KM 31(1989)
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PREDICTING THE MONEY MULTIPLIER IN THE NETHERLANDS ONCE MORE

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Summary

In this note we reexamine Bomhoff's study on the predictability of the so-called money multiplier in the Netherlands. Reliable predictions of this multiplier form one prerequisite for a policy of monetary base control. Using ARIMA models we show that the predictability has reduced considerably during the last decades. We conclude that Bomhoff's earlier optimistic view with respect to the feasibility of a policy of monetary base control in the Netherlands is not warranted.

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1. Introduction

In most industrial countries the monetary authorities try (or tried) to control the growth of some money stock. In the Netherlands De Nederlandsche Bank (DNB) - i.e. the Netherlands central bank - uses the liquidity ratio as its intermediate target. The liquidity ratio consists of total liquidity (M_2) as a percentage of net national income. As Fase (1980) argues, this policy of controlling the liquidity ratio may easily be translated into a policy of a desired growth rate for M_2, taking into account (unavoidable) price increases, the expected growth in real income and cyclical fluctuations in the demand for liquidity. Generally, DNB tries to control M_2 using credit ceilings for the banking system. Some authors have argued, however, that the Dutch monetary authorities should pursue a policy of (some kind of) monetary base control.[1] We can clarify the difference by means of figure 1. The upper part of this figure shows the situation during most of the after-war period; the lower part shows the suggested alternative.

Figure 1. Controlling total liquidity

instruments	indicator	intermediate target	ultimate target
credit ceilings	direct	→ M_2	→ price stability
open market operations, swaps etc	monetary base	→ M_2	→ price stability

A policy of monetary base control is more in line with the recent deregulation of the Dutch capital market than traditional credit restrictions which hamper competition in the banking sector. The idea behind monetary base control is that the monetary authorities can control - at least parts of - the monetary base. On the basis of a target value for the intermediate target, the allowed growth rate of the monetary base is determined. If monetary policy is directed towards controlling a monetary aggregate like M_1 or M_2 then the money-multiplier - i.e. the ratio between the aggregate and the monetary base - has to be predicted.[2] DNB has rejected monetary base control because of some alleged difficulties to control liquidity growth in this indirect manner.

As noted, a policy of monetary base control as suggested by some Dutch economists implies that the so-called 'money multiplier' has to be predicted, because total liquidity and not the monetary base is the intermediate target. Various methods can be used for this prediction, one of them being Box-Jenkins time series analysis. The purpose of this note is to review and update the empirical evidence on this issue.

The remainder of this note is organised as follows. In the following section Dutch monetary policy is briefly discussed. The analytics of a policy of monetary base control are discussed in the third section. In the fourth section our estimation procedure is introduced and in the fifth section our empirical results are discussed. In the final section we compare our results with previous estimates.

2. Monetary policy in the Netherlands

Long before central banks in other industrial countries started to focus on money growth, the Dutch monetary authorities used a version of the cash balance variant of the quantity theory as the basis for their policy decisions. It is assumed that surplus liquidity will sooner or later be used for consumption and investment purposes, which will eventually cause the general price level to rise.

Dutch monetary policy is directed towards control of the liquidity ratio, i.e. total liquidity as a percentage of net national income, which is regarded as a good indicator of monetary latitude. Total liquidity consists of narrowly defined money - referred to in Dutch parlance as primary liquidity - and other short term claims on government and the banking sector, referred to as secondary liquidity. According to Holtrop - the main architect of Dutch monetary policy after the Second World War - these "claims can be converted by the holder into money on short notice and without loss. Since conversion cannot be refused, the holder has the power to force the debtor to money creation" [Holtrop (1972), p. 226]. Since its introduction the general definition of total liquidity has not changed, although some minor adjustments took place due to the pressures of financial innovations.[3]

Three sources of changes in total liquidity can be distinguished: public sector finance, the balance of payments and the behaviour of the banking sector. The policy of the Dutch central bank is primarily aimed at influencing the growth of net-credit supply of the banking sector, taking into account the expected liquidity creation by the other sources. Both direct and indirect methods have been (are) used to control the expansion of bank credit. During 1973-77, for instance, an indirect system of credit control has been in force. By means of changes in the required liquidity ratios of the banking system, the liquidity of the banks, and hence their net-credit expansion, was manipulated by the central bank. Between 1977 and 1981 direct restrictions (credit ceilings) with regard to bank net-credit expansion have been used. In 1986 and 1987 DNB and the private banking sector agreed on a restriction of the growth of net-credit supplied by the latter.[4]

Some Dutch authors have argued in favour of a policy of (some kind of) monetary base control [see, for instance, Korteweg (1980)], but DNB has always rejected the desirability and feasability of such a policy. It has serious doubts about the possibilities to control some of the sources of base money. This applies especially with regard to changes in the monetary base which are due to changes in gold and offical reserves and transactions with central government. The lack of stability of the money multiplier (m) is also regarded as an important hindrance for a policy of monetary base control. Zijlstra - the former president of DNB - argues e.g.: "This stability of m ... follows from the reasonable stability of other relationships.... Algebraically, this is perfectly in order. However, the stability of these ratios is not entirely beyond challenge" [Zijlstra (1979), pp. 17-18]. The simple analytics of monetary base control are discussed in the following section.

3. Monetary base control

The analytics of monetary base control can be explained by means of equation (1):

(1) $M = m.B$

where M is the money stock concept, B is some measure of the monetary base and m is the multiplication factor (the 'money multiplier').

The 'money multiplier' reflects behavioural relationships of the public, the banking sector and the monetary authorities [see e.g. Korteweg & Van Loo (1977)].

As noted in the previous section, the money stock concept used in the Netherlands is total liquidity (M_2). In Dutch literature on the monetary base three different concepts of the monetary base are discerned, each one being connected to M_2 by a corresponding multiplier. The monetary base (B) consists of currency in circulation (C) plus the reserves of the banking sector (R). The adjusted monetary base (B^a) is found by subtracting the borrowed reserves (discounts and advances) from the monetary base. The third concept is the redefined monetary base (B^r), which is found by adding the net foreign asset position (NFA) of the banking sector to the corrected monetary base. As Bomhoff argues: "The argument for the second correction ... is that in an open economy banks have an alternative to borrowing from the central bank: they can borrow from foreign credit markets. With a more-or-less fixed exchange rate, ... the Central Bank will be obliged to purchase or sell whatever amount of foreign currency the banking system supplies or asks" [Bomhoff (1977), p. 337].

In table 1 the behaviour of the multipliers is shown for the period 1958.I - 1985.IV and two subperiods.

Table 1. Behaviour of different money multipliers

	1958.I-1985.IV		1958.I-1971.II		1971.III-1985.IV	
	mean	coefficient of variation[1]	mean	coefficient of variation	mean	coefficient of variation
$m_b = M/B$	4.0	0.25	3.0	0.10	4.8	0.10
$m_c = M/B^a$	4.5	0.34	3.1	0.13	5.7	0.18
$m_r = M/B^r$	3.8	0.41	2.7	0.19	4.9	0.31

[1] Standard deviation normalized by mean

A feasible policy of (some kind of) monetary base control as suggested by Bomhoff and Korteweg implies that at least two conditions should be satisfied. First, the central bank should be able to control the sources of the monetary base and second, the ´money multiplier´ should be predictable. It is to this last issue that we confine our attention.

As Bomhoff (1977) notes the ´money multiplier´ may be predicted using three different methods:

1) the definitional method according to which the multiplier is regarded as the ratio of the monetary stock and the monetary base each of which is predicted;
2) the regression method, which implies the prediction of the multiplier on the basis of a single equation; and
3) the behavioural method: the multiplier is predicted on the basis of a structural model.

In the next section we will discuss one particular type of the regression method to estimate money multipliers, because this method is used both by Bomhoff (1977) and Fase (1980).

4. An ARIMA-model of the money-multiplier

4.1. Introduction

In the preceeding section three possible methods of predicting the multiplier were mentioned. In this section a regression method is employed in which only the values of the time series observed in the past are used. This method of analysing the multiplier series has been developed by Box & Jenkins (1970). It is based on autoregressive and moving average processes of stationary time series, i.e. series which are time invariant.

An autoregressive (AR) process uses previous values of the process as independent variables:

$$z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + \dots + \phi_p z_{t-p} + a_t \qquad \text{AR(p)}$$

In this equation, a_t stands for a random shock with mean zero and variance σ_a^2.

A moving average (MA) process contains a weighted sum of previous random shocks:

$$z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \dots - \theta_q a_{t-q} \qquad \text{MA(q)}$$

Often, both AR and MA terms are included in the model. This leads to a mixed autoregressive, moving average ARMA (p,q) process:

$$z_t = \phi_1 z_{t-1} + \dots + \phi_p z_{t-p} + a_t - \theta_1 a_{t-1} - \dots - \theta_q a_{t-q} \qquad \text{ARMA(p,q)}$$

ARMA processes can be used provided the series is stationary. However, non-stationary series occur frequently. One method to make the series concerned stationary is taking the d-th difference of the series. For example, the series of the first differences of z_t (i.e. $x_t = z_t - z_{t-1}$, with d=1) may be stationary. A process containing AR and MA terms which can be made stationary by differencing is called an autoregressive integrated moving average (ARIMA) process of order (p,d,q). An example is the ARIMA (1,1,1) process:

$$(z_t - z_{t-1}) = \phi_1 (z_{t-1} - z_{t-2}) + a_t - \theta_1 a_{t-1}$$

The values of p,d,q and the coefficients of the model have to be estimated. Box & Jenkins distinguish three stages in the iterative process of finding the quantitative specification of the model: identification, estimation and diagnostic checking. In the identification-stage we will try to get some notion of the models which may be further investigated. We want to get some idea of the value of d, so as to make the series stationary and of the values of p and q so as to give an initial value to the orders of the AR and MA components. In the second stage, these parameters will be estimated. Finally, the fitted model will be subjected to different kind of tests (diagnostic checking), i.e. the significance of the estimated parameters and the residuals of the fitted model will be examined. On the basis of these checks we will formulate new identification-suggestions. This process will continue until we are content with the ARIMA-specification.

If alternative specifications hold, a choice is made on the bases of considerations regarding parsimony and similarity. According to the principle of parsimony the smallest possible number of parameters for an adequate representation is employed. By similarity is meant that if possible, in the ARIMA-models for the three money multipliers the same parameters are used.

4.2. Specification of the model

In the analysis we will use quarterly values for the three multipliers as defined in the third section for the 1958.I-1985.IV period.

Before we can apply the Box & Jenkins-method, we must be sure that no structural shifts occur within the time series. However, a close inspection of the data strongly suggests the occurrence of a structural break at the beginning of the seventies [see figure 2]. We have taken the moment that the Dutch Guilder started to float against the US dollar as shifting date, because the change from a fixed to a flexible exchange rate system has had an important effect on all monetary quantities. This structural change implies that we have to analyse two different time series; one for the period 1958.I-1971.II containing 54 observations and the other for the period 1971.III-1985.IV with 58 terms. Newbold and Granger (1974) argue that reasonably reliable results with the ARIMA techniques can be obtained if time series are used which contain at least 40 observations. Hence there is, in this respect, no problem in cutting the series into these parts.

Now we can start with the specification of the model. The tools used in the analysis are the autocorrelation function (acf) and the partial autocorrelation function (pacf). The acf indicates how the correlation between two values of the series changes as their lag structure changes.[5] The pacf measures the correlation of the current and lagged series taking account of the predictive power of all the values of the series with smaller lags.[6]

Multiplier series with data from 1958.I to 1971.II

The acf and pacf of the time series for the three multipliers pointed strongly towards a differencing of d = 1. Hence we continued the analysis with the series of first differences $x_t = z_t - z_{t-1}$. The autocorrelation functions of these series showed high values for r_1, r_4, r_{12} and r_{16}, where r_i is the correlation coefficient for the current value of a variable and the i-th lag of the variable concerned.[7] Together with the striking values for f_{11} and f_{44} -the partial autocorrelations[8] with respectively the first and fourth lag- this gave an indication of an autoregressive process with the terms p = 1 and p = 4. Surprisingly, r_8 was not significant in either of the three series. The series of m_b also had significant values for r_9 and r_{11}. However, we could not find any economic interpretation of these values and hence we did not incorporate them into the model. The results for the three multiplier series are shown in table 2.

Figure 2a. M_b, 1958.1 - 1985.4

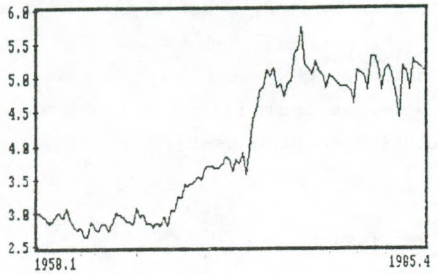

Figure 2b. M_c, 1958.1 - 1985.4

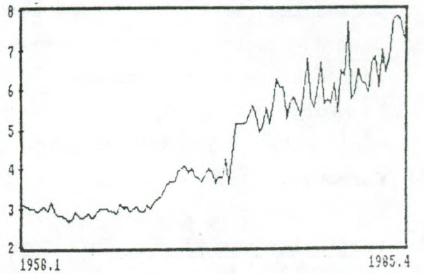

Figure 2c. M_r, 1958.1 - 1985.4

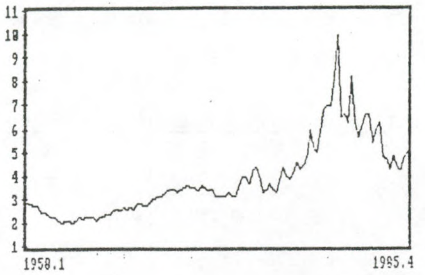

Table 2. Estimated money multipliers, 1958.I - 1971.II*

Multiplier	Specification	$N\Sigma r_k^2$
m_b	$x_t = \underset{(0.13)}{-\,0.29}\, x_{t-1} + \underset{(0.13)}{0.30}\, x_{t-4} + a_t$	14.57
m_c	$x_t = \underset{(0.14)}{-\,0.23}\, x_{t-1} + \underset{(0.14)}{0.27}\, x_{t-4} + a_t$	11.86
m_r	$x_t = \underset{(0.13)}{-\,0.07}\, x_{t-1} + \underset{(0.13)}{0.38}\, x_{t-4} + a_t$	10.72

* Estimated standard deviations are shown below each coefficient.

The autocorrelation functions of the residuals yielded no significant values any more. The standard error of r_9 and r_{11} of the residuals of m_b were less than 2 s.d. Other possible models with both moving average and autoregressive terms gave no satisfactory results. The values for the portmanteau lack of fit test (last column in Table 2) are all much smaller than the corresponding chi-square $\chi^2_{22}(.95) = 33.9$. Hence, there is hardly any doubt as to the adequacy of the model. The AR(1) coefficient for m_r, is clearly not significant. Nevertheless, we included it for reasons of similarity. The models as given in table 2 have been used for forecasting purposes.

Multiplier series with data from 1971.III-1985.IV

Here too, there was hardly any doubt about the stationarity of the series of first differences. However, the autocorrelation function (acf) and partial autocorrelation function (pacf) gave a much less unambiguous view. High values of these functions are given in table 3 below.

Table 3. High values of the (potential) autocorrelations of the series of first differences

Multiplier	Autocorrelations with with acf $\geq$ 0,2	Partial autocorrelations with pacf $\geq$ 0,2
m_b	r_1 r_4 r_7 r_8 r_{15}	f_{11} f_{44} f_{35} f_{77}
m_c	r_1 r_4 r_6 r_8 r_{12} r_{18}	f_{11} f_{22} f_{33} f_{66}
m_r	r_1 r_2 r_6 r_8 r_{10} r_{12} r_{14} r_{16} r_{18}	f_{11} f_{32} f_{33} f_{44} f_{66}

In contrast with the pre-1971 series a combination of highly significant r_1 values and damping in f_{11}, f_{22}, f_{33} was visible. This pointed to a first order moving average process. We also saw a damping of parts of r_4 r_8 r_{10} r_{16} together with a fairly high value of f_{44}. This made the variable x_{t-4} a good candidate for inclusion in the model, which is also economically reasonable since it represents the seasonal pattern of the series of quarterly values of the multipliers. The other high values of the acf and pacf seem to have no justification in economic theory. They might be due to an overall whimsical character of the series. Our preliminary estimates for the multipliers for the period 1971.III - 1985.IV are shown in table 4.

Table 4. Estimated money multipliers, 1971.III - 1985.IV

Multiplier	Specification	High values of acf	& pacf
m_b	$x_t = \underset{(0.14)}{0.27}\, x_{t-4} - \underset{(0.14)}{0.20}\, a_{t-1} + a_t$	-	-
m_c	$x_t = \underset{(0.14)}{0.25}\, x_{t-4} - \underset{(0.13)}{0.51}\, a_{t-1} + a_t$	r_6 r_{12}	f_{66}
m_r	$x_t = \underset{(0.14)}{0.49}\, x_{t-4} - \underset{(0.14)}{0.32}\, a_{t-1} + a_t$	r_6 r_{12} r_{18}	f_{66}

This is undoubtedly an elegant specification from the similarity point of view. Furthermore, none of the coefficients (except for the MA(1) coefficient of the m_b-series) are insignificant, nor gives the portmanteau lack of fit test reason for questioning the model. Nevertheless, we were not content with this specification, because the acf and pacf of the m_c and m_r series gave such unambiguous indications of an AR(6) factor that we could not omit it. It also turned out that the m_b series gave a much better specification by adding an MA(4) factor to the equation. In table 5 our preferred estimation results are presented.

Table 5. Estimated money multipliers, 1971.III - 1985.IV

Multiplier	Specification	$N\Sigma r_k^2$
m_b	$x_t = \underset{(0.29)}{0.65}\, x_{t-4} \underset{(0.14)}{-0.29}\, a_{t-1} \underset{(0.30)}{-0.52}\, a_{t-4} + a_t$	14.73
m_c	$x_t = \underset{(0.14)}{0.23}\, x_{t-4} \underset{(0.14)}{-0.50}\, a_{t-1} \underset{(0.14)}{-0.30}\, x_{t-6} + a_t$	14.66
m_r	$x_t = \underset{(0.15)}{0.40}\, x_{t-4} \underset{(0.15)}{-0.27}\, a_{t-1} \underset{(0.14)}{-0.40}\, x_{t-6} + a_t$	11.83

The specification given in table 5 is much more satisfactory. There are no (partial) autocorrelations with high values any more. The coefficients are all significant at at least the 90% level. The portmanteau lack of fit test gives no reason for questioning the adequacy of the model on statistical grounds.[9] The specifications as given in table 5 have been used to forecast the money multipliers.

5. Predicting the money multipliers

As we have argued in the third section, the predictive power is an important criterium for the usefulness of the multiplier. Only if the predictions are accurate enough, they can be used in monetary policy. In order to compare the three multipliers in the two subperiods, the root of the mean square error is calculated for predictions with the models fitted to each period. This is done for the last four quarters of each period. The results are shown in table 6.

Table 6. Prediction results for the money multipliers, 1958.I - 1985.IV

	1958.I - 1971.II			1971.III - 1985.IV		
	m_b	m_c	m_r	m_b	m_c	m_r
root of mean square errors in predicting next quarter´s multiplier (% at annual data)	1.4%	3.8%	4.2%	4.4%	9.9%	3.7%
root of mean square errors in predictinig next four quarters multipliers (% at annual data)	1.4%	6.0%	3.9%	4.4%	15.2%	6.9%

Note that in the first row, predictions for each quarter are made on the basis of the information up to that quarter. In the second row we let the quarterly errors accumulate on an annual basis.

Two points are striking. First, there is a considerable difference in predictability between the three multipliers; m_b has on average the highest predictive power and m_c the lowest. Second, the prediction results for the first period are substantially better than for the second; the root of mean square errors for 1958.I - 1971.II is, on average, twice as small as for 1971.III - 1985.IV. Although some may even doubt wether the predictive power in the first period suffices, it is obvious that the predictive power in the second period is rather poor.

6. Comparison with other research

As we have noted, a policy of (some kind of) monetary base control as suggested by some Dutch authors requires that the monetary base can be controlled by the monetary authorities; moreover the money multiplier should be stable enough to be predicted. Bomhoff (1977) concludes that for the Netherlands which is a ".... highly open economy, accurate multiplier predictions would .... have been possible" [Bomhoff (1977), p. 327]. Fase (1980) however, argues that he "... presented some empirical evidence yielding rather poor estimates both for the model to predict the money multiplier and the relationship between money stock and base money" [Fase (1980), p. 200]. Bomhoff examined the predictability of the money multipliers for M_1. However, in the Netherlands total liquidity is used as an intermediate target for monetary policy and therefore we have followed Fase in examining the money multipliers for M_2.

Bomhoff confined his analysis primarily to the period 1963-1968[10], while Fase focussed upon the period 1968-1978. Bomhoff notes: "our prediction algorithm ...... generates forecasts of average quality for 1966, 1967 and 1968 and detoriates sharply only in 1969" (p.341). Given the different behaviour of the money multipliers during different periods it can therefore be no surprise that Fase´s conclusions are not as supportive as Bomhoff´s results. Our results also clearly indicate that the predictability of the money multipliers diminished during the seventies[11]; the prediction errors were generally substantially higher which seems to substantiate DNB´s claim that monetary base control is not feasible in te Netherlands.

It is also interesting to note that the predictability of m_b is the highest, both for Bomhoff´s estimates as for our results. As we have noted in the third section, the monetary base is adjusted for components which are controlled not so much by the monetary authorities as by commercial banks. So, the monetary base concept which is probably the most difficult one to control can be better predicted than concepts which are easier to control.[12]

Notes

* University of Groningen. The authors would like to thank Drs. L.H. Hoogduin, prof. dr. S.K. Kuipers, dr. C.G.M. Sterks, Dr. W. Voorhoeve and the referee for their comments on an earlier version of this paper.

[1] See e.g. Bomhoff (1977), Korteweg (1980) and Sijben (1986).

[2] Korteweg (1980) refers to the Swiss experience with a policy of monetary base control. Indeed, the Swiss central bank targetted M_1, using the monetary base as its prime instrument between 1975 and 1978 [see Büttler et al. (1979)]. However, the multiplier model estimated by the Swiss central bank turned out to be unstable. Since 1980 the intermediate target has been set in terms of the monetary base [see Kohli & Rich (1986)]. As the referee pointed out, in this case, instability of a multiplier model does not preclude a policy of monetary base control. What matters is whether or not there is a stable and close relationship between the base and the ultimate target, and whether the central bank can exercise a close control over the base.

[3] A part of the saving deposits is now included in total liquidity, depending on the rate of circulation of the saving account concerned. Moreover, since the recent deregulation of the Dutch capital market, certificates of deposits -which did not exist prior to the deregulation- are also regarded as part of total liquidity.

[4] Formally, DNB only asked the banking sector to restrict the growth of its liquidity creation; DNB did not introduce a quantitative credit restriction.

[5] The autocorrelation as function of k is defined as:

$$\zeta_k = E\{[z_{t-k}-\mu][z_t-\mu]\}/E\{[z_t-\mu]^2\}$$

with μ is the expected value of z.

[6] The partial autocorrelation as function of k is the k^{th} coefficient in the equation:

$$\zeta_j = \phi_{k1}\zeta_{j-1} + \phi_{k2}\zeta_{j-2} + \ldots\ldots + \phi_{kk}\zeta_{j-k}$$

[7] r_k is an estimator for ρ_k, the true autocorrelation function. The quantity ρ_k, regarded as a function of the lag k, is defined as:

$\rho_k = cov(x_t, x_{t+k})/var(x_t)$

[8] f_{kk} is an estimator for ϕ_{kk}, the true partial autocorrelation function. The quantity ϕ_{kk}, regarded as a function of the lag k, is defined as:

$$\phi_{kk} = \begin{cases} \rho_1 & \text{for } k = 1 \\ (\rho_k - \sum_{j=1}^{k-1} \phi_{k-1,j}\cdot\rho_{k-j})/(1 - \sum_{j=1}^{k-1} \phi_{k-1,j}\cdot\rho_j) & \text{for } k = 2,3,\ldots.. \end{cases}$$

with $\phi_{k,j} = \phi_{k-1,j} - \phi_{kk}\cdot\phi_{k-1,k-j}$ for $j = 1,2,\ldots..k-1$

[9] The related chi-square value at 95% with 21 degrees of freedom is 32.7.

[10] Bomhoff's full sample period is 1957-1972. He notes however that "the degree of variability increases significantly for all three multipliers near the end of the period under review" (p.340).

[11] Fase does not use his estimated equations to predict the money multipliers. When he divided his sample period into two sub-periods the estimates turned out to differ considerably between these periods. According to Fase "this points in the direction of a lack of stability on the part of the multiplier model, and therefore gives little hope this is a suitable approach to establish an operational framework for money supply control" (p.200). In our view, this is however not necessarily true; it depends on the issue of whether before and after some (identifiable) structural break the money multiplier can be predicted.

[12] It is important that our conclusions are correctly understood: they are based on a sample period in which monetary policy was not directed towards monetary base control, which implies that conclusions with regard to the predictability might have been different if monetary policy had been different. Moreover, the outcomes of other methods to predict the money multipliers (a structural approach e.g.) may be substantially better and therefore this paper should not be seen as a definite dismissal of a policy of monetary base control in the Netherlands.

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Ontvangen: 18-03-1989
Geaccepteerd: 07-04-1989