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Testing Partial Adjustment and Error Correction Specifications for Dutch Money Demand

Han van der Knoop

Using tests for non-nested models I investigate the partial adjustment (PAM) and the error correction mechanism (ECM) as alternative specifications for Dutch money demand. Both the PAM and the ECM must be rejected, thus leaving the decline of the income velocity of broad money demand in the Netherlands during the eighties not really intelligible.

Mailing address: dr H.S. van der Knoop
Ministry of Finance
P.O. Box 20201
2500 EE The Hague
Netherlands
Phone: 070-3427046

1. Introduction*

In the Netherlands the broadly defined amount of money is intermediary target variable of monetary policy. The Dutch monetary authorities assess the monetary situation by the liquidity ratio, i.e. M2 as percentage of national income. During the eighties this liquidity ratio showed a strong increase. To explain this, a money demand equation has been estimated according to the Box-Jenkins (1976) approach to time series analysis (Van der Knoop and Hooijmans, 1985). According to this equation, a large part of the rise in the liquidity ratio was to be attributed to the noise (i.e. the part of M2 that is not attributable to the variables of the equation). Since this is not very satisfactory for both theorist and policymaker, a large number of possible determinants has been investigated up to now in order to reduce the unexplained part of the equation. Basing ourselves upon the very rich money demand literature as well as upon suggestions of policymakers we tried as explanatory variables several trade cycle indicators, domestic and foreign interest rates, a measure of inequality for the personal income distribution, turnover on the Amsterdam stock exchange, flow of exports and imports, rate of inflation, production capacity utilisation, currency circulation as an indicator of the flow of transactions in the informal economy, receipts on public issues of governments debt, calendar variation, population size, variability of interest rates and inflation, backlog of company orders - without any avail, however.

In recent versions of the equation the noise appeared to contain a deterministic trend. Since this offers hardly a genuine explanation for critical policymakers, the question arose whether the importance of the noise might be due to an incorrect specification of the dynamic properties of the model. To motivate this surmise I propose to consider for broadly defined money M, measured on a quarterly basis, the following simplified version of our dynamic regression model (given in full in Eq.(2))

$$\log\underline{M}=\omega(B)\underline{Z}+\underline{N}_{-1}+\underline{a}+\varepsilon \tag{1}$$

Here, as in the following, stochastic variables are underlined in order to distinguish them from the values they assume. I use the backward shift

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operator B which is for a time series observation $\underline{X}_t$ defined by $B\underline{X}_t = \underline{X}_{t-1}$; operator B can be treated as if it were a real (or complex) variable and gives us a convenient way of handling the dynamic properties of time series. Polynomial $\omega(B)$ represents the operator

$$\begin{aligned}\omega(B)\underline{X}_t &= (\omega_0 - \omega_1 B - \ldots - \omega_r B^r)\underline{X}_t \\ &= \omega_0\underline{X}_t - \omega_1\underline{X}_{t-1} - \ldots - \omega_r\underline{X}_{t-r}\end{aligned}$$

For ease of exposition the time index t will be left out in the sequel. This should cause no misunderstanding since all time series variables have been defined in the data appendix. $\underline{Z}$ represents in this section an explanatory variable, of course measured also on a quarterly basis; noise $\underline{N}=\log\underline{M}-\omega(B)\underline{Z}$; $\underline{a}$ is white (that is, it is a random drawing from a stable distribution with mean zero) and independent from $\underline{Z}$ for any lag and from $\underline{N}_{-1},\underline{N}_{-2},\ldots$. Eq.(1) implies that noise $\underline{N}$ is not stationary and contains a deterministic trend since

$$\underline{N}=\underline{N}_{-1}+\underline{a}+\varepsilon$$

so that

$$(1-B)\underline{N}_t=\underline{a}_t+\varepsilon$$

hence

$$\underline{N}_t = \nabla^{-1}\,\underline{a}_t + \varepsilon t + \text{constant}$$

in which $\nabla = 1-B$ and t = time.

Now suppose that we would replace the term $\underline{N}_{-1}$ in (1) by $(1-\pi)\log\underline{M}_{-1}$ $(0\leq\pi\leq1)$. Then (1) becomes

$$\log\underline{M}=\omega(B)\underline{Z}+(1-\pi)\log\underline{M}_{-1}+\underline{a}+\varepsilon \tag{1'}$$

which can be rearranged to give

$$\nabla\log\underline{M}=\pi[\omega^*(B)\underline{Z}-\log\underline{M}_{-1}]+\underline{a}+\varepsilon$$

with $\omega^*(B) = \omega(B)/\pi$. Note that the partial adjustment model (PAM) arises when $\omega^*(B) = \omega_0$ for then

$$\log\underline{M}-\log\underline{M}_{-1}=\pi(\omega_0\underline{Z}-\log\underline{M}_{-1})+\underline{a}+\varepsilon$$

with π representing the rate of adjustment of $\underline{M}$ to its prefered value represented by $\omega_0\underline{Z}$, while the error correction model (ECM) arises when $\omega^*(B) = \omega_0 - \omega_1 B$ for then

$$\begin{aligned}\log\underline{M} - \log\underline{M}_{-1} &= \pi(\omega_0\underline{Z} - \omega_1\underline{Z}_{-1} - \log\underline{M}_{-1}) + \underline{a} + \varepsilon \\ &= \pi\{(\omega_0 - \omega_1)\underline{Z} + \omega_1(\underline{Z} - \underline{Z}_{-1}) - \log\underline{M}_{-1}\} + \underline{a} + \varepsilon \\ &= \pi\{\Omega\underline{Z} - \log\underline{M}_{-1}\} + \delta(\underline{Z} - \underline{Z}_{-1}) + \underline{a} + \varepsilon\end{aligned}$$

in which the change in money holdings is the sum of a portion of the deviation from the prefered value $\Omega\underline{Z}$ and a portion of the change in $\underline{Z}$. PAM and ECM enjoy a certain popularity among money demand researchers; notably the PAM is widely used in money demand equations. References are given in section 5.

Obviously the dynamic properties of (1') are completely different from those of (1), notably with respect to the transfer of the influence of $\underline{Z}$ to $\underline{M}$. Whereas according to (1) we saw that

$$\log\underline{M} = \omega(B)\underline{Z} + \frac{\underline{a}}{1-B} + \varepsilon t + \text{constant}$$

(1') says that, in terms of the operator B,

$$\log\underline{M} = \frac{\omega(B)}{1 - (1-\pi)B}\underline{Z} + \frac{\underline{a}}{1 - (1-\pi)B} + \varepsilon\pi^{-1}$$

in which $\{1-(1-\pi)B\}^{-1}\ \varepsilon = (1-1+\pi)^{-1}\ \varepsilon = \pi^{-1}\varepsilon$ since ε is a constant. Consequently the part of the change of money demand over k periods attributable to a change of $\underline{Z}$ is $\omega(B)(\underline{Z}-\underline{Z}_{-k})$ according to Eq.(1), whereas, using the expansion

$$\frac{\omega(B)}{1-(1-\pi)B} = \omega(B)\{1+(1-\pi)B + (1-\pi)^2B^2 + \ldots\}$$

we can derive for Eq.(1') that this change equals

$$\omega(B)\left[\{1 + (1-\pi)B + \ldots + (1-\pi)^{k-1}B^{k-1}\}\underline{Z} - \frac{1-(1-\pi)^k}{1-(1-\pi)B}\underline{Z}_{-k}\right]$$

$$\approx \omega(B)(\underline{Z} + \underline{Z}_{-1} + \ldots + \underline{Z}_{-k+1})$$

for π close to 0 and k not large. Hence, depending of course on the specific properties of $\underline{Z}$ and $\omega(B)$, the explanatory variable in (1') may carry more weight than in (1). Also, Eq.(1) would attribute an amount of εk of the change in money demand to the deterministic trend, which is in Eq.(1') absent.

Eq.(1) and (1') though, being two non-nested alternatives, may approximate each other when the contribution of $\underline{Z}$ to the explanation of log$\underline{M}$, and π are small. By consequence the noise of the equation may be confused with the lagged dependent variable so that Eq.(1) might arise as a mis-specification of Eq.(1'). Davidson, Hendry, Srba and Yeo (1978, p. 685, 686) discuss such a situation, too. They do not, however, use formal tests for "non-nested" models to discriminate between different possibilities. In this paper we intend to clear up the situation by employing the so-called J-test of Davidson and MacKinnon (1981) developed for testing a model against non-nested alternatives. The relevance of this approach for the assessment of the monetary facts is obvious. The plan of the article is as follows. In section 2 I present cursorily my prefered equation for the demand for money. In section 3 the procedure for testing non-nested models is described in broad outline. Section 4 gives the results of tests set up along the lines of this introduction, while section 5 elaborates on the PAM and the ECM. Finally, section 6 concludes.

The results will throw some light on the approach of Kuipers and Boertje (1988). These authors start from the outset for their money demand equation with a PAM, without testing it against alternatives, however. They then attribute the rise in the liquidity ratio in the early eighties in the Netherlands mainly to the fall in the labour income ratio of the business sector. Yet it is not clear to what extent their explanation is exhaustive since they do not report on the contribution of the noise.

2. A Transfer Function Model for Money Demand

My prefered description of the economy wide demand for broad money in the Netherlands on a quarterly basis is:

$$\log M = (\underset{.05}{.38} + \underset{.05}{.34}B + \underset{.05}{.13}B^2 + \underset{.05}{.14}B^3)\log Y + \qquad (2)$$

$$+ (\underset{.0036}{.0050} + \underset{.0037}{.0103}B + \underset{.0037}{.0097}B^2 + \underset{.0038}{.0167}B^3)\alpha$$

$$- .0373\alpha(78I-) - .0413B\alpha(77IV-) - .0099B^2\alpha(77III-)$$
$$\quad .0144 \qquad\qquad .0144 \qquad\qquad .0132$$

$$- .0447B^3\alpha(77II-) + .097S(78I-) - .070Cr(77)$$
$$\quad .0134 \qquad\qquad .043 \qquad\qquad .016$$

$$- .024Cr(80) + N$$
$$\quad .010$$

$$\nabla N = \underset{.006}{.039}I + \underset{.006}{.032}II - \underset{.006}{.033}III - \underset{.006}{.012}IV + a$$

$$\sigma_a = .0139;\ \chi^2_{MM} = 16.2(26.3);\ \chi^2_{MY} = 22.0(21.0);\ \chi^2_{M\alpha} = 10.4(21.0).$$

All estimates in this paper are Gaussian (i.e. maximum likelihood under the assumption of normally distributed errors) with corresponding estimated large sample approximations of the standard errors stated under each coeffficient. In models without autocorrelation parameters being estimated Gaussian estimators are of course identical to least squares estimators. As is well known these produce in finite samples a bias if a lagged dependent variable is present as regressor. The estimation period is 1970I-1987IV while the variables are given in the appendix.

Exhibit 1 shows quarterly M over the estimation period, as well as the within-sample predictions of eq.(2). In absolute level the correspondence between the two series is impressive - as is usually the case -, but measured in relative rates of change (see exhibit 2) it is less than perfect. Exhibit 3 shows the residuals of eq.(2), per cent of M; clearly eq.(2) still leaves something to explain.

As diagnostic checks of the model the chi-squared or (Box-)Pierce statistics have been calculated on 16 residual autocorrelations or crosscorrelations with the prewhitened inputs $\underline{Y}$ and $\underline{\alpha}$; relevant approximate .05-critical values have been stated between parentheses. These diagnostics must be understood as follows. If the model is correct, no inadequacies should appear when it is put to the test. The whiteness of residual $\underline{a}$ is an important feature. This hypothesis is tested by the first chi-squared statistic. Also, the residual should not contain any part that still is determined by the explanatory

Exhibit 1: Broad money in the Netherlands, absolute level per quarter

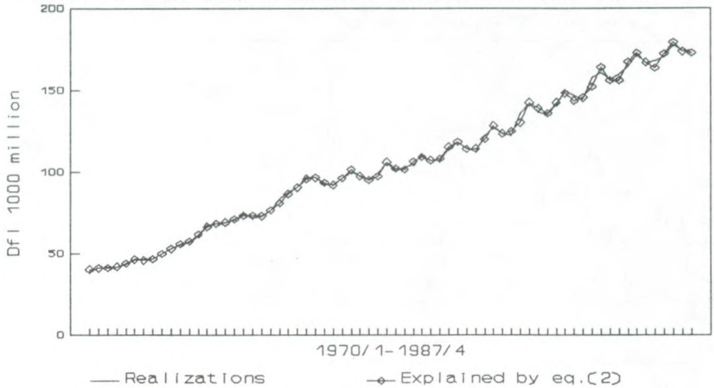


Exhibit 2: Broad money, quarterly relative rate of change

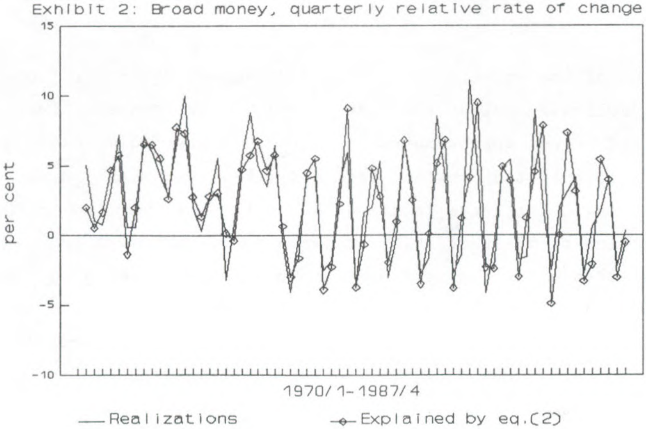
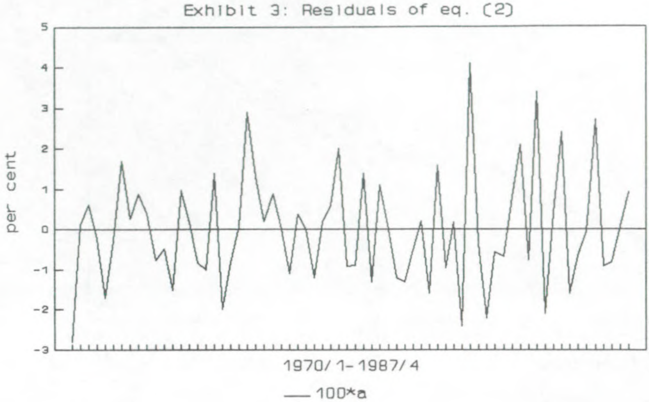


Exhibit 3: Residuals of eq. (2)



variables. This can be tested by the last two chi-squared statistics (which are calculated from the correlations between residual a and the prewhitened - that is, converted into white noise - inputs). All chi-squared statistics should not exceed their 5%-critical values if the model is correct. The outcome of the Pierce-statistic for Y seems to be due to the large lag-13 value of the cross-correlation function for which no explanation could be found.

The specification of the equation is standard by including income Y and interest rates. Following Heller and Khan (1979) we represented interest rates by the yield curve, approximated by a second-degree polynomial of the period to maturity; only the constant term α of this approximation appeared to exert a significant influence in the equation*). As a consequence of a change in definition of M2 as of 1978, implemented by the Dutch central bank to eliminate short-term interest effects, the correction terms α(.) to S(.) had to be introduced. Lastly the step functions Cr(.) correspond to the only periods for which a statistically significant effect could be determined of measures of the Dutch central bank, intended to restrict the growth of M2 through credit ceilings.

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*) Of course, since the yield curve varies in time, this constant α differs between quarters and does not represent a constant in equation (2)

It is proposed not to give a detailed account of Eq.(2) since it can be found elsewhere for an almost identical predecessor (Van der Knoop and Hooijmans, 1985). Let us close with two remarks. First, since in earlier research the coefficients of real GNP and of its deflator did repeatedly not differ significantly from each other, as judged from Wald- and Lagrange Multiplier(LM)-tests, only nominal GNP has been included. Second, money illusion is absent. Eq.(2) has been estimated under the restriction that the income elasticity of the demand for broad money or the total effect of the transfer function of $\log\underline{Y}$, that can be calculated as $\tilde{\omega}_y(1)$, equals 1; with a value of .4 the restriction passes the LM-test with 1 degree of freedom. The consequence is that Eq.(2) can be arranged as $\log(M/Y) = (-.62-.28B-.15B^2)\nabla\log Y+\ldots$, from which it appears that the liquidity ratio or the inverse income velocity of M2 does not depend on the level of GNP but only - negatively - on GNP growth rate. Such dynamics have been found also for the United Kingdom by Hendry (1979), Currie (1981), Hendry and Richard (1983) and Patterson and Ryding (1984), though they were not always significant in these investigations.

3. Tests for non-nested alternatives

In the notation of Davidson and Mackinnon (DM, 1981) we can represent Eq.(2) after a slight rearranging as

$$H_0:\log\underline{M}=f(\underline{X},\beta)+\underline{a}_0$$

in which $\underline{X}$ represents the explanatory variables, β is a vector of parameters and $\underline{a}_0$ is independently distributed with zero expectation. An alternative hypothesis, however, is the possibly non-linear model

$$H_1:\log\underline{M}=g(\underline{Z},\gamma)+\underline{a}_1 \tag{3}$$

in which $\underline{Z}$ represents a vector of other explanatory variables with another parameter vector γ while $\underline{a}_1$ is defined analogously to $\underline{a}_0$. Assume that H_0 is not nested within H_1 and vice versa. Consider now the artificial compound model

$$H_c:\log\underline{M}=(1-\theta)f(\underline{X},\beta)+\theta g(\underline{Z},\gamma)+\underline{a} \tag{4}$$

If H_0 is true, then $\theta=0$. Hence a test of H_0 against H_1 would be to estimate model (4), possibly through non-linear least squares, and to test whether $\theta=0$. This approach will be adopted in section 4.

Generally, however, one cannot be sure that θ,β and γ will be identifiable in H_c. DM therefore proposed to replace γ in (4) by its least squares estimate $\hat{\underline{\gamma}}$ according to (3) and to estimate θ and β in

$$H_c': \log\underline{M} = (1-\theta)f(\underline{X},\beta)+\theta\hat{\underline{g}}+\underline{a}' \tag{5}$$

with $\hat{\underline{g}}=g(\underline{Z},\hat{\underline{\gamma}})$. DM showed that the t-statistic on $\hat{\underline{\theta}}$ according to the (possibly non-linear) least squares procedure in (5) is asymptotically distributed as $N(0,1)$ when H_0 is true, and $\underline{X}$ and $\underline{Z}$ are independent of $\underline{a}$ and do not contain the lagged dependent variable. They called this test the J-test, because θ and β are estimated jointly. MacKinnon, White and Davidson (1983) relaxed some of the conditions which DM used to derive their results. In particular, they allowed the functions f and g to depend on lagged dependent variables (as is the case with our models) and did not require the error term to be normally distributed. They proved their results for the so-called P-test which, however, gives the same results as the J-test with the linear functions which we will consider.

4. Testing the presence of a lagged dependent variable

Let us represent Eq.(2) in differenced form as

$$\begin{aligned} H_0:\log\underline{M} = {} & \omega_y(B)\nabla\log\underline{Y} +\ldots+ \omega_{Cr(80)}\nabla Cr(80) + \\ & \omega_I I +\ldots+ \omega_{IV} IV + \log\underline{M}_{-1} + \underline{a}_0 \end{aligned} \tag{6}$$

with the non-nested alternative according to Eq.(1')

$$\begin{aligned} H_1:\log\underline{M} = {} & \omega_y(B)\log\underline{Y} +\ldots+ \omega_{Cr(80)} Cr(80) + \\ & \omega_I I +\ldots+ \omega_{IV} IV + (1-\pi)\log\underline{M}_{-1} + \underline{a}_1 \end{aligned} \tag{7}$$

This leads to the compound model (4)

$$\begin{aligned} H_c:\log\underline{M} = {} & \omega_y(B)(1-\theta_y B)\log\underline{Y} +\ldots+ \omega_{Cr(80)}(1-\theta_{Cr(80)}B)Cr(80)+ \\ & \omega_I I +\ldots+ \omega_{IV} IV + \theta_M\log\underline{M}_{-1} + \underline{a} \end{aligned} \tag{8}$$

with

$$\theta_y = \ldots = \theta_{Cr(80)} = 1-\theta$$

and

$$\theta_M = 1-\theta\pi .$$

Through (8) we can test H_0 and H_1 - as a first investigation - directly against each other by employing an LM-test. First we test H_0 by imposing in (8) the restrictions $\theta_y=\ldots=\theta_{Cr(80)}=\theta_M=1$ and $\tilde{\omega}_y(1)=1$ (this ensures absence of money illusion under H_0). The LM-test of these restrictions gives 11.4 which is well below the approximate .05-critical value of 19.7 of the chi-squared distribution with 11 degrees of freedom. Second we test H_1 by imposing in (8) the restriction $\theta_Y=\ldots=\theta_{Cr(80)}=0$ and $\tilde{\omega}_y(1)+\theta_M=1$ (this ensures absence of money illusion under H_1). The LM-test of these restrictions gives 25.9 which clearly exceeds the approximate .05-critical value of 18.3 of the chi-squared distribution with 10 degrees freedom. Hence the tests in (8) point towards rejection of H_1 and acceptance of H_0.

As a second investigation we employed DM's J-test. To test H_0 (7) was estimated (under the restriction $\tilde{\omega}_y(1)+1-\pi=1$ to ensure absence of money illusion) after which $\hat{g}=\log M-a_1$ was added - according to (5) - as regressor in (6). This equation was estimated under the restrictions that $\tilde{\omega}_y(1)=1-\theta$ and that the coefficients of $\log \underline{M}_{-1}$ and of $\hat{\underline{g}}$ sum up to 1; the first restriction ensures absence of money illusion in (5) while the second one follows also from (5). The t-statistic for θ assumed a value of .85 which falls well below its approximate .05-critical value of 1.96; the LM-test of the two restrictions gave .4, which falls also well below the relevant approximate .05-critical value of 6.0 of the chi-squared distribution with 2 degrees of freedom. This points towards acceptance of H_0. To test H_1 the analogous procedure (in which H_0 and H_1 were reversed) was followed. Now θ was estimated as .98 with a t-statistic of 5.09 which clearly exceeds 1.96; the LM-test on the restriction $\tilde{\omega}_y(1)+1-\pi+\theta=1$ that excludes money illusion in this case came to 8.0, which also exceeds the relevant approximate .05-critical value of 3.8 of the chi-squared distribution with 1 degree of freedom. This points towards rejection of H_1 in favour of H_0.

5. Further tests of PAM and ECM

The previous section throws some light on the role of the lagged dependent variable in Eq.(2), and hence, implicitly, on the plausibility of PAM and ECM. It does not, however, purport to test these two mechanisms explicitly as alternative dynamics for Eq.(2). Since the PAM belongs to the standard approach in money demand studies (see for instance the work of Chow (1966), Goldfeld (1973), Fase and Kuné (1974), Laidler (1977), Fase (1979), Boughton (1981), Judd and Scadding (1982), Ouliaris and Corbae (1985), Spencer (1985), Goldfeld and Sichel (1987) or Fair (1987)), while the ECM also enjoys a certain popularity amongst researchers (see for instance Davidson, Hendry, Srba and Yeo (1978), Salmon (1982) and Engle and Granger (1987) or, on the field of money demand, Hendry and Mizon (1978), Hendry (1979), and Klovland (1987)), this section is devoted to an explicit investigation of these two mechanisms.

In both PAM en ECM we have to specify a long term or equilibrium demand for M2. It follows from section 2 that it should read as

$$\log\underline{M}^{*}=\beta_1\log\underline{Y}+\beta_2\underline{\alpha}+\beta_3Cr(77)+\beta_4Cr(80)+\beta_5I+\beta_6II+\beta_7III+\beta_8IV \tag{9}$$

The ECM represents M2 as

$$\log\underline{M}-\log\underline{M}_{-1}=\lambda(\log\underline{M}*-\log\underline{M}_{-1})+\sum_{i=1}^{k}\delta_i(\underline{X}_i-\underline{X}_{i,-1})+\underline{u} \tag{10}$$

with $\underline{X}_i$, $i=1,\ldots,k$ the factors which determine $\underline{M}^*$. In the PAM the $\delta_i=0$ for all i. When estimating Eq.(10) after Eq.(9) has been substituted we must take the change of definition of M2 into account that the Dutch central bank has implemented as of 1978 to eliminate the influences of short-term interest rates on M2. Without going into the details (which are available upon request) I specify the required correction terms as

$$\omega_0^{(1)}\xi(78I)+\omega_0^{(2)}S(78I-)$$

for the PAM and as

$$(\omega_0^{(1)}-\omega_1^{(1)}B)\underline{\alpha}(78I-)+\omega_0^{(2)}B\underline{\alpha}(77IV-)+\omega_0^{(3)}S(78I-)$$

for the ECM. Compare for the newly defined variables the data appendix.

Estimation of the PAM gives

$$\begin{array}{l} \nabla\log M=\underset{.04}{.13}\log Y+\underset{.004}{.013}\alpha-\underset{.014}{.038}\alpha(78I-)-\underset{.020}{.018}\xi(78I) \\ \qquad +\underset{.029}{.065}S(78I-)-\underset{.012}{.022}Cr(77)-\underset{.011}{.010}Cr(80)+\underset{.011}{.072}I \end{array} \tag{11}$$

$$\begin{array}{lllll} +.068II & +.013III & +.016IV & -.13\log M_{-1} & +a_{PAM} \\ .010 & .011 & .011 & .04 & \end{array}$$

$$\sigma_a=.0182;\chi^2_{MM}=15.6(26.3);\chi^2_{MY}=23.7(23.7);\chi^2_{M\alpha}=9.1(23.7)$$

while estimation of the ECM (with a rearranging of the seasonal terms) gives

$$\begin{array}{llll} \nabla\log M=.031\log Y & +.010\alpha & -(.043 & -.026B)\alpha(78I-) \\ .046 & .005 & .016 & .018 \end{array} \tag{12}$$

$$\begin{array}{llll} +.000B\alpha(77IV-) & +.020S(78I-) & -.020Cr(77) & -.0045Cr(80) \\ .026 & .030 & .013 & .0108 \end{array}$$

$$\begin{array}{llll} -\ .031\log M_{-1} & +.26\nabla\log Y & +.0034\nabla\alpha & -.037\nabla Cr(77) \\ .046 & .08 & .005 & .022 \end{array}$$

$$\begin{array}{llllll} -.019\nabla Cr(80) & +.062I & +.036II & -.028III & -.012IV & +a_{ECM} \\ .013 & .010 & .013 & .012 & .013 & \end{array}$$

$$\sigma_a=.0163;\chi^2_{MM}=10.7(26.3);\chi^2_{MY}=21.1(22.4);\chi^2_{M\alpha}=14.9(22.4)$$

Both equations have been estimated over the period 1970I-1985IV. The estimations have been subjected to restrictions that ensure absence of money illusion (i.e. the coefficients of log$\underline{Y}$ and log$\underline{M}_{-1}$ sum up to 0) since this is a property of Eq.(2); the LM-test for this restriction exceeds with an outcome of 20.2 for the PAM and of 17.0 for the ECM clearly its approximate .05-critical value of 3.8. The estimation results are poor. Note that both the PAM and the ECM contain a positive deterministic trend.

Application of DM's J-test approach with the model of Eq.(2) and (11) or (12) as alternative hypotheses is straightforward. It gives table 1.

It may be noted that the equilibrium demand for (broad) money is taken unlagged in Eq.(10). Both PAM and ACM can be specified with $\underline{M}^*_{-1}$ instead of $\underline{M}^*$ in (10). For the J-test this gives table 2.

Table 1: J-test results with $\underline{M}^*$ in (10)

H_0	H_1	θ-estimate	t-value
(2)	PAM	0.10	0.50
PAM	(2)	1.00	7.14*
(2)	ECM	0.21	1.00
ECM	(2)	0.99	5.82*

*) H_0 rejected on an approximate .95-level of confidence.
Note: estimation period is 1970I-1985IV.

Tabel 2: J-test results with $\underline{M}^*_{-1}$ in (10)

H_0	H_1	θ-estimate	t-value
(2)	PAM	0.10	0.45
PAM	(2)	1.00	9.09*
(2)	ECM	0.19	0.86
ECM	(2)	1.00	6.67*

*) H_0 rejected on an .95-level of confidence.
Note: estimation period is 1970I-1985IV.

Both tables point clearly towards acceptance of Eq.(2) and rejection of PAM and ECM as alternative dynamics for Eq.(2).

We investigated the ECM further by splitting up nominal GNP in real GNP and its deflator. No significant coefficients for the deflator, however, resulted. Since introduction of lags for real GNP and its deflator did not alter this result, we did not pursue the ECM further.

6. Conclusions

The conclusion is obvious. The dynamic properties of Eq.(2), a money demand equation of a Box-Jenkins variety, have been tested im- and explicitly against the alternative specifications implied by the partial adjustment and the error correction mechanism. The tests for non-nested models that we used corroborate the dynamics of (2). The PAM, the ECM or related mechanisms which imply the presence of the lagged dependent variable in a level equation are clearly not valid as alternative dynamic specifications of Eq.(2). Hence, the rise in the liquidity ratio, or the decline in the income velocity of broad money demand since 1980 in the Netherlands remains for a large part attributed to the noise of Eq.(2) and, hence, not really intelligible. This leaves the monetary authorities in the Netherlands with a difficulty in assessing the monetary facts.

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Appendix

Y	nominal Gross National Product in quarter t in billions of Dutch guilders
I,II,III,IV	seasonal dummies, assuming the value 1 in the relevant quarter
Cr(77)	dummy variable which is 1 in 1977II, III, IV to represent the effect of a credit restriction of the Dutch Central Bank
Cr(80)	As Cr(77). Now 1 for the whole of 1980
M	Domestic money stock (M2) in billions of Dutch guilders, end of quarter
S(78I-)	Stepfunction to represent the effect of a change in definition in M as of 1978
α	First coefficient of an approximation of the yieldcurve by a polynomial of degree 2
$\alpha(.)$	$=\alpha$ starting in the period in the argument, otherwise 0.
$\xi(.)$	pulsefunction which is 1 in the period in the argument

Literature

Boughton, J.M. (1981), Recent Instability of the Demand for Money: An International Perspective, Southern Economic Journal, 47, 579-97.

Box, G.E.P. and G.M. Jenkins (1976), Time Series Analysis, Forecasting and Control, Revised Edition, Holden Day, San Francisco.

Chow, G.C. (1966), On the Long-Run and Short-Run Demand for Money, Journal of Political Economy 74(2), 111-31.

Currie, D (1981), Some Long Run Features of Dynamic Time Series Models, Economic Journal, 91, September, 704-15.

Davidson, J.E.H., D.F. Hendry, F. Srba and S. Yeo (1978), Econometric Modelling of the Aggregate Time-Series Relationship between Consumers' Expenditure and Income in the United Kingdom, Economic Journal, 88, December, 661-92.

Davidson, R. and J.G. MacKinnon (1981), Several Tests For Model Specification in the Presence of Alternative Hypotheses, Econometrica, 49, May, 781-93.

Engle, R.F and C.W.J. Granger (1987), Co-Integration and Error Correction: Representation, Estimation and Testing, Econometrica, 55,251-76.

Fair, R.C. (1987), International Evidence on the Demand for Money, Review of Economics and Statistics, 69, August, 473-80.

Fase, M.M.G. (1979), The Demand for Financial Assets, the Time Series Evidence for the Netherlands: 1963II-1975II, European Economic Review, 12, 381-94.

Fase, M.M.G. and J.B. Kuné (1974), De vraag naar liquiditeiten in Nederland, 1952-1971, Economist, 122, 326-56 (in Dutch).

Goldfeld, S.M. (1973), The Demand for Money Revisited, Brookings Papers on Economic Activity, 3, 577-638.

Goldfeld, S.M. and D.E. Sichel (1987), Money Demand: the Effects of Inflation and Alternative Adjustment Mechanisms, Review of Economics and Statistics,69, August, 511-5.

Heller, H.R. and M.S. Khan (1979), The Demand for Money and the Term Structure of Interest Rates, Journal of Political Economy, 87,1, 109-29.

Hendry, D.F. (1979), Predictive Failure and Econometric Modelling in Macro-Economics: The Transactions Demand for Money, in: Economic Modelling, Current Issues and Problems in Macro-Economic Modelling in the UK and the US, ed. P. Ormerod, Heinemann, London, 27-42.

Hendry, D.F. and G.E. Mizon (1978), Serial Correlation as a Convenient Simplification, not a Nuisance: a Comment on a Study of the Demand for Money by the Bank of England, Economic Journal, 88 (September), 549-63.

Hendry, D.F. and J.F. Richard (1983), The Econometric Analysis of Economic Time Series, International Statistical Review, 51, 111-63.

Judd, J.P. and J.L. Scadding (1982), The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature, Journal of Economic Literature, 20, September, 993-1023.

Klovland, J.T. (1987), The Demand for Money in the United Kingdom, 1875-1913, Oxford Bulletin of Economics and Statistics, 49, August, 251-71.

Kuipers, S.K. and B. Boertje (1988), On the Causes of the Rise in the Liquidity Ratio in the Netherlands during the Early Eighties, Economist, 136, 50-90.

Laidler, D.E.W. (1977), The Demand for Money: Theories and Empirical Evidence, 2nd ed, New York, Dun-Donelley Publ. Corp.

MacKinnon, J.G., H. White, and R. Davidson (1983), Tests for Model Specification in the Presence of Alternative Hypotheses, Journal of Econometrics, 21, 53-70.

Ouliaris, S. and D. Corbae (1985), The Demand for Money: A Variable Adjustment Model, Economics Letters, 18, 197-200.

Patterson, K.D. and J. Ryding (1984), Dynamic Time Series Models with Growth Effects Constrained to Zero, Economic Journal, 94, March, 137-43.

Salmon, M. (1982), Error Correction Mechanisms, Economic Journal, 92, 615-29.

Spencer, D.E. (1985), Money Demand and the Price Level, Review of Economics and Statistics, 67, August, 490-6.

Van der Knoop, H.S. and F.C. Hooijmans (1985), De evenwichtigheid van de huidige liquiditeitsquote, Maandschrift Economie, 49, 389-409 (in Dutch).