

Schweizerische Zeitschrift für Volkswirtschaft und Statistik
Revue suisse d'Economie politique et de Statistique

*Herausgegeben von der Schweizerischen Gesellschaft für Statistik und Volkswirtschaft
Publiée par la Société suisse de Statistique et d'Economie politique*

Redaktion / Rédaction: Prof. Dr. E. Baltensperger

126. Jahrgang / 126^e année Heft / Fasc. 4 Dezember / Décembre 1990

Are Larger Monetary Aggregates Interesting?
Some Exploratory Evidence for Switzerland Using Feedback Models*

By Andreas M. Fischer and Michel Peytrignet,
Swiss National Bank, Zurich

1. Introduction

For the last decade and a half the Swiss National Bank (SNB) pursued its policy objective of price stability by targeting narrow monetary aggregates. The 1973 switch to floating exchange rates allowed countries to follow more independent monetary policies, initiating the SNB's course for targeting M1. However, hampered with difficulties in predicting the money multiplier, the SNB elected to target the monetary base in 1980. The success of Swiss monetarism under base targeting, measured by hitting its growth targets and keeping inflation at bay, began to wane in the last two years. The 1988 and 1989 deviations between the actual growth rate of the monetary base relative to its targeted value were nearly -7% and -4% . A chief reason for the sharp reduction in base growth was the combined introduction of the new liquidity prescriptions (Birchler, 1988) and the Swiss Interbank Clearing System (Vital/Mengle, 1988). These changes in bank operating procedures produced large shifts in the narrow monetary aggregates, however the evidence for M3 is less clear.

The brief, yet disenchanting episodes of monetarism in foreign countries (particularly in the United States and in the United Kingdom) induced many central banks to adhere to their "old remedies" with an eye for larger monetary aggregates. Whereas the SNB has played down the significance of larger aggregates, the events abroad and the troublesome experience of the last two years have begun to kindle interest in the attractiveness of money demand functions for larger monetary aggregates.

* We would like to thank Martin Maurer, Blurette Mouron, Georg Rich and Umberto Schwarz for helpful commentary. All econometrics in this paper is performed using PC-GIVE.

Although empirical studies on the Swiss demand for money have focused primarily on either the monetary base or M1, this bias in the empirical literature is explained by the SNB's emphasis on targeting a narrow monetary stock. This paper attempts to partially fill this gap by considering an alternative monetary stock, namely M3.¹

In particular we are interested in the predictive performance of money demand functions for M3 using feedback models (*Hendry*, 1988). Several feedback specifications are presented and contrasted for Switzerland covering the 1967 – 1989 period. Particular emphasis is placed throughout on the performance of various feedback specifications under structural stability analysis and on the interpretation of the long-run equilibrium solutions. The main results of our analysis are the unsatisfactory features of these specifications.

Econometric models based on feedback rules represent simplified rules which agents may follow in complex environments. Unlike feedforward models which attempt to include the potential role of expectations in determining current behavior, feedback models presume that agents respond to lagged and current observations when deciding current values of their choice variables. Both feedback and feedforward models have become popularized under the error-correction approach. To obtain satisfactory empirical specifications of feedback behavior, several strategies have been formulated. They are all based on the recognition of the existence of a long-run relation between the modeled variable and its determinants. In our analysis, several strategies for finding the long-run relationship between money and other variables are used.

We begin our analysis by reproducing the empirical results for M3 by *Kohli* (1984) and *Belongia* (1988). We show that their Goldfeld specifications, which are similar to the M1 demand functions estimated by *Kohli* (1984) and *Kohli/Rich* (1986), are mis-specified for quarterly data on grounds of serial correlation. We deviate from the attempts by *Rötheli* (1988), *Kohli* (1987) and *Heri* (1988) to interpret the mis-specification of M1 through regime shifts. In particular these authors point to the SNB's policy switch to monetary targeting after the introduction of flexible exchange rates in 1973. Consequently they conjecture that the instability of the demand for money function stems from a change in the exogeneity status for money, which was induced by the SNB's policy shift from exchange rate to monetary targeting.

Although the exogeneity argument seems plausible for Switzerland, the results in *Kohli* (1987) suggest that "buffer stock" models (*Laidler*, 1984) are less stable than partial adjustment models. Moreover, *Fischer* (1990) directly tests the exogeneity status for M1 demand, rejecting the hypothesis that money is exogenous. These results suggest that the exogeneity argument appears to be less plausible for M3. Thus, throughout our analysis, we retain the traditional assumption of endogenous money and examine the al-

¹ M3 contains banknotes plus sight – time – and savings deposits held by the non-bank sector of the economy.

ternative interpretation that the functional mis-specification stems from not identifying properly the short- and long-run dynamics.²

2. Some Problematic Features for M3 Under a Partial Adjustment Specification

The first model to be estimated is inspired by the results of *Kohli* (1984) and *Belongia* (1988), which implement a *Goldfeld* (1973) type specification to mimic a partial adjustment model. Annual data were used in the Kohli study, however the 20 degrees of freedom used in his investigation yield little power for hypothesis testing. As in *Belongia* (1988), we prefer to work with quarterly data. The Kohli-Belongia regression yields the following results for the 1967 : 3 – 1989 : 4 period:

$$\begin{aligned}
 (m3 - p)_t = & - 0.67935 & + 0.92093(m3 - p)_{t-1} & - 0.94542\pi_t & + 0.12043y_t \\
 & (3.45914) & (56.91456) & (8.43304) & (4.13570) \\
 & - 0.00878i_t^L & + 0.00165i_t^S & & - 0.00171Q1 - 0.01078Q2 \\
 & (5.70017) & (0.77331) & & (0.78081) & (4.89695) \\
 & - 0.01672Q3 & & & & \\
 & (7.87469) & & & &
 \end{aligned} \tag{2.1}$$

Sample 1967 : 3 – 1989 : 4

$$R^2 = 0.99 \quad \sigma = 0.70 \% \quad DW = 1.39 \quad h = 2.94$$

$$\begin{array}{lll}
 AR(6,75) = 2.46^* & ARCH(6,69) = 1.71 & Norm(2) = 0.25 \\
 AR(1,80) = 8.64^{**} & ARCH(1,79) = 2.49 & Het(13,67) = 2.07^*
 \end{array}$$

where $(m3 - p)_t$ is real M3 in log (deflated with the CPI), Q_i $i = 1, 2, 3$ are the seasonal dummies, π_t is the inflation rate computed as the one-quarter difference of the log of CPI, y_t is the log of the real Swiss GDP, i_t^L the rate of return on government bonds (Bundesobligationen), and i_t^S the interest rate paid on savings deposits which are included in M3.³ All the variables have the correct sign, but the own rate i_t^S is not significant with a t -value of 0.77.

The Durbin-Watson (DW) statistic and the more appropriate h -statistic clearly highlight the presence of residual autocorrelation. An LM-test for first-order autocorrelation (Godfrey, 1978), distributed as an F-test confirms this result: $AR(1, 80) = 8.64$

² *Hendry* (1979), *Gordon* (1984) and *Rose* (1985) show that dynamic specification can be critical to the constancy of money demand models.

³ The coefficients of π_t , i_t^L and i_t^S have to be interpreted as semi-elasticities.

[0.0043].⁴ Although we do not find any strong evidence of ARCH (Engle, 1982), the White (1980) test for general heteroskedasticity is significant.⁵

The presence of first-order residual autocorrelation in equation (2.1) introduces a bias in the estimates of the coefficients and the standard errors. To obtain consistent estimates of the parameters, first-order autocorrelation can be removed in an ad-hoc manner using a Cochrane-Orcutt estimation method. The Cochrane-Orcutt correction yields:

$$\begin{aligned}
 (m3 - p)_t = & -0.77665 + 0.91218(m3 - p)_{t-1} - 0.92551\pi_t + 0.13557y_t \\
 & (3.1429) \quad (45.3499) \quad (8.1774) \quad (3.7385) \\
 & - 0.00850i_t^L + 0.00032i_t^S - 0.00138Q1 - 0.01093Q2 \\
 & (4.2895) \quad (0.1178) \quad (0.7149) \quad (5.3658) \\
 & 0.01669Q3 \\
 & (9.2751)
 \end{aligned} \quad (2.2)$$

Sample 1967:3 – 1989:4

$$\alpha = 0.32337(2.9161) \quad \sigma = 0.68 \%$$

$$\text{ARCH}(6,69) = 2.68^* \quad \text{Norm}(2) = 0.19$$

$$\text{ARCH}(1,79) = 8.32^{**} \quad \text{Het}(13,67) = 2.13^*$$

where α is the first-order autocorrelation coefficient. This coefficient is significantly different from zero and its magnitude is acceptable. All the other variables have the right signs and are significant, except i_t^S . The statistic σ – the standard error of the equation – suggests that equation (2.2) fits the data slightly better than equation (2.1).

Table 2.1: Analysis of 1-step Forecasts

Date	actual	forecast	difference	std. err.	t-value
1988 1	6.389027	6.387457	0.001569	0.007133	0.219985
1988 2	6.410542	6.401592	0.008950	0.007086	1.263133
1988 3	6.416055	6.418798	-0.002744	0.007178	-0.382195
1988 4	6.421189	6.434506	-0.013317	0.007090	-1.878353
1989 1	6.429032	6.419424	0.009608	0.007299	1.316364
1989 2	6.437024	6.426941	0.010083	0.007241	1.392389
1989 3	6.434220	6.436164	-0.001944	0.007334	-0.265114
1989 4	6.431158	6.432713	-0.001555	0.007338	-0.211948
Tests of Parameter CONSTANCY over 1988:1 – 1989:4					
CHOW TEST(8,71) = 1.19 [0.3166]					

⁴ The figure in bracket shows the probability to obtain the value 8.64 from an F-distribution given the degrees of freedom. The expression can be interpreted as the probability to erroneously rejecting the hypothesis when it is in fact true.

⁵ One star means that the variable is significant at the 5 % critical level and two stars at the 1 % level.

A test for parameter constancy suggests that the Kohli-Belongia regression corrected for serial correlation is fairly stable. For the 1980:1 to 1989:4 period the one-step forecast error is never significantly different from zero. A Chow-test for parameter constancy over that forecasting period yields a value of $F(40, 39) = 1.49$ [0.1070]. If we repeat this exercise with forecasting horizons of 8 quarters, we obtain the results given in Table 2.1. Although these results suggest that the Goldfeld specification is relatively stable, several diagnostic tests indicate that model (2.2) is mis-specified.

Despite the unambiguous economic justifications for implementing the Cochrane-Orcutt procedure, the specification now clearly suffers from ARCH. Potentially the presence of ARCH stems from the remaining serial correlation that has not been handled correctly. Serial correlation may stem from omitted variables, dynamic mis-specification or from a common factor (COMFAC) reduction (*Hendry/Mizon, 1978*). However the COMFAC reduction needs to be tested and does not necessarily warrant the use of the Cochrane-Orcutt procedure. A further problem in the Goldfeld specification is the fact that the lagged dependent variable is very close to one. This suggests a latent problem of non stationarity (unit root) for real balances. Both of these problems of non stationarity and serial correlation may be overcome by implementing the proper variable transformations, an omitted variable representing long-run behavior, and a less restrictive lag structure – features characterized by feedback models. Before discussing the results, several strategies for specifying feedback models are outlined.

3. The Econometrics of Feedback Models

The feedback model is ingrained in the concept of the Data Generating Process (DGP) (*Hendry/Richard, 1983*), which is defined to be a joint probability distribution of all the sample data. The feedback model is a marginalized and conditioned representation of the DGP, that seeks to incorporate long-run equilibrium relations supported by economic theory. The use of these relations in feedback models, commonly called the error correction mechanism (ECM), includes only observed variables and is not founded on the explicit modeling of expectations.

It is known for certain that the simplified representation of the marginalized DGP cannot be strictly valid. Therefore *Hendry (1987)* proposes that one looks for a model which is congruent with all the evidence. A specification is congruent when the information contained in the data and omitted from the specified model is not important to the problem at hand. For a representation to be congruent, the feedback model must capture both the long-run equilibrium relations and the shape of the short-run dynamics. Recently several methods have been proposed to obtain this result. The specification strategies can be classified into three main groups, according to whether the long-run equilibrium and the short-run dynamics are jointly modeled, or modeled in a two-step procedure, or by imposing theoretical restrictions.⁶

⁶ Much of the debate on specification strategies is handled in the growing literature on the use of

3.1 The Simultaneous Specification of Long-Run Equilibrium and Short-Run Dynamics

The simultaneous procedure, proposed by *Wickens/Breusch* (1988), is implemented by starting from a general baseline model which includes long lags of both the dependent and independent variables. Inherent in the general to simple strategy is the belief that economic theory can only suggest which variables have to be correlated, but only the data can determine the precise dynamic relationship between them.

As an example, consider the problem of modeling a stationary series y_t by a vector of stationary variables X_t . The baseline model has the following form:

$$y_t = \alpha_0 + \sum_{i=1}^M \alpha_i y_{t-i} + \sum_{i=0}^W \beta_i X_{t-i} + \mu_t, \quad (3.1)$$

where α_0 is a constant, the β 's are $1 \times n$ vectors of coefficients and μ_t is the true innovation. A static equilibrium is defined by,

$$X_t = X^* \quad \text{for all } t, \quad (3.2)$$

in which case, $y_t = y^*$ will also be constant if $|\sum \alpha_i| < 1$, and y_t converges to

$$y^* = K X^*, \quad \text{where } K = \sum \beta_i / (1 - \sum \alpha_i). \quad (3.3)$$

The vector K contains the static long-run parameters and the expression $y_t - K X_t$ is called the ECM. With the use of the ECM, the baseline model may be transformed in the following manner:

$$\Delta y_t = \sum_{i=1}^D \alpha_i \Delta y_{t-i} + \sum_{i=0}^F \beta_i \Delta X_{t-i} + \varrho(y_{t-1} - K X_{t-1}) + e_t. \quad (3.4)$$

The purpose for the ECM in the model is to drive back y_t to the long-run growth path.

A necessary condition for the feedback interpretation of the ECM is that $\varrho < 0$. The economic interpretation is that there is a long-run equilibrium relation given by the vector ($y = K X$). When deciding y_t , agents respond to past deviations from equilibrium in such a manner that the change in y_t tends to correct for past errors. Alternatively, a positive value for ϱ would amplify the past disequilibrium, preventing the model to converge. In the presence of adjustment costs within the framework of

various transformations of a general autoregressive-distributed lag (ADL) model for estimation of long-run multipliers, in particular see *Banerjee/Gailbraith/Delado* (1990). *Wickens/Breusch* (1988) and *Bardsen* (1989).

dynamic inter-temporal optimization, *Nickell* (1985) shows that $\rho > 0$ can be generated by rational forward looking behavior.

A negative ECM coefficient, however, is not sufficient to imply that this specification can be interpreted as a feedback model. As shown in *Nickell* (1985), it is perfectly possible to obtain a negative coefficient on the ECM term within a *feedforward* theoretical framework. The feedback model can be interpreted as the reduced form of a feedforward model in which case the estimated coefficients are convolutions of the expectations parameters.⁷

If the variables in (3.1) have a unit root and the ECM constitutes a *cointegrating* relation, *Hendry/Neale* (1988) show that the parameters in the cointegrating vector define a stationary linear combination of non-stationary variables and are not effected by whether observed or expected variables are included in the underlying structural relation.

Under rational expectations, actual and expected variables differ only by a stationary expectational error which by its nature does not affect the estimated cointegrating relation. Consequently, in the cointegrated case the long-run elasticities derived from the feedback model will not differ greatly from the elasticities stemming from the feedforward model.

3.2 The Two-Step Procedure

In the two-step procedure, the dynamics of the short- and long-run relation are modeled separately. The first-step estimates the equilibrium relationship of the variables with a unit root. This *static* regression has been termed the cointegration regression. Various testing procedures for cointegration are given in *Engle/Granger* (1987), *Stock/Watson* (1988), *Johansen* (1988) and *Phillips/Ouliaris* (1986). The second-step uses the residuals from the cointegration regression as an ECM term and models the short-run dynamics around the lagged static relationship.⁸

The above procedure, proposed by *Engle/Granger* (1987), exploits the cointegration property implying a causal bond between the cointegrated variables. The underlying causal bond stems from the long-run equilibrium relation which can be used as a starting point in specifying a valid representation of the DGP. This result stems from the Granger-Engle Representation Theorem: that if some series form a cointegrating vector then an ECM representation exists.

The ECM representation has several crucial features not included in the Kohli-Belongia specification. It seeks to transform variables such that they are all stationary,

⁷ *Kelly* (1985) shows that the long-run elasticities derived from the feedback model are different from the true behavioral elasticities due to the presence of expectations.

⁸ *Engle/Granger* define the ECM somewhat differently as in *Hendry et al.* (1984) and the simultaneous method.

thus the asymptotic properties apply to the estimated parameter. Further the short-run dynamics are modeled by the distributed lags of the differences of the variables included in the cointegrating vector in a consistent way with the long-run behavior which is represented by the ECM. Another interesting feature is that under the hypothesis of cointegration, *Stock* (1987) has shown that the OLS estimates of the cointegration regression are super consistent, converging in probability at the rate T^{-1} instead of $T^{-1/2}$.

The applied researcher, however, has to be aware that several problems arise in the two-step procedure. The cointegration regression provides only one equilibrium relation. When more than two variables are considered, no unique solution is given. This problem can be overcome with the *Johansen* (1988) procedure, which provides a test for the number of existing numerical values and cointegrating vectors.⁹ Often, however, it is difficult to give an economic interpretation to the different cointegrating vectors. A further problem of the two-step procedure regards the bias. In a Monte Carlo study, *Banerjee et al.* (1986) observe that, in the case of a bivariate cointegrating regression, doubt must be cast on the small sample properties of the Engle and Granger procedure. In fact it is not clear whether little is to be gained in omitting the short-run dynamics from the static cointegration regression, see *Wickens/Breusch* (1988).

3.3 Imposing Theoretical Restrictions in the Long-Run Relation

An alternative strategy for developing the long-run relation is for the researcher to impose restrictions directly into the ECM suggested by economic theory. This third strategy, which is essentially a mix between the other two, has been used by *Baba et al.* (1987), *Domowitz/Hakkio* (1990) and *Hendry* (1985). The main motivation behind imposing the restrictions is that economic theory usually has the most to say regarding the long-run behavior of a model. For example, consider the long-run behavior of a simple money demand function,

$$m3 = \alpha_0 + \alpha_1 p + \alpha_2 y + \alpha_3 i^L \quad (3.5)$$

with the restrictions $\alpha_0 = 0$, $\alpha_1 = 1$, $\alpha_2 = 1$, $\alpha_3 = 0$. In this case the long-run relation (i.e. the ECM term) becomes the inverse of velocity (i.e. Friedman's quantity theory of money). Alternatively if we maintain price homogeneity with the restriction $\alpha_2 = \frac{1}{2}$, we are imposing Baumol's theory of transactions. This strategy, however, has its drawbacks if it is felt that interest rates or some other variables are important for the long-run relation. In such cases, economic theory may give us no clear answer as to what the long-run elasticities should be.

⁹ It should be noted that, like the cointegration test of Engle and Granger, the Johansen procedure is also extremely sensitive to the choice of lag dynamics.

On the basis of these considerations, the following empirical analysis for M3 attempts to highlight the different methodologies of dynamic specification for feedback models.

4. Empirical Results of the Feedback Model

4.1 The Simultaneous Specification

We begin with the procedure outlined in section 2.1, starting from a general baseline model:¹⁰

$$(m3 - p)_t = \alpha_0 + \sum_{i=1}^5 \alpha_i (m3 - p)_{t-i} + \sum_{i=0}^5 \beta_i y_{t-i} + \sum_{i=0}^5 \delta_i \pi_{t-i} + \sum_{i=0}^5 \lambda_i i_{t-i}^L \quad (4.1)$$

From the above estimated baseline model, we obtained the following long-run solution:¹¹

$$\text{ECM :} \quad (m3 - p) = - 8.972 + 1.555y - 14.043\pi - 0.307i^L \quad (4.2)$$

(1.250) (0.120) (3.790) (0.108)

Sample 1967:3 – 1989:4

The standard errors are calculated following the procedure in *Bardsen* (1989). All the coefficients of the long-run solution have plausible signs and are significant. Next, we modeled the short-run dynamics and imposed the ECM from equation (4.2) into equation (4.3):

$$\begin{aligned} \Delta(m3 - p)_t = & - 0.00058 + 0.40605\Delta(m3 - p)_{t-1} + 0.11870\Delta y_t \\ & (0.00094) \quad (0.08530) \quad (0.03890) \\ & - 0.85428\Delta\pi_t - 0.03138\Delta i_{t-1}^L - 0.05059\text{ECM}_{t-1} \quad (4.3) \\ & (0.10369) \quad (0.01133) \quad (0.01051) \end{aligned}$$

$$R^2 = .77 \quad \sigma = 0.56 \% \quad \text{Sample} \quad 1967:4 - 1989:4$$

$$\text{AR}[6,77] = 2.03 \quad \text{ARCH}[6,71] = 0.55 \quad \text{Het}[10,72] = 1.60 \quad \text{Norm}(2) = 0.03$$

¹⁰ Based on the preliminary results, the role of the own rate of return for M3 (i^S) has been left out of the feedback analysis.

¹¹ For reasons of space we do not include the baseline regression, however upon request it will be gladly provided. For the baseline model, various lag lengths were selected, based on a Wald test we used the specification given in (4.1). From here on, all the variables except the interest rates are deseasonalized using X-11, and all the variables are expressed in log form, except the inflation rate.

The diagnostic tests reported with the equation imply that they are a congruent representation of the DGP. The *Jarque-Bera* (1980) test for Normality (Norm) shows no serious deviations from its null. The Lagrange Multiplier (*Godfrey*, 1978) test for autocorrelation of the residuals (AR) from first up to sixth-order is unable to reject the null of no autocorrelation. Furthermore the two tests for heteroskedasticity (Het and ARCH) detect no serious signs of mis-specification.

Although the overall performance of equation (4.3) appears to be good according to the reported diagnostic tests, the recursive stability analysis reveals that several breaks occurred within the sample. The one-step recursive residuals are depicted in Figure 1. In particular the model mis-predicts during the late 1970s and 1980s and not during the early 1970s as is often claimed by the 1973 regime shift argument.

A further inconsistency with the model lies in the stationarity of the various regressors. We find that all of the regressors are stationary except for the ECM term. An ADF test gives a value of -2.40 for the sample. This result may suggest that either there is no long-run relation for the four variables in equation (4.2) or that the long-run elasticities derived from the feedback models may not capture deep behavioral parameters, because of the presence of expectational errors.

4.2 The Two-Step Specification

Before conducting the necessary cointegration regressions, several unit root tests were performed for the variables of interest. The results of our ADF tests are given in Table 4.1. Overall the evidence suggests that money, prices and income have a unit root, however for long-term interest rates it is hard to determine whether they are stationary or first-difference stationary.¹²

Table 4.1: ADF(4) – Unit Root Tests

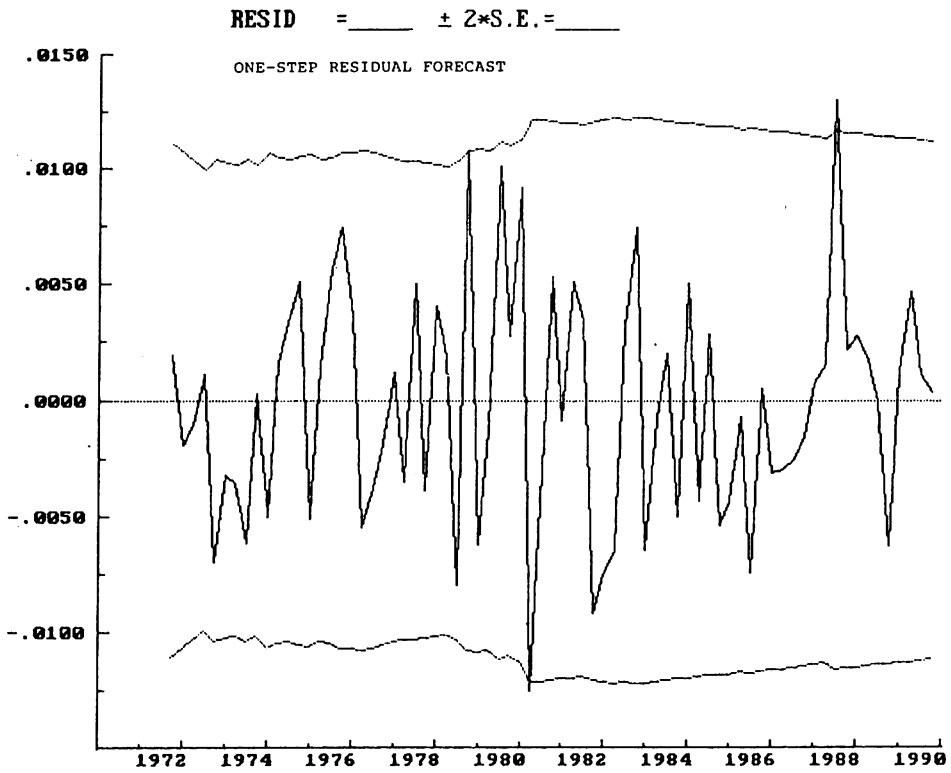
variable	level	first difference
$m3$	-1.43	-3.23
$m3 \cdot p$	-0.82	-3.72
p	-1.01	-2.72
y	-1.33	-9.39
iL	-3.13	-4.22

Notes: ADF(4) denotes Augmented Dickey Fuller test with four lags. Sample (1961:3 – 1989:4), except for y the sample was 1967:3 – 1989:4.

Next, we have performed several cointegration tests, which are given in Table 4.2. Overall the results reveal that only money, prices and income are cointegrated for the 1980s. Several other findings stem from Table 4.2. The cointegration results highlight

¹² Although our ADF tests depict prices to be $I(2)$, an MA(1) component of 0.54 for $\Delta^2 p_t$ suggests that we have over differenced the data.

Figure 1



the large differences between the long-run solutions in the two-step and simultaneous methods. This can be seen by comparing the long-run elasticities given in equation (4.2) and the point estimates of prices and income from the cointegration regressions given in Table 4.2. The cointegration results also suggest that the long-run elasticities for prices and income changed considerably in the 1980s. Consequently the results reveal that it would have been dangerous to impose theoretical restrictions (i.e. strategy three) for the ECM component without prior testing. The long-run elasticities of prices and income are also sensitive to the selected sub-sample, revealing structural instability in the long-run relation. This observation has been pointed out previously by *Heri* (1988).

Table 4.2: Cointegration Tests

variables	sample	coef. of p	coef. of y	ADF(4)	10% C.V:
$m3, p, y, i^L, \pi$	67:2-89:4	1.29	1.13	-2.45	-4.26
	73:1-89:4	1.34	1.11	-2.05	-4.42
	80:1-89:4	0.60	2.07	-3.27	-4.42
$m3, p, y, i^L$	67:2-89:4	1.30	1.12	-2.43	-3.89
	73:1-89:4	1.32	1.13	-2.11	-4.02
	80:1-89:4	0.59	2.08	-3.29	-4.02
$m3-p, y, i^L$	67:2-89:4	1	1.80	-2.49	-3.59
	73:1-89:4	1	1.68	-3.55	-3.73
	80:1-89:4	1	1.64	-3.55	-3.73
$m3, p, y$	67:2-89:4	1.46	0.78	-3.44	-3.59
	73:1-89:4	1.57	0.75	-3.34	-3.73
	80:1-89:4	0.68	2.03	-4.05*	-3.73
$m3-p, y$	67:2-89:4	1	1.82	-2.37	-3.03
	73:1-89:4	1	1.71	-2.37	-3.28
	80:1-89:4	1	1.66	-3.93*	-3.28

Notes: ADF(4) denotes an augmented Dickey Fuller test with four lags, except for the test $m3 - p, y$ (1973:1–1989:4) lags of order two were used. Critical Values (C.V.) were taken from *Engle/Yoo* (1987). Coef. of p and coef. of y are the point estimates of prices and income.

Following the estimation of the static regressions, we used their residuals to form the ECM and modeled the short-run dynamics around it. Our cointegration results from Table 4.2 were reconfirmed, for we were only able to obtain a significant $ECM_{(m3-p, y)}$ for the 1980:2–1989:4 period. This regression yielded the following results:

$$\begin{aligned} \Delta(m3 - p)_t = & 0.128710 + 0.230052\Delta y_t - 0.503575\pi_t \\ & (0.01599) \quad (0.16834) \quad (0.18486) \\ & - 0.077836i_{t-1}^L - 0.003580ECM_{t-1} \\ & (0.01088) \quad (0.00130) \end{aligned} \quad (4.4)$$

$$R^2 = .84 \quad \sigma = 0.47\% \quad \text{Sample } 1980 : 2 - 1989 : 4$$

$$AR[6,28] = 2.02 \quad ARCH[6,22] = 0.62 \quad Het[8,25] = 1.87 \quad Norm(2) = 1.35$$

Due to the disparity between the standard errors and those corrected for heteroskedasticity, White's Heteroskedastic Consistent standard errors are given in the parentheses. All the variables are significant except short-run income. The Godfrey tests for first- to sixth-order serial correlation (AR) reveal no serious signs of mis-specification. A particular feature of this specification, unlike equation (4.3), is that lagged money and the first differences of the long-term interest rate and inflation do not enter the feedback model.

Although this particular specification no longer appears to suffer from serial correlation as under the Kohli/Belongia specification, the model is not internally consistent. The inconsistency lies with the positive constant and the steady-state solution implied by the ECM.¹³ This result can best be demonstrated if the constant is dropped from the above model. In doing so we obtained the following results:

$$\begin{aligned} \Delta(m3 - p)_t = & 0.418886\Delta y_t - 1.22276\pi_t + 0.008944i_{t-1}^L - 0.001313ECM_{t-1} \\ & (0.25539) \quad (0.23013) \quad (0.00188) \quad (0.00177) \\ R^2 = & .64 \quad \sigma = 0.81\% \quad \text{Sample } 1980 : 2 - 1989 : 4 \end{aligned} \quad (4.5)$$

$$AR[6,29] = 3.45^* \quad Het[8,25] = 2.05 \quad ARCH[3,29] = 5.37^{**} \quad Norm(2) = 0.04$$

The non robustness of (4.4) is highly evident. The ECM term is no longer significant, the sign of the interest rate term has changed, and the diagnostic tests highlight the sensitivity of the mis-specified model.

5. Conclusions

Our preliminary results showed that the commonly applied Goldfeld specification for M3 resulted in a model which suffered from autocorrelation. We attempted to overcome this correlation problem by estimating empirical models based on the assumption of feedback behavior. Several strategies were outlined for finding the long-run solutions, which were then introduced into the dynamic model as an additional variable in the form of an ECM.

Overall our specified models for M3 do not exhibit strong feedback behavior. The ECM term which drives back real money balances towards its long-run growth path was in most cases very small and suffered from problems of non stationarity and structural instability. Consequently, it is not surprising that the various strategies produced nonuniform models. Hence, it is ill-advised to impose restrictions derived from theory in the ECM without testing the stability of the equilibrium relation.

Our non constancy results clearly suggest that money demand equations for M3 do not outperform money demand equations for narrow monetary aggregates. Furthermore the instability of the equilibrium relations for M3 with other macroeconomic variables casts doubt as to whether M3 can act as an "interesting" indicator. The unstable

¹³ For a simple demonstration of this result, see Harvey (1981, 288–289).

equilibrium relations also indicate that a feedforward model for M3 must be treated with caution, for it requires the explicit modeling of the expectations process. In general, such modeling procedures are more likely to encounter problems of non stationarity and structural instability for the long-run relation.

References

- Baba, Yoshihisa/Hendry, David F./Starr, Ross M.* (1987): US Money Demand 1960–1984. Nuffield Discussion Paper, No. 27, Oxford University.
- Banerjee, Anindya/Delado, Juan J./Hendry, David F./Smith, Gregor W.* (1986): Exploring Equilibrium Relationships in Econometrics Through Static Models: Some Monte Carlo Evidence. *Oxford Bulletin of Economics and Statistics* 48, 253–277.
- Banerjee, Anindya/Gailbraith, John W./Delado, Juan J.* (1990): Dynamic Specification and Linear Transformation of the Autoregressive-Distributed Lag Model. *Oxford Bulletin of Economics and Statistics* 52, 95–104.
- Bardsen, Gunner* (1989): Estimation of Long Run Coefficients in Error Correction Models. *Oxford Bulletin of Economics and Statistics* 51, 345–350.
- Belongia, Michael T.* (1988): Stability of Swiss Money Demand: Evidence for 1982–1987. *Geld, Währung und Konjunktur, Quartalsheft*, March, 75–81.
- Birchler, Urs, W.* (1988): Neue Liquiditätsvorschriften und Geldpolitik. *Geld, Währung und Konjunktur, Quartalsheft*, March, 68–74.
- Domowitz, Ian/Hakkio, Crag S.* (1990): Interpreting an Error Correction Model: Partial Adjustment, Forward-Looking Behavior, and Dynamic International Money Demand. *Journal of Applied Econometrics* 5, 29–46.
- Engle, Robert F.* (1982): Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of the U.K. Inflation. *Econometrica* 50, 987–1008.
- Engle, Robert F./Hendry, David F./Richard, J.F.* (1983): Exogeneity. *Econometrica* 51, 227–304.
- Engle, Robert F./Yoo, Byung Sam* (1987): Forecasting and Testing in Cointegrated Systems. *Journal of Econometrics* 35, 143–159.
- Engle, Robert F./Granger, Clive W.J.* (1987): Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica* 55, 251–276.
- Fischer, Andreas M.* (1990): Is Money Really Exogenous? Testing for Weak Exogeneity in Money Demand. SNB, Zürich, Paper presented at the Konstanz Seminars on Monetary Theory and Monetary Policy.
- Godfrey, J.L.* (1978): Testing Against General Autoregressive and Moving Average Error Models when the Regressors include Lagged Dependent Variables. *Econometrica* 46, 1293–1301.
- Goldfeld, Steven* (1973): The Demand for Money Revisited. *Brookings Papers in Economic Activity* 3, 577–646.
- Gordon, Robert J.* (1984): The Short-run Demand for Money: A Reconsideration. *Journal of Money, Credit, and Banking* 16, Pat. 1, 403–434.
- Harvey, Andrew C.* (1981): *The Econometric Analysis of Time Series*. Phillip Allan Publishers.
- Hendry, David F.* (1979): Predictive Failure and Econometric Modelling in Macroeconomics: The Transactions Demand for Money. In: *P. Ormead* (ed.), *Economic Modelling*. London: Heinemann, 217–242.
- Hendry, David F.* (1985): Monetary Economic Myth and Econometric Reality. *Oxford Review of Economic Policy* 1, 72–83.
- Hendry, David F.* (1987): *Econometric Methodology: A Personal Perspective*. Ch. 10 in: *T. Bewley* (ed.), *Advances in Econometrics*, Cambridge: Cambridge University Press.
- Hendry, David F.* (1988): The Encompassing Implications of Feedback versus Feedforward Mechanisms in Econometrics. *Oxford Economic Papers* 40, 132–149.

- Hendry, David F./Mizon, Gregory E. (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, 549–563.
- Hendry, David F./Richard, Jean-François (1983): The Econometric Analysis of Economic Time Series. *International Statistical Review* 51, 111–163.
- Hendry, David F./Pagan, Adrian P./Sargan, J. Denis (1984): Dynamic Specification. Ch. 18 in: *Griiches, Z./Intriligator, M.* (eds.), *Handbook of Econometrics*, Vol. II. North-Holland, Amsterdam.
- Hendry, David F./Neale, Adrian J. (1988): Interpreting Long-Run Equilibrium Solutions in Conventional Macro Models: A Comment. *Economic Journal* 88, 549–563.
- Heri, Erwin W. (1988): Money Demand Regressions and Monetary Targeting Theory and Stylized Evidence. *Schweizerischer Zeitschrift für Volkswirtschaft und Statistik*, 123–149.
- Jarque, Carlos M./Bera, Anil K. (1980): Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals. *Economics Letters* 6, 255–259.
- Johansen, Soren (1988): Statistical Analysis of Co-integrating Vectors. *Journal of Economic Dynamics and Control* 12, 231–254.
- Kelly, Chris M. (1985): A Cautionary Note on the Interpretation of Long-Run Equilibrium Solutions in Conventional Macro Models. *Economic Journal* 95, 1078–1086.
- Kohli, Ulrich (1984): La Demande de Monnaie en Suisse Réexaminée. *Geld, Währung und Konjunktur*, Quartalsheft, December, 64–70.
- Kohli, Ulrich (1985): Le Demande de Monnaie en Suisse: Aspects Divers. *Geld, Währung und Konjunktur*, Quartalsheft, June, 150–164.
- Kohli, Ulrich (1987): Exogenous Money, Monetary (Dis)equilibrium and Expectational Lags. *Kredit und Kapital* 20, 179–199.
- Kohli, Ulrich/Rich, Georg (1986): Monetary Control: The Swiss Experience. *Cato Journal* 5, 911–926.
- Laidler, David E.W. (1984): The “Buffer Stock” Notion on Monetary Economics. *Economic Journal*, Supplement 94, 17–34.
- Nickell, Steve (1985): Error Correction, Partial Adjustment and All That: An Expository Note. *Oxford Bulletin of Economics and Statistics* 47, 119–129.
- Phillips, Peter C.B./Ouliaris, S. (1986): Testing for Cointegration. *Cowles Foundation Discussion Paper*, No. 893, Yale University.
- Rose, Andrew K. (1985): An Alternative Approach to the American Demand for Money. *Journal of Money, Credit, and Banking* 17 Part 1, 439–455.
- Rötheli, Tobias (1988): Money Demand and Inflation in Switzerland: An Application of the Pascal Lag Technique. *Federal Reserve of St. Louis, Review*, 43–52.
- Stock, James H. (1987): Asymptotic Properties of the Least Squares Estimators of Cointegrating Vectors. *Econometrica* 55, 1035–1056.
- Stock, James H./Watson, Mark W. (1988): Variable Trends in Economic Time Series. *Journal of Economic Perspectives* 2, 147–174.
- White, Hal (1980): A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48, 817–838.
- Wickens, M.R./Breusch, T.S. (1988): Dynamic Specification, the Long-Run and the Estimation of Transformed Regression Models. *Economic Journal* 98, 189–205.
- Vital, Christian/Mengle, David L. (1988): SIC: Switzerland's New Electronic Interbank Payment System. *Federal Reserve Bank of Richmond, Economic Review*, 12–27.

Summary

Are Larger Monetary Aggregates Interesting?

We examine the predictive performance of money demand functions for M3 using feedback models. Several feedback specifications are presented and contrasted for Switzerland covering the 1967–1989 period. The main result of our analysis highlights several unsatisfactory features of these specifications. Our specified models do not exhibit strong feedback behavior. The error correction mechanism, which drives back real money balances towards its long-run growth path, was in most cases small and suffered from problems of non stationarity and structural instability.

Résumé

Est-ce que des agrégats monétaires plus larges sont intéressants?

Dans cet article, nous examinons les performances prédictives de plusieurs fonctions de demande de l'agrégat monétaire M3. Pour ce faire, nous utilisons des modèles dits à correction d'erreurs passées (*feedback E. C. M*) dans lesquels les déviations par rapport à un modèle statique de long terme sont corrigées par un modèle dynamique de court terme. Plusieurs spécifications sont estimées en utilisant des données suisses couvrant la période 1967–1989. La plupart des spécifications présentent plusieurs caractéristiques insatisfaisantes: le mécanisme de correction d'erreurs reste faible et souffre de problèmes de non stationnarité et d'instabilité structurelle.

Zusammenfassung

Sind grössere Geldmengen-Aggregate von Interesse?

In der vorliegenden Arbeit wird mit Rückkoppelungsmodellen die Effizienz von Geldnachfragefunktionen für M3 untersucht. Verschiedene Spezifikationen

werden für die Schweiz für die Periode 1967–1989 geschätzt. Das Hauptresultat weist auf einige unbefriedigende Eigenschaften dieser Spezifikationen hin. Der Fehler-Korrektur-Mechanismus war in den meisten Fällen sehr klein und ist durch Nicht-Stationarität und strukturelle Instabilität gekennzeichnet.