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ALTERNATIVE OPERATING PROCEDURES FOR MONETARY POLICY – A NEW LOOK AT THE MONEY SUPPLY PROCESS

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ABSTRACT

Alternative Operating Procedures for Monetary Policy – A New Look at the Money Supply Process*

This paper develops a new framework for the process of money supply. In contrast to models like McCallum (1989) based on the money multiplier analysis or the credit market models of Brunner and Meltzer (1966, 1973) our model explicitly illustrates the interaction of non-banks, banks and the central bank on the two relevant markets: the market for central bank money and the market for bank credit (which is identical to the macroeconomic 'money market'). Special emphasis is placed on the role of the central bank and its alternative control procedures for the supply of base money: targeting the central bank rate or the quantity of high-powered money. It is shown that within the concept of monetary targeting the choice of the optimal control procedure critically depends on the relative strength of different shocks: if disturbances on the credit market dominate, monetary base targeting is to be preferred; conversely, if money multiplier shocks dominate, interest rate targeting should be favoured.

JEL Classification: E51, E52
Keywords: money supply process, operating procedures, money multiplier

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NON-TECHNICAL SUMMARY

The evaluation of different monetary policy concepts and operating procedures requires a clear understanding of the underlying process of money supply. The mechanistic money multiplier models that can be found in every standard textbook have several shortcomings, however. They neither formulate behavioural functions for banks and non-banks, nor do they include the control procedures of the central bank. Even more elaborate money supply models like McCallum (1989) or Brunner and Meltzer (1966, 1973) cannot completely overcome these shortcomings. We thus develop a framework that integrates the interdependent transactions of the three sectors (banks, non-banks and the central bank) that are involved in the process of money supply. Special emphasis is placed on the central bank's control options for achieving a targeted money stock. That is, we try to identify the optimal control procedure for a central bank that pursues a policy of monetary targeting and is confronted with different shocks. The model itself and the graphical expositions are made as easy and clear as possible to give an intuitive, but still comprehensive, insight into the complex problem.

We begin by reviewing a money supply model developed by McCallum that is based on a money multiplier with interest elastic excess reserves. This underlying behavioural function for commercial banks results in a money supply function of banks that depends positively on the interest rate. This is not a solid basis for a realistic model, however, because the excess reserve ratio in most developed countries is too small to play a significant role for the money supply. Hence the relation between the money supply and the interest rate must be derived differently.

In our two-stage model we argue (and this is implicitly assumed in all mechanistic money supply models and also in McCallum's model) that the money market is a perfect mirror of the credit market under certain simplifying assumptions. Money demand always goes along with credit demand and money supply simultaneously provokes credit supply. Thus it is sufficient to formulate behavioural functions for only one of the two market sides. We derive the credit supply function from profit-maximizing bank behaviour. Then credit supply depends positively on the price of credits (credit market rate), and negatively on the price of the 'input factor' high-powered money (central bank rate) and the default costs. Money demand and equivalently credit demand can be derived from standard money demand theories and are assumed to depend positively on income and negatively on the credit market

rate. The equilibrium money stock and the credit market rate are determined on this macroeconomic market for money (credit).

To achieve the equilibrium money stock commercial banks need a specific amount of high-powered money, which can be determined via the money multiplier. The central bank as the monopolistic supplier of the input factor high-powered money can either set its price (central bank rate) or the quantity of the monetary base. On the market for monetary base, the central bank determines via its operating procedures – interest rate targeting versus monetary base targeting – the conditions that are crucial for the credit (money) supply of commercial banks. Both control procedures lead to equally efficient outcomes in a deterministic world. But, in a stochastic world they crucially depend on the relative strength of disturbances: shocks to money demand, the money multiplier and the credit supply.

If disturbances of the money demand or credit supply dominate (i.e. shocks on the macroeconomic money/credit market), they are automatically compensated by monetary base targeting so that the targeted money stock will be realised. Conversely, if money multiplier shocks predominate, interest rate targeting is the superior control procedure. The reason is that such shocks only transmit into the quantity of the monetary base but not into the money stock. Important for our policy recommendations is that we ask for the optimal control procedure within the concept of monetary targeting. If money demand shocks permanently break up the relation between money and prices, monetary base targeting still guarantees the targeted money stock, but this no longer guarantees the achievement of the final goal of price stability. In that case the whole concept of monetary targeting must be questioned.

In section 4 we extend our analysis by drawing attention to the possible differences between the money and credit markets. We show that our results are not invalidated even if both markets are not perfect mirrors as we assumed in our simple model.

Alternative operating procedures for monetary policy
- A new look at the money supply process

0. Introduction

While for economists the goal of monetary policy is certainly price stability, it is much more a point of controversy what monetary concept to pursue and control procedure to choose to achieve it. This is not only discussed with respect to a future monetary policy of the ECB, but also for the present policy practised by the Deutsche Bundesbank or the Federal Reserve System.[1] In all cases a more or less accurate control of the money stock is a prerequisite. Thus, to evaluate different monetary policy proceedings it is foremost necessary to understand the process of money creation in an economy and how a central bank can keep the money stock under control.

A customary way to be found in every standard textbook is the mechanistic money multiplier model, in which the central bank can exert complete control over the money supply. More elaborate versions (Brunner and Meltzer 1966, Brunner 1973) introduce behavioural functions for banks and non-banks and determine a simultaneous equilibrium on the money and credit market. While these models integrate the behaviour of commercial banks and the non-banking sector, they do not explicitly model the market for high-powered money and the role of the central bank as a monopolistic supplier of the monetary base. The interdependence of commercial banks', non-banks' and the central bank's decisions requires a

We thank Julian Reischle for his helpful comments, from which this paper has benefited a lot.

[1] For a discussion about the ECB policy see CEPR conference report ("What Monetary Policy for the European Central Bank", forthcoming), Cassard, Lane and Masson (1994) and Kremers and Lane (1992). Comments on the Bundesbank policy were made by Bofinger (1994).

framework that combines all these aspects in a complete model of the money supply process. As a result such a model can be used to identify optimum control procedures depending on the relative strength of possible shocks.

Our analysis starts from a different perspective than the famous Poole model (Poole 1970), which tries to identify optimal monetary policy instruments -interest rate versus monetary targeting- within the IS-LM model. Poole does not distinguish between instruments and targets, because he assumes that the central bank can exactly set the money stock or *the* interest rate.[2] With this paper we go a step further. For the concept of monetary targeting we pinpoint the preferable control procedure of the central bank depending on the relative strength of disturbances on the macroeconomic credit or money market and of the money multiplier. Thus, the whole analysis takes place on a level beneath Poole's model, because we look at the variables a central bank controls directly: the central bank rate or the monetary base.[3]

The paper is organised as follows. Section 1 reviews a traditional non-linear money supply model as presented by McCallum (1989). It goes a step beyond most standard textbook models, but not far enough to detect the concrete central bank's options in the money supply process. Our two-stage model of the money supply that is presented in section 2 tries to overcome this. In section 3 the role of shocks for the preferable control procedure -monetary base targeting versus interest rate targeting- will be discussed. Some of the assumptions that were made to keep the model simple will be relaxed in section 4 and compared with the Brunner-Meltzer model. Section 5 provides some concluding remarks.

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[2] A more thorough analysis in that respect is pursued by Canzoneri and Dellas (1995). They also conduct empirical research for the U.S. and come to the conclusion that targeting M1 could have provided better results with respect to price stability and the level of real interest rates.

[3] A model in which the effects of targeting a short-term interest rate for prices and real output are analysed, was developed by Bomhoff (1994). In contrast to other models (Barro 1989) it uses two different interest rate: a policy determined short-rate and a market determined long-rate of interest.

1. A traditional money supply model[4]

In the process of money creation the monetary base (H), defined as the sum of currency (C), required (RR) and excess reserves (ER) can be viewed as an 'input' factor, solely provided by the central bank, which by actions of banks and non-banks is transformed into the 'output' money stock (M) that consists of currency (C) and deposits (D). The money multiplier (m) linking the 'input' and 'output' can be derived as an identity from the definitions of these two concepts.

(1) $M=C+D$

(2) $H=C+R=C+RR+ER$

(3) $$m=\frac{M}{H}=\frac{C+D}{C+R}=\frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{R}{D}}=\frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{RR}{D}+\frac{ER}{D}}=\frac{b+1}{b+rr+er}$$

Introducing behavioural functions for the money multiplier components transfers it from tautology to theory. Following McCallum (1989, p. 57) b and rr are assumed to be exogenous. The currency ratio (b) depends mainly on institutional features and the required reserve ratio (rr) is legally determined. However, the voluntarily held excess reserves are negatively related to their opportunity costs, the interest rate (i) as a representative rate of interest earned on all types of assets.

(4) $$er=er\begin{pmatrix}(-)\\ i\end{pmatrix}$$

Substituting the behavioural function of the excess reserves (eq. 4) into the money multiplier and isolating M, yields a money supply function that is positively related to the interest rate (eq. 5). Adding a standard money demand function (eq. 6), in which the nominal money demand (PL) depends negatively on the interest rate (i) and

[4] The model presented in this chapter is based on McCallum (1989, pp. 55-73).

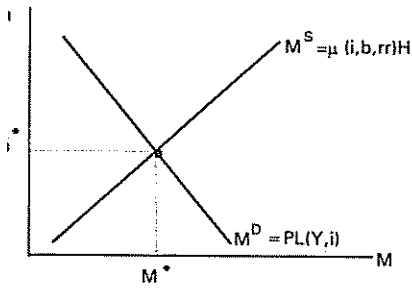
positively on real income (y), one can derive a money market equilibrium condition (eq. 7) with an equilibrium money stock M* as presented in figure 1.

Figure 1: The money market

$$(5) \quad M^S = \mu \left(\begin{matrix} (+) & (-) & (-) \\ i, & b, & rr \end{matrix} \right) H$$

$$(6) \quad M^D = PL \left(\begin{matrix} (-) & (+) \\ i, & y \end{matrix} \right)$$

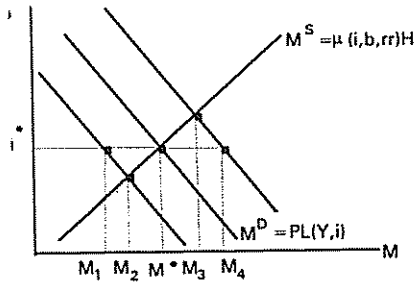
$$(7) \quad M^D = M^S$$



If M* is the targeted money stock, a central bank has two options to achieve it. For a given money demand it can either set the monetary base (H) or the interest rate (i) such that the money supply function yields M*. As long as the model excludes any randomness both procedures are equally efficient. In McCallum's model high-powered money and *the* interest rate are both operating instruments directly manipulated by the central bank. In his view interest rate control derives from the institutional fact that the "Fed maintains a huge portfolio of marketable U.S. government securities, including Treasury bills and bonds" (McCallum 1989, p. 64f). Applied to the graphical illustration interest rate targeting means an endogenous monetary base and an infinitely elastic money supply curve at the targeted interest rate (i^*).

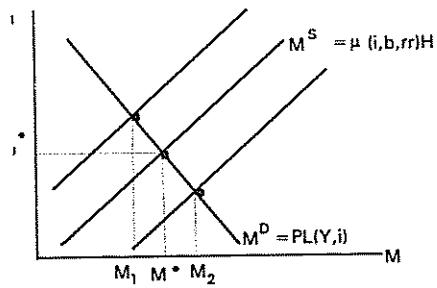
Stochastic disturbances then have a crucial impact on the preferred control procedure. **Money demand shocks** resulting in shifts of the money demand curve (figure 2) affect the equilibrium money stock much stronger if the interest rate is held constant (M_1M_4) than if the monetary base is kept unchanged (M_2M_3).

Figure 2: Money demand shocks



Money supply shocks (figure 3) lead to the opposite outcome. Interest rate targeting completely offsets the money supply shocks and leaves M* unchanged, while monetary base targeting results in money stock variations (M_1M_2). It can be concluded from the analysis that in situations where money demand shocks dominate monetary base targeting should be preferred, while in the case of a dominantly unstable money supply interest rate targeting should be the favoured control procedure.[5]

Figure 3: Money supply shocks



[5] Because the graphical technique is somewhat biased against the monetary base procedure, McCallum also provides an algebraic analysis that supports the graphical results under certain conditions (McCallum 1989, p. 67-71). As long as the variance of disturbances on the money demand side is larger or equal to the variance of disturbances on the money supply side ($\sigma_z^2 \geq \sigma_\varepsilon^2$), high-powered money is the better control procedure. If $\sigma_\varepsilon^2 > \sigma_z^2$ interest rate control is more likely to be favoured the steeper the money demand curve is relative to the money supply curve.

Although the described money supply model yields strong results for monetary policy, it also suffers from two short-comings.

Firstly, the positive linkage between the money supply and the interest rate solely rests on the assumption of excess reserves that are interest dependent. But for the U.S. or Germany the excess reserve ratio is rather small with 0.13% and 0.09% (ER/D) such that an interest rate change could hardly influence the money multiplier and the money supply.[6] Secondly, no distinction is made between

- the interest rate a central bank controls directly, ('central bank rate') and via arbitrage the interbank money market rate and

- the interest rate that is determined on the macroeconomic money (or credit market) which reflects banks' and non-banks' transactions.

Both points of critique[7] will be addressed in the following chapters.

2. A simple two-stage money supply model

2.1 The credit and money market

Given the central bank's monetary policy actions, the money stock is determined on the macroeconomic money market. In this section we assume that this market is a complete mirror image of the credit market. This means that the **money demand**, i.e. non-banks' demand for currency and deposits, goes along with a supply of non-

[6] A numerical example for the minor reaction of the multiplier is given in Mishkin (1995, p.396).
[7] A third short-coming is that in the case of money demand shocks neither a constant interest rate nor a constant monetary base can guarantee the targeted money stock (see figure 2). While for a given interest rate the shifts in the money demand are completely accomodated by monetary base changes, in the case of monetary base targeting additional money supply depends on the interest elasticity of excess reserves.

banks' assets to the banking system. In our simple analysis we assume that the only assets that can be offered by non-banks are IOUs, which are nothing else but bank credits. That means every demand for money provokes an identical demand for bank credit.

From the simplified consolidated balance sheet of the banking system (table 1) it can be seen that also the **money supply** is equivalent to the supply of credit, differing only in the shift parameter 'net worth of other items' (OI) that for now is assumed to be constant. Possible deviations of the money supply from the credit supply will be explained in more detail in section 4.1.[8] As long as no explicit market is formulated for the OI-component, the money market is a perfect mirror of the credit market. Therefore, a credit market equilibrium simultaneously yields a money market equilibrium, which is nothing else than **Walras' Law** for a two goods (credit and money) economy.

Table 1: A simplified consolidated balance sheet of the banking system

Assets		Liabilities	
Loans	(L)	Currency	(C)
•Loans to the private sector ($L_{Banks/Priv}$).		Deposits	(D)
• Loans to the public sector ($L_{Banks/State}$)		Net worth of other items	(OI)

(8) $M=C+D=L-OI$

For both market sides a behavioural function has to be formulated. We explicitly model a function of the private sector' s money demand and credit supply function of commercial banks. Because of the assumed identity of both markets, they are identical with the credit demand and money supply functions respectively. In our

[8] Since the net worth of other items also comprises net external assets, we can already for the simple analysis assume an open economy, in which the central bank is not obliged to intervene on the foreign exchange market.

model analysis we assume prices to be constant, which makes a distinction between nominal and real variables redundant.

Money (credit) demand (M^D, L^D) is assumed to depend positively on income (y) and negatively on an interest rate representing the opportunity costs of holding money. Here we use the credit market rate (i_L), which can be derived from different money demand theories like the Keynesian liquidity preference theory, the Baumol-Tobin-model, Friedman's neo-quantity theory or a utility maximising approach as presented in McCallum (1989). Since the credit demand of the public sector ($\bar{L}^D_{Public}$) relies mainly on political factors, it is here taken to be exogenous.

$$(9) \qquad M^D = L^D = L^D_{Private}\left(\overset{(-)}{i_L}, \overset{(+)}{y}\right) + \bar{L}^D_{Public}$$

The **credit supply function** of commercial banks can be derived from a profit-maximising bank behaviour. The banks' profit function (π) is the difference between their revenues ($i_L L$) and the costs of granting credits. [9]

$$(10) \qquad \pi = i_L L - i_{CB} L_{CB/Banks} - J$$

The latter consists of two components: the price (the central bank rate: i_{CB}) to be paid for the input factor high-powered money received by credits from the central bank ($L_{CB/Banks}$), and the default costs (J)

$$(11) \qquad J = \beta L^2$$

that are assumed to rise more than proportionally with the amount of credits granted.[10] β stands for the risk factor of insolvency. The relation between the money

[9] The idea of using general price theoretic considerations to determine the credit supply behaviour is not new. Riese (1986) shows that it was already formulated by Tobin (1963). Competing commercial banks as members of financial intermediaries not only take the revenues of granting credits into account, but also the costs of obtaining monetary base from the central bank.

[10] A similar credit supply function based on a profit-maximising approach under consideration of the default risk can be found in Fuhrmann (1986, p. 122ff).

stock (M) and the monetary base (H) is characterised by the money multiplier (m), that depends on the currency ratio (b=C/D) and the reserve ratio (r=R/D).

$$(12) \quad M = \frac{b+1}{b+r} H = mH$$

The component central bank credits ($L_{CB/Banks}$) in the profit function (eq. 10) can be substituted by equation (13)

$$(13) \quad L_{CB/Banks} = L + (1-m)H - OI_{Banks}$$

that is derived from two further equations in the following way. Equation (8) defines the money stock as the sum of currency (C) and deposits (D) or as the difference between the credit supply of commercial banks (L) and the net worth of other items of the banking system (OI) that consists of the net worth of the central bank (OI_{CB}) and the net worth of commercial banks (OI_{Banks}) (see table 1).

$$(8) \quad M = C + D = \underbrace{L - OI_{CB} - OI_{Banks}}_{-OI}$$

The second equation needed to derive equation (13) is the monetary base that results from the simplified balance sheet of the central bank[11] and is defined as the sum of currency (C) and reserves (R) or the difference between credits of the central bank to commercial banks ($L_{CB/Banks}$) and the net worth of other items of the central bank (OI_{CB}).

$$(14) \quad H = C + R = L_{CB/Banks} - OI_{CB}$$

Substituting equation (14) in (8) yields

[11] The underlying simplified central bank balance sheet is the following:

Assets		Liabilities	
Loans to banks	($L_{CB/Banks}$)	Currency	(C)
		Reserves	(R)
		Net worth of other items	(OI_{CB})

(8)' $M = L - L_{CB/Banks} + H - OL_{Banks}$.

Equation (8)' can then be rearranged to

(13) $L_{CB/Banks} = L + (1-m)H - OL_{Banks}$.

Substituting equation (13) into the banks' profit function (10) yields

(10)' $\pi = i_L L - i_{CB}[L + (1-m)H - OL_{Banks}] - \beta L^2$.

Computing the first derivative of the profit function with respect to credits ($d\pi/dL$) and setting it equal to zero, generates our credit supply function (eq. 15).

$$\frac{d\pi}{dL} = i_L - i_{CB} - 2\beta L = 0$$

$$L^S = \frac{i_L - i_{CB}}{2\beta}$$

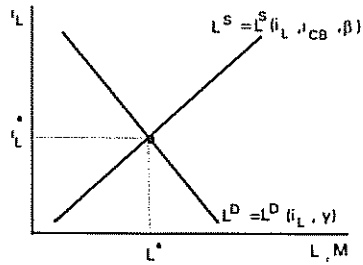
(15) $$L^S = L^S\left(\overset{(+)}{i_L}, \overset{(-)}{i_{CB}}, \overset{(-)}{\beta}\right)$$

Commercial banks' supply of credits is positively related to the credit market rate. This relationship results directly from the profit-maximising behaviour of banks and no longer indirectly as in the McCallum model from the excess reserves in the money multiplier. In addition, it depends negatively on the central bank rate, that can be set by the central bank, and the default risk. Equilibrium on the credit and macroeconomic money market is obtained by

(16) $L^D = L^S = L = M$

which is illustrated in figure 4.

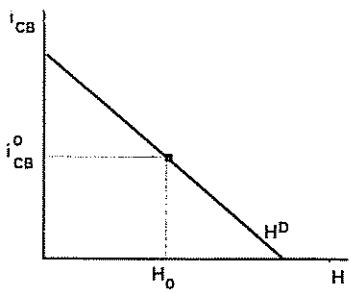
Figure 4: The credit and money market



2.2 The role of the central bank in the money supply process: the complete model

As the only supplier of high-powered money a central bank can either set its price or the quantity. Confronted with commercial banks' demand for high-powered money the central bank acts as a monopolist and sets that point on the price-demand curve that results in the targeted money stock.[12]

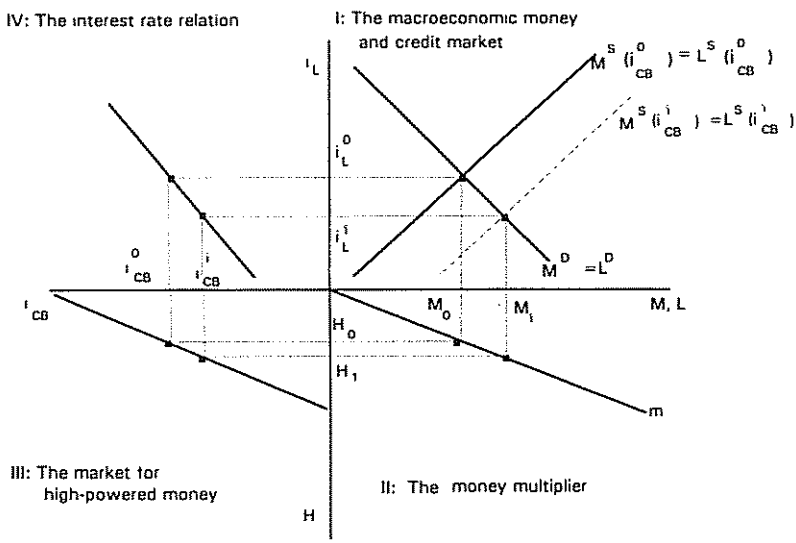
Figure 5: The central bank's control options



[12] Since the falling aggregate demand curve is the outcome of the interdependent money supply process, it can only be derived in the context of the complete model, which will be done in figure 6.

If it targets the central bank rate and sets for example i^0_{CB}, the monetary base H_0 will result from the commercial banks' demand decisions. In contrast to McCallum's model the central bank's interest rate policy directly affects the market for high-powered money and not the macroeconomic money market on which the central bank has only an indirect influence. If the central bank targets the quantity of high-powered money for example by auctioning H_0, then the central bank rate is the endogenous variable. For a given aggregate demand function of high-powered money and the exclusion of any stochastic disturbances both control procedures lead to the same conditions for the 'input factor'. The monetary base is then transformed into the money stock through transactions of banks and non-banks on the credit (money) market. Combining the different stages in a single graph illustrates the interplay of the whole process.

Figure 6: The complete money supply model



The first quadrant shows the credit (money) market for a given central bank rate i_{CB}^0. For the equilibrium money stock M_0 commercial banks need the amount H_0 of monetary base, which can be derived from the money multiplier relation in the second quadrant. The combination of i_{CB}^0 and H_0 gives one point on the monetary base demand curve illustrated in the third quadrant; at a given central bank rate i_{CB}^0 banks are willing to ask at most the amount H_0. The complete demand curve for high-powered money is the outcome of alternative levels of central bank rates. If the central bank follows an expansionary monetary policy and reduces the central bank rate to i_{CB}^1, input costs for commercial banks decrease such that they can grant the same amount of credits at a lower credit market rate or offer more credits at the given rate, i.e. the credit supply curve shifts to the right. In the new equilibrium on the credit market (macroeconomic money market) the money stock has increased (M_1) which requires an additional amount of high-powered money. This is represented in the negatively sloped aggregate demand curve for monetary base in the third quadrant. Thus, the central bank can achieve every desired money stock that corresponds with its monetary concept by either setting the central bank rate or the monetary base.

The underlying interest rate independence of the money multiplier in our model corresponds with McCallum's assumption about the trend-dominated currency ratio and our observation about the insignificant role of the interest elasticity of the excess reserve ratio.

Combining the old and new equilibrium in the graph also reveals a positive linear relationship between the two different interest rates in the fourth quadrant. The interpretation is similar to the money multiplier as a relation between the money stock and the monetary base. Every equilibrium credit market rate goes along with exactly one central bank rate (for example i_L^0 and i_{CB}^0). Since the 'interest rate curve' is the remaining relation of the system its slope depends on the conditions on

the credit (money) market, the money multiplier and on the aggregate monetary base demand.

It is important to note that the model is based on a short-term and medium-term perspective. In the **very short run** the money stock becomes more or less endogenous. The reason is that commercial banks cannot reduce their credit portfolio overnight. Thus their sensitivity to changes in the central bank is relatively low. In figure 6 a reduction of the central bank rate to i_{CB}^1 would shift the credit supply curve by a much smaller amount to the right. The new equilibrium money stock then hardly deviates from the initial money stock M_0 as well as the monetary base that is needed to realise it. The central bank rate change only has a little effect on the quantity of monetary base demanded by commercial banks, which means that the monetary base demand in the third quadrant becomes relatively steep (interest inelastic). Thus, achieving major changes of the money stock also in the very short run then requires extremely large changes in the central bank rate, which most central banks try to avoid.

3. The effects of shocks on the monetary control procedure

For a deterministic world the model has shown that a central bank has complete control over the money stock independently of the control procedure it uses. Only by introducing the more realistic case of stochastic shocks one can evaluate which of the two methods is preferable. For the following we assume that a central bank follows the concept of monetary targeting that has played and still plays an important role in central banks' policies. The Deutsche Bundesbank for example publicly announces money growth targets since 1975. It has to be stressed again that our analysis is different to Poole's analysis (1970) of finding the optimal monetary concept (interest rate targeting versus monetary targeting) within the IS-LM model.

We argue on a level beneath, taking monetary targeting as the given monetary concept, and try to find the optimal control procedure to accomplish it.[13]

3.1 Money demand shocks

In the case of an unstable money demand the money demand curve shifts to M^D_1 or M^D_2 as shown in figure 7.[14] An underlying assumption of the analysis is the instability of the aggregate money demand such that the currency ratio and the money multiplier stay unchanged. That means changes in the two components currency and deposits work in the same direction. This kind of instability does not reflect changes in payment habits or shifts within the different components of money (here M1) which can be observed especially during periods of crisis. They will be described in detail in section 3.2 'Shocks of the money multiplier'.

For a given money supply function the shifts of the money demand curve to M^D_1 and M^D_2 result in the new equilibrium money stocks M^*_1 and M^*_2 and the corresponding credit market rates i_L^1 and i_L^2. The change in the money demand also affects commercial banks' demand for monetary base. If the money demand increases, the banks demand at the initial central bank rate i_{CB}^0 a higher quantity of high-powered money H_1, which is equivalent to a downward shift of the monetary base demand curve in the third quadrant. Moreover, the 'interest rate curve' in the fourth quadrant is affected and shifts upwards. For the opposite case of a reduced money demand the equilibrium money stock decreases as well as the credit market rate and the banks' demand for high-powered money. Consequently, the demand curve for the monetary base shifts upwards and the 'interest rate curve' downwards. The

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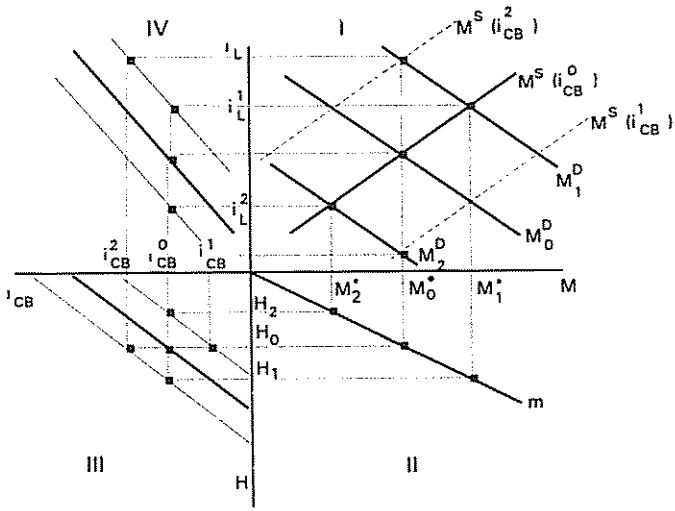
[13] The different levels of analysis can be structured as follows. The ultimate *goal* of monetary policy is price stability. To achieve it a central bank has the choice between alternative *monetary concepts* that might include intermediate *targets*. Since these targets are not under the direct control of the central bank, different *control procedures* have to be analysed. They can directly be obtained by the central bank's operating *instruments*.

[14] To keep the analysis simple, changes in the interest or income elasticities of money demand that would affect the slope will not be discussed. However, the effects are generally the same.

instability of the interest rate relation means that every change in the equilibrium credit market rate at the initial central bank rate must lead to shifts in the 'interest rate curve' (see the derivation of the model in figure 6).

Figure 7: Money demand shocks



The ultimate effects of money demand shocks now crucially depend on the central bank's underlying control procedure. If it pursues a **policy of interest rate targeting**, i.e. it fixes the level of the central bank rate (here i_{CB}^0), the money demand disturbances will be transformed into fluctuations of the monetary base. The central bank will offer exactly that amount of high-powered money which commercial banks need to realise the new equilibrium money stocks M^*_1 and M^*_2. Thus, an unstable money demand results in money stock changes as well as in changes of the credit market rate, although the central bank rate is kept constant.

By **targeting the monetary base** the central bank aims at a certain level of monetary base (here H_0). In the case of money demand disturbances and resulting shifts in the commercial banks' monetary base demand it has to adjust the central bank rate correspondingly. For an increase in the demand of high-powered money it has to allow an increase of the central bank rate up to i_{CB}^2, such that H_0 will be realised on the new base demand curve. The higher costs of refinancing reduce the credit supply and shift the banks' credit supply curve just as much upwards that the equilibrium money stock reaches the initial level M*. Analogously in the case of a reduction in the money demand the central bank rate has to decline to i_{CB}^1 so that the credit supply increases. Thus, under the operating procedure of monetary base targeting, fluctuations in the money demand and the effects on the money stock can be completely compensated by fluctuations of the central bank rate.

For a central bank aiming at a certain money stock and being confronted with fluctuations in the money demand the control procedure of *monetary base targeting* is definitely *superior* to interest rate targeting. This conclusion is apparent, if one visualises the construction of our model. As long as the money multiplier is stable, a constant monetary base always results in a constant money stock.

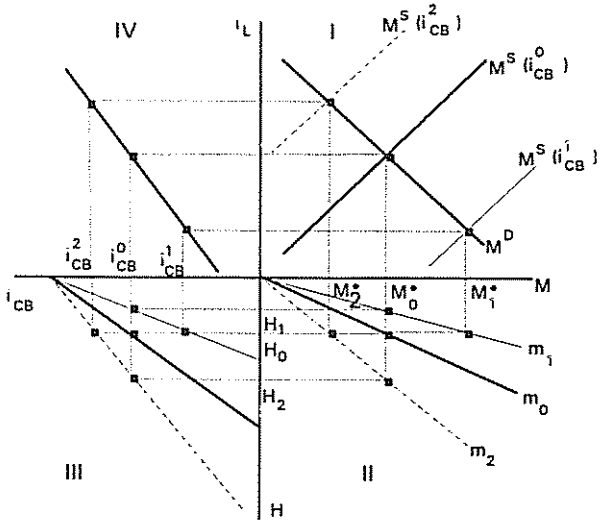
3.2 Shocks of the money multiplier

Fluctuations of the money multiplier are another major source of disturbances in our model. They can only result from changes in the currency ratio, because we assume that the second component of the multiplier, the reserve ratio, is under the control of the central bank which determines the required reserve ratio. The very small influence of the excess reserve ratio will be neglected (see 2.2). For the following analysis we assume a change in the currency ratio such that the aggregate money demand as the sum of the two components remains unchanged.[15] A reduction

[15] If fluctuations in the currency ratio affect the aggregate money demand curve, one has to distinguish between two cases, one in which the money multiplier shock dominates the money

(increase) in the currency ratio will lead to a higher (lower) multiplier, resulting in a steeper (flatter) relation m_1 (m_2) between M and H in figure 8. The immediate impact is an equivalent instability of the demand for central bank money. At a given central bank rate i_{CB}^0 commercial banks only need a smaller (larger) amount of high-powered money H_1 (H_2), because of the increased (reduced) money multiplier.[16] The 'interest rate curve' stays unchanged, because the equilibrium money stock results from the same central bank rate and credit market rate.

Figure 8: Money multiplier shocks



Again the control procedure of the central bank has a crucial influence on how the shock will be transmitted. If the central bank holds the central bank rate constant, money multiplier shocks cause fluctuations in the monetary base. The initial

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demand shock and vice versa. To study this point it is much easier to separate the disturbances as it is done here with the two sections '3.1 Money demand shocks' and '3.2 Shocks of the money multiplier'.

[16] Because the changes in the money multiplier imply rotations of the multiplier curve, the central bank demand curve will also rotate instead of shifting parallel as in the case of money demand instabilities.

equilibrium money stock M^*_0 can also be realised with the new multiplier relations, as commercial banks are willing to obtain exactly that amount of high-powered money that is offered at the fixed central bank rate. Thus, the money stock remains unchanged, since the new multiplier values do not affect the money demand or supply curve. This is no longer the case if the central bank targets the monetary base which results in changes in the central bank rate. This will produce shifts in the money (credit) supply (M^S_1 and M^S_2) and consequently in the money stock.

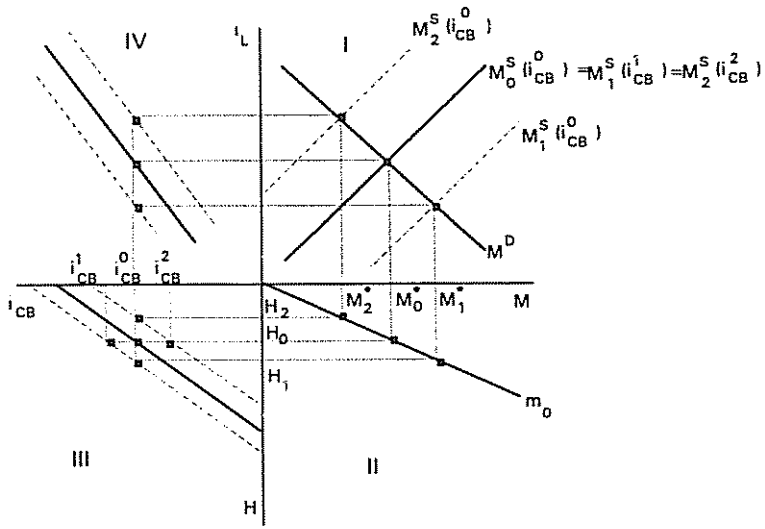
At a more general level one can say that, it is optimal for a central bank to counteract shocks by using the relation of the money supply process that remains relatively stable and can on this way counteract the disturbances. In the case of *money demand shocks* the 'interest rate relation' becomes unstable, while the money multiplier is unaffected. Consequently, the central bank should follow a policy of *monetary base targeting*. In the case of *money multiplier shocks*, the 'interest rate relation' remains unchanged, thus it is optimal to pursue a policy of *interest rate targeting*.

3.3 Credit supply shocks

A third possible disturbance can affect the credit (money) supply side. The origins can either be changes in the costs of examining the creditworthiness of borrowers or direct changes in the default risk factor (β). Both sources cause shifts of the credit supply curve as it is shown in figure 9.[17] For a given central bank rate this leads to changes in the demand for monetary base and the 'interest rate curve'. If the central bank targets the central bank rate level, it has to allow for changes in the monetary base and the credit (money) supply instability fully transmits into variations of M (M^*_1 and M^*_2).

[17] The influence of changes in β on the slope of the credit supply curve will be neglected.

Figure 9: Credit (money) supply shocks



But, as in the case of money demand shocks, money stock fluctuations can be avoided by choosing the procedure of monetary base targeting. Then the ensuing changes in the central bank rate will cause shifts of the credit (money) supply curves back to their initial position, so that the initial money stock results. Thus, such shocks also require the utilisation of the stable multiplier relation and the application of the monetary base control.

3.4 Summary of the results

Our analyses have shown that the optimal control procedure for a policy of monetary targeting crucially depends on the relative strength of different disturbances. If shocks on the macroeconomic money (credit) market dominate, monetary base targeting is preferable. If money multiplier shocks prevail, the central bank should target the central bank rate. Put differently, it is always superior to utilise the relative stable relation of the system. In the case of money (credit) market shocks the

'interest rate relation' becomes unstable and monetary base targeting should be pursued. In the opposite case of money multiplier instabilities interest rate targeting should be followed. These conclusions are consistent with McCallum's results (see section 1.). The seeming contradiction, that he recommends interest rate targeting in the case of money supply shocks, while we favour monetary base targeting is due to McCallum's formulation of the money supply function, which is directly based on the money multiplier. Hence his money supply shock is identical with our money multiplier shock.

Table 2: Overview of the results

control procedure	sources of shocks		
	money demand	money multiplier	credit (money) supply
interest rate targeting (i_{CB}=constant)	• M changes • i_L changes	• M=constant • i_L=constant	• M changes • i_L changes
monetary base targeting (H=constant)	• M=constant • i_L changes (more than in the case of interest rate setting)	• M changes • i_L changes	• M=constant • i_L=constant
favoured control procedure	monetary base targeting	interest rate targeting	monetary base targeting

4. Extensions and a comparison with the Brunner-Meltzer model

4.1 Differences between the credit and money market

The most important simplification we have made so far to keep our analysis as clear as possible was the assumption that the money market is a perfect mirror of the

credit market (and v.v.). This is not a specific feature of our model but implicitly incorporated in all mechanistic money multiplier models and also in McCallum's in section 1. We summarised the differences between the money supply and the credit supply as a variable called 'net worth of other items'. However, we neglected it in the graphical expositions, since we assumed it to be exogenous. On demand side of the credit market and the money market we assumed a complete identity, because of the omittance of any other sources of obtaining currency and deposit holdings (=money demand) next to bank credits. Both simplifications had the side-effect that money was simply defined as the sum of currency and deposits, without specifying the latter.

The purpose of the following explanations is to generalise our model. Therefore, firstly the differences between the money and credit market have to be laid open, secondly the role of money stock definitions has to be analysed and thirdly the effects on our results obtained from sections 2 and 3 have to be checked. To detect the differences between the credit and money market one has to use a somewhat more detailed balance sheet of the banking system. Table 3 shows which items have been hidden behind the variable 'net worth of other items' and it also shows the different monetary aggregates that can be composed. The different monetary aggregates are defined according to the Bundesbank's procedure. The reason for not applying the Fed's definitions is on the one hand their extreme complexity that does not help in the analysis and on the other hand the fact that only the Bundesbank pursues a monetary policy concept which uses a single monetary aggregate (M3).

Table 3: An extented consolidated balance sheet of the banking system

Assets	Liabilities
• net external assets of the banking system (NEA_{BS})	• currency (C) • sight deposits (D) = M1 • time deposits (for less than 4 years) (T)
• bank lending (L) - loans to the private sector ($L_{Banks/Priv}$) - loans to the public sector ($L_{Banks/State}$)	= M2 • savings deposits (at 3 months notice) (S) = M3 • monetary capital formation (= other interest bearing assets held with banks) (MC) • net worth of other items (OI)

In the extended consolidated balance sheet commercial banks' and central bank's acquisition of assets go along with an increase in the money supply. The liabilities side shows that the wider the money definition is, the higher is the conformity with credit supply. Equation (17) shows the differences between the supply of M3 and commercial banks' credit supply.[18] [19] To allow for deviations between the supply and demand side on both markets, one has to look at the planned (ex ante) variables instead of the realised (ex post) values.

(17) $M3^S=NEA_{BS}+L^S-MC^S-OI$ with S=supply of

[18] It is apparent that the deviations also comprise savings deposits when money is defined as M2 and time deposits when M1 is chosen.

[19] We still assume that central bank lending to the public sector is prohibited (see for example Art. 104 of the Treaty of the European Community).

The **money supply** exceeds the credit supply by the item of net external assets and is smaller by the items of monetary capital formation and net worth of other items. If the banking sector acquires net foreign assets, it automatically increases the supply of money, but these transactions leave the credit supply unchanged. If commercial banks increase the supply of monetary capital (or the net worth of other items, which is the remaining variable and shall not be analysed in detail here), this must go along with a decrease of the supply of monetary assets included in M3. To distinguish credit and money **demand** a similar balance sheet analysis can be employed. For the demand side it is necessary to look at the consolidated balance sheet of the private and public sector (table 4). Equation (18) shows the differences between the demand for M3 and the demand for bank credits.

Table 4: The consolidated balance sheet of the private and public sector

Assets	Liabilities
• currency (C)	• loans from banks to the private sector ($L_{Banks/Priv}$)
• sight deposits (D)	
• time deposits (for less than 4 years) (T)	
• savings deposits (at 3 months notice) (S)	• loans from banks to the public sector ($L_{Banks/State}$)
= M3	
• monetary capital formation (= other interest bearing assets) (MC)	
• net external assets of the private and public sector (NEA_{PP})	• net worth (NW)
• physical assets (PA)	

(18) $M3^D=L^D-MC^D-NEA_{PP}-PA+NW$ with D=demand for

Credit demand exceeds money demand by the items monetary capital formation, net external assets and physical assets. The logic behind this is that the utilisation of credits for purchasing other assets than the ones incorporated in M3 does not affect M3 itself.[20] As long as the components on the demand and supply side that constitute the differences between the money and credit stock are viewed as constants, one can indeed assume that the money market is a perfect mirror of the credit market differing only in this term. To allow for and explain changes in these variables one has to formulate separate behavioural functions for all variables. This will not be done here, because it goes beyond the scope of this study. However, equation (19), that results from subtracting equation (18) from equation (17), gives a first insight into the problem and shows how the perfect mirror of the credit and money market is disturbed, if one allows changes in the constant term and/or introduces a third market.[21]

(19) $(M3^S-M3^D)=(L^S-L^D)+(MC^D-MC^S)+NEA_{BS}+NEA_{PP}+(PA-OI-NW)$

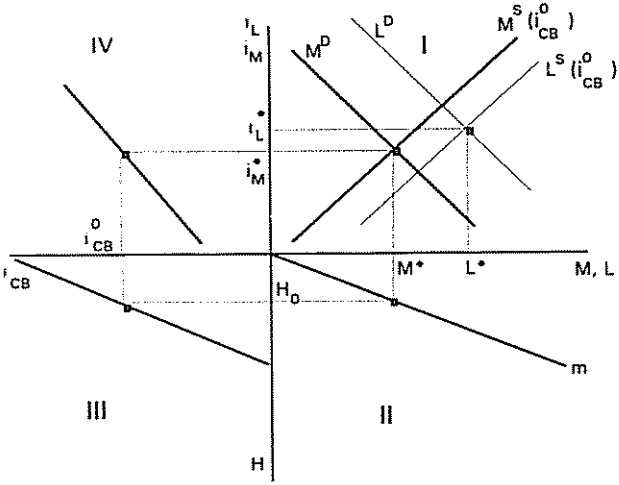
For our model it is important to notice that an extended analysis with markets for interest bearing assets would increase the amount of interdependencies because of alternative assets and financing options. The resulting several interest rates can then reaffect the initial decisions on the separate markets. Figure 10 serves as a mere illustration of a model that explicitly distinguishes between the credit and money market. It is assumed that the credit demand is much larger than the money demand, because of the three components monetary capital demand, net external assets, and physical assets from equation (18). The credit supply is also assumed to

[20] Transactions that simultaneously affect MC, NEA_{PP} or PA and the item net worth (NW) leave both money and credit demand unchanged. An example is the production of physical assets that are exported. This change is mirrored in the item net worth, such that the difference between PA and NW remains constant.

[21] If the money, credit, and monetary capital markets are in equilibrium (their excess demands equal zero) then equation (19) documents the level of accumulated wealth of the economy (wealth=NEA_{BS}+NEA_{PP}+PA=OI+NW).

exceed the money supply, but by a smaller amount. The money multiplier in the second quadrant is now defined as $m = \frac{M3}{H} = \frac{1+b+t+s}{b+r(1+t+s)}$ (with t=T/D and s=S/D).

Figure 10: Differences between the credit and money market



The equilibrium interest rate on the money (i_M) and credit market (i_L) can thus deviate just as the equilibrium money and credit stocks. These deviations do not have to stay constant, because certain transactions do not simultaneously have to affect both demand and both supply sides. That means not all changes on the credit market have to lead to simultaneous changes on the macroeconomic money market. However, our results from section 3 are not invalidated by these extensions. On the contrary disturbances of the money demand or money supply functions and the money multiplier will lead to the same conclusions concerning the preferred monetary control procedure as in the simple analysis. This justifies the simplicity of our model construction in that section. The only restriction derived from the extended model is that looking solely at the credit market is no longer enough. Instead

information is needed about the immediate impact from the credit to the money market. Then the conclusions can be drawn in the same way as before.

4.2 Distinctions to the Brunner-Meltzer model

The illustrative exposition of an extended model has shown that in order to make the model more and more realistic it could be helpful to introduce behavioural functions for all model variables and include a market for real assets. Both can be found in the Brunner-Meltzer approach (Brunner and Meltzer 1966, Brunner 1973). One important feature in their model is the dependence of the credit supply function on the level of monetary base, but nevertheless this as well as the other behavioural functions are based on an ad hoc level. In addition, the Brunner-Meltzer model lacks an explicit consideration of the control options of the central bank. The distinction and interdependence of the loan and securities market plays a major role in their model. The reason is presumably the importance of outright-operations in the monetary policy of the Fed. But, since this is a specific institutional arrangement for the U.S., for a simple theoretical model it is more straightforward to assume the direct control of the monetary base via credits from the central bank to commercial banks. This is the de facto procedure of the Deutsche Bundesbank.

As a consequence of the missing market for high-powered money in the Brunner-Meltzer model they cannot identify the optimal control procedure in the case of shocks. The analysis of instabilities on the money and credit market which Brunner carries out in his 1973 paper (pp. 512-531) only aims at identifying the optimal monetary strategy or target. Thus, he argues on the same level as Poole (1970) when he compares the preferability of controlling the interest rate on the money and credit market versus controlling the money stock. In addition, the Brunner-Meltzer model in all its complexity especially with its numerous assumptions about elasticities cannot meet our claim of giving an easily understandable, intuitive, but

still comprehensive insight into the interdependent money supply process. This is perhaps the reason why it cannot be found in any of the leading U.S. textbooks of monetary economics.[22] Surprisingly, the opposite is true for most of German textbooks, in which one can find more or less elaborate versions of the Brunner-Meltzer model adjusted to the German institutions.[23]

5. Conclusions

In this paper a framework was developed that illustrates a two-stage money supply process. In contrast to existing money supply models like McCallum's model based on the money multiplier analysis or the credit market model of Brunner and Meltzer our model combines the interaction of non-banks, banks and the central bank. Special emphasis was paid to the role of the central bank and its different control procedures, which consist of targeting the central bank rate or the quantity of high-powered money. It was shown that within the concept of monetary targeting the choice of the optimal control procedure depends crucially on the relative strength of disturbances on the money (credit) market or the money multiplier. As long as shocks on the money (credit) market dominate, monetary base targeting is to be preferred and conversely, as long as money multiplier shocks dominate interest rate targeting has to be favoured.

Since the money stock serves as an intermediate target only, the paper leaves it open whether this concept is still adequate if frequent and longer-term disturbances occur. It is well known that this approach rests on two prerequisites. Firstly, the money stock must be controllable by the central bank's operating instruments, which section 3 has shown is not undermined by stochastic shocks as long as the relative

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[22] See for example Mishkin (1995), McCallum (1989), Goldfeld and Chandler (1986), Campbell and Campbell (1988) or Meyer (1982).

[23] See for example Jarchow (1993), Issing (1993), Duwendag (1993), Fuhrmann (1986), Monissen, (1982) or Thieme (1985).

strength can correctly be measured and the preferred control procedure employed. Only in the case of approximately equally strong shocks on the money market side and the money multiplier there is no longer a favourable control procedure to dampen these disturbances. Secondly, a close and stable relationship to the final goal of price stability is required. In the case of permanent money demand instabilities, which is nothing else than a break up of the relation between money and prices, our model results are indeed limited, because monetary targeting then no longer remains meaningful with respect to its final goal.

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