We shall comment briefly on these.

We assume that the markets for loans and deposits are competitive. The central bank lends and borrows at the same rate and without limit. Arbitrage then make interst rates in the ordinsry banks the same, Lending is determined by the demands of borrowers. Monetary policy affects aggregate demand in the same way as you learned as undergraduates. What is new is that we also look at the effect of monetary policy on bank balances and we try to answer questions like “what are the effects on bank balances of an increased propensity to save? “ All the time we have in mind a closed economy and a short period where prices are predetermined and output is determined by aggregate demand. In the next section we look at financial frictions

The real side

Equations (1) to (6) say that aggregate demand is the sum of consumption and investment demand. Consumption depends in (2) on income (actual, Y and permanent,$\bar{Y}$),

wealth and the real interest rate . We assume households get the whole national income and households directly or indirectly own the whole capital stock. The price of one unit of the existing capital, Q depends negatively on the real interest rate.The rate of new investment depends positively on the price of existing capital. Equations (5) and (6) represent the Q-theory of investment.

$$Y = C + I \tag{1}$$

$$C = C(Y, \bar{Y}, W, i - \pi_e) \tag{2}$$

$$S = Y - C \tag{3}$$

$$W = (QK_0 + D_0 - L_0)/P \tag{4}$$

$$Q = Q(P, i - \pi_e) \tag{5}$$

$$I = I(Q/P) \tag{6}$$

So far we have got 6 equations and 6 endogenous variables Y, C, I, S W and Q. The only exogenous variable is i, while we treat P and π_e as predetermined. The six equations we can combine in one IS-equation:

$$Y = C(Y, \bar{Y}, (Q(P, i - \pi_e)K_0 + D_0 - L_0)/P, i - \pi_e) + I(Q(P, i - \pi_e)/P) \tag{7}$$

If we plug in the exogenous interests rate here, we can solve the IS-equation for output and then go on to find find consumption.

Investment and saving goes on through the period. Since we are looking at a closed economy, $S = I$. A higher interest rate reduces output, consumption and investment in the usual way.

The financial side

Sectoral balance sheets like the one in Table 5 give an overview of the financial structure of an economy. Like the production and income accounts they seem a good starting point for modelling. The economy is divided in five institutional sectors. Firms are borrowers and households are lenders. We have included six financial instruments.

The entries in the table are the amounts of assets and liabilities that belong in each of the five institutional sectors. A minus indicates a liability. Net worth is assets minus liabilities. This is the same as the current value of the equity in the sector. As a simplification we have set equity in the two banking sectors equal to zero. Households own all the shares in the firms. For simplicity we have assumed that banknotes and coins are not in use. Some other cells are empty almost by definition.

Table 5: Sectoral balance sheets in model 1

Instrument	Government	Central bank	Banks	Firms	Households	Sum
CB Deposits		-$M0$	$M0$			0
Bank Deposits			$-D$		D	0
Repos F-loans		L_r	$-L_r$			
Bank Loans			L	$-L$		0
T-bills	$-B$	B_c	B_b		B_p	0
Real capital				QK		QK
Net worth	-B	0	0	E_f	E_p	QK
Shares				$-E_f$	E_f	0
Wealth	$W_g = -B$	0	0	0	$W_p = E_p + E_f$	QK

In the table there are six assets, five with variable interest rates and one with variable price. The interest rates on deposits and on ordinary loans in the central bank are set by the central bank and are equal. For all the other interest rates and the required return on capital to be equal to the policy rates we need : 1) no default risk, 2) All markets are competitive. 3) Regulatory constraints on capital adequacy and liquidity are not binding. However, we can allow default risk if we reinterpret i to mean the safe interest rate and suppose all agents are risk neutral. Risk neutrality means that investors / banks require the same expected returns from risky assets as from safe assets. The interest rate would then be i plus the a default premium equal to the expected loss from default, Loans to and from the central bank are safe, those from due to heavy collateral requirements.

Default means that the borrower fails to observe his obligations in the loan contract. Default often leads to bankruptcy. Model 1 can be reinterpreted to cover cases where borrowers may default due to exogenous events. Suppose that the probability that an individual borrower defaults during a short time interval is $p\Delta t$. Given default the loss is x per cent of the loan. If the borrower pays an interest per unit of time i_B, then the bank's expected net return per unit of time is

$$i_B - px - i$$

Banks have many customers. If their default risks are stochasticaly independent, the law of large numbers says that the bank's actual return is almost certain to be equal to its expected return. Competition between banks will then drive the net return down to zero making $i_B = i + px$. The interest rate on bank loans will be equal to the policy rate plus a default premium px that covers the expected cost of default. However, the expected borrowing costs is not the same as r_B. The cost of default is an equal gain for the borrower. Hence, the expected borrowing cost is still the policy rate$i$.
The expected credit losses depend positively on the interest rate and negatively on the firm's equity capital. This means that when the policy interest rate goes up, the bank lending rate will go up even more because expected loan losses increase. Some have seen this additional increase in interest rates as an "accelerator" that enhances the effect of monetary policy, However, the firm's cost of capital is still equal to the policy rate, as is also the expected return of the bank.
If default leads to extra administrative or other costs, then the expected value of these will have to be added to the cost of capital. Disruption of production may be a significant cost that leads to accelerator effects.

We can extend the range where the model is applicable even further. For risk that can be diversified away risk aversion does not matter. Even a risk-averse investor should then be content with a default premium that just covers the expected loss from default. Macro risk that hits all over may require extra risk premiums.

The balance sheet shows the state of the sectors at a point in time. There are eight portfollio elements that we might want to know how are determined. However the four Bs sum to zero, and B_g and B are decided at the discretion of the authorities. Hence, when one of the two remaining Bs are decided, all are decided. Each sector has to obey its budget constraint. The agents start with initial holdings given and can only reallocate a given wealth. Apparently this gives us five equations, , but adds only three independent equations. We started with 8 variables and now have counted five restrictions on these.That gives us three degrees of freedom.

The normal way to close a model like this is to add behavioral equations. However, risk neutra investors do not care about which assets they hold as long as they give the same expected return. There is one exception banks, care about the level of their reserves because of the asymmetry of the outcomes. we can postulate a demand for reserves:

$$M0 = \rho D \tag{8}$$

where ρ is a function of the difference between the policy rate and the penalty rate. The next assumption we shall make is that firms aim for a constant debt

to equity ratio by financing a share λ of investment with debt;

$$\Delta L = \lambda PI\Delta t \tag{9}$$

Lastly we let the govenment decide the share β of its bills that are sold directly to households.

$$B_p = \beta B \tag{10}$$

These assumptions are rather arbitrary. but should be sufficient to determine the entries in the balance sheet.

Note that if we consolidate the banking sector by adding the two columns, we get

$$-D + L + B_c + B_b = 0$$

or,if we use ( ),

$$D = L + B - B_p \tag{11}$$

Deposits are equal to what the banking system has lent to the rest of the economy, including the government.

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Financial flows

WE are interested in how the balances evolve over time due to savings and investments. Consider then a short period of lengthΔt. The changes from the beginning to the end of the period then has to obey

$$\begin{aligned} \Delta L &= \lambda PI\Delta t & (12)\\ \Delta B_p &= \beta PS_g\Delta t & (13)\\ \Delta B &= -PS_g\Delta t & (14)\\ \Delta D &= \Delta L + \Delta B - \Delta B_p & (15) \end{aligned}$$

By inserting the first three equations in the fourth, we get

$$\Delta D = [\lambda PI - (1-\beta)PS_g]\Delta t \tag{16}$$

Because of the equality between saving and investment (16) can also be written

$$\Delta D = [\lambda P(S_p + S_g) - (1-\beta)PS_g]\Delta t$$

Bank lending creates deposits whether the loans go to the private or the public sector.Equation (17) shows that deposits and household savings will be positively correlated, but this is not a causal relation.

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An increase in i reduces both both consumption and investment demand. The effect on aggregate demand would be the same if we dropped the banks from the model and assumed that households lend directly to firms. An exogenous increase in investment demand will raise the demand for bank loans. Savings will go up accordingly. An exogenous increase in consumption demand has no effect on investment. Demand for loans does not change. Nor does aggregate saving change.

0.5 More complex trasmission mechanisms

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We all know that the interest rates that banks offer are not the same as the central banks' policy rates. This rises the question of whether an increase in the policy rate will be transmitted one for one to the interest rates that the banks charges. One reason that it might not is that higher interest rates may cause more borrowers to default and increase the amounts that are lost. The banks may then raise their lending rates to cover the higher expected loan losses. But if more customers fail, perhaps more more banks also fail. Then banks will be less willing to lend to each other. If banks charge higher interest rates for loans to other banks, perhaps that will infect the rates their customers pay. The mechanism we have sketched here, is called a financial accelerator. It speeds up the effect of monetary policy.

Interest rates are not the only conditions on loans. It is common for banks to require that investors either have some equity in the project or posts some collateral. One reason is that this reduces moral hazard problems. Since a higher interest rate reduces the value of buildings and of equity in existing firms, investors have less collateral to come up with and have to curtail their investments. Again this works as a financial accelerator.

The two mechanisms we have described now works in reverse. If a negative shock hits the real economy, there will be more defaults and the value of potential and actual collateral will decline. The risk that banks default increases. Banks raise their lending rates. Ultimately the result could be a banking crisis.

Shocks may also come from the banking sector itself, for example trough increased competition.

Businessmen often complain that they do not get loans even if they have good projects. Often this just means that the bank and the investor disagree about how good the project is. Regulatory reserve requirements or capital adequacy rules may in the short run be a constraint on bank lending. Normally a producer whose output is constrained to a certain quantum will prefer to ration the output by price. However, a higher price could make the customers with relatively safe projects drop out, while the firms with highly risky projects stay, knowing that if the project fails the bank takes part of the loss, and if it succeeds the investor takes all the gain. Stiglitz and Weisss () argue that banks are unable to distinguish between high-risk and low-risk projects, it may be optimal for them to keep interest rates relatively low and draw lots to decide who shall get loans and who shall not. x and y argue that this kind of credit rationing is unlikely to be the global profit maximum. Anyhow. we shall argue that binding constraints of the on the lending of individual banks are not likely to be important in macro except in severe Crises.we shall come back to.

0.6 The interbank market and the price of liquidity

Cash management and reserve demand

We need to look more closely at how banks handle liquidity risk and price setting.

The traditional view has been that a bank's demand for reserves at the CB stems from the risk risk that depositors lose faith in the bank and reclaim their deposits. The standard textbook assumed that a constant fraction of the deposits were held in reserve at the central bank. This does not fit the facts. One example : From 31/12 19996 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 in Norges Bank were 24 billion. Between the two dates deposits in ordinary banks grew steadily while deposits in Norges Bank fluctuated. There is no reason to expect a strict proportionality. The main motive for holding deposits at the central bank is not to meet a run from ordinary depositors, it is technical issues related to managing the cash flow through the payments system. Whether a run by ordinary customers can be handled, depends on whether the bank is solid and trusted by other banks. If customers take their deposits to another bank, they can be replaced by interbank loans. If customers change from deposits to currency, the central bank will supply the required amount.

If a bank is not solid and trustworthy, fellow banks will normally be the first to discover and to run. Liquidity reserves cannot save a bank in such calamity. Reserves are for handling the everyday variation in the cash-flow in and out. Failing to pay on time in NBO may be be devastating even if the bank is solid and trusted by everyone in advance. This underscores the need for reserves, but not all of them have to be at the central bank. Table 4 shows that for Norwegian banks deposits in other banks and bonds and bills are more important quantitatively than deposits at the central bank.

A large part of the movements of deposits in and out of a bank is predictable. There are seasonal and monthly variations. Banks can prepare for these by building a portfolio of interbank loans that mature at the time the payments are due. Such portfolios may also contain t-bills or loans to the central bank with the same maturity. The three instruments have in common that they yield market interest rates that are better than on deposits in the central bank.

The same sort of instruments can be used as reserves for meeting unexpected withdrawals, if their second-hand markets are sufficiently liquid. Uncertainty is resolved gradually as new information comes in. There will be a hierarchy where the most liquid instruments are held in reserve for handling the uncertainty that is resolved last. Deposits in the central bank are reserves against the uncertainty that remains on the day of settlement.

Banks are often lenders at some maturities and borrowers at others.The different kinds of reserves are close but imperfect substitutes in normal times. On this background one should not expect a simple proportionality between deposits and any particular measure of reserves. Interbank loans like other loans create deposits. Hence, the volumes adapts to demand. The supply of reserves at the central bank also adapts to demand. The focus in the older literature on how M_0 limited the amount of credit in the economy seems misplaced in today's world. Instead we need to discuss interest rate determination.

Interbank borrowing rates

As mentioned before, the market operations unit in the central bank makes the overnight interest rate stays close to the policy rate. With risk neutral banks the three-month rate would then be equal to the average of the expected policy rates plus a liquidity premium. A three month loan is more than a set of 90 overnight

loans. It includes a commitment that is costly to the lender and valuable to the borrower. The lender has an increased risk of being short of funds before the central bank closes for the day. The lender then has to borrow at the penalty rate or make an expensive last minute bid for funds from other banks. The cost of the commitment is the expected value of the additional interest costs and eventual reputation loss that occur because of it. Lenders come forward only if they are compensated for this trough a liquidity premium. The marginal cost of committing funds is likely to be increasing in the amount the bank lends. The reason is that not only does the size of the eventual shortfalls increase, but the expected number of them also increases. In the end the liquidity premium is determined by demand and supply in the market for interbank loans.

In addition to the liquidity premium lenders may require a default premium if there is any risk that the borrowing bank defaults.

These premia are is not directly observable but sometimes they can be deduced with help from derivatives markets. t-bills and currency swaps can be used to get an idea of how large costs of default is baked into the interest rate.

In quiet times the sum of the two premiums can be quite low and fairly constant, as seen in Figure x . Figure Y shows that

Interbank markets can dry up almost completely as they did after the bankruptcy of the investment bank Lehman Brothers i 2008.

Conceptually it is also difficult to distinguish between liquidity and default premia. Default means two things for the lending bank: 1) A part of the loan is lost forever. 2)The reminder will not be available until long after the agreed time, maybe, it takes years. The loss of liquidity is particularly serious for a bank. hence, If it is known that a specific bank has had losses that threaten its survival other banks will shay away from it or demand high premium for lending to it. In this way a small risk of default may lead to a substantial rise in the interbank borrowing rates. Poor solidity leads to poor liquidity which leads to even poorer solidity for banks that are net borrowers in the interbank market. The outcome could be default and bankruptcy. Or the bank is sold quickly to stronger bank before all equity is lost,

Since banks lend to each other there is always an element of contagion when a bank fails, and more for bigger and or more interconnected banks. If one bank has revealed unexpected loses, this may change the the expectations about other banks and rise the premiums they must pay. There may be a general increase in the interbank borrowing rate with an accompanying increase in the borrowing rate for ordinary customers. This may again harm banks. Holmstrøm xxx points out that the worst case is when it is known that the average default risk is high, but little is known publicly about the state of individual banks. Then banks that may lend to others, will fear that the banks who ask them for loans have been turned down by other, better informed banks.

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.

run starts in the interbank market and ends there. It is banks that run on banks.

If one bank fails, other banks will have to write-off part of or all their claims on the failed bank. Any remaining claims will be illiquid. Hence, other banks suddenly become both less solid and less liquid. With large volumes in the interbank market this means that defaults can be contagious, especially if big banks default. Low transparency in the interbank increases the risk of contagion since it is difficult to figure out which banks had claims on the failed bank at the moment it failed.