This paper analyzes the demand for narrow money balances in the Netherlands. Demand for narrow money balances had increased markedly in relation to GNP in the Netherlands throughout the 1980s. This phenomenon could not be explained satisfactorily with traditional Goldfeld-type money demand functions which had performed well until that time. Drawing on advances in dynamic modeling from the error corrections and cointegration literature, and incorporating yield-curve effects and the exchange rate of the guilder with the U.S. dollar as additional monetary indicators significantly improves the performance of money demand estimates.

JEL Classification numbers:
C22, E41

1/ The author is grateful to Hari Vittas, Ashok Lahiri, Thierry Pujol, and participants in a meeting at the Netherlands Bank for useful comments and discussions, and to Susan Becker for research assistance.
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Summary

The demand for narrow money balances in the Netherlands increased markedly in relation to GNP throughout the 1980s, a phenomenon that was not observed prior to this period. The abrupt shift in velocity cannot be explained with traditional money demand functions, which consistently overpredict money demand through the mid-1980s and consistently underpredict it thereafter.

To help explain the demand for narrow money in the 1980s the analysis in this paper is extended in two ways. First, drawing on advances in dynamic modeling advocated by David Hendry, the paper estimates an autoregressive distributed lag model of narrow money balances. This specification is then reduced to result in an error corrections model, including, among other things, the effects of changes in the slope of the yield curve—the difference between long- and short-term interest rates. Second, two variables are added and incorporated in the above search for proper dynamic specification. These concern the guilder/U.S. dollar exchange rate as a potential external indicator of influence on domestic money demand as suggested in the currency substitution literature, and a cyclical indicator to help specify short-run dynamics. The long-run solution derived from the error corrections model is checked against a direct estimate of long-run narrow money demand as suggested in the literature on cointegration; the two estimates are found to be practically identical.

The analysis suggests that the behavior of money demand and of the liquidity ratio in the Netherlands during the 1980s can reasonably well explained using this improved (dynamic) specification, and by incorporating the exchange rate. Indeed, the overprediction of Dutch money demand during the early 1980s disappears when accounting for the significant strengthening of the U.S. dollar against the guilder, and vice versa during the second half of the 1980s.

A corollary to incorporating the exchange rate variable in money demand functions is that it provides a potentially important external indicator of the stance of monetary policy. A substitution out of domestic currency into foreign currency, because, say, monetary policy is perceived by market participants as too loose, leading to fears of a depreciation, is bound to increase the domestic interest rate and decrease the exchange rate. If the monetary authorities focus myopically on signals from domestic money markets alone—the domestic interest rate increases—they might misread the stance of their policy as being too tight. If the monetary authorities view the domestic interest rate and the exchange rate jointly as monetary indicators, then they are less likely to misread these market signals.
I. Introduction

The motive for this study is twofold. First, there has been concern about the evolution of the liquidity ratio in the Netherlands, defined as the ratio of money to national income, which has risen sharply since the early 1980s. 1/ Prior to this date, the liquidity ratio remained fairly constant over time. While it is so that this decline in velocity is not unique to the Netherlands and furthermore coincides with a considerable hardening of the exchange rate vis-à-vis the deutsche mark, presumably rendering the money stock largely endogenous, its occurrence marks a rather abrupt departure from previous experience and therefore begs explanation.

Second, not only have error terms increased in size in econometric studies of money demand covering the 1980s, in many countries, including the Netherlands, the coefficient estimates of conventional money demand specifications themselves have become unstable. Hence, this study is also a specification search for money demand functions that retain their desirable econometric properties.

Several potential causes of the breakdown of conventional money demand specifications have been advanced, ranging from the influence of financial innovations and technical progress in payments systems, the (presumably increasing) influence of unreported economic activities, increasingly sophisticated adaptation processes of the public with regard to monetary policies perhaps not captured in relatively static traditional specifications, to the emergence of increased international money and capital market linkages between economies as short-term and long-term money and capital flows have been liberalized. Indeed, drawing on recent advances in dynamic modeling, this study focuses in part on the dynamics of money demand as a possible avenue for improving estimation results. In addition, the specification of equilibrium money demand is expanded to include the exchange rate as a variable which may in some circumstances indicate variation in demand for domestic money or domestic currency denominated liquid assets originating abroad. The exchange rate as an external monetary indicator alongside the domestic interest rate as a domestic monetary indicator has been widely suggested in the currency substitution literature. 2/

1/ The ratio of broad money (M2) to national income has risen by some 20 percentage points since 1980; the ratio of narrow money (M1) to national income has risen by nearly 8 percentage points since then.

2/ Kremers and Lane (1990) present an aggregate M1 money demand function for EMS countries incorporating the possible effects of currency substitution between ECU currencies and the U.S. dollar. This note may be viewed as a complementary effort by tracing the potential effects of currency substitution between the dollar and an individual currency of the EMS (here the Netherlands guilder).
As this note was finalized, Fase and Winder (1990) of the Netherlands Bank published a similar paper on the demand for narrow and broad money balances in the Netherlands which suggests that, both for M1 and M2, advanced dynamic specifications might suffice to re-establish a stable money demand function without the need to incorporate an external money demand indicator. In contrast, while we could successfully replicate previous estimates of money demand for M2 covering data through the 1970s, we were unsuccessful in resurrecting the stability of money demand for broad aggregates when including the 1980s. As a consequence, this study focuses on the demand for M1 for which the instability of money demand could be resolved. The reasons for the disparity in the results of two studies are not immediately evident, especially because the approach here in principle allows for a nested specification as in Fase and Winder. On the other hand, however, Fase and Winder use a different scale variable for income, other than employed here, while addressing seasonal factors through explicit seasonal dummies. This study employs seasonally adjusted data and draws on a slightly different data set. A more rigorous comparative analysis with similar data sets aimed at disentangling the differences in the results of the two studies has not yet been completed.

1. Conventional money demand specification

A conventional point of departure for looking at money demand has been the studies by Goldfeld (1973, and 1976). Goldfeld’s approach was to estimate the demand for money by specifying a dynamic adjustment process comprising a Koyck transformation of a stock adjustment process, with or without the need to "correct" for a first-order serially correlated error term. The steady-state solution of Goldfeld’s basic equation of this type, estimated with U.S. data for 1952q1-1973q4, was

\[(1) \quad m - p = 0.629y - 0.056rs - 0.197rl\]

where m, p, and y are logarithms of real narrow money balances, the GNP deflator, and real GNP; and rs and rl represent short- and long-term interest rates (rates on T-bills and time deposits, respectively). Price homogeneity was imposed on theoretical grounds. The long-run real income elasticity of less than unity is consistent with the Baumol-Tobin proposition of economies of scale in holdings of cash. Both interest rates are intended to represent substitute prices, so the negative coefficients are as expected.

While Goldfeld was interested in this equation with a view toward analyzing its inability to predict a sharp rise in velocity of narrow money balances in the U.S. that began in 1974, this section uses the same approach to demonstrate the breakdown and inability to predict the sharp rise in the liquidity ratio in the Dutch case beginning in 1981. There is no such breakdown in samples covering data prior to 1981.
Consider the results of specifying a Goldfeld-type demand equation for M1 in the Netherlands for 1957q1 through 1989q4 as reported in equation 1.1 in Table 1 below. 1/ The coefficient estimates are reasonable, have the expected sign and are all highly significant. The mean lag response of 2.3 quarters compares favorably to much longer and often theoretically implausible findings of other money demand studies employing a Koyck lag specification. The long-run solution to equation (1) also would appear reasonable:

\[ (2) \quad m - p = 0.860y - 0.014rs - 0.029rl \]

However, there are a number of problems with this equation. There is evidence of residual autocorrelation as the first order autocorrelation test statistic is high though not quite significant at the 5 percent level; the test statistic for autocorrelation of order 1 through 5 is significant at the 5 percent level. Furthermore, the significant Reset statistic suggests potential misspecification of the equation. Indeed, the breakdown of equation 1.1 can be demonstrated by considering its (in)ability to forecast money demand developments during the 1980s.

The forecasting performance and the stability of equation 1.1 are investigated by re-estimating the equation for 1957q1-1979q4 with out-of-sample conditional forecasts for the 40 quarters of 1980q1 through 1989q4. Parameter estimates for the subsample are shown in equation 1.2. These parameter estimates are quite different from those covering the full sample. The coefficient on the lagged dependent variable is cut in half implying a mean lag response of only 0.5 quarters. The impact elasticity on real income now equals 0.50 as predicted by the Baumol-Tobin inventory model of money demand. The short-term interest semi-elasticity has doubled in size while the (impact) long-term interest semi-elasticity has remained nearly unchanged. The impact of the dummy step variable has more than doubled. 2/ The steady state solution to equation 1.2 is now:

\[ (3) \quad m - p = 0.757y - 0.013rs - 0.011rl \]

which is similar to the one for the entire sample period with the exception of the influence of the long-term interest rate which has been cut roughly in half.

1/ The data used in this study are described in Appendix I. All the empirical results were obtained with the program PC-GIVE by D.F. Hendry and the Oxford Institute of Economics and Statistics; see Hendry (1989). Various goodness-of-fit indicators and test statistics generated in PC-GIVE and reported here are summarized in Appendix II.

2/ The dummy step variable (dl) captures breaks in the money stock series. Occasional revisions of the money stock series tended to increase the monetary aggregate. As a result, the value of the dummy variable was increased by unity at each break in the series.
Table 1. Netherlands: Money Demand Estimates 1/

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<td>.334</td>
<td>.448</td>
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<td></td>
<td>(15.8)</td>
<td>(5.68)</td>
<td>(5.93)</td>
<td>(5.05)</td>
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<tr>
<td>y</td>
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<td>.503</td>
<td>.501</td>
<td>.419</td>
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<td></td>
<td>(6.63)</td>
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<td>(11.32)</td>
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<td>-.00694</td>
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<td>.0112</td>
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<td>(3.06)</td>
<td>(4.49)</td>
<td>(5.31)</td>
<td>(1.63)</td>
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Goodness-of-fit indicators:

| R-sq | 0.996 | 0.996 | 0.996 | 0.992 |
| F(k-1,n) | 5802.9 | 4406.6 | 5163.1 | 1244.6 |
| S    | 1.78% | 1.35% | 1.32% | 1.33% |
| DW   | 1.67  | 1.58  | 1.60  | 1.44  |
| FPE  | .000331 | .000196 | .000185 | .000195 |
| Mean lag | 2.3q   | 0.5q   | 0.5q   | 0.8q   |

Test statistics for white noise error terms:

| AR 1-1 | F[1,124] | 3.60 | F[1,84] | 4.67* | F[1,91] | 4.61* | F[1,51] | 6.65* |
| AR 4-4 | F[1,124] | .20  | F[1,84] | .11  | F[1,91] | .12  | F[1,51] | .06  |
| ARCH   | F[4,117] | .45  | F[4,77] | 0.52 | F[4,84] | .42  | F[4,44] | .22  |
| HESC   | F[10,114] | 1.39 | F[10,74] | 0.80 | F[10,81] | 1.00 | F[10,41] | .87  |
| Chow   | F[0,0]   | ...  | F[40,85] | 3.27**| ...  | F[40,52] | .98  |
| FC-Chi-sq | ...    | 8.34 | ...    | 1.21  |
| RESET  | F[1,124] | 9.79**| F[1,84] | 0.04 | F[1,91] | .09  | F[1,51] | .74  |

1/ T-statistics appear in parenthesis. As regards test statistics for white noise error terms, single * denotes significance at 5 percent, double ** denotes significance at 1 percent; descriptors for goodness of fit and test statistics are described in Appendix II.
Considering stability tests and the forecasting performance of the equation, we note that the Chow test is rejected at the 1 percent level while the forecast Chi-square statistic is well over the benchmark value of 2 indicating poor forecast performance. Problems with first order autocorrelation remain also.

To help pinpoint the timing of the breakdown in stability, the conditional forecast performance of equation 1.2 is shown in Chart 1 (upper panel); the fitted equation appended with these out-of-sample conditional forecasts is shown in Chart 1 (lower panel). The lighter line in Chart 1 (upper panel) displays forecasts with their approximate 95 percent confidence bands. The darker line shows the log of actual real money stock during the forecast period. Forecasts run off track beginning at 1981q3 and remain off track after that date. Specifically, conditional forecasts consistently overpredict money demand from the end of 1981 through the end of 1985, and consistently underpredict money demand thereafter. Such a forecast error pattern could suggest a missing variable as, for instance, it appears correlated with the major swings in the value of the guilder-U.S. dollar exchange rate. The equation overpredicts when the U.S dollar is strengthening, potentially revealing a shift into dollar assets, and underpredicts when the guilder is strengthening, potentially revealing a shift into guilder assets.

Forecast performance with Koyck lag specifications for Dutch narrow money demand had not always been as poor as shown above. Prior to 1981q3, such specifications generally performed well as can been seen by contrasting the findings above with those from earlier subsamples. Equivalent to the comparison between equation 1.1 and 1.2, equation 1.3 now shows parameter estimates for the "full" sample 1957q1-1981q3, whereas equation 1.4 presents parameter estimates for the subsample 1957q1-1971q3, leaving again 40 quarters to explore the conditional forecasting ability of the equation.

Parameter estimates for both equations are close to those for 1.2 and their long-run solutions are as in (3). Despite the continued presence of first order autocorrelation (equations are not "corrected" for autocorrelation), there appear to be no other major problems with the equation prior to 1981q3. The Reset statistic passes easily, the Chow stability test statistic is very low and the Chi-square forecast statistic is satisfactory.

For comparison with the forecasting performance into the 1980s, the forecast results for the 1970s are shown in Chart 2 (upper and lower panels). As before, Chart 2 (upper panel) shows the actual and forecast money demand (with two-standard deviation error bands), while Chart 2 (lower panel) shows actual and predicted values of money demand appended with the conditional forecast results for the last ten years of the sample. These forecast results are clearly very good, especially considering that they track monetary behavior up to 40 quarters out of sample.
In summary, Koeyck lag specifications of Dutch narrow money demand perform quite well until the early 1980s. It is the emergence of the breakdown after 1981q3 that needs to be explained.

2. An alternative specification of money demand

A number of factors may have contributed in cumulative fashion to the breakdown of traditional money demand specifications during the early 1980s. Among these, one can envisage the occurrence of regime shifts, perhaps related to the establishment of the EMS, or being associated with an acceleration of financial innovation, the liberalization of international money and capital markets, and the emergence of new instruments. New channels of influence on money demand may thus have been opened up, leading potentially to econometric problems associated with missing variables. Adding to that, and even with a given set of instruments and variables, it is likely that economic agents will evolve new ways in responding to shocks, policy announcements, or in their management of financial affairs. Econometrically, this may imply that traditional specifications have become lacking in dynamic sophistication.

As regards missing variables, two alternatives are explored. One involves the guilder-U.S. dollar exchange rate (variable f/$) as a potential indicator of influence on money demand from international money and capital markets; the other concerns a cyclical indicator (variable c2). The latter follows Fase and Kune (1974), and den Butter and Fase (1981) who in studies of broad monetary aggregates (M2) for the Netherlands and a number of European countries found demand for money to be correlated with business cycle indicators (here a detrended index of labor utilization). Theoretically, the cycle may influence money demand in either direction, because demand for precautionary balances could rise in a cyclical downturn and fall in a cyclical upturn (negative correlation with money demand), or because the cyclical indicator could act as an accelerator, decreasing transactions balances in a downturn and increasing transactions balances in an upturn (positive correlation with money demand).

The role of the exchange rate in money demand (for industrial countries) is more complex and has become known as indirect currency substitution, following McKinnon (1982, 1983, and 1984). In brief, McKinnon postulates a stable world demand for money, but with potential shifts in composition among the main currencies—the U.S. dollar, the deutsche mark and the yen—and their satellite currencies, including the guilder. Suppose, for example, that policy announcements, or (credible) official accords regarding the desired pattern of exchange rates lead to a revision of exchange rate expectations and thereby trigger international money and capital flows between the main currencies, say a shift from the U.S. dollar to the deutsche mark. Interest rates in the United States may then be forced up and those in Germany (Netherlands) may be forced down until the interest differential reflects the (revised) expected adjustment in the U.S. dollar exchange rate—the Fisher Open condition. An increase in the value
CHART 1
NETHERLANDS
Real Money Demand and Forecast; Koyck Lag Specification 1/

Sources: The Netherlands Bank; and regression 1.2.
1/ Based on quarterly data, 1957Q1 - 1989Q4.

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CHART 2
NETHERLANDS
Real Money Demand and Forecast: Koyck Lag Specification 1/

Sources: The Netherlands Bank; and regression 1.4.
1/ Based on quarterly data, 1957Q1 - 1981Q3.
of the deutsche mark would then signal increased demand for deutsche mark
denominated assets and deutsche mark money demand; similarly, a decrease in
the external value of the U.S. dollar would signal the reduction in demand
for dollar denominated asset and dollar money balances, as though on a
global scale there had been an indirect substitution of deutsche mark for
U.S. dollar balances.

In the event of indirect currency substitution shifts in international
capital markets, the exchange rate would provide the "correct" signal as
regards the demand for domestic money--an increase in the value of the
domestic currency signaling an increase in money demand--whereas the
domestic monetary indicator, the domestic interest rate, would provide a
"wrong" signal as regards demand for domestic money--an increase in interest
rates being the result of withdrawal from domestic currency denominated
assets with an attached reduction of demand for domestic money.

Leaving the exchange rate out of consideration in money demand may lead
to a myopic--and incorrect--monetary policy response. Thus a rising
domestic interest rate might be perceived as money being too tight; a
falling domestic interest rate might be perceived as money being too loose.
By responding to domestic monetary signals only, the monetary authorities
could increase money supply when demand is decreasing and vice versa,
thereby frustrating the international (bond arbitrage) equilibrating
mechanism and preventing interest cum exchange rate adjustments from
establishing the Fisher Open condition. Econometrically, such policy
response could lead to a positive correlation between the exchange rate and
the money stock initially, so that the expected negative correlation between
the exchange rate and money demand is found only in the lagged response of
money to the exchange rate.

Finally, the issue of dynamics in money demand specification. A Koyck
specification is known to restrict the lagged response to be unique across
explanatory variables. Furthermore, such specification can impose
autocorrelated error terms, depending on whether the underlying model is one
reflecting adaptive expectations or a partial adjustment model (see, e.g.,
Johnston (1984), Chapter 9, and Hendry (1986)).

As a result, the analysis here follows the approach to dynamic modeling
in Hendry (1989). Hendry's approach starts from an autoregressive
distributive lag (ADL) class of models as in:

\[ a_{0L}(m) = b + a_{1L}(p) + a_{2L}(y) + a_{3L}(rs) + a_{4L}(rl) 
+ a_{5L}(f/$) + a_{6L}(c2) + e, \]

where \( L(.) \) is the lag operator, and which is estimated in levels with an
appropriate number of lags on each variable (for quarterly observations the
initial number of lags on each variable is suggested at 5). Based on
coefficient estimates from this free dynamic format, the equation is then
reduced to a more parsimonious specification potentially combining levels
and differences. The admissibility of the reduction process from the general model to the specific (parsimonious) model is monitored with a number of statistical tests available in PC-GIVE.

A common result of this testing down process is a dynamic model combining first difference variables with levels. The feedback from the levels suggests evidence of correction for deviations from long-run equilibrium—known as error correction—and models of this type are known as "error correction models." Indeed, the error correction model can be solved to yield estimates of the long-run relationship (in levels) between the variables under discussion.

Proceeding in this fashion, a freely formatted ADL model was first formulated based on Goldfeld-type variables only. While this improved the performance of the equation to some extent, the result could not carry a satisfactory forecast performance and stability analysis past 1983. A forecast error pattern emerged similar to that in Chart 1 (upper panel) generally with overpredictions of the narrow money stock before late 1985, followed by persistent underpredictions after that date.

Thus, we explored including the guilder-U.S. dollar exchange rate as an indicator of international influences on money markets in the Netherlands, as described above, and the cyclical indicator. 1/ Results are in Table 2. Equation 2.1 reflects estimates and test statistics obtained by regressing the narrow real money stock on income, prices, short- and long-term interest rates, the exchange rate, the cyclical variable and the two dummy variables.

1/ After inspection of preliminary results, a second dummy variable was added to the equation. As noted, the first, called d1, is a step variable increasing by unity each time there is a break in the series for narrow money balances as indicated in the publications of the Netherlands Bank. One disadvantage of this dummy is that it restricts coefficients to be equal each time there is a break in the series. This did not prove to present a problem except for the end of 1985 when a new series was started owing to the setting up of the Postbank and an expansion and revision of the monetary survey of insurance companies, pension funds and social insurance funds. The robust upward shift in the intercept term that is present in the data since then was captured by an additive second dummy variable (d85q4), measuring unity from 1985q4 onwards. This additive dummy to d1 was also explored in the equations of section 2 but did not materially alter the conclusions there.
The results conform to theoretical priors. Coefficients are of reasonable magnitude and have the correct sign. \(1/\) The general-to-specific approach reduced the initial specification in levels to an error corrections model as reflected by the lagged variable on the liquidity ratio, the presence of levels in prices, short-term interest rates, the yield curve and the exchange rate. It is important to note that the specification of the liquidity ratio in the dynamic equation was not imposed but derived in the reduction process and checked against admissibility tests. Similarly, the yield curve variable, i.e., the long-term interest rate minus the short-term interest rate, was derived, not imposed.

While the impact elasticity of real money balances on changes in real income is close to 0.5, as predicted by the Baumol-Tobin inventory model of money demand and close to the findings in the Goldfeld specifications reported above, the long-run elasticity of money with respect to income is unity as reflected in the error correction term. Inflation influences the dynamics of money demand. A negative coefficient of -0.646 on the first difference of the log of prices indicates an acceleration effect from the presence of inflation in the economy.

Perhaps somewhat surprisingly, there is negative feedback from the level of prices, indicating that money is less than homogeneous in prices as defined by the GNP deflator. However, there is a nearly equal and offsetting influence on real money balances from the contemporaneous guilder-U.S. dollar exchange rate; i.e., as the guilder depreciates vis-à-vis the U.S. dollar, this has a direct effect on prices and costs in a large component of the economy which may not be adequately represented in the GNP deflator. Thus, the positive coefficient on the contemporaneous exchange rate not only is consistent with a money supply response to changes in interest rates and exchange rate changes as indicated above, it could also indicate that money may be homogeneous in prices as measured by a broader index such as the total demand deflator, a potential avenue for future research.

\(1/\) The cyclical variable did not survive the equation reduction process in levels, as expected, for it is not reasonable to suppose that cyclical influences remain in the long-run solution. The positive coefficient on the first difference [lagged 2 quarters] suggests that the slowdown in labor utilization, in conjunction with the contemporaneous different variable on income, reduces demand for transactions balances.
Table 2. Netherlands: Money Demand Estimates

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<tr>
<td>(m - p - y)[-1]</td>
<td>-.331 (-5.6) -.340 (-4.5) -.400 (-4.6)</td>
</tr>
<tr>
<td>Δy</td>
<td>.408 ( 5.7) .411 ( 5.1) .476 ( 5.2)</td>
</tr>
<tr>
<td>Δp</td>
<td>-.646 (-5.5) -.660 (-4.2) -.715 (-4.5)</td>
</tr>
<tr>
<td>p[-4]</td>
<td>-.082 (-3.6) -.075 (-2.3) -.111 (-3.9)</td>
</tr>
<tr>
<td>Δrs</td>
<td>-.0109 (-10.3) -.0112 (-9.9) -.0117 (-9.8)</td>
</tr>
<tr>
<td>rs[-1]</td>
<td>-.0065 (-4.7) -.0057 (-3.5) -.0073 (-4.2)</td>
</tr>
<tr>
<td>rs[-2]</td>
<td>-.0018 (-1.3) -.0031 (-2.1) -.0028 (-1.9)</td>
</tr>
<tr>
<td>(r1-rs)[-3]</td>
<td>-.0033 (-2.7) -.0041 (-3.2) -.0036 (-2.6)</td>
</tr>
<tr>
<td>f/$[-1]</td>
<td>.060 ( 1.7) .061 ( 1.0) .068 ( 1.8)</td>
</tr>
<tr>
<td>Δ(f/$)[-1]</td>
<td>-.110 (-2.0) -.088 (-1.0) -.112 (-1.9)</td>
</tr>
<tr>
<td>f/$[-2]</td>
<td>-.055 (-1.4) -.079 (-1.2) -.055 (-1.3)</td>
</tr>
<tr>
<td>f/$[-5]</td>
<td>-.043 (-2.2) -.014 (-0.4) -.061 (-2.8)</td>
</tr>
<tr>
<td>Δc2[-2]</td>
<td>.012 ( 3.0) .008 ( 1.2) .015 ( 3.1)</td>
</tr>
<tr>
<td>constant</td>
<td>-1.163 (-5.7) -1.231 (-5.0) -1.357 (-4.2)</td>
</tr>
<tr>
<td>dl</td>
<td>.013 ( 2.8) .011 ( 1.9) .017 ( 3.0)</td>
</tr>
<tr>
<td>d85q4</td>
<td>.015 ( 1.7) . . . .017 ( 1.7)</td>
</tr>
</tbody>
</table>

Goodness-of-fit indicators:

- **R-squared:** .684 .709 .751
- **F(k-1,n):** 16.0 12.5 13.05
- **S:** 1.31% 1.28% 1.38%
- **FPE:** .000193 .000192 .000227

Test statistics for white noise error terms:

- **AR 1-1:** F[1,110] .75 F[1,71] .19 F[1,64] .10
- **AR 4-4:** F[1,110] .21 F[1,71] .08 F[1,64] 1.34
- **AR 1-5:** F[5,106] .47 F[5,67] .78 F[5,60] 2.81*
- **ARCH:** F[4,103] .73 F[4,64] .33 F[4,57] .43
- **HESC:** F[29,81] 1.25 F[28,43] .80 F[29,35] 1.02
- **Chow:** ... F[40,72] 1.12 ... ... 1.27 ...
- **FC-Chi-sq:** ... 1.27 ... ...
- **RESET:** F[1,110] 2.18 F[1,71] 2.99 F[1,64] 1.90

1/ The dummy variable d85q4 was brought to the left hand side, using its coefficient in 2.1, for forecasting purposes in equation 2.2.
2/ Figures in square brackets indicate lags in quarters.
The impact semi-elasticity on short-term interest rates is small (-.011) but highly significant and robust across subsamples. Furthermore, the feedback from the level of interest rates suggests that the level of narrow money is cointegrated with the level of short-term interest rates. The yield curve was also found to affect demand for narrow money balances as the long- and short-term interest rates lagged three quarters appeared significant but with opposite sign, i.e., the difference between long- and short-term interest rates (ri-rs) in Table 2 is negatively correlated with demand for narrow money balances. A steepening of the yield curve would thus lead to a reduction of narrow money balances, and a flattening of the yield curve would lead to an increase in the demand for money balances. However, since the short-term interest elasticity dominates that for the yield curve, the net result of a change in the yield curve on the demand for narrow money would depend on the relative magnitudes of change in the long- and short-term interest rates.

The signs on the exchange rate variable and its first difference are as expected. Given the extreme openness of the Dutch economy, a depreciation of the guilder vis-à-vis the U.S. dollar instantaneously imparts an inflationary impact on the economy and could be interpreted in the contemporaneous form to signal a price effect on money demand, as noted above. Furthermore, the positive and significant contemporaneous exchange rate variable may reflect a policy response to exchange rate, or rather international money demand, shifts also as noted above. However, the lagged exchange rate variables, both in differenced form and levels, consistently imparted a negative influence on money balances in accordance with the indirect currency substitution interpretation. In equation 2.2, the 1980s were left out and the exchange rate effect weakened with T-ratios on the exchange rate coefficients around unity. Dropping the 1960s and including the 1980s, as in equation 2.3, considerably strengthened the presence of exchange rates in the equation without noticeably affecting any of the other variables. Thus there seems to be evidence that the exchange rate played an increasing role, as suggested in the indirect currency substitution literature, in narrow money demand as guilder-U.S. dollar exchange rate variability became more pronounced.

To investigate the forecast ability of the dynamic money demand equation, equation 2.1 was rerun through 1979q4 and its results (equation 2.2) used to provide conditional forecasts for the 40 quarters from 1980q1 through 1989q4. Chart 3 (upper panel) presents the actual change in narrow money balances and the forecast values including 95 percent confidence bands. The forecast period appended to the historical actual and predicted values are reflected in Chart 3 (lower panel). These results represent a significant improvement over the forecast performance of Koyck lag specifications presented above. Conditional forecasts for the 1980s track the actual developments in the change in narrow money very well. The fit of the dynamic equation is good, the Chow test passes easily and the forecast Chi-square statistic is a low 1.27, indicating good forecast performance. Systemic positive or negative forecast errors have disappeared and points of
inflection in the change of narrow money demand are tracked very closely
with the exception of the last two quarters of 1989. In brief, it appears
that a more careful analysis of dynamics together with the introduction of
previously missing variables contributes considerably to explaining the
apparent instability of narrow money demand in the Netherlands.

3. Long-run solutions and co-integration

Solving equation 2.1 for its long-run solution yields

\[(m - p - y) = -3.51 + (0.18 f/\$ - 0.25 p) - 0.025 rs - 0.010 (r_l-r_s)
- 0.30 f/$[\text{lagged}] + 0.39 d1 + 0.45 d85q4\]

where the influence of the contemporaneous exchange rate has been
interpreted as affecting the price level whereas lagged exchange rate
components of the dynamic equation as reflecting indirect currency
substitution. The long-run semi-elasticity of the short-term interest rate
is now -0.025, or the equivalent of -0.25 at an interest rate level of
10 percent. This is not out of line with other studies on M1 and for
comparison, using a broad money aggregate and a long-run interest variable,
den Butter and Fase (1981) found interest elasticities of -0.34 and -0.30 in
Dutch money demand functions. The elasticity with respect to changes in the
yield curve, or long-term interest rates only, is about half that of the
elasticity on the short-term interest rate. However, the (lagged) response
to a depreciation in the exchange rate is slightly larger than the influence
of the short-term interest rate, suggesting about an equivalent role in
determining domestic monetary conditions from the international monetary
variable (the exchange rate with the dollar) as compared to the purely
domestic monetary variable (the interest rate).

To check the long-run results and their interpretation as reflecting a
cointegrated relationship between the liquidity ratio and prices, the
exchange rate, and interest rates, the long-run solution was estimated
directly in a static levels form. This approach follows the work on co-
integration by Engle and Granger (1987) and Engle and Yoo (1987) who
establish that the relationship between long-run co-integrated variables can
be derived either indirectly as in an error corrections framework above, or
directly in a two-step process. The first step would entail the estimation
of a static equation interpreted as the long-run or equilibrium relationship
among the variables. Subsequently, a dynamic equation would be estimated in
which the lagged residual from the static equation is included as an
explanatory variable representing disequilibrium feedback.

The use of this framework is appropriate if both the dependent variable
and the explanatory variables are integrated of order 1--I(1), but a co-
integrating specification exists such that the residuals from this equation
are integrated of order zero--I(0). In turn, a variable is defined to be
integrated of order 1 if it must be differenced once to gain stationarity.
A set of variables is said to be integrated of order 1 if a linear
CHART 3
NETHERLANDS
Changes in Real Money Demand and Forecast; ADL Specification 1/

Sources: The Netherlands Bank; and regression 2.2.
1/ Autoregressive distributed lag specification; based on quarterly data, 1957Q1 - 1989Q4.

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combination, as in the regression equation, can be found so that the residual is I(0). While it is not our purpose here to redo the analysis beginning with the estimation of the long-run solution, it is interesting to see if the first step of the Engle-Granger process results in estimates for the long-run solution that are comparable to those derived from the dynamic solution above. 1/

Table 3 presents the results of estimating the long-run parameters of demand for narrow money balances directly. For comparison, equation 3.1 repeats the results obtained by computing the long-run solution from the dynamic equation estimated in 2.1. The direct estimation of the long-run solution is presented in different guises, both including and excluding the inflation rate, and separately entering in the contemporaneous and lagged exchange rate to allow distinction between policy response and price effects on the contemporaneous variable, and indirect currency substitution effects on the lagged variable. Results are close to the solution derived from the error corrections model presented in 2.1. Homogeneity in the GDP deflator again is rejected, while the interpretation of a price level effect from the contemporaneous exchange rate variable is maintained. Semi-elasticities on the short-term interest rate and the yield curve are very close to those of the long-run solution derived from 2.1. The inflation variable is not significant and was left out from further consideration. Finally, while the restriction regarding the income variable in the liquidity ratio of equation 2.1 was accepted by the equation reduction process, estimating the income variable in unconstrained form here suggests that the long-run elasticity of money demand with respect to income is just shy of unity (coefficient is 0.91 with a standard error of 0.032, equation 3.5). Other coefficient estimates or their significance are not much affected.

1/ The augmented Dickey-Fuller test is employed here to test for co-integration. This test statistic involves regressing the first difference of the residual from the first step regression equation on the lagged value of the level of these residuals, a constant, and lagged values of the differenced residual. The test statistic is provided by the T-ratio on the lagged level variable. A T-ratio in excess of critical value (here -3.77 for a 1 percent test) implies that the null hypothesis of nonstationarity of the residual term in the estimate of long-run solution is rejected in favor of the alternative that the residuals are integrated of order zero--I(0)--and hence are stationary. As noted in Table 3, all different specifications of the long-run equation appear to have stationary residuals, supporting the hypothesis that variables are co-integrated.
Table 3. Netherlands: Co-Integration Regressions

<table>
<thead>
<tr>
<th>Equation no.</th>
<th>3.1</th>
<th>3.2</th>
<th>3.3</th>
<th>3.4</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample period</td>
<td>57q1-89q4 (all)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(m - p - y)</th>
<th></th>
<th>(m - p)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory variable:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>...</td>
<td></td>
<td>...</td>
<td></td>
<td>.91 (31.2)</td>
</tr>
<tr>
<td>p</td>
<td>-.25</td>
<td>-.24 (10.1)</td>
<td>-.24 (10.1)</td>
<td>-.26 (10.2)</td>
<td>-.18 (5.8)</td>
</tr>
<tr>
<td>f/$</td>
<td>.18</td>
<td>.14 (2.6)</td>
<td>.14 (2.5)</td>
<td>-.10 (6.0)</td>
<td>.11 (2.0)</td>
</tr>
<tr>
<td>f/$[-1]</td>
<td>-.30</td>
<td>-.25 (4.7)</td>
<td>-.25 (4.6)</td>
<td>...</td>
<td>-.21 (4.0)</td>
</tr>
<tr>
<td>rs</td>
<td>-.025</td>
<td>-.028 (10.8)</td>
<td>-.027 (10.9)</td>
<td>-.025 (9.5)</td>
<td>-.024 (9.4)</td>
</tr>
<tr>
<td>(rl-rs)</td>
<td>-.010</td>
<td>-.017 (5.0)</td>
<td>-.017 (4.9)</td>
<td>-.014 (3.8)</td>
<td>-.013 (3.9)</td>
</tr>
<tr>
<td>Δp</td>
<td>...</td>
<td>.19 (1.0)</td>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>-3.51</td>
<td>-3.54 (44.2)</td>
<td>-3.55 (44.7)</td>
<td>-3.52 (41.2)</td>
<td>-3.44 (40.7)</td>
</tr>
<tr>
<td>d1</td>
<td>.039</td>
<td>.039 (7.3)</td>
<td>.037 (7.4)</td>
<td>.041 (7.7)</td>
<td>.032 (6.3)</td>
</tr>
<tr>
<td>d85q4</td>
<td>.045</td>
<td>.027 (2.19)</td>
<td>.030 (2.4)</td>
<td>.025 (1.9)</td>
<td>.046 (3.6)</td>
</tr>
</tbody>
</table>

| R-squared | .95 | .95 | .94 | .99|
| F(k-1,n)  | 290.12 | 331.45 | 332.55 | 2520.36 |
| s         | 2.21% | 2.21% | 2.39% | 2.13% |
| DW        | 1.02 | 0.99 | .92 | .98 |

Residual analysis  

<table>
<thead>
<tr>
<th>Dependent variable: Δresid</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T-value on resid [-1]</td>
<td>-6.02</td>
<td>-5.89</td>
<td>-5.84</td>
<td>-5.63</td>
</tr>
<tr>
<td>Critical value ADF, 1%</td>
<td>-3.77</td>
<td>-3.77</td>
<td>-3.77</td>
<td>-3.77</td>
</tr>
</tbody>
</table>
Equations 3.3 and 3.4 are provided for comparison. Deleting the inflation term in the long-run solution does not affect the results in any way. In addition, estimating the equation with a contemporaneous exchange rate variable only leaves the results unaffected. In short, the specification as derived from the dynamic model in 2.1 and the first step direct long-run solution estimate appear consistent and reasonably robust to changes in specification.

Chart 4 presents the actual and predicted values of the liquidity ratio obtained from regression 3.3. The goodness of fit is obvious and the ability to explain the evolution in the actual liquidity ratio for M1 in the Netherlands, including developments during the 1980s, is evident with the notable exception of the last two quarters in 1989. The message from this analysis for M1 is that it appears that the evolution of velocity in the 1980s can be explained with the variables under consideration.

Based on the results of equation 3.3, Table 4 summarizes contributions to growth in the narrow money stock during the 1980s. As noted, equation 3.3 tracks the narrow money stock reasonably well. For the decade as a whole, the actual and the predicted changes in the money stock differ by some f. 6.5 billion, practically all of this due to the error term in the last two quarters of 1989. 1/

As expected, the growth in nominal income accounts for the bulk (f. 31.4 billion) of increased demand in the narrow money stock. However, the analysis above also suggests that changes in short-term interest rates and the exchange rate of the guilder (the currency substitution variable) have been major sources of variation in narrow money demand during the period. The demand for narrow money balances is estimated to have increased by f. 16.4 billion during 1981q3/1983q1 as a result of the sharp drop in the short-term interest rate. In contrast, the recent increase in short-term interest rates is estimated to have reduced narrow money demand by nearly f. 12 billion. Similarly, the erosion in the value of the guilder through 1985q1 is estimated to have led to a steady shift away from guilders (and into dollars), whereas the sharp increase in the value of the guilder during 1985q2/1988q2 is estimated to have led to a shift back into guilders of some f. 15.2 billion.

1/ While the large error term for the last two quarters of 1989 is puzzling, it is possible that the preliminary nature of data contribute at least in part to this problem.
Table 4. Netherlands: Contributions to Growth in M1

<table>
<thead>
<tr>
<th></th>
<th>80q1/81q3</th>
<th>81q3/83q1</th>
<th>83q1/85q2</th>
<th>85q2/88q2</th>
<th>88q2/89q4</th>
<th>Total since 1980q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual narrow money stock:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td>2.7</td>
<td>11.3</td>
<td>7.2</td>
<td>23.7</td>
<td>8.7</td>
<td>53.6</td>
</tr>
<tr>
<td>Predicted narrow money stock:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1-hat</td>
<td>-0.6</td>
<td>16.0</td>
<td>5.7</td>
<td>23.4</td>
<td>2.7</td>
<td>47.1</td>
</tr>
</tbody>
</table>

Contribution from:

Nominal income:
\[ P \times y = Y \]
\[ \begin{array}{cccccc}
4.3 & 4.2 & 9.5 & 5.0 & 8.4 & 31.4 \\
\end{array} \]

Prices (\( p + f/$\)):
\[ \begin{array}{cccccc}
1.6 & -1.2 & 2.3 & -6.9 & 0.7 & -3.5 \\
\end{array} \]

Short-term interest rate (rs):
\[ -2.1 & 16.4 & -4.0 & 6.2 & -11.9 & 4.6 \\
\]

Exchange rate (f/$ [lagged]):
\[ -4.0 & -1.3 & -5.6 & 15.2 & -3.7 & 0.6 \\
\]

Yield curve (r1 - rs):
\[ -0.4 & -4.5 & 3.5 & -2.0 & 5.3 & 1.9 \\
\]

Revision of data series (d1 + d85q4):
\[ - & 2.4 & - & 5.9 & 4.1 & 12.4 \\
\]

Sources: The Netherlands Bank, Annual Report; Quarterly Bulletin (various issues); Kwartaalconfrontatie van Middelen and Bestedingen, 1957-1980; and staff calculations based on equation 3.3.
Liquidity Ratio Equilibrium and Its Determinants

Source: The Netherlands Bank; and staff calculations based on equation 3.3.
1/ Variables multiplied by their coefficients in regression 3.3 and shifted so that the value for 1980q1 equals zero.
As regards the influence on money of changes in the shape of the yield curve, the authorities have at times attempted to curb the growth in liquidity through measures intended to steepen the yield curve. The above analysis suggests that the steepening of the yield curve during 1981q3/1983q1 reduced narrow money demand by f. 4.5 billion. More recently, the flattening of the yield curve has led to an increase in narrow money demand by over f. 5 billion. While this confirms a link between the shape of the yield curve and the money stock, it is more difficult to judge whether this should give rise to concern as the estimates presented here are based on an equilibrium relationship.

When expressed in terms not of the narrow money stock but of the liquidity ratio, the basic picture that emerges is of course similar (Chart 4, lower panel). The impact of the decline in short-term interest rates during the early 1980s is clearly visible, as is the negative influence on the liquidity ratio from the recent rise in short-term interest rates. The influence of the currency substitution variable is also pronounced: negative contributions to the liquidity ratio during the early 1980s, positive contributions thereafter. The price variable--defined in the broad sense here to reflect the contribution of the GNP deflator and the contemporaneous exchange rate combined--tended, on balance, to raise the liquidity ratio during 1980-1985 and to reduce moderately thereafter.

4. Conclusions

The empirical results of this note suggest that an appropriate dynamic specification and the inclusion of previously missing variables in a money demand function can help explain the increase in the Dutch narrow money stock and in the M1 liquidity ratio during the 1980s. A striking find is that the guilder-U.S. dollar exchange rate in Dutch money demand, alongside domestic interest rates, can act as a valuable monetary indicator.

While the influence of currency substitution on money demand for the ECU bloc as a whole had been suggested in previous studies (e.g., Kremers and Lane, 1990), not much evidence exists that this influence can also be empirically relevant for individual currencies within the ECU region. It is plausible that the hard currency policy pursued by the Netherlands Bank with the deutsche mark as anchor currency transmits this currency substitution feature onto the guilder money markets.

A second feature of money markets which has attracted attention in the Netherlands is the influence of changes in the shape of the yield curve on money demand. The authorities have at times been concerned that a flattening of the yield curve might exacerbate the upward trend in the liquidity ratio by encouraging substitution from long-term to short-term
liabilities of the banking system. This note indeed suggests that a flattening of the yield curve increases money demand and vice-versa. However, at the same time, these shifts appear to reflect equilibrium behavior. That is, these extra money balances are willingly held and there is no reason to expect a spillover into expenditures and prices so long as money holders can return with equal ease to longer-term assets if the yield curve were to steepen again.
Data

Most data are from three main sources published by the Netherlands Bank (DNB): Kwartaalconfrontatie van middelen en bestedingen, 1957-1980, Monetaire en financiele jaar-en kwartaalreeksen, 1957-1983, and Quarterly Bulletin, various issues. Recent data on income and prices are from the Central Bureau of Statistics (CBS), Quarterly National Accounts, new series from 1977. Series for real income, prices, and the money stock were seasonally adjusted by the staff, using the U.S. Bureau of the Census X-11 variant of Method II. Since not all data are available in continuous series since 1957q1, data were spliced, when necessary, after seasonal adjustment of subsets.

Income: Real GNP at 1980 prices, seasonally adjusted. CBS and DNB.

Prices: GNP deflator, 1980=100, seasonally adjusted. CBS and DNB.

Money: Narrow money, seasonally adjusted. DNB

Short-term interest rates: Three-month cash loan rate to local authorities, DNB.

Long-term interest rates: Government bond rate, five longest-term issues, DNB.


Cyclical indicator: Index of labor utilization (100 minus unemployment rate as defined by Central Planning Bureau), detrended, and detrended index derived from data on business cycle indicator, in Den Butter and Fase, 1981.


d85q4: Additive dummy variable, unity since 1985q4.
Diagnostics and Test Statistics

Underlying diagnostics and test statistics are standard features of PC-GIVE regression output. More detailed descriptions can be found in Hendry (1989).

Goodness of fit indicators:

R-sq: Squared coefficient of multiple correlation. This indicator is dependent on choice of transformation of the dependent variable.

F (k-1, n-k): F-statistic on null that R-sq = zero (also dependent on choice of transformation of the dependent variable).

S: Standard error of the regression times 100 percent (not dependent on choice of transformation of the dependent variable).

DW: Durban-Watson statistic. If equation contains lagged dependent variable, DW is biased toward 2. Appropriate Lagrange Multiplier tests, see below, are also provided.

FPE: Final prediction error. Informational scaler based on regression variance used to choose between alternative models in a class.

Test statistics for white noise error term:

AR i-i (i-j): Lagrange Multiplier test for residual autocorrelation of order i (i through j). Distributed as Chi-sq. However, for finite samples, the F-form reported here is recommended as the diagnostic test (Harvey, 1981). Note that this test is valid for models with lagged dependent variables.


HESC: Lagrange Multiplier test for heteroscedasticity associated with squares of the explanatory variables based on White, 1980. F-form reported here.

Chow: Chow test for parameter stability over the last t observations of the current sample. Reported in F [t, T-t] form.

FC-CHI-sq: Forecast Chi-square test statistic for parameter stability. CHI-sq statistic to compare within with post-sample residual variances, divided by dof to make it comparable to F-test, as reported here. Numerical value always greater than Chow test. Values greater than 2 generally imply weak forecasting ability.
RESET: (Regression Specification test) Langrange Multiplier test for omitted variables (in form of powers of linear combinations of the explanatory variables). This test to see if the original functional form, lacking higher order explanatory variables, is incorrect.
Recursive Estimation

It is often useful to check the stability of the parameter estimates as in 3.3 by running recursive regressions. The recursive procedure commences with an initial set of regression estimates based on some suitable minimum number of observations. Subsequent observations are then added one at a time, and a time series is constructed and plotted showing the evolution of the recursive error term and point estimates of the parameters.

Proceeding in this way, the stability of the long-run estimates of money demand equation 3.3 was investigated further by regressing the equation recursively from 1966 onward. Residuals of this exercise are presented in Chart 5. The confidence band is penetrated once in 1981q3, dating the same period that the Koyck specification of section 2 began to exhibit instability, and during the last two quarters of 1989. In general, however, these recursive residuals appear satisfactory and do not indicate major instability problems.

The series of charts beginning with Chart 6 present further evidence of parameter stability of the long-run equilibrium relationship. These charts track the recursive point estimates of the coefficients in 3.3 delineated on both sides by a two standard error confidence band. In general, the point estimates stabilize during the early 1970s to around their final values. It is not unusual to find fairly wide confidence bands and relatively more volatile point estimates at the beginning of the recursive estimation as the sample is still limited. Another factor that may have played a role here is the very limited variability of the exchange rate during the earlier periods in the sample and its interaction with the constant in the equation.

The recursive point estimates of the coefficients lend further support to the apparent lack of homogeneity in prices as measured by the GNP deflator. The coefficient on the right-hand side price variable in equation 3.3 is consistently and significantly below zero, indicating price elasticity for money demand below unity. However, the coefficient on the contemporaneous exchange rate variable is above zero and nearly of comparable magnitude. The coefficients on the lagged exchange rate, the short-term interest rate and the yield curve variable stabilize after the early 1970s with point estimates in accord with theoretical priors and fairly close to their full sample values. Together with the results presented in Table 3, these findings indicate further support for the hypothesis that international financial variables, notably the exchange rate, can play an important role in the determination and interpretation of money demand developments domestically.
This chart depicts the sequence of estimated equation standard errors and one-step ahead residuals obtained by successively extending the sample by a single observation from 1966Q1 to 1989 Q4. These residuals consist of the last residual of each of the successive regressions; if they are to be normally distributed with zero mean, they must be close to zero and 95 percent of them must lie within the band delineated by two estimated standard errors.
APPENDIX III

Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.

CHAiR 6
NETHERLANDS
MONEY DEMAND RECURSIVE PARAMETER ESTIMATE\textsuperscript{1}
PRICES

\textsuperscript{1}Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.
CHART 7
NETHERLANDS
MONEY DEMAND RECURSIVE PARAMETER ESTIMATE\(^1\)
CONTEMPORANEOUS EXCHANGE RATE

\(^1\) Obtained by recursively estimating eq.3.3 from 1966 Q1 to 1989 Q4.
CHART 8
NETHERLANDS
MONEY DEMAND RECURSIVE PARAMETER ESTIMATE
LAGGED EXCHANGE RATE

+ 2 standard errors

- 2 standard errors

Recursive parameter estimate on lagged exchange rate ($/[-1]$)

1 Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.
CHART 9
NETHERLANDS
MONEY DEMAND RECURSIVE PARAMETER ESTIMATE
SHORT-TERM INTEREST RATE

Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.

1 Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.
Obtained by recursively estimating eq 3.3 from 1966 Q1 to 1989 Q4.
References


