FINDING THE RIGHT NOMINAL ANCHOR: THE COINTEGRATION OF MONEY, CREDIT AND NOMINAL INCOME IN NORWAY

by

Gunnar Bårdsen*

and

Jan Tore Klovland

No. 350

*Temporary Address:
(until August 1990)

Department of Economics
University of Warwick
COVENTRY
CV4 7AL

After August 1990

Norwegian School of Economics
and Business Administration
5035 Bergen-Sandviken
Helleveien 30
NORWAY

FINDING THE RIGHT NOMINAL ANCHOR: THE COINTEGRATION OF MONEY, CREDIT AND NOMINAL INCOME IN NORWAY*

by

Gunnar Bårdsen

and

Jan Tore Klovland

ABSTRACT

Using cointegration techniques this paper presents an empirical analysis of the relationship between nominal GDP or domestic expenditure on the one hand and money and credit variables on the other. The main findings are: (1) In the period from 1966 to 1983 there is a relatively firm relationship between the nominal income variables and credit, which subsequently breaks down completely during the ensuing period of credit market deregulation; (2) Nominal income and the broad money stock, M2, are cointegrated throughout the period 1966 to 1989 within a model augmented by the own rate of interest on M2 and a bond yield. Thus M2, adjusted for the effects of interest rates affecting the demand for money, seems to provide the most reliable long–run anchor for nominal income in Norway in the period considered here.

* This research was completed while the first author was visiting the Department of economics at the University of Warwick. The exellent working conditions offered there is gratefully acknowledged.

1. INTRODUCTION

Which financial quantity variable – money or credit – does provide the most reliable information about the ultimate effects of monetary policy on nominal income? Is it credit, which for decades has been the monetary authorities' main target variable in Norway, or is 'the quantity of money ... "all that matters" for the long–run determination of nominal income'?[1] This is a crucial question for monetary authorities everywhere, irrespective of the design of financial markets or the choice of exchange rate system.

This issue has always been regarded as a fundamental one in monetary theory. Following the significant changes in the conduct of monetary policy in the 1980s, empirical research on this issue has also been intensified in recent years, especially in the United States. Before reviewing briefly some relevant theoretical and empirical aspects of this literature (section 2), we add some further remarks on the specific issues addressed in this paper and their relation to the peculiar institutional features of financial markets and policy formulation in Norway.

The empirical analysis undertaken here is not based on an assumption that either money or credit should serve as a short–run target for monetary authorities in Norway in a rigid sense. Neither money nor credit bears a sufficiently tight relationship with nominal income in the short run to warrant targeting these financial aggregates on a monthly or maybe even quarterly basis. Our concern is to examine which financial quantity variable performs best as a 'policy guide' or 'information variable'[2] with respect to the desired long run path of nominal income.

Contrary to contemporary official statements it appears in retrospect that neither money nor credit aggregates have been taken seriously as intermediate targets of monetary policy in Norway until very recently. In official policy statements sectoral credit aggregates, particularly bank credit, used to play a significant role. It became increasingly clear during the past two decades, however, that the instruments used to control credit growth were grossly inadequate, as realized growth rates persistently surpassed the target levels by whopping figures.[3] The ineffectiveness of monetary

---

[1] Friedman and Schwartz (1982, p. 57).

[2] See B.Friedman (1983a, 1988a) for a discussion of the role of money and credit as information variables.

[3] Between 1967 and 1987 there was an overshooting of original targets for credit growth as

policy largely stemmed from the overriding goal of interest rate smoothing, which in practice implied keeping nominal interest rates lower than the market–clearing level. Thus in practice monetary policy was conducted without a financial quantity variable to anchor the path of nominal income.

With the exchange rate taking priority over nominal interest rates as from the 1986 devaluation, it may be argued that some form of nominal anchor now has been imposed on the economy. However, purchasing power parity is only assumed to reflect nominal disturbances, and imperfectly so in anything but the long run. Real shocks (to for example productivity or terms of trade) may affect the real exchange rate perrmanently, being of particular importance to the resource based Norwegian economy.[4] Consequently, pegging the exchange rate is no panacea for achieving the desired long–run course of nominal income. Finding a financial aggregate which is closely linked with nominal income is still an important issue.

2. THE TRANSMISSION OF MONETARY IMPULSES

The proposition that changes in the stock of money has a long run effect upon nominal income is hardly controversial, although there is still little consensus concerning which of David Hume's (1752) 'one hundred canals' actually carry the bulk of monetary impulses. To cite just one example from the vast literature on the macroeconomics of monetary influences on nominal income, none is more appropriate than Milton Friedman's (1956) restatement of the quantity theory of money. In this approach the importance of money for the course of nominal income follows from the existence of a stable and well–defined demand–for–money function coupled with a supply function depending on at least some important factors which do not affect the demand side as well. While most other macroeconomic models yield qualitatively the same results in the long run, it is well known that there are differences of opinion as to the stability of this relationship. The really controversial issue regards the short run, whether the business cycle is 'a dance of the dollar', as Irving Fisher (1923) and his successors

---

formulated in annual National Budgets in 20 out of 21 years, cf. the Report of the committee on monetary policy (NOU 1989:1, *Penger og kreditt i en omstillingstid, Oslo, 1989*), p. 59.

[4] For an evaluation of the empirical evidence and limitations of purchasing power parity, see Dornbusch (1987). Edison and Klovland (1987) found that the effects of real factors were quite important in testing for PPP relationships between Norway and the United Kingdom over the past century.

maintained. This issue is, however, beyond the scope of the present paper, in which the main focus is on long–run relationships.

The proposition that credit may play a role in the monetary transmission mechanism is also widely recognized, but again this is more a question of relative importance rather than either money or credit.[5] In an economy characterized by highly segmented credit markets and enforced rationing of intermediated credit to large borrower groups, as was more or less the case in Norway until the end of 1983, there is, of course, no lack of arguments for linking credit with nominal income or expenditure. In addition, recent theoretical developments have shown that, even in an economy without disequilibrium credit rationing, there are several routes through which credit markets interfere with the monetary transmission mechanism.[6] In the model developed by Stiglitz and Weiss (1981) the loan supply curve may bend backwards due to informational asymmetries, causing a form of credit rationing by banks. Bernanke (1983) and Blinder and Stiglitz (1983) stressed the special role played by bank credit in an economy where important sectors of borrowers do not have easy access to non–intermediated forms of credit. Disruptions of financial flows to such sectors are highlighted in periods such as the Great Depression of the 1930s, when increased riskiness of loans and shrinkage of borrowers' collateral caused by worsening of their balance sheet position made these sectors highly dependent on the sustained credit creation ability of the banking system. But even in more normal periods many economies exhibit institutional features of credit market segmentation which enhance the role of bank credit.

Bernanke and Blinder (1988) have developed a very simple model of aggregate demand which in general allows for both money and credit. There is a separate role for the credit market if bank loans and other forms of customer–market credit are not considered as perfect substitutes for auction–market credit (or bonds) by either borrowers or lenders. Similarly, there is a role for money as long as money and bonds are not perfect substitutes. The fuzziness of the distinction between money and bonds has been a preoccupation in much of Tobin's work,[7] but whether the process of

---

[5] Friedman and Schwartz (1963, p.32) are inclined to 'casting the "credit" market as one of the supporting players rather than a star performer'. In the macroeconomic models summarized in Brunner and Meltzer (1988) the transmission of monetary impulses to output depends on the operation and properties of the credit market.

[6] Gertler (1988) contains a survey of the literature on the links between the financial system and aggregate economic behaviour.

[7] Cf. Tobin (1969, p.334): 'The essential characteristic — the only distinction of money from securities that matters...— is that the interest rate on money is exogenously fixed by law or convention, while the rate of return on securities is endogenous, market determined'.

financial innovation eventually creates new money substitutes that completely blur the distinction between the two types of assets is in the end an empirical question.

In this framework the crucial condition which determines whether money or credit is the variable to target is the relative magnitude of money–demand and credit–demand shocks. We are thus led to examine the relative stability of the long run demand function for money and for credit.

The apparent breakdown in the early 1980s of the demand function for M1, the money stock definition monitored most closely by the monetary authorities in the United States, has led some economists to suggest that credit aggregates may bear a more stable relationship to nominal income than does money.[8] On balance, though, the empirical evidence from the US, where most of the studies have been made, is mixed.

Bernanke (1988, p.11), drawing on the results in Bernanke and Blinder (1988), concluded that 'credit demand has been more stable than money demand since the deregulation process began in 1980'.[9] On the other hand, the cointegration tests presented in B. Friedman (1988a) show that neither monetary aggregates (monetary base, M1, M2) nor credit were cointegrated with nominal income in samples ending in 1987.[10] Indeed, Benjamin Friedman (1988b, p.63), who was one of the leading proponents of targeting credit (in addition to money) in the early 1980s concluded that 'the movement of credit during the post–1982 period bore no more relation to income or prices than did any of the monetary aggregates'. Moreover, the results in Mehra (1989), who used data from 1952 through 1988, indicate that M2, nominal GNP and the commercial paper rate form a cointegrating vector. Thus under less stringent conditions, allowing the money stock to adjust to interest rate movements, the broad monetary aggregate may still seem to be a candidate for the role as a policy guide.

The evidence from the United States so far thus gives little or no indication as to whether money or credit bears the most stable relationship to nominal income. The evidence for the United Kingdom surveyed by Goodhart (1989) gives a similar impression. We therefore proceed to the empirical analysis on Norwegian data with no firm preconceptions, either on theoretical or empirical grounds, as to the most likely

[8] See e.g. B. Friedman (1983a,1983b).

[9] Similar conclusions can be found in Fackler (1988) and Lown (1988).

[10] In the paper introducing the cointegration approach Engle and Granger (1987) found that no monetary aggregate, except possibly M2, was cointegrated with nominal GNP.

outcome. It should also be noted that the organization of financial markets and the design of monetary policy in Norway differ quite much from these countries, particularly with respect to the attention given to credit growth by the authorities. The interesting question is then whether this fact may tip the balance in favour of the credit aggregates.

3. THE DATA AND THE DEREGULATION OF CREDIT MARKETS IN NORWAY

In the empirical analysis on Norwegian quarterly data we report the outcome of testing for cointegration between different money or credit aggregates on the one hand and income or expenditure and interest rates on the other. We are focusing on four financial quantity variables:

M1 = narrow money stock
M2 = broad money stock
KA = total domestic credit
KB = domestic bank credit.

The main difference between M1 and M2 is the inclusion of time and saving deposits in the latter. KA is a comprehensive measure of domestic credit extended to the private sector and local governments from all private and public banks and financial intermediaries.[11] KB is limited to ordinary loans from commercial and savings banks only, being included because of the long–standing preoccupation with bank credit by the monetary authorities. All data are seasonally unadjusted.[12] Further details on the data can be found in Appendix 1.

Most attention will be given to the broad aggregates, M2 and KA, which are the variables now regularly monitored by the monetary authorities. Figure 1 shows the four–quarter growth rates of these two variables over the period 1967 Q1 to 1989 Q1. Figure 2 presents the same curves for M1 and KB. Our main concern here is to examine the long run behaviour of these series in relation to nominal income or expenditure, but a comparison of the short run movements is of some interest in light

---

[11] See BØ (1988) for a description of this aggregate. The data used before 1983 reflect a slightly narrower definition due to data availability. See Appendix 1 for further details.

[12] M2 and KA have been adjusted for distortions to the published banking statistics figures in 1986 and 1987. Such adjustments were of less relevance to M1, but here substantial changes in the definition of demand deposits employed in the banking statistics have made this series suspect after 1986.

of the deregulation of financial markets and the significant changes in monetary policy in the 1980s.

Table 1 gives a summary statement of some main events in the process of deregulation of financial markets in Norway. At the end of 1983 all regulations specified here were in operation. The only important form of intermediated credit not subject to quantitative restrictions was credit granted by loan associations to large real capital investment projects in manufacturing industries. The developments in 1984 and 1985 implied a drastic relaxation of credit rationing with regard to borrowers who did not have access to auction–market credit, households and small businesses in particular. The surge in credit growth beginning about 1984 is clearly visible in the growth rates of KA and KB in Figures 1 and 2. The temporary reversal to direct credit controls in 1986 and part of 1987 turned out not to be particularly effective. The financial institutions were to a large extent able to channel credit flows to their customers through new financial instruments, evading the existing regulations. A major factor which finally helped to bring an end to the credit boom was probably the move towards a more flexible interest rate policy in December 1986.[13]

A comparison of growth rates of M2 and KA as shown in Figure 1 reveals that prior to 1983 these two financial aggregates expanded at a similar rate in the long run, although M2 growth was somewhat more volatile in the short run. As from 1983 the growth rates began to differ markedly. Credit growth largely outstripped the rate of increase of the money stock. This came about as banks, in particular, were able to fund their loan expansion from sources other than deposit liabilities, chiefly by being given the opportunity to borrow from the central bank on a large scale and attracting funds from abroad. Accordingly, M2 and KA bear roughly the same long–run relationship to nominal income until 1983; thereafter, the trends are diverging.

These empirical relationships are highlighted in Figures 3 to 6, which show the (logarithm of) the ratio of the four financial aggregates to nominal expenditure (see definition below). The solid lines show actual values, while the dotted lines represent four–quarter moving averages. All ratios hover around a roughly constant level up to 1983, exhibiting relatively mild cyclical fluctuations. Thereafter the credit–expenditure ratios start rising in an unprecedented manner, signalizing a break in the previously relatively stable relationships. This contrasts with the seemingly

---

13 Steffensen and Steigum (1990) and NOU 1989:1 contain an analysis of the financial deregulation process.

Table 1. Credit market regulations in Norway, 1983 – 1989.

Type of regulation	Dates when abolished (A) or reintroduced (R)				
	BANKS	FINANCE COMP.	LOAN ASS.	LIFE INSUR.	NON–LIFE INSUR.
Direct loan controls[1]	A1984Q1 R1986Q1 A1987Q3	A1988Q3	A1988Q3		A1988Q3
Primary reserve req.	A1987Q2	A1987Q3		A1987Q2	
Bond investment quota[2]	A1984Q1			A1985Q1	
Loan guarantee limits	A1984Q3 R1986Q1 A1988Q3	A1984Q3 R1986Q1 A1988Q3	A1984Q3 R1986Q1 A1988Q3	A1984Q3 R1986Q1 A1988Q3	A1984Q3 R1986Q1 A1988Q3
Max int. rate on loans	A1985Q3			A1985Q3	

1) Credit extended by the finance companies in the form of factoring and leasing contracts was exempted as from 1984Q3. The regulations concerning mortgage loan associations only applied to loans to households and selected industries.
2) The dates refer to the point in time when the required percentage of growth was set equal to zero, viz. net additions to the bond portfolio were no longer required. The regulation was completely removed in 1985 Q1 for banks and in 1985 Q3 for life insurance companies.
General notes. If no date is specified, no regulation applies. In all other cases the regulation was in operation at the end of 1983. The information is compiled from *Annual reports of the Norges Bank* 1984 – 1988 and various issues of *Penger og Kreditt* in the same period.

normal behaviour of the ratio of M2 to expenditure. It thus appears that the process of deregulation and rapid financial innovations which gained momentum around 1983/1984 fundamentally changed the relationships between credit and income. The role of credit as a useful information variable can still be rescued, however, if there are other variables which can account for this changing relationship.

In order to simplify the exposition we will be using 'nominal income' rather vaguely when referring to the aggregate nominal measure of economic activity (production or expenditure) which is assumed to be the variable on which the authorities are focusing. In the empirical analysis below we employ whichever of the following variables yielding the closest relationship with the financial aggregates:

Y = nominal gross domestic product

X = nominal gross domestic expenditure, excluding investment in oil and gas, pipeline transport, ships and oil platforms.

The petroleum and shipping sectors are excluded from X since prices and economic activity generated in these sectors are determined by forces largely exogenous to domestic monetary policy. We include both a production and an expenditure measure since both are of concern to the authorities' policy goals; Y has a direct bearing on internal balance (production and employment) while X, being a measure of aggregate demand, is the variable most directly influenced by monetary and fiscal policy. The course of these variables may differ to some extent in the short and intermediate run in an open economy – and more so in Norway than in most other countries – but the choice between them should matter less in the analysis of long run behaviour. Several other income variables were examined, including GDP minus oil and shipping, but we have chosen to report the results only from the specifications that proved to be most stable empirically.

Finally, the interest rates employed in the money and credit equations are:

RD1 = average rate of interest on demand deposits

RD2 = average rate of interest on time and savings deposits

RL = yield on long–term bonds issued by private mortgage loan associations

RB = average interest rate on bank loans.

4. THE INDIVIDUAL TIME SERIES PROPERTIES

4.1 *Motivation*

The cointegration technique developed by Granger (1986) and Engle and Granger (1987) lends itself in a natural way to assessing the robustness of the long–run relationships between nominal income (GDP or domestic expenditure) on the one hand and money and credit on the other. If no stable long–run relationships exist between two variables Y and M, the residuals ψ_t from the cointegrating regression

(1) $\psi_t = Y_t - \alpha M_t$

(where α_t is the estimated cointegrating parameter) will tend to drift apart over time. The results from applying such tests are reported in section 5.1. An alternative procedure proposed by Johansen (1988) is employed in section 5.2.

Before testing for cointegration can be performed it must be verified that the variables involved are integrated of the same order. A variable Z is said to be integrated of order d $\left[Z \sim I(d)\right]$ if it has a stationary, invertible non–deterministic ARMA representation after differencing d times. Accordingly, we first proceed to an examination of this aspect of the time series, paying special attention to the seasonality of the data used here.

4.2 *Testing for seasonal unit roots*

Most macroeconomic time series are found to be integrated of order one,[14] i.e. there is a unit root in the autoregressive representation of the levels of the variables. Testing for unit roots with data that are appropriately seasonally adjusted, or in cases where no seasonality is present, is conducted within the framework developed by Dickey and Fuller (1979, 1981).[15] This type of tests assumes that the root of interest is at the zero or annual frequency and that there are no other unit roots at other (seasonal) frequencies.

This assumption is no longer a priori plausible when the sample consists of seasonally unadjusted data. In a recent paper Hylleberg, Engle, Granger and Yoo (1988), hereafter referred to as HEGY, have proposed a test for unit roots in a univariate time series which explicitly tests for roots at seasonal frequencies as well.[16]

This procedure may be briefly outlined as follows: The time series Z_t is assumed to be generated by a general autoregression

$$\varphi(L)Z_t = \varepsilon_t$$

[14] Nelson and Plosser (1982), Schwert (1987).

[15] Extensions of the Dickey–Fuller tests to deal with various forms of non–white residuals or structural change have been suggested by Said and Dickey (1985), Phillips (1987) and Perron (1989).

[16] Osborn *et al.* (1988) present a comparison of the hypotheses embedded in different unit root tests in a seasonal framework, also suggesting a new test which may distinguish between seasonal and non–seasonal unit roots.

where $\varphi(L)$ is a polynomial in the lag operator L defined by $L^jZ_t=Z_{t-j}$ (j=1,2,...) and ε_t is a serially uncorrelated stochastic variable with mean zero and constant variance. HEGY show that testing for unit roots at all frequencies with quarterly data can be derived from the ordinary least squares regression of $\Delta_4Z_t = Z_t - Z_{t-4}$ on lagged values of Z_t and a deterministic part μ_t [intercept (I), seasonal dummies (SD), linear time trend (TR)]

$$\Delta_4Z_t = \pi_1Y_{1,t-1} + \pi_2Y_{2,t-1} + \pi_3Y_{3,t-2} + \pi_4Y_{3,t-1} + \sum_{i=1}^{p}\gamma_i\Delta_4Z_{t-i} + \mu_t + \varepsilon_t$$

where

$$Y_{1t} = (1 + L + L^2 + L^3)Z_t$$
$$Y_{2t} = -(1 - L + L^2 - L^3)Z_t$$
$$Y_{3t} = -(1 - L^2)Z_t$$

There will be no seasonal unit roots if π_2 (bi–annual cycle) and either π_3 and π_4 (annual cycle) are different from zero. Conditional on this being the case, the next step is to test whether $\pi_1 = 0$, which corresponds to testing for a unit root at the long–run or zero frequency. Tests on individual π's are based on *t*–tests. The joint test for π_3 and π_4 is an *F*–test whose critical values are given in HEGY. The specification of the deterministic component, μ_t, may include none, some or all of the variables I, SD and TR defined above, depending on which alternative is considered most appropriate.

Table 2 reports the results from applying the HEGY seasonal unit root tests to quarterly data on money, credit, nominal income variables as well as interest rates. The sample starts in 1987 Q2 or later, depending on the maximum lag p on Z_{t-i} that is required to whiten the residuals. The last observation used is 1989 Q1, except for M1, for which data are not available after 1986 Q4. All variables, except interest rates, are in logs. Results are reported for five different combinations of I, SD and TR. In view of the seemingly strong seasonality exhibited by the money, credit and income series in Figures 1 and 2 most attention is given to the equations where the seasonal dummies are included in the case of these variables.

For each variable the joint hypothesis that $\pi_3 = \pi_4 = 0$ is rejected, in most cases individual tests for either $\pi_3 = 0$ or $\pi_4 = 0$ are also rejected. With the exception of (the logarithm of) KA (LKA) the hypothesis $\pi_2 = 0$ is also rejected. Accordingly, with the possible exception of KA, there does not appear to be unit roots at the seasonal frequencies.

Turning now to testing for a unit root at the long–run frequency, using the t_1 statistic, all variables are found to be $I(1)$, i. e. integrated of order one.

5 TESTING FOR COINTEGRATION BETWEEN NOMINAL INCOME AND MONEY OR CREDIT

5.1 *The Engle–Granger cointegrating regression*

When we consider a p–component vector of series $\boldsymbol{x}_t \sim I(d)$, a linear combination of these series

$$(2) \qquad \beta' \boldsymbol{x}_t = z_t$$

will also in general be integrated of order d. If however $z_t \sim I(d-b)$, $b > 0$, then $\boldsymbol{x}_t$ is said to be cointegrated of order (d, b): $\boldsymbol{x}_t \sim CI(d, b)$, still following Engle and Granger (1987). Note that the number of cointegrating vectors are given by the number of columns, or the rank, $0 \leq r < p$ of β.

Stock (1987) established the important result that if the series are cointegrated and $r = 1$, a super–consistent estimate of β is provided by the OLS–regression of (2), choosing x_{1t}, say, as the dependent variable. This is the method advocated by Engle and Granger (1987).

The success of this approach depends upon all variables being stationary at the seasonal frequencies, as the estimates might otherwise not be unique, as argued in Hylleberg *et al.* (1988). But according to the tests above, cointegrating regression should be a valid procedure for most of the variables in the present data set. It follows naturally that testing for cointegration in this original set–up implies establishing whether the residuals from the cointegrating regression represent a stationary series. This is easily done by applying the standard Dickey–Fuller (DF and ADF) and

Sargan–Bhargava (CRDW) tests.[17]

It might be conjectured that there can be some problems with this approach if the data contain deterministic components, as in the present case. First, since the critical values of Engle and Granger (1987) and Engle and Yoo (1987) are derived under the assumptions of no deterministic components, these values will not be appropriate if any deterministic components are not corrected for in using the tests. It also follows that the CRDW and DF tests are more likely to exhibit upward bias than the ADF test, since the latter will correct for the induced autoregression in the residuals through the augmentation. Secondly, if any deterministic terms do not cancel out, it is to be expected that this induces a bias in the estimate of the cointegrating vector from that part of the deterministic components that is not picked up by any corresponding representation in the regression. The problem hinges on the fact that such effects will not 'go away' by expanding the sample size.

The natural solution to these problems would be to correct for any deterministic components present, which in this context might be to remove the seasonal means. This is the solution adopted in testing for unit roots in individual series, not only by Hylleberg *et al.* (1988), but also by Dickey, Hasza and Fuller (1984), Dickey, Bell and Miller (1986) and Osborn *et al.* (1988). Following Lovell (1963), theorem 4.1, this is equivalent to include seasonal dummies in the cointegrating regression. But what if no seasonal effects are present? A small simulation study indicated that in this case the critical values of the DF–statistic will be smaller than if seasonal dummies had been excluded. A conservative strategy should therefore be to adopt the usual critical values and include seasonal dummies in the regression.

5.1.1 *The models*

Our testing procedure for cointegration between (the logs of) nominal income and financial aggregates is in three steps of increasing model generality.

(a) *The constant–velocity model.* Here we test whether money (or credit) is cointegrated with nominal income and with cointegrating parameter $\alpha_1 = 1$ in the model

[17] See Engle and Granger (1987) for details.

$$(3) \qquad LM_t = \alpha_1 LY_t + \mu_t + \psi_{1t}$$

where as before μ_t is the deterministic part.[18] The case where α_1 is unity is of particular importance since in this case (with no time trend) nominal income and money grow in exact proportion over time, i.e. the long–run income elasticity of money demand is equal to one. Accordingly, to achieve an x per cent growth in nominal income the trend growth of money should also be x per cent.

(b) *The simple velocity–drift model.* This model is represented by (2) but with the cointegrating parameter α_1 freely estimated. Thus if α_1 is less than unity the authorities must allow for an upward drift in velocity over time; to achieve an x per cent growth of nominal income money must grow by less than x per cent.

(c) *The interest rate augmented model.* In this model a vector of interest rates R_t, assumed to affect money (credit) demand or supply, is added to (3),

$$(4) \qquad LM_t = \alpha_2 LY_t + \beta R_t + \mu_t + \psi_{2t}.$$

If LM, LY and R form a cointegrating vector, money (or credit) would be useful for monetary authorities as an information variable with respect to nominal income after being adjusted for the influence of R.

In the case of the money stock equations the interest rate vector R consists of the own rate (the bank deposit rates RD1 or RD2), which is assumed to take on a positive coefficient, and the bond yield, RL, which represents the rate of return on substitute assets. These money demand equations are broadly consistent with recent results from dynamic modelling of the demand for M1 and M2 on the same data set.[19]

The specification of credit demand equations is less obvious, since there is little or no recent empirical evidence on such equations with Norwegian data. Here we adopt a simple loan demand and supply model, similar to the one employed by King (1986), in

---

[18] We have chosen to normalize on the financial aggregates rather than on nominal income since this facilitates a direct comparison with standard money demand functions. As explained by Engle and Granger (1987, p. 261) normalization matters very little in testing for cointegration.

[19] See Bårdsen (1990) and Klovland (1990) for the modelling of M1 and M2, respectively. The money market rate, RS, was never of any importance in the cointegration tests, and is therefore not included in the analysis. However, this variable played a useful role in the dynamic modelling of the demand–for–money functions.

which the bank lending rate, RB, and the yield on mortgage loan association bonds, RL, are candidates in the demand and (possibly also) supply functions for credit. The cointegrating regressions must be viewed as reduced–form equations, which makes the signs of the RB and RL coefficients theoretically indeterminate.

5.1.2 *The empirical results*[20]

(a) *The constant–velocity model.* When α_1 is set equal to one a priori in (2), the HEGY procedure used in section 4.1 can be used to test for cointegration as well, since this restriction is equivalent to testing whether the variable (LM–LY) is $I(0)$ or not. The outcome of such tests is reported in Table 3. A separate test is conducted on the pre–deregulation sample ending in 1983 Q4. It turned out that the income variables that performed 'best', in the sense of being nearest to forming a cointegrating vector, was nominal expenditure, X, for M1 and M2 and nominal GDP, denoted by Y, in the case of KA and KB. Only these combinations of variables are reported here; other variants were of no particular interest.

It follows from the results in Table 2 that all income and financial variables have a unit root at the same (zero) frequency; hence cointegration between these variables is possible. On the other hand, since none of the variables, except possibly KA at the bi–annual cycle, has a unit root at the seasonal frequencies, these variables cannot be seasonally cointegrated.

There are only two cases where there is some evidence of cointegration in the period up to 1983 Q4. The strongest evidence is for cointegration between Y and KA. In this equation a unit root at the zero frequency is rejected in favour of stationarity at the 1 per cent significance level. A similar conclusion seems to be warranted at the 5 per cent level in the case of X and M1, after removal of deterministic seasonality in the auxiliary regression. The most important result, however, is that over the full sample there is no evidence of cointegration between any of these variables. In conclusion, whereas the authorities may have had some confidence in monitoring M1 with a view to assessing the long–run movements of nominal domestic expenditure[21] and likewise

---

[20] The results in this section were obtained using the recursive least squares option of PC–GIVE, version 6.0.

[21] Note once again that the performance of M1 is restricted to a sample ending in 1986 Q4.

monitoring KA in the case of nominal GDP prior to 1984,[22] these results indicate that the foundation of such guidelines subsequently disappeared. Accordingly, the constant–velocity model provides no role for either money or credit as information variables.

(*b*) *The simple velocity–drift model.* Relaxing the restriction $\alpha_1 = 1$ in (2) implies that the HEGY procedure can no longer be used. Instead we report the Durbin–Watson statistic from the cointegrating regression (2), CRDW, and the augmented Dickey–Fuller statistic (ADF). Including the seasonal dummy variables S1, S2, S3 in the cointegrating regression is natural considering the strong evidence of deterministic seasonality in Tables 4 and 5 (also compare the reduction in residual standard error between 1 and 2, 3 and 4 in these tables). However, the critical values of these statistics derived by Sargan and Bhargava (1983) and Engle and Granger (1987) are not tabulated for equations containing deterministic seasonals. Noting that the values of the test statistics are always lower with the seasonal dummies included, a conservative procedure is to rely primarily on this specification, applying the ordinary critical values in this case as well.

The results given in Table 4 show that in the sample ending in 1983 Q4 the estimated values of the cointegrating parameter α_1 are only slightly above unity in the case of M1, M2 and KA. Hence the difference from the constant–velocity model appears to be rather small. But, in contrast to that model, cointegration is no longer rejected at the 1 per cent level for M1, KA and KB (in the latter case the estimate of α_1 is 0.94). Consequently, all variables, except M2, seem to perform well before 1984.

Extending the sample to 1989 Q1 results in an upward drift in the estimates of α_1. Using recursive least squares, the time path of the parameter estimates can be traced, as shown in Figures 8, 10, 12 and 14. In the case of the credit variables there is a dramatic deterioration in the goodness of fit – the residual standard error increases by a factor of 3 in the case of KA, while it is more than 4 times higher in the KB equation when the sample is extended from 1983 Q4 to 1989 Q1. Figures 11 and 13 visualize the complete breakdown after 1983 of the previously relatively firm relationships between GDP and credit. It stands to reason that neither KA nor KB can be cointegrated with Y in the full sample, a conclusion which is evident from Table 4.

---

22 On the other hand, KA does not appear to be cointegrated with Q (GDP minus oil and shipping) before 1984. Q is probably the nominal income variable most closely monitored by the authorities in Norway.

Figure 9 shows that the M2 equation is only slightly affected by extending the sample, but equation B4 of Table 4 shows that it still does not pass the cointegration test. The cointegration between M1 and X is still accepted at the 5 per cent level on data up to 1986 Q4.

In conclusion, generalizing the constant–velocity model to allow for a possible drift in income–money (credit) ratios over time does not produce a cointegrating vector that can withstand the deluge of credit market deregulation after 1983. The credit equations collapsed completely, whereas the M2 equation turned out to be far more robust without passing the formal tests.

(*c*) *The interest rate augmented model.* The estimation results are given in Table 5, one–step residuals and recursive estimates of α_2 in Figures 15 to 22. The major difference between the results from the augmented model compared with the previous simple models is in the money stock equations, particularly M2. Augmenting the model with a view to reflecting a standard money demand specification yields a cointegrating vector consisting of LX, LM2, RD2 and RL. This model passes the test for cointegration at the 1 per cent level over the full sample. A similar result is obtained with M1 in the sample ending in 1986. The signs and magnitudes of the coefficient estimates are consistent with the range of estimates established in the money demand literature. Figures 15 through 18 show that the one–step residuals from these equations are relatively satisfactory even in the difficult post–1983 period, although some instability is discernible in the parameter estimates.[23]

The augmented credit equations again break down completely after 1983. This is clear from the test statistics in Table 5, vividly illustrated by the exploding residual errors in Figures 19 and 21 and the wave–like path of coefficient estimates in Figures 20 and 22. Thus, in contrast to the money stock equations, augmenting the model in order to take into account the effect of interest rate movements on credit growth does not lead to a cointegrating vector.

5.2 *The Johansen procedure*

---

[23] In Klovland (1990) it is found that a wealth–constrained money demand model is superior to the specification used here in terms of parameter stability and predictive performance.

5.2.1 *Motivation*

One of the drawbacks of the approach of the previous section is the implicit assumption of only one cointegrating vector. Even in a small problem like ours it is quite possible that several long–run relationships exist.

The problem of establishing the number of cointegrating vectors in a given set of variables has been solved by Johansen (1988).[24] Although this apparatus is quite impressive in terms of its complexity, the intuition behind the approach is rather simple.

Briefly described, the method relies upon the concept of canonical correlations from the theory of multivariate analysis. The data are divided into a differenced and a levels part. Under the assumption of *I*(*1*) processes the differenced data are stationary. The technique of canonical correlations is used to find linear combinations of the data in levels which are as highly correlated as possible with the differences. It follows that these linear combinations must be stationary, or cointegrated.

Another appealing aspect of the Johansen approach is its completeness in the sense that it provides tests of linear restrictions on the cointegrating vectors as well as estimates of its elements and information about its rank. Finally, this method also takes account of the short–run dynamics and any simultaneity in the estimation process.

5.2.2 *The procedure*

To be a bit more specific, the assumption is that x_t is generated by

(5) $$x_t = \Sigma^{k}_{i=1}\pi_i x_{t-i} + \mu i + \Phi D_t + \epsilon_t,$$

rewritten as

(6) $$\Delta x_t = \Sigma^{k-1}_{i=1}\Gamma_i \Delta x_{t-i} - \pi x_{t-k} + \mu i + \Phi D_t + \epsilon_t, \epsilon_t \sim NIID(0, \Omega),$$

---

24 The procedure is further developed in Johansen and Juselius (1989), which also contains some applications.

with $\Gamma_m = -I + \Sigma_{i=1}^{m}\pi_i$, $m = 1,...,k-1$; $\pi = I - \Sigma_{i=1}^{k}\pi_i = \alpha\beta'$ and i and D_t being intercept and seasonal dummies, respectively.

Equation (6) is the interim multiplier representation of (5).[25]

The estimate of β is then found in two steps. The first step consists of correcting the differences and the levels for the short–run and the deterministic components. This amounts to running the regressions

$$(7)\qquad \begin{bmatrix} \Delta x_t = \Sigma_{i=1}^{k-1}\Gamma_i\Delta x_{t-i} + \mu i + \Phi D_t + r_{0t} \\ x_{t-k} = \Sigma_{i=1}^{k-1}\Gamma_i\Delta x_{t-i} + \mu i + \Phi D_t + r_{kt} \end{bmatrix}.$$

Next, the covariance matrix S of r_{0t} and r_{kt} is partitioned as

$$(8)\qquad S = \begin{bmatrix} S_{00} & S_{0k} \\ S_{k0} & S_{kk} \end{bmatrix}.$$

A result from multivariate analysis then states that the r linear combinations $\hat{\beta}' r_{kk}$ maximizing the correlation with r_{00} are given by the r largest of the eigenvectors $\hat{\beta} = [\hat{\beta}_1 ... \hat{\beta}_r]$ corresponding to the p eigenvalues $\hat{\lambda}_1 > ... > \hat{\lambda}_p$ from solving[26]

$$(9)\qquad |\lambda S_{kk} - S_{k0}S_{00}^{-1}S_{0k}| = 0.$$

In the present setting the eigenvectors are normalized to $\hat{\beta}' S_{kk}\hat{\beta} = I$.

The result also follows from obtaining estimates of α and Ω from the regression of r_{0t} on $\beta' r_{kt}$, which gives the concentrated likelihood function proportional to

$$(10)\qquad L(\beta) = |\hat{\Omega}(\beta)|^{-T/2} = |s_{00} - s_{0k}\beta(\beta' s_{kk}\beta)^{-1}\beta' s_{k0}|^{-T/2}$$

25 See Hylleberg and Mizon (1989) for an extensive survey of different representations of cointegrated systems, including the interim multiplier form.

26 A good introduction can be found in Krzanowski (1988, pp. 432 – 445).

or

(11) $$L^{-2/T}(\beta) = |s_{00}|\,|\beta'(s_{kk} - s_{k0}s_{00}^{-1}s_{0k})\beta| / |\beta' s_{kk}\beta|.$$

Equation (11) is minimized by the choice of $\hat{\beta} = [\hat{\beta}_1 \ldots \hat{\beta}_r]$ from (9) with the solution

(12) $$(L_{max})^{-2/T} = |s_{00}| \prod_{i=1}^{r} (1 - \lambda_i).$$

Since this result is derived under the hypothesis of $\pi = \alpha\beta'$, and the unconstrained function would be (12) with $r = p$, the likelihood ratio test for 'at most r cointegrating vectors', becomes

(13) $$-2ln(Q\,;\, r \mid p) = -T\,\Sigma_{i=r+1}^{p}(1 - \hat{\lambda}_i),$$

and a test of the relevance of column $r+1$ in β is obtained by computing

(14) $$-2ln(Q\,;\, r \mid r+1) = -T\,(1 - \hat{\lambda}_{r+1}).$$

Equation (13) is what is referred to as the 'trace' test in the tables, while (14) is denoted 'λ_{max}'.[27]

5.2.3 *The results*

The results of applying the Johansen procedure to the present information set can be seen in Tables 6 to 9.[28] In each case panel A refers to the sample period ending in 1983 Q4, while panel B reports the statistics obtained when the sample is extended to 1986 Q4 for LM1 and to 1989 Q1 for LM2, LKA and LKB.

The main result is that according to these tests stationary relationships exist between money, income and interest rates as well as credit, income, and interest rates – also

---

[27] Johansen (1988, 1989) and Johansen and Juselius (1989) give further details on these tests.

[28] The results were obtained using a RATS–program written by Søren Johansen, Katarina Juselius and Henrik Hansen, which was kindly made available to us by Kenneth F. Wallis.

after the credit market liberalization. Taken as such these findings are at odds with the conclusions obtained in the previous section.

But in our setting the issue of parameter stability is also crucial. Taking a closer look at the estimated cointegrating vectors, a familiar distinction between the different models readily appears. While the money models appear relatively unaffected by the credit deregulation, the estimates of the cointegrating vectors go 'all over the place' in the case of the credit equations.

This is especially evident for the parameters of the income variables. The long–run elasticities of income in the money models show only mild fluctuations between the two samples, but the corresponding estimates in the credit models are much more volatile. Regarding the interest rates, more unstable estimates are obtained in general. But again the credit models fare the worst – RB even changing sign in the KA model, while the M2 model appears to be basically unaffected by the extension to the deregulation period.

For the purpose of targeting a basic requirement is a model with stable coefficients. Given this requirement, the obvious candidate is the M2 model, thus reinforcing the conclusion reached in the previous section.

6. SOME CONCLUDING REMARKS

Using cointegration techniques this paper has presented the results of an empirical analysis on Norwegian data of the long–run relationship between nominal GDP or domestic expenditure on the one hand and money and credit variables on the other. The main findings are: (1) In the period from 1966 to 1983 there is a relatively firm relationship between the nominal income variables and credit, which subsequently breaks down completely during the ensuing period of credit market deregulation; (2) Nominal income and the broad money stock, M2, are cointegrated throughout the period 1966 to 1989 within a model augmented by the own rate of interest on M2 and a bond yield. Thus M2, adjusted for the effects of interest rates on the demand for money, seems to provide the most reliable long–run information on the course of nominal income in Norway in the period considered here.

The main reason why the augmented credit models fail to pass the Engle–Granger cointegration tests over the full sample, while the stability of the M2 equation is not much affected by the credit market deregulation process, is evidently that no simple and stable model of the credit market has been uncovered yet. It may be that after a transition period, in which credit markets adjust to a more market–oriented environment, the previously firm relationships between nominal GDP and credit aggregates will reemerge. It is also conceivable that further research may be able to model the credit market in a more satisfactory manner. Until such results materialize, however, the long–run stability of relatively simple demand–for–money functions speaks in favour of using money as the anchor for the long–run course of nominal income.

REFERENCES

BERNANKE, B.S. (1983) Nonmonetary effects of the financial crisis in the propagation of the Great Depression, *American Economic Review* **73**, 257–276.

BERNANKE, B.S. (1988) Monetary policy transmission: Through money or credit, *Federal Reserve Bank of Philadelphia Business Review*, November/December, 3–11.

BERNANKE, B.S. and A.S. BLINDER (1988) Credit, money, and aggregate demand, *American Economic Review (Papers and Proceedings)* **78**, 435–439.

BLINDER, A.S. and J.E. STIGLITZ (1983) Money, credit constraints, and economic activity, *American Economic Review (Papers and Proceedings)* **73**, 297–302.

BRUNNER, K. and A.H. MELTZER (1988) Money and credit in the monetary transmission process, *American Economic Review (Papers and Proceedings)* **78**, 446–451.

BØ, O. (1988) Norges Banks' credit indicator – data sources and method of calculation, *Norges Bank Economic Bulletin* **59**, 197–205.

BÅRDSEN, G. (1990) Dynamic modelling and the demand for narrow money in Norway, Norwegian School of Economics and Business Administration, mimeo.

DICKEY, D.D., W.R. BELL and R.B. MILLER (1986) Unit root in time series models: Tests and implications, *The American Statistican* **40**, 12–26.

DICKEY, D.A. and W.A. FULLER (1979) Distribution of the estimates for autoregressive time series with a unit root, *Journal of the American Statistical Association* **74**, 427–431.

DICKEY, D.A. and W.A. FULLER (1981) Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica* **49**, 1057–1072.

DICKEY, D.D., D.P. HASZA and W.A. FULLER (1984) Testing for unit root in seasonal time series, *Journal of the American Statistical Association* **79**, 355–367.

DORNBUSCH, R. (1987) Purchasing power parity, pp. 1075–1085 in J. EATWELL, M.MILGATE and P. NEWMAN (eds.) *The new Palgrave: A dictionary of economics*, vol. 3, London: Macmillan.

EDISON, H.J. and J.T. KLOVLAND (1987) A quantitative reassessment of the purchasing power parity hypothesis: Evidence from Norway and the United Kingdom, *Journal of Applied Econometrics* **2**, 309–333.

ENGLE, R.F. and C.W.J. GRANGER (1987) Co–integration and error correction: Representation, estimation, and testing, *Econometrica* **55**, 251 – 276.

ENGLE, R.F. and B.S. YOO (1987) Forecasting and testing in co–integrated systems, *Journal of Econometrics* **35**, 143–159.

FACKLER, J.S. (1988) Should the Federal Reserve continue to monitor credit? *Federal Reserve Bank of Kansas City Economic Review*, June, 39–50.

FISHER, I. (1923) The business cycle largely a 'dance of the dollar', *Journal of the American Statistical Association* **18**, 1024–1028.

FRIEDMAN, B.M. (1983a) The roles of money and credit in macroeconomic analysis, pp. 161–199 in J. TOBIN (ed.) *Macroeconomics, prices, and quantities: Essays in memory of Arthur M. Okun*, Oxford: Basil Blackwell.

FRIEDMAN, B.M. (1983b) Monetary policy with a credit aggregate target, *Carnegie–Rochester Conference Series on Public Policy* **18**, 117–148.

FRIEDMAN, B.M. (1988a) Monetary policy without quantity variables, *American Economic Review* (*Papers and Proceedings*) **78**, 440–445.

FRIEDMAN, B.M. (1988b) Lessons on monetary policy from the 1980s, *Journal of Economic Perspectives* **2**, 51–72.

FRIEDMAN, M. (1956) The quantity theory of money – a restatement, pp. 3–21 in M. FRIEDMAN (ed.) *Studies in the quantity theory of money*, Chicago: University of Chicago Press.

FRIEDMAN, M. and A.J. SCHWARTZ (1963) Money and business cycles, *The Review of Economics and Statistics* (*Supplement*) **45**, S32–S64.

FRIEDMAN, M. and A.J. SCHWARTZ (1982) *Monetary trends in the United States and the United Kingdom: Their relation to income, prices, and interest rates, 1867–1975*, Chicago: University of Chicago Press.

GERTLER, M. (1988) Financial structure and aggregate economic activity: An overview, *Journal of Money, Credit, and Banking* **20**, 559–588.

GOODHART, C. (1989) The conduct of monetary policy, *Economic Journal* **99**, 293–346.

GRANGER, C.W. (1986) Developments in the study of cointegrated economic variables, *Oxford Bulletin of Economics and Statistics* **48**, 213–228.

HUME, D. (1752) Political discourses, reprinted in E. ROTWEIN (1955, ed.) *David Hume: Writings on economics*, London: Nelson.

HYLLEBERG, S., R.F. ENGLE, C.W.J. GRANGER and B.S. YOO (1988), Seasonal integration and cointegration, Department of Economics, University of California at San Diego, Discussion Paper 88–32.

HYLLEBERG, S. and G.E. MIZON (1989) Cointegration and error correction mechanisms, *Economic Journal* (*Supplement*) **99**, 113–125.

JOHANSEN, J. (1988) Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* **12**, 231–254.

JOHANSEN, J. (1989) Likelihood based inference on cointegration. Theory and applications, Institute of Economics, University of Copenhagen, Lecture notes.

JOHANSEN, J. and K. JUSELIUS (1989) The full information maximum likelihood procedure for inference on cointegration – with applications, Institute of Economics, University of Copenhagen, Discussion Paper 89–11.

KING, S.R. (1986) Monetary transmission: Through bank loans or bank liabilities, *Journal of Money, Credit, and Banking* **18**, 290–303.

KLOVLAND, J.T. (1990) Wealth and the demand for money in Norway, 1968–1989, Norwegian School of Economics and Business Administration, Discussion Paper 01/90.

KRZANOWSKI, W.J. (1988) *Principles of multivariate analysis: A user's perspective*, Oxford: Clarendon Press.

LOVELL, M.C. (1963) Seasonal adjustment of economic time series, *Journal of the American Statistical Association* **58**, 993–1010.

LOWN, C.S. (1988) The credit–output link vs. the money–output link: New evidence, *Federal Reserve Bank of Dallas Economic Review*, November, 1–10.

MEHRA, Y.P. (1989) Some further results on the sources of shift in M1 demand in the 1980s, *Federal Reserve Bank of Richmond Economic Review*, September/October, 3–13.

NELSON, C.R. and C.I. PLOSSER (1982) Trends and random walks in macroeconomic time series: Some evidence and implications, *Journal of Monetary Economics* **10**, 139–162.

OSBORN, D.R., A.P.L. CHUI, J.P. SMITH and C.R. BIRCHENHALL (1988) Seasonality and the order of integration for consumption, *Oxford Bulletin of Economics and Statistics* **50**, 361–377.

PERRON, P. (1989) The great crash, the oil price shock, and the unit root hypothesis, *Econometrica* **57**, 1361–1401.

PHILLIPS, P.C.B. (1987) Time series regression with a unit root, *Econometrica* **55**, 277–301.

SAID, S.E. and D.A. DICKEY (1985) Hypothesis testing in ARIMA (p,1,q) models, *Journal of the American Statistical Association* **80**, 369–374.

SCHWERT, G.W. (1987) Effects of model specification on tests for unit roots in macroeconomic data, *Journal of Monetary Economics* **20**, 73–103.

STEFFENSEN, E. and E. STEIGUM (1990) Konjunkturforløp og bankkrise, Center for Applied Research, Norwegian School of Economics and Business Administration/University of Oslo, working paper 1/1990.

STOCK, J.H. (1987) Asymptotic properties of least squares estimators of cointegrating vectors, *Econometrica* **55**, 1035–1056.

STIGLITZ, J. and A. WEISS (1981) Credit rationing in markets with imperfect information, *American Economic Review* **71**, 393–410.

TOBIN, J. (1969) A general equilibrium approach to monetary theory, *Journal of Money, Credit, and Banking* **1**, 15–29.

APPENDIX A1

THE DATA

DEFINITIONS AND SOURCES OF THE DATA IN TABLE A1.

(1) **M1** = Coin and currency notes, unutilized bank overdrafts and building loans and demand deposits held by the domestic non—bank public. The bank deposits included in this aggregate comprise deposits in domestic and foreign currency with domestic commercial and savings banks and postal institutions, excluding all deposits held by non—residents. The data listed here have been adjusted for changes in the definition of deposits after 1986 Q4 by imposing a growth rate between 1986 Q4 and 1987 Q1 equal to the average of the previous three years. However, due to the continued changes in the coverage of the demand deposit item in the banking statistics data on M1 after 1986 Q4 are not used in the empirical analysis. Source: Norges Bank and own calculations.

(2) **M2** = M1 plus all time and savings deposits (except savings accounts with tax allowance). The published fugures on M2 from 1984 Q2 to 1988 Q1 have been adjusted for underreporting of deposit figures in the banking statistics (cf. *Penger og Kreditt,* 1987/4, pp. 195—205) as follows (in 1000 millions of NOK):

YEAR	Q1	Q2	Q3	Q4
1984	0.0	0.3	1.0	1.3
1985	2.0	2.3	3.0	3.8
1986	8.8	15.7	22.1	22.8
1987	22.3	21.8	13.0	3.5
1988	0.2	0.0	0.0	0.0

Source: As for M1.

(3) **KA** = Loans to the non—financial private sector and municipalities from all domestic private and public banks, private finance companies, loan associations, insurance companies and pension funds. Beginning 1983 Q1 this series was spliced with the Norges Bank's credit indicator by multiplying the former series by the ratio (1.12) between the two variables in December 1982. The coverage of the credit indicator is slightly broader, also comprising market loans through private intermediaries as well as bonds and loan certificates issued by certain sectors. (See BØ (1988) for further details). Sources: Compiled from various issues of *Credit Market Statistics*; as from 1983 Q1 data obtained from the Norges Bank.

(4) **KB** = Loans to the non—financial sector and municipalities from domestic commercial and savings banks. Source: As for KA.

(5) **Y** = Nominal gross domestic product. Source: Various issues of Quarterly National Accounts.

(6) **X** = Nominal gross domestic expenditure, excluding investment in the following sectors: petroleum and natural gas, pipeline transport, oil platforms and ships. Source: As for Y.

(7) **RD1** = Average interest rate paid on banks' demand deposits. Quarterly data prior to 1978 are

obtained by linear interpolation between end–of–year figures. Between 1978 Q1 and 1985 Q3 the series is a weighted average of lowest (weight = 1/3) and highest (weight = 2/3) interest rates paid on demand deposits by commercial and savings banks. As from 1985 Q4 properly averaged data compiled by the Norges Bank. Sources: Various issues of *Credit Market Statistics* and *Penger og Kreditt.*

(8) **RD2** = Average interest rate paid on banks' total deposits denominated in domestic currency (NOK). Methods of calculation and sources as for RD1.

(9) **RL** = Yield to average life of long term bonds (more than 6 years to expected maturity date) issued by private mortgage loan associations. Source: Own yield calculations based on bond prices quoted at the Oslo Stock Exchange.

(10) **RB** = Average effective interest rate (including commissions) on advances in NOK by commercial and savings banks. As from 1985 Q3 data compiled by the Norges Bank. Earlier end–of–year data from *Credit Market Statistics* crudely adjusted by multiplicative factors in order to avoid obvious breaks in the levels of the series. As a consequence the level of this interest rate series may be subject to a considerable margin of error, particularly before 1980. Quarterly movements prior to 1977 were estimated from changes in the discount rate of the Norges Bank, otherwise linearly interpolated between end–of–year figures. Between 1977 Q1 and 1985 Q3 quarterly data were interpolated using the highest figures on bank lending rates in the interest rate statistics published in *Penger og Kreditt.* Source: As for RD1.

GENERAL NOTES

Data on M1, M2, KA, KB and RL are quarterly averages of end–of–month data. The figures for RD1, RD2 and RB tabulated in A1 are end–of–quarter estimates; in the empirical analysis reported in the paper data for period t are constructed as averages of end–of–quarter figures for period t and $t-1$.

TABLE TABLE A1. QUARTERLY DATA 1966 - 1989.

YEAR	I I I	M1 *(1)*	M2 *(2)*	KA *(3)*	KB *(4)*	Y *(5)*	X *(6)*	RD1 *(7)*	RD2 *(8)*	RL *(9)*	RB *(10)*
1966 Q1	I	12.31	29.74	44.06	17.75	12.74	11.59	0.09	2.58	5.37	6.20
Q2	I	12.35	29.92	45.36	18.52	13.08	12.77	0.10	2.59	5.40	6.20
Q3	I	13.02	30.92	46.20	18.85	14.60	13.40	0.11	2.60	5.56	6.20
Q4	I	13.81	31.89	46.95	19.03	14.15	14.37	0.12	2.61	5.55	6.30
1967 Q1	I	13.64	32.54	48.20	19.50	13.51	12.75	0.12	2.64	5.75	6.40
Q2	I	13.69	32.92	49.52	20.25	14.40	14.26	0.12	2.67	5.77	6.40
Q3	I	14.05	33.77	50.33	20.54	15.82	14.51	0.13	2.70	5.65	6.40
Q4	I	14.76	34.85	51.24	20.72	15.97	15.32	0.13	2.73	5.59	6.50
1968 Q1	I	14.43	35.10	52.33	20.99	15.19	13.59	0.18	2.75	5.48	6.60
Q2	I	14.61	35.69	53.79	21.74	15.42	14.69	0.23	2.77	5.37	6.60
Q3	I	15.28	36.82	54.79	22.10	17.01	14.99	0.28	2.79	5.33	6.60
Q4	I	16.36	38.48	56.17	22.50	16.13	15.89	0.34	2.81	5.34	6.60
1969 Q1	I	16.45	39.64	57.65	23.11	16.04	15.03	0.38	2.83	5.35	6.60
Q2	I	16.57	40.13	59.62	24.34	16.40	15.97	0.42	2.85	5.37	6.60
Q3	I	17.44	41.32	61.05	24.97	18.40	16.59	0.46	2.87	5.75	7.60
Q4	I	18.38	42.61	62.95	25.58	18.58	18.99	0.50	3.47	6.70	7.60
1970 Q1	I	18.36	43.47	64.63	26.06	17.71	17.09	0.56	3.57	6.39	7.70
Q2	I	19.02	44.92	66.95	27.17	19.63	19.16	0.63	3.66	6.40	7.70
Q3	I	19.90	46.57	68.50	27.69	21.02	19.50	0.70	3.75	6.42	7.70
Q4	I	20.98	48.40	70.61	28.14	21.51	21.78	0.77	3.84	6.43	7.80
1971 Q1	I	21.33	50.59	72.54	28.58	21.11	19.34	0.81	3.84	6.44	7.80
Q2	I	21.70	51.23	75.30	30.03	21.83	21.33	0.84	3.84	6.44	7.80
Q3	I	22.71	52.74	77.12	30.69	23.49	21.86	0.87	3.83	6.41	7.80
Q4	I	23.77	54.71	79.39	31.31	22.68	23.79	0.90	3.83	6.41	7.80
1972 Q1	I	23.94	56.52	81.57	31.87	22.91	21.18	0.92	3.83	6.47	7.90
Q2	I	24.34	57.42	84.38	33.29	23.96	22.81	0.93	3.82	6.45	7.90
Q3	I	25.52	59.14	86.38	34.01	25.48	23.45	0.95	3.82	6.35	7.90
Q4	I	26.51	60.55	89.10	34.96	26.06	25.56	0.97	3.81	6.32	7.90
1973 Q1	I	26.51	62.60	91.87	35.83	25.78	23.29	0.96	3.86	6.37	8.00
Q2	I	26.98	64.20	94.97	37.28	26.48	25.43	0.95	3.92	6.42	8.00
Q3	I	28.04	66.00	97.12	37.82	29.47	26.36	0.95	3.97	6.39	8.00
Q4	I	29.16	67.47	100.55	39.03	30.13	29.20	0.94	4.03	6.39	8.00
1974 Q1	I	29.79	70.31	103.57	40.21	30.40	26.83	1.00	4.08	6.40	8.00
Q2	I	29.70	70.70	107.75	42.48	31.00	30.32	1.04	4.14	7.40	9.00
Q3	I	30.75	72.46	110.31	43.37	33.65	31.50	1.13	4.20	7.48	9.00
Q4	I	33.08	75.36	113.36	44.13	34.68	34.66	1.20	4.26	7.48	9.00
1975 Q1	I	33.79	77.62	116.79	45.46	33.86	31.54	1.26	4.32	7.56	9.10
Q2	I	34.59	79.00	121.06	47.58	36.97	35.69	1.33	4.38	7.56	9.20
Q3	I	37.30	83.61	124.52	48.67	38.58	36.15	1.39	4.44	7.62	9.30
Q4	I	39.49	86.78	129.97	50.77	39.29	40.39	1.46	4.50	7.50	9.40
1976 Q1	I	41.28	90.90	135.12	52.37	39.74	36.65	1.50	4.60	7.45	9.50
Q2	I	41.90	93.05	141.77	55.38	40.50	40.58	1.53	4.71	7.44	9.50
Q3	I	43.81	96.71	146.82	57.11	44.46	42.08	1.57	4.81	7.48	9.50
Q4	I	46.39	101.06	152.40	58.74	46.01	46.28	1.60	4.92	7.50	9.70
1977 Q1	I	48.00	106.56	158.32	60.86	45.85	42.26	1.65	5.00	7.52	9.70
Q2	I	47.73	108.17	165.73	64.53	45.50	47.33	1.71	5.07	7.58	9.80
Q3	I	50.00	113.36	170.99	66.12	49.50	48.51	1.76	5.15	7.59	9.80
Q4	I	52.55	118.04	177.37	67.84	50.68	53.06	1.82	5.22	7.96	10.00
1978 Q1	I	52.50	121.64	184.62	70.24	49.90	46.92	2.00	6.22	8.65	11.30
Q2	I	51.71	122.29	190.73	72.36	51.35	49.87	2.20	6.37	8.62	11.50
Q3	I	53.91	125.98	195.69	72.75	54.50	50.70	2.30	6.30	8.64	12.00
Q4	I	56.48	130.58	202.08	73.93	57.32	56.33	2.40	6.33	8.55	12.00
1979 Q1	I	56.67	135.80	208.98	75.62	55.01	49.28	2.20	6.22	8.45	12.00
Q2	I	57.33	137.71	216.84	79.02	56.76	53.47	2.50	6.15	8.44	12.00
Q3	I	61.29	143.42	222.79	80.97	61.24	53.99	2.60	6.50	8.44	12.00
Q4	I	63.12	148.50	229.42	82.50	65.67	60.63	2.60	6.88	9.19	12.10
1980 Q1	I	63.31	153.64	235.90	84.10	68.27	57.61	2.80	7.05	10.68	12.10
Q2	I	63.48	154.23	242.78	87.08	69.58	60.87	3.10	7.17	10.70	12.20
Q3	I	66.02	159.63	249.15	89.40	71.15	63.79	3.30	7.25	11.03	13.10
Q4	I	69.42	165.92	255.58	90.78	76.05	71.78	3.50	7.32	10.85	13.30
1981 Q1	I	70.25	173.40	262.49	92.97	77.06	63.30	3.80	7.33	11.74	13.50
Q2	I	70.84	174.12	271.42	97.33	78.77	68.47	4.00	7.33	12.71	13.70
Q3	I	75.21	180.94	278.38	99.35	84.47	70.75	3.60	7.38	13.13	13.70
Q4	I	77.48	186.12	286.32	101.87	87.38	79.42	3.40	7.72	13.13	13.80
1982 Q1	I	78.90	194.38	294.95	105.52	86.15	72.37	3.70	7.87	14.02	13.80
Q2	I	79.79	194.65	304.45	109.89	87.14	77.87	3.90	7.97	14.16	14.00
Q3	I	82.93	199.26	312.51	112.26	91.30	80.10	4.10	8.02	14.18	14.20
Q4	I	86.11	203.89	321.34	114.20	97.68	87.04	4.40	8.37	14.14	14.30
1983 Q1	I	86.77	212.06	333.19	119.26	96.47	78.65	4.50	8.27	14.02	14.30
Q2	I	87.13	210.07	343.21	125.67	98.50	82.07	4.90	8.30	13.96	14.40
Q3	I	91.62	217.70	354.90	128.74	100.40	85.36	4.70	8.20	13.81	14.20
Q4	I	95.48	223.48	366.13	128.28	106.82	91.78	4.80	8.30	13.46	14.10

TABLE TABLE A1. QUARTERLY DATA 1966 – 1989.

YEAR	I	M1 *(1)*	M2 *(2)*	KA *(3)*	KB *(4)*	Y *(5)*	X *(6)*	RD1 *(7)*	RD2 *(8)*	RL *(9)*	RB *(10)*
1984 Q1	I	96.34	234.30	379.27	138.59	106.27	86.48	4.90	8.47	13.27	14.10
Q2	I	98.65	235.79	392.39	146.23	109.60	92.00	5.10	8.33	13.20	13.80
Q3	I	105.03	246.60	407.79	152.71	114.78	95.49	5.10	8.58	13.19	13.50
Q4	I	113.10	262.73	423.18	159.71	121.86	104.65	5.00	8.57	13.15	13.30
1985 Q1	I	117.69	276.97	438.57	169.05	122.34	98.15	5.50	8.65	13.14	13.20
Q2	I	120.45	275.67	457.42	180.95	119.92	103.98	5.70	8.60	13.33	13.30
Q3	I	129.29	290.83	482.32	193.50	123.89	108.73	5.60	8.73	13.66	13.40
Q4	I	138.98	306.73	509.91	208.48	134.05	120.02	6.50	8.90	13.89	13.41
1986 Q1	I	139.59	321.63	534.51	222.83	122.97	112.24	6.60	9.05	14.65	14.00
Q2	I	146.99	326.63	561.57	235.62	123.42	123.87	6.80	9.20	14.52	14.70
Q3	I	150.57	337.60	590.16	245.50	128.96	126.12	7.00	9.50	14.51	15.10
Q4	I	155.87	349.97	615.57	251.89	138.37	140.76	8.10	10.40	14.83	16.00
1987 Q1	I	158.72	362.43	646.85	270.39	135.10	125.33	8.80	10.90	15.12	16.10
Q2	I	167.37	363.20	672.96	283.10	133.97	131.31	8.80	10.80	14.73	16.27
Q3	I	169.60	364.30	694.60	301.33	142.02	135.84	9.10	11.00	14.50	16.65
Q4	I	181.03	379.87	721.70	322.94	151.84	150.98	9.70	11.30	14.40	16.78
1988 Q1	I	186.00	399.54	742.23	338.13	145.56	132.90	10.00	11.40	14.66	16.87
Q2	I	183.97	392.81	755.97	345.81	145.86	136.35	10.00	11.20	14.20	16.61
Q3	I	195.36	395.35	779.83	340.03	149.09	137.73	9.70	10.90	14.20	16.49
Q4	I	213.97	403.49	787.80	343.39	153.74	147.29	9.80	10.70	13.50	16.44
1989 Q1	I	220.94	413.30	788.30	347.90	151.00	133.41	8.80	9.70	12.20	15.64
Q2	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q3	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q4	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2. Tests for seasonal unit roots in money, credit, nominal income and interest rate variables 1967 Q1 – 1989 Q1.

variable	μ_t	lags of $\Delta_4 Z_{t-i}$	zero frequency t_1 π_1	bi-annual t_2 π_2	annual frequency t_3 π_3	t_4 π_4	F $\pi_3 \cap \pi_4$
LM1		1,3–5	2.74	–1.81	–1.36	–0.83	1.30
	I	1,3–5	0.26	–1.75	–1.36	–0.83	1.30
	I,SD		0.29	–5.37**	–6.62**	–4.30**	58.73**
	I,TR	1,3–5	–2.99	–1.68	–1.38	–0.68	1.20
	I,SD,TR	1,4–5	–3.03	–3.04**	–4.25**	–0.27	9.47**
LM2		1–5	0.05	–0.46	0.33	–1.59	1.34
	I	1–5	–1.46	–0.48	0.18	–1.70	1.47
	I,SD	3–4	–1.18	–4.32**	–2.48	–6.16**	43.93**
	I,TR	1–5	–3.04	–0.45	0.11	–1.51	1.16
	I,SD,TR	1,4–5	–2.16	–4.25**	–2.78	–5.78**	43.20**
LKA		1–4	2.02	–1.24	–2.23*	–3.09**	7.93**
	I	1–4	0.23	–1.22	–2.34*	–2.96**	7.79**
	I,SD	1–4	0.15	–1.32	–2.81	–3.24**	10.68**
	I,TR	1–4	–2.50	–1.22	–2.40*	–2.90**	7.74**
	I,SD,TR	1–4	–2.48	–1.36	–2.91	–3.12**	10.57**
LKB		1,3,5	1.31	–3.08**	–1.62	–1.90	3.16*
	I	1,3,5	–0.13	–3.03**	–1.63	–1.83	3.04
	I,SD		–1.18	–4.54**	–3.47*	–8.02**	58.55**
	I,TR	1,3,5	–3.72*	–2.89**	–1.96*	–1.47	3.06*
	I,SD,TR		–1.55	–4.70**	–3.80*	–7.53*	58.50**
LX		1,2,4,5	1.44	–0.56	–0.32	1–18	0.76
	I	1,2,4	–1.38	–0.77	–0.55	–1.35	1.07
	I,SD		–1.11	–4.98**	–6.83**	–4.89**	57.96**
	I,TR	1,2,4,5	–1.20	–0.52	–0.47	–1.03	0.66
	I,SD,TR		–1.63	–5.11**	–7.06**	–4.80**	60.15**
LY		1,2,4,5	0.73	–1.93*	–1.65	–1.31	2.32
	I	1,2,4,5	–1.67	–1.95*	–1.79	–1.24	2.47
	I,SD	2	–1.21	–5.30**	–3.27	–2.61*	9.50**
	I,TR	1,2,4,5	–0.2[illegible]	–1.93*	–1.77	–1.22	2.41
	I,SD,TR	2	–0.56	–5.29**	–3.25	–2.61*	9.44**
RD1		1–8,10	4.17	–7.13**	–3.62**	–2.46**	10.52**
	I	1–8,10	3.82	–7.20**	–3.77**	–2.41**	10.97**
	I,SD	1–8,10	3.76	–7.00**	–3.59**	–2.29	9.96**
	I,TR	1–8,10	1.48	–7.15**	–3.68**	–2.34*	10.33**
	I,SD,TR	1–8,10	1.46	–6.96**	–3.48*	–2.23	9.35**
RD2		1–5	2.01	–5.26**	–0.92	–3.80**	7.66**
	I	1–5	0.24	–5.24**	–0.95	–3.75**	7.50**
	I,SD	1,4–5	0.26	–7.67**	–1.10	–5.95**	18.03**
	I,TR	1–5	–2.18	–5.11**	–1.00	–3.59**	6.97**
	I,SD,TR	1,4–5	–2.19	–7.51**	–1.19	–5.65**	16.14**
RL			0.34	–5.99**	–3.70**	–6.05**	36.11**
	I		–1.14	–5.96**	–3.77**	–5.96**	35.88**
	I,SD		–1.18	–5.83**	–3.59*	–5.83**	33.78**
	I,TR		–1.49	–5.98**	–3.87**	–5.76**	35.33**
	I,SD,TR		–1.41	–5.85**	–3.68*	–5.60**	33.12**
RB		1–5	1.76	–6.25**	0.31	–4.07**	8.35**
	I	1–5	–0.80	–6.22**	0.25	–4.06**	8.29**
	I,SD	1–5	–0.79	–6.10**	0.22	–4.00**	8.02**
	I,TR	1–3	–2.33	–6.59**	1.03	–5.90**	18.03**
	I,SD,TR	1–3	–2.28	–6.46**	1.00	–5.78**	17.33**

Notes. The test procedures follow Hylleberg et al.[HEGY] (1988). The sample period starts in 1967 Q2; estimation begins in this or subsequent quarters depending on the number of lags of included. The end of the estimation period is 1989 Q1 for all variables except LM1, for which data end in 1986 Q4. For π_1, π_2, π_3 and $\pi_3 \cap \pi_4$ test statistics that are significantly different from zero at the 5 (1) per cent level are denoted by * (**); for π_4 the significance levels used are 2.5 (1) per cent.

Table 3. HEGY cointegration tests for variables in the 'constant velocity' model.

variable / sample period	μ_t	lags of $\Delta_4 Z_{t-i}$	zero frequency t_1 π_1	bi-annual t_2 π_2	annual frequency t_3 π_3	t_4 π_4	F $\pi_3 \cap \pi_4$
LM1–		1,4	0.85	–0.49	–1.65	–0.76	1.64
LX	I	1,4	–2.12	–0.56	–1.92*	–0.50	1.97
	I,SD	1	–3.08*	–3.10*	–4.94**	–1.19	12.98**
1967–	I,TR	1,3,4	–2.74	–0.41	–1.79	–0.80	1.95
1983	I,SD,TR	1	–3.76*	–2.95*	–5.12**	–0.80	13.49**
LM1–		1,4	1.41	–0.51	–1.78	–1.08	2.17
LX	I	1,4	–0.41	–0.52	–1.81	–1.04	2.19
	I,SD	1	–1.97	–3.00*	–4.81**	–1.68	13.02**
1967–	I,TR	1,4,5	–1.92	–0.45	–1.61	–0.83	1.64
1986	I,SD,TR	1	–3.16	–2.84	–5.00	–1.27	13.35**
LM2–		1,2,4	0.59	–0.51	–0.66	–0.68	0.45
LX	I	1,2,4,5	–1.74	–0.40	–0.54	–0.49	0.27
	I,SD		–2.12	–5.07**	–6.74**	–3.10**	38.76**
1967–	I,TR	1,2,4,5	–2.04	–0.40	–0.53	–0.49	0.26
1983	I,SD,TR		–2.40	–5.09**	–6.78**	–3.05**	38.83**
LM2–		1,2,4	1.34	–0.65	–0.65	–0.86	0.60
LX	I	1,2,4	0.14	–0.64	–0.64	–0.86	0.59
	I,SD		–0.63	–5.44**	–6.67**	–3.80**	40.42**
1967–	I,TR	1,4,5	–1.44	–0.46	–0.77	–0.47	0.41
1989	I,SD,TR		–1.82	–5.51**	–6.84**	–3.70**	41.43**
LKA–		2,8	–0.06	–5.60**	3.33	3.23	6.43**
LY	I	2,5	–4.22**	–4.87**	2.76	3.01	4.91**
	I,SD	2,5	–4.34**	0.56	1.50	1.15	1.15
1967–	I,TR	2,5	–4.41**	–4.88**	2.78	3.00	4.94**
1983	I,SD,TR	2,5	–4.15**	–4.36**	0.55	1.52	1.19
LKA–		1,2,4,5,8	1.13	–2.09*	1.22	1.05	0.77
LY	I	1,2,4,5,6	1.52	–2.13*	1.31	1.06	0.87
	I,SD	1,4,5,8	1.16	–1.80	–0.87	0.56	0.95
1967–	I,TR	1,2,4,5,8	0.39	2.18	1.36	1.13	0.94
1989	I,SD,TR	1,4,5,8	0.10	–1.84	–0.93	0.59	1.07
LKB–		2,8	–1.56	–5.14**	–1.23	–2.24*	3.49*
LY	I	2,8	–0.61	–5.10**	–1.19	–2.22*	3.37*
	I,SD		–1.07	–4.06**	–4.10**	–2.45*	13.82**
1967–	I,TR	2,8	–1.93	–5.11**	–1.24	–2.16*	3.31*
1983	I,SD,TR		–2.20	–4.08**	–4.27**	–2.33**	14.32**
LKB–		1,2,4,5,8	0.23	–1.63	–0.98	–1.54	1.72
LY	I	1,2,4,5	–2.63	–1.52	–1.32	–1.30	1.75
	I,SD	1,5	–2.81	–2.54	–4.62**	–1.88	12.52**
1967–	I,TR	1,2,4,5	–2.58	–1.51	–1.32	–1.33	1.78
1989	I,SD,TR	1,5	–2.77	–2.57	–4.60**	–1.91	1.63

See notes to Table 2 for explanation of statistics and significance levels.

Table 4. Tests for cointegration in the simple model.

A. Dependent variable: **LM1**

	1966 Q2 – 1983 Q4		1966 Q2 – 1986 Q4	
	(A1)	(A2)	(A3)	(A4)
LX	1.017	1.022	1.042	1.046
INTERCEPT	–0.02	–0.09	–0.10	–0.17
S1		0.111		0.109
S2		0.030		0.032
S3		0.048		0.049
SER	0.050	0.030	0.055	0.038
CRDW	2.34	0.65	1.91	0.43
ADF(k)	–5.05**	–4.01*	–4.86**	–3.47*
k	4	4	4	4
Q(m)	16.24	9.90	24.51	15.31
m	21	21	23	23

B. Dependent variable: **LM2**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(B1)	(B2)	(B3)	(B4)
LX	1.017	1.024	1.052	1.055
INTERCEPT	0.83	0.74	0.72	0.64
S1		0.136		0.140
S2		0.059		0.062
S3		0.063		0.064
SER	0.061	0.039	0.066	0.044
CRDW	2.01	0.31	1.81	0.26
ADF(k)	–3.87*	–2.33	–4.11**	–2.79
k	4	0	4	4
Q(m)	18.12	10.16	23.62	6.26
m	21	22	23	23

C. Dependent variable: **LKA**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(C1)	(C2)	(C3)	(C4)
LY	1.011	1.013	1.100	1.101
INTERCEPT	1.20	1.17	0.90	0.87
S1		0.042		0.049
S2		0.044		0.048
S3		–0.006		0.004
SER	0.041	0.034	0.102	0.101
CRDW	1.18	0.79	0.22	0.12
ADF(k)	–5.58**	–5.13**	–2.51	–2.91
k	8	8	8	8
Q(m)	21.00	15.27	25.86	22.27
m	19	19	23	23

D. Dependent variable: **LKB**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(D1)	(D2)	(D3)	(D4)
LY	0.939	0.941	1.093	1.094
INTERCEPT	0.50	0.47	–0.01	–0.05
S1		0.038		0.052
S2		0.051		0.057
S3		0.002		0.009
SER	0.040	0.034	0.157	0.158
CRDW	1.12	0.74	0.11	0.06
ADF(k)	–5.37**	–4.88**	–3.58*	–2.82
k	8	8	8	8
Q(m)	19.14	12.36	17.02	16.15
m	19	19	23	23

Notes. The diagnostics are: SER = standard error of the cointegrating regression; CRDW = Durbin–Watson statistic from the cointegrating regression; Q(m) = Ljung–Box Q–statistic for autocorrelated residuals with m degrees of freedom.

The test statistic is: ADF(k) = Augmented Dickey–Fuller statistic with maximum lag equal to k, but with insignificant terms deleted. Test statistics that are significantly different from zero at the 5 (1) per cent level are denoted by * (**). The critical values are taken from Table 2 in Engle and Yoo (1987) – in order to minimize the type I error.

Table 5. Tests for cointegration in the augmented model.

A. Dependent variable: **LM1**

	1966 Q2 – 1983 Q4		1966 Q2 – 1986 Q4	
	(A1)	(A2)	(A3)	(A4)
LX	0.957	0.989	0.976	1.004
RD1	0.085	0.074	0.059	0.058
RL	−0.029	−0.030	−0.020	−0.026
INTERCEPT	0.28	0.15	0.19	0.09
S1		0.112		0.110
S2		0.030		0.032
S3		0.046		0.048
SER	0.047	0.024	0.047	0.025
CRDW	2.47	0.88	2.37	0.91
ADF(k)	-5.81^{**}	-4.75^{**}	-5.85^{**}	-4.93^{**}
k	4	4	4	4
Q(m)	13.88	11.55	23.07	21.32
m	21	21	23	23

B. Dependent variable: **LM2**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(B1)	(B2)	(B3)	(B4)
LX	0.762	0.845	0.838	0.899
RD2	0.118	0.084	0.072	0.057
RL	−0.022	−0.016	−0.007	−0.009
INTERCEPT	1.33	1.11	1.16	0.98
S1		0.113		0.120
S2		0.046		0.050
S3		0.053		0.055
SER	0.048	0.028	0.052	0.031
CRDW	2.04	0.54	2.00	0.46
ADF(k)	-5.34^{**}	-4.26^{*}	-7.23^{**}	-4.58^{*}
k	5	0	4	4
Q(m)	11.83	11.58	21.08	10.35
m	20	24	23	23

C. Dependent variable: **LKA**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(C1)	(C2)	(C3)	(C4)
LY	0.897	0.925	0.857	0.872
RB	0.053	0.046	0.082	0.079
RL	−0.026	−0.026	−0.022	−0.024
INTERCEPT	1.31	1.25	1.17	1.13
S1		0.041		0.042
S2		0.042		0.042
S3		−0.005		0.004
SER	0.035	0.027	0.090	0.089
CRDW	1.48^{**}	1.13^{**}	0.22	0.13
ADF(k)	-5.60^{**}	-4.79^{**}	−1.42	−1.63
k	8	0	8	8
Q(m)	16.97	15.89	19.36	17.03
m	19	19	23	23

D. Dependent variable: **LKB**

	1966 Q2 – 1983 Q4		1966 Q2 – 1989 Q1	
	(D1)	(D2)	(D3)	(D4)
LY	0.901	0.929	0.787	0.804
RB	0.030	0.024	0.099	0.096
RL	−0.022	−0.021	−0.025	−0.026
INTERCEPT	0.52	0.46	0.33	0.28
S1		0.039		0.042
S2		0.052		0.048
S3		0.003		0.009
SER	0.037	0.030	0.146	0.147
CRDW	1.36^{**}	1.02^{**}	0.10	0.06
ADF(k)	-5.57^{**}	-4.51^{**}	−1.21	−0.98
k	8	0	8	8
Q(m)	16.29	15.32	18.18	19.25
m	19	19	23	23

See notes to Table 4 for explanation of statistics and significance levels.

Table 6. The Johansen procedure for LM1.
VAR with 5 lags, constant and seasonal dummies included.

Panel A. Sample period 1967 Q3 – 1983 Q4, 66 observations.

The eigenvalues:

	0.400	0.254	0.131	0.008

The test statistics:

	Testing the number of cointegrating vectors			
Test	$r=0$	$r\leq 1$	$r\leq 2$	$r\leq 3$
trace	62.839^{***}	29.140^{*}	9.777	0.524
λ_{max}	33.699^{***}	19.362^{*}	9.253	0.524

The eigenvectors:

LM1	66.748	58.945	1.700	7.459
LX	–58.103	–59.363	0.434	–0.040
RD1	–16.318	–1.963	–0.040	–5.667
RL	5.528	0.711	0.122	0.846

Normalization by LM1 of the first eigenvector:
LM1 = 0.870LX + 0.244RD1 – 0.083RL

Panel B. Sample period 1967 Q3 – 1986 Q4, 78 observations.

The eigenvalues:

	0.292	0.214	0.071	0.003

The test statistics:

	Testing the number of cointegrating vectors			
Test	$r=0$	$r\leq 1$	$r\leq 2$	$r\leq 3$
trace	51.625^{**}	24.735	5.994	0.216
λ_{max}	26.890^{*}	18.741	5.777	0.216

The eigenvectors:

LM1	46.834	47.858	–5.026	–17.232
LX	–47.277	–47.201	8.325	13.418
RD1	–1.415	–4.759	–1.184	3.666
RL	0.774	1.764	–1.363	–1.285

Normalization by LM1 of the first eigenvector:
LM1 = 1.009LX + 0.030RD1 – 0.017RL

{ * } = { greater than the 10 % critical value; }
{ ** } = { greater than the 5 % critical value; }
{ *** } = { greater than the 1 % critical value. }
The critical values are taken from Johansen and Juselius (1989).

Table 7. The Johansen procedure for LM2.
VAR with 6 lags, constant and seasonal dummies included.

Panel A. Sample period 1967 Q4 – 1983 Q4, 65 observations.

The eigenvalues:

	0.418	0.295	0.101	0.001

The test statistics:

	Testing the number of cointegrating vectors			
Test	$r=0$	$r\leq 1$	$r\leq 2$	$r\leq 3$
trace	64.795^{***}	29.632^{*}	6.933	0.030
λ_{max}	35.163^{***}	22.699^{**}	6.903	0.030

The eigenvectors:

LM2	66.251	–30.342	–12.998	12.784
LX	–59.245	20.662	1.503	–12.842
RD2	–3.786	7.152	4.132	–1.216
RL	0.710	–2.393	–0.004	0.187

Normalization by LM2 of the first eigenvector:
LM2 = 0.894LX + 0.057RD2 – 0.011RL

Panel B. Sample period 1967 Q4 – 1989 Q1, 86 observations.

The eigenvalues:

	0.299	0.146	0.042	0.023

The test statistics:

	Testing the number of cointegrating vectors			
Test	$r=0$	$r\leq 1$	$r\leq 2$	$r\leq 3$
trace	49.772^{**}	19.246	5.687	2.014
λ_{max}	30.526^{**}	13.559	3.672	2.014

The eigenvectors:

LM2	47.546	33.213	4.174	–0.845
LX	–37.041	–31.388	–9.047	5.875
RD2	–5.486	0.045	0.654	–0.603
RL	1.153	–0.772	0.680	–0.306

Normalization by LM2 of the first eigenvector:
LM2 = 0.779LX + 0.115RD2 – 0.024RL

{ * } = { greater than the 10 % critical value; }
{ ** } = { greater than the 5 % critical value; }
{ *** } = { greater than the 1 % critical value. }
The critical values are taken from Johansen and Juselius (1989).

Table 8. The Johansen procedure for LKA.
VAR with 6 lags, constant and seasonal dummies included.

Panel A. Sample period 1967 Q4 – 1983 Q4, 65 observations.

The eigenvalues:	0.335	0.227	0.156	0.022
The test statistics:	Testing the number of cointegrating vectors			
Test	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
trace	55.688^{***}	29.205^{*}	12.445	1.415
λ_{max}	26.484^{*}	16.760	11.030	1.415
The eigenvectors:				
LKA	62.855	−9.680	−13.115	54.444
LY	−54.317	2.509	25.478	−49.386
RB	−3.160	3.561	−1.748	−3.495
RL	0.788	−1.551	−0.698	2.464

Normalization by LKA of the first eigenvector:
LKA = 0.864LY + 0.050RB – 0.013RL

Panel B. Sample period 1967 Q4 – 1989 Q1, 86 observations.

The eigenvalues:	0.288	0.174	0.136	0.020
The test statistics:	Testing the number of cointegrating vectors			
Test	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
trace	59.980^{***}	30.738^{*}	14.309	1.754
λ_{max}	29.242^{**}	16.429	12.555	1.754
The eigenvectors:				
LKA	5.045	−7.189	19.922	4.254
LY	−14.009	6.455	−14.614	5.908
RB	3.155	0.173	−2.267	−1.259
RL	−1.059	0.466	0.859	−0.846

Normalization by LKA of the first eigenvector:
LKA = 2.777LY – 0.625RB + 0.210RL

$\begin{bmatrix} * \\ ** \\ *** \end{bmatrix} = \begin{Bmatrix} \text{greater than the 10 \% critical value;} \\ \text{greater than the 5 \% critical value;} \\ \text{greater than the 1 \% critical value.} \end{Bmatrix}$
The critical values are taken from Johansen and Juselius (1989).

Table 9. The Johansen procedure for LKB.
VAR with 4 lags, constant and seasonal dummies included.

Panel A. Sample period 1967 Q2 – 1983 Q4, 67 observations.

The eigenvalues:	0.381	0.171	0.136	0.001
The test statistics:	Testing the number of cointegrating vectors			
Test	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
trace	54.511^{**}	22.357	9.801	0.041
λ_{max}	32.154^{**}	12.557	9.759	0.041
The eigenvectors:				
LKB	44.971	−31.262	25.012	15.372
LY	−31.286	30.006	−26.382	−10.473
RB	−4.410	−0.480	1.419	−1.189
RL	1.819	−1.020	−0.751	0.746

Normalization by LKB of the first eigenvector:
LKB = 0.696LY + 0.098RB – 0.040RL

Panel B. Sample period 1967 Q2 – 1989 Q1, 88 observations.

The eigenvalues:	0.337	0.190	0.131	0.002
The test statistics:	Testing the number of cointegrating vectors			
Test	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
trace	67.263^{***}	31.091^{*}	12.535	0.135
λ_{max}	36.172^{***}	18.556	12.400	0.135
The eigenvectors:				
LKB	7.706	3.593	6.211	1.786
LY	−2.441	−9.683	−2.970	1.894
RB	−2.265	1.549	−0.831	0.179
RL	1.160	−0.191	−0.228	−0.815

Normalization by LKB of the first eigenvector:
LKB = 0.317LY + 0.294RB – 0.151RL

$\begin{bmatrix} * \\ ** \\ *** \end{bmatrix} = \begin{Bmatrix} \text{greater than the 10 \% critical value;} \\ \text{greater than the 5 \% critical value;} \\ \text{greater than the 1 \% critical value.} \end{Bmatrix}$
The critical values are taken from Johansen and Juselius (1989).

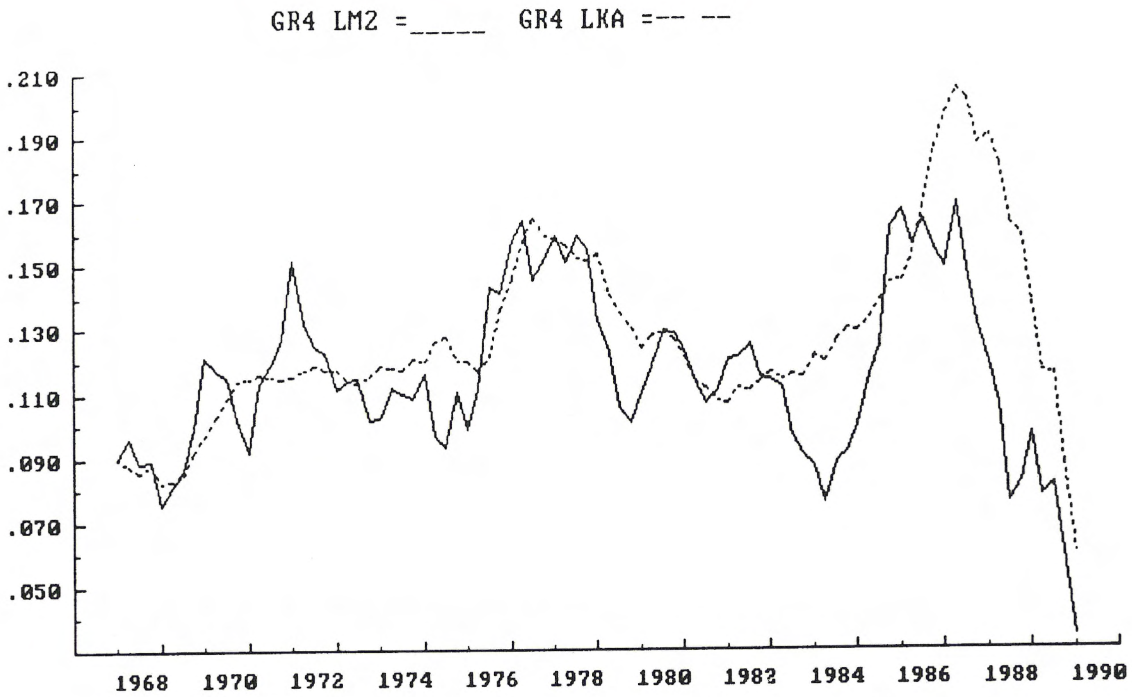

Figure 1. Four—quarter growth rates of the logs of M2 (solid line) and KA (dotted line).

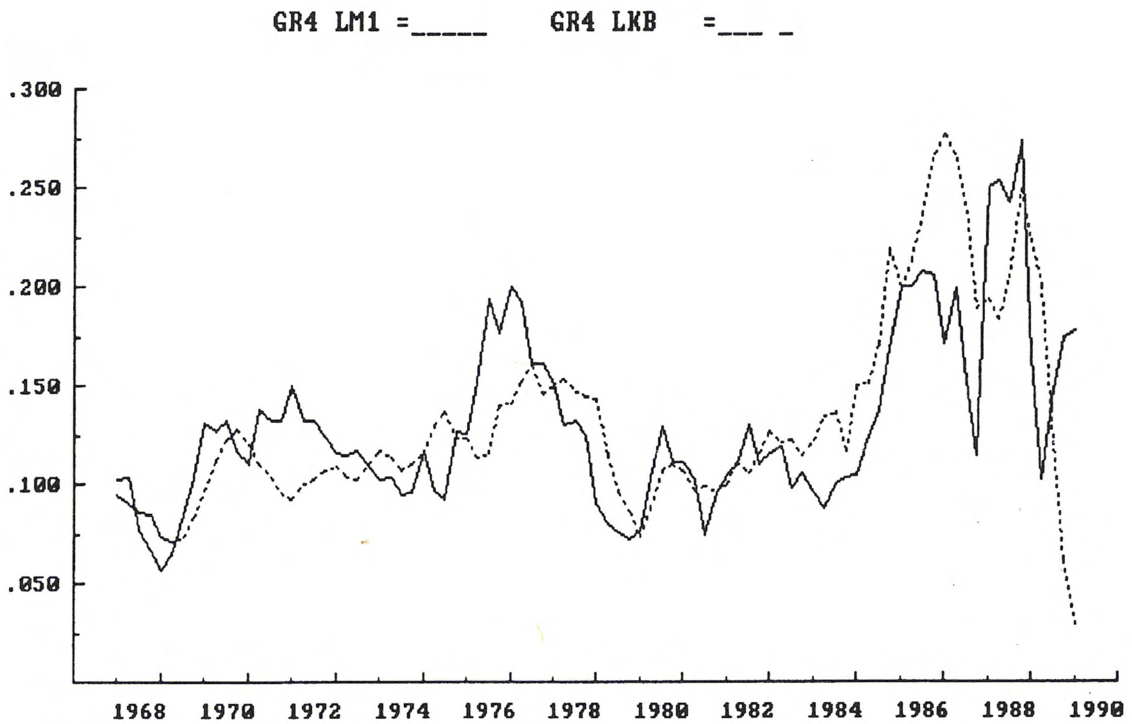

Figure 2. Four—quarter growth rates of the logs of M1 (solid line) and KB (dotted line).

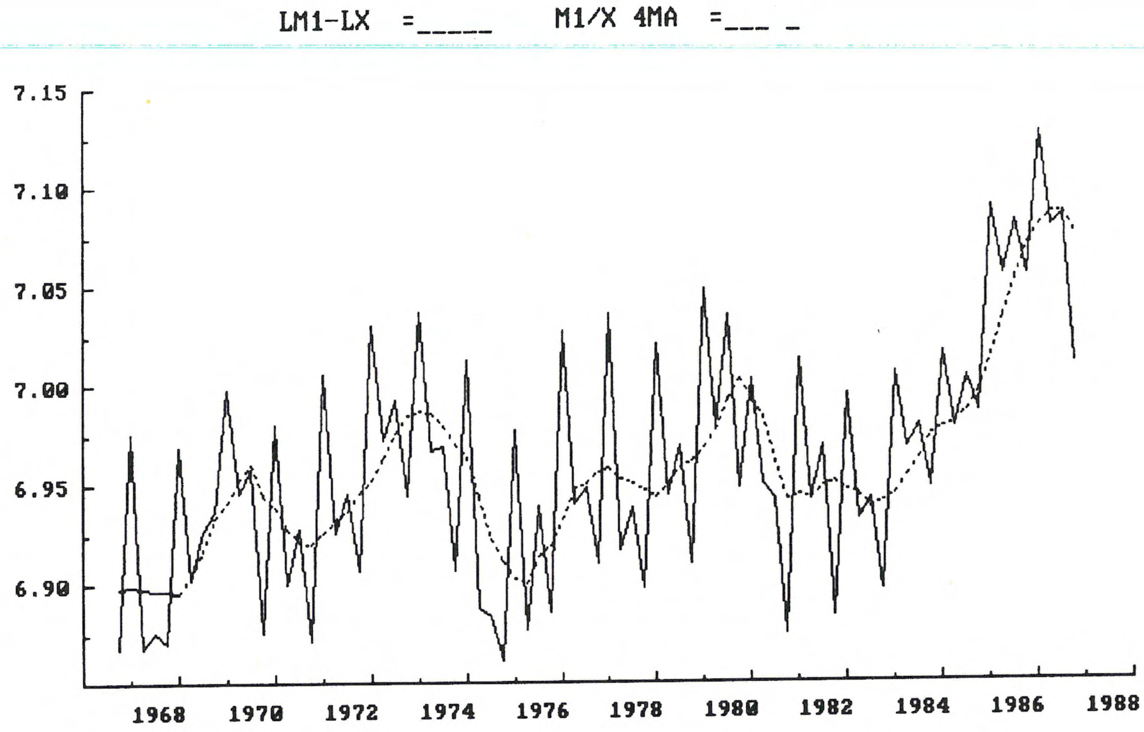

Figure 3. Actual and four—quarter moving average of the log of the ratio of M1 to X.

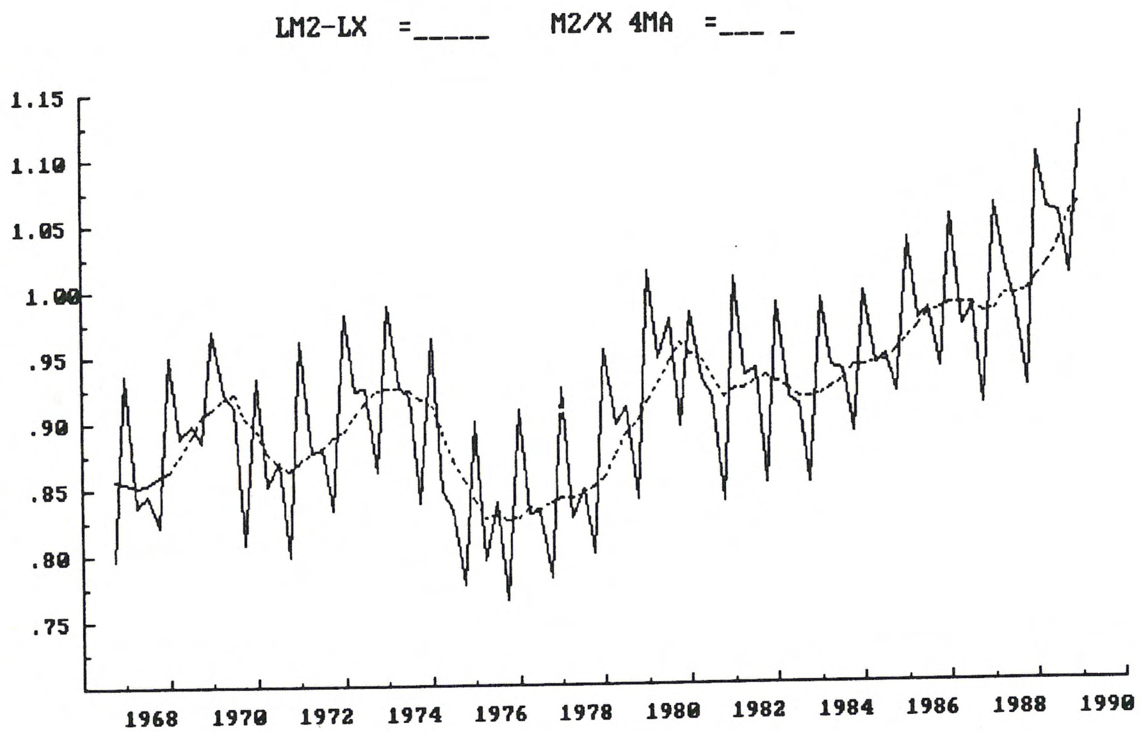

Figure 4. Actual and four—quarter moving average of the log of the ratio of M2 to X.

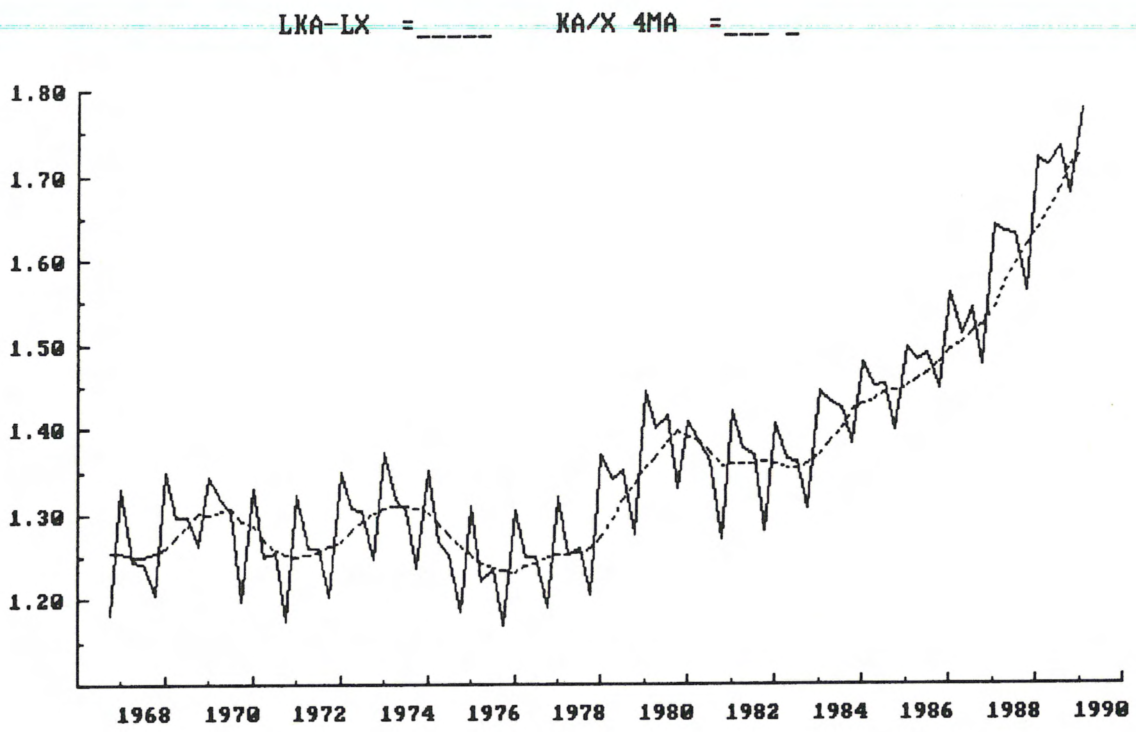

Figure 5. Actual and four—quarter moving average of the log of the ratio of KA to X.

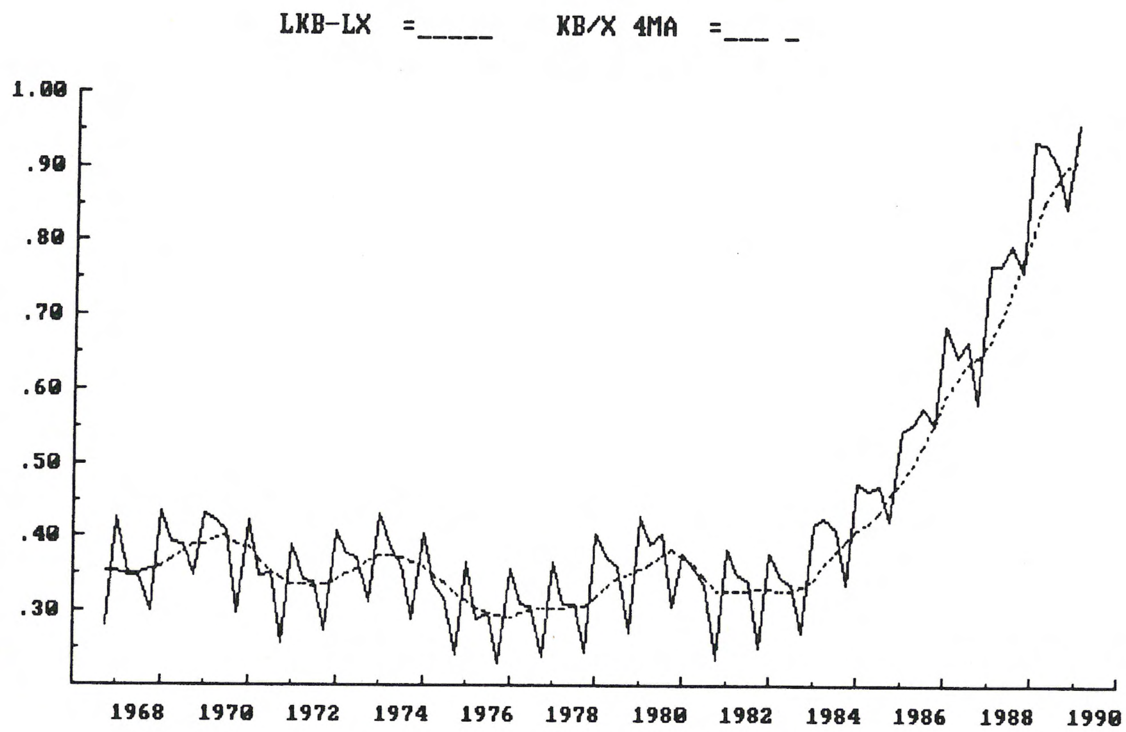

Figure 6. Actual and four—quarter moving average of the log of the ratio of KB to X.

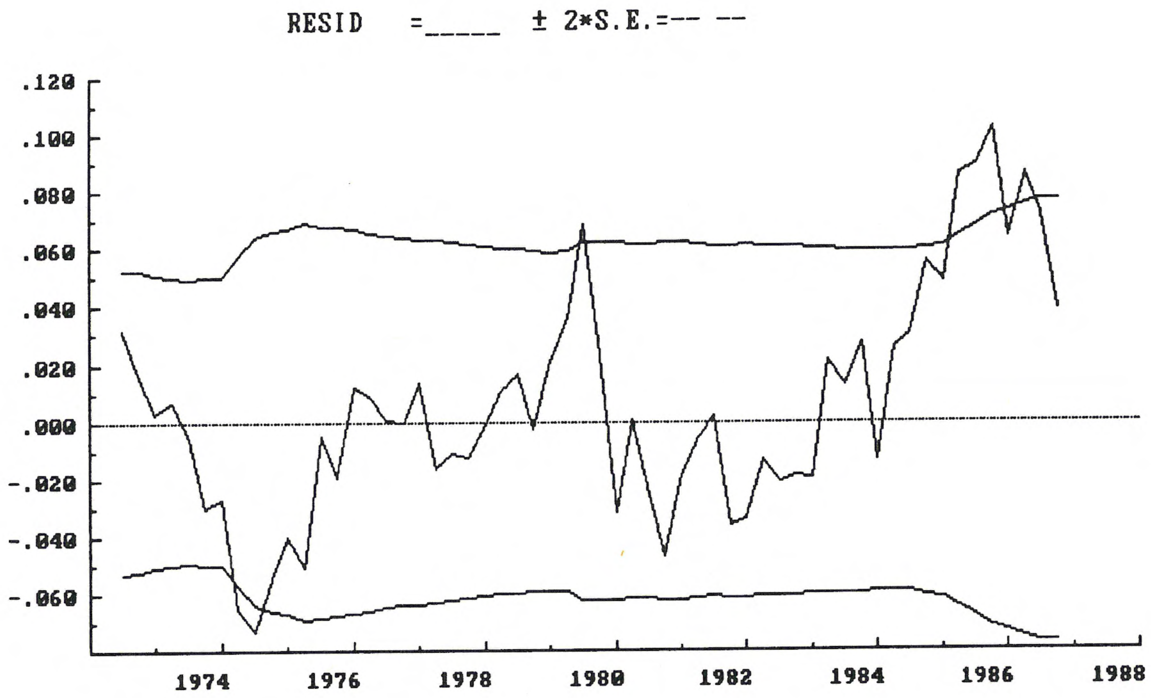

Figure 7. One–step residuals from the M1 equation in the simple model, Table 4 (A4).

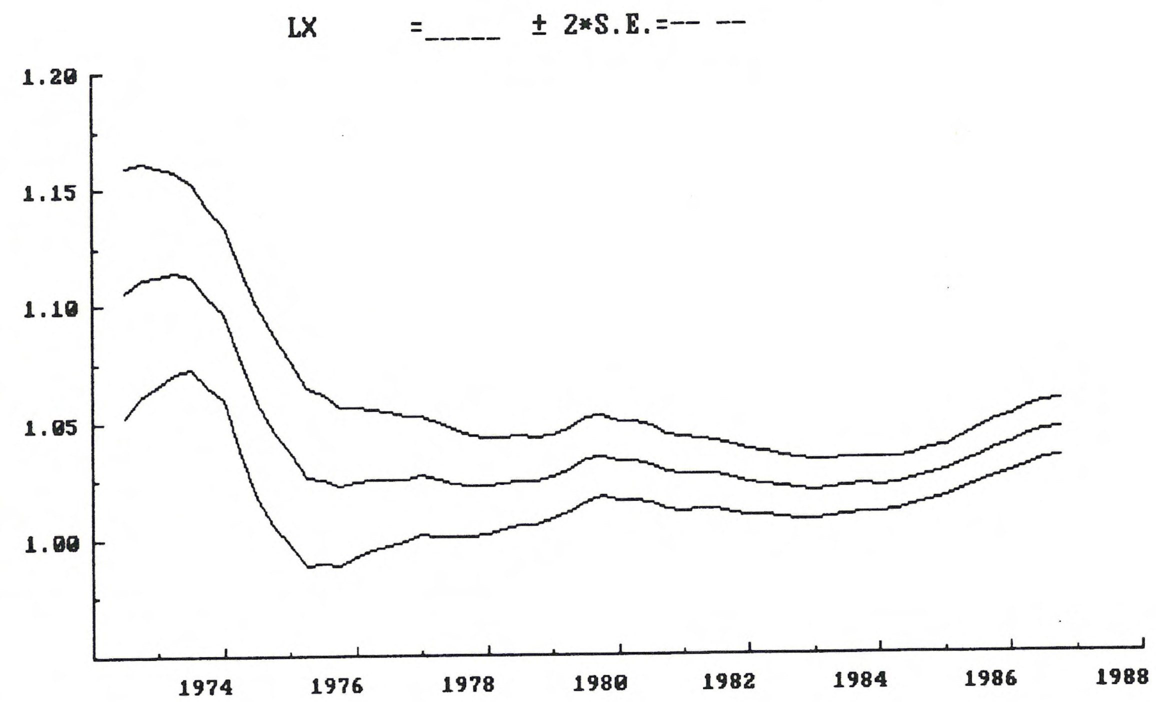

Figure 8. Recursive estimates of α_1 in the M1 equation in the simple model, Table 4 (A4).

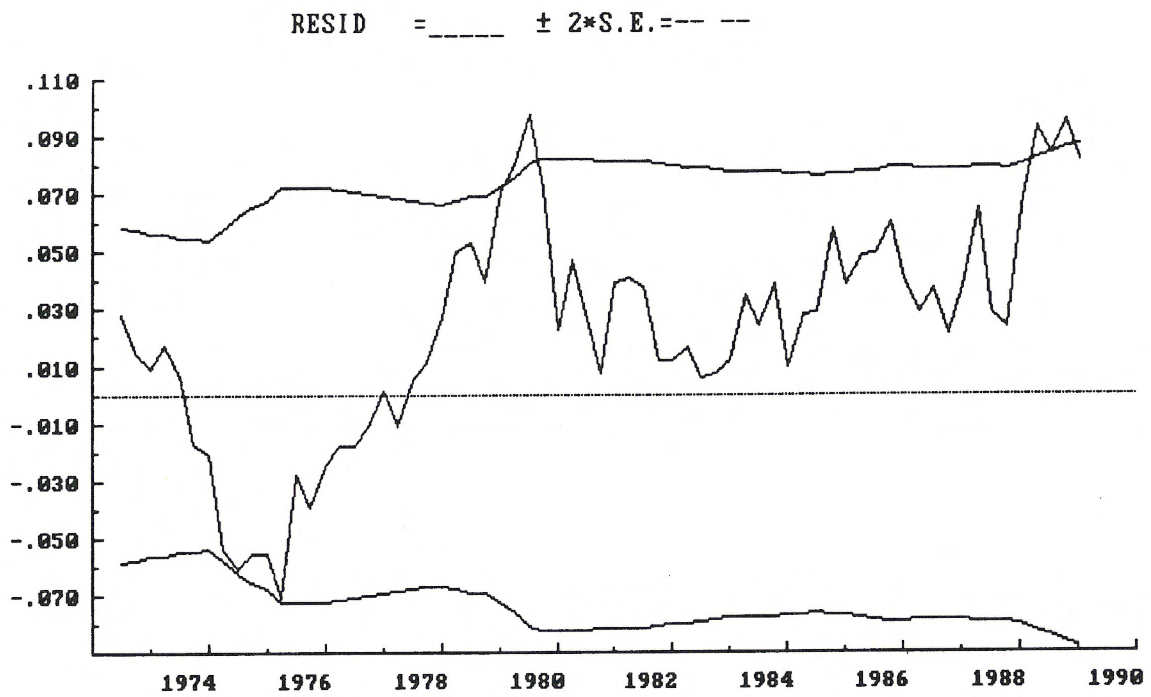

Figure 9. One–step residuals from the M2 equation in the simple model, Table 4 (B4).

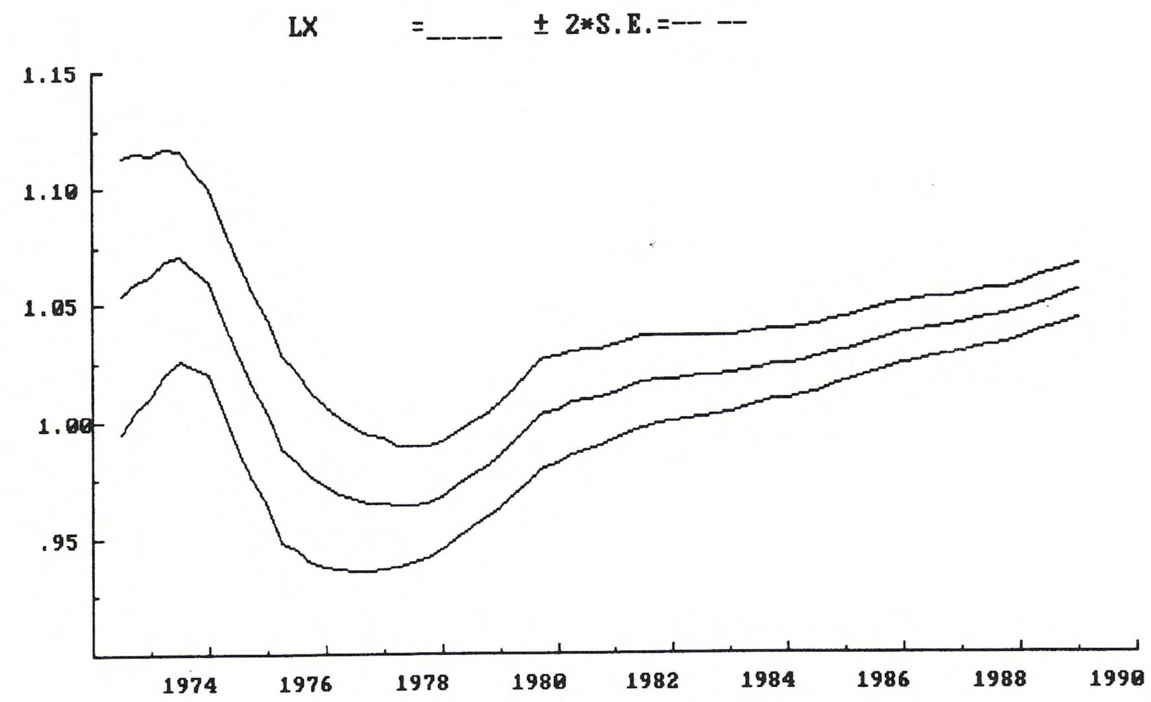

Figure 10. Recursive estimates of α_1 in the M2 equation in the simple model, Table 4 (B4).

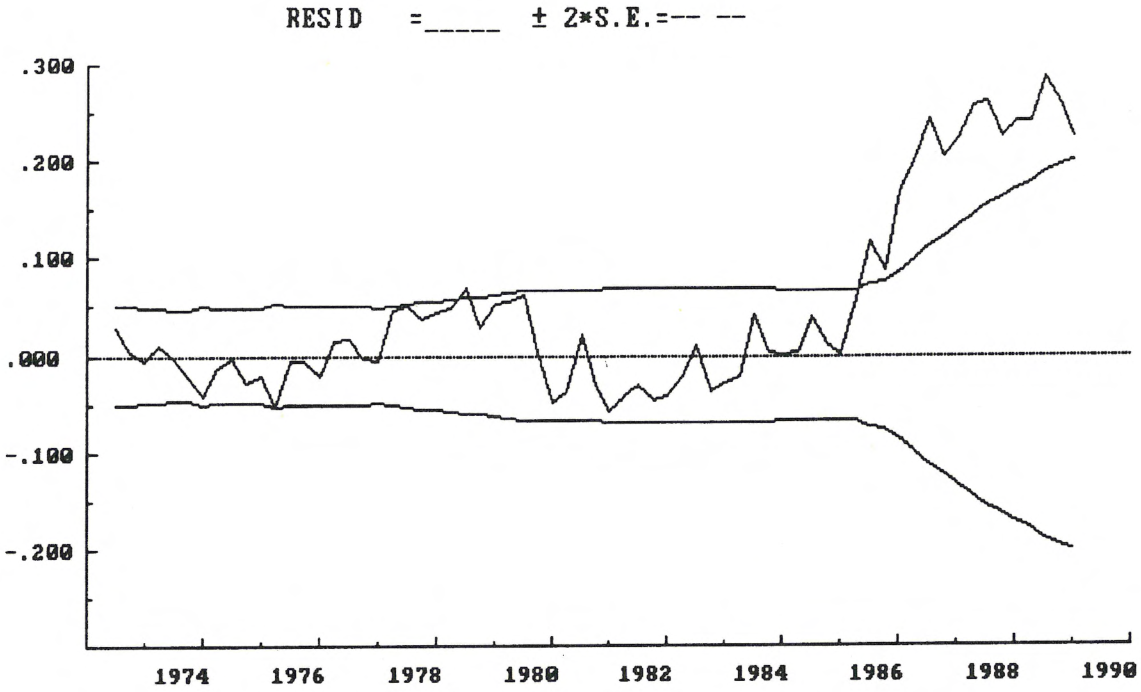

Figure 11. One–step residuals from the KA equation in the simple model, Table 4 (C4).

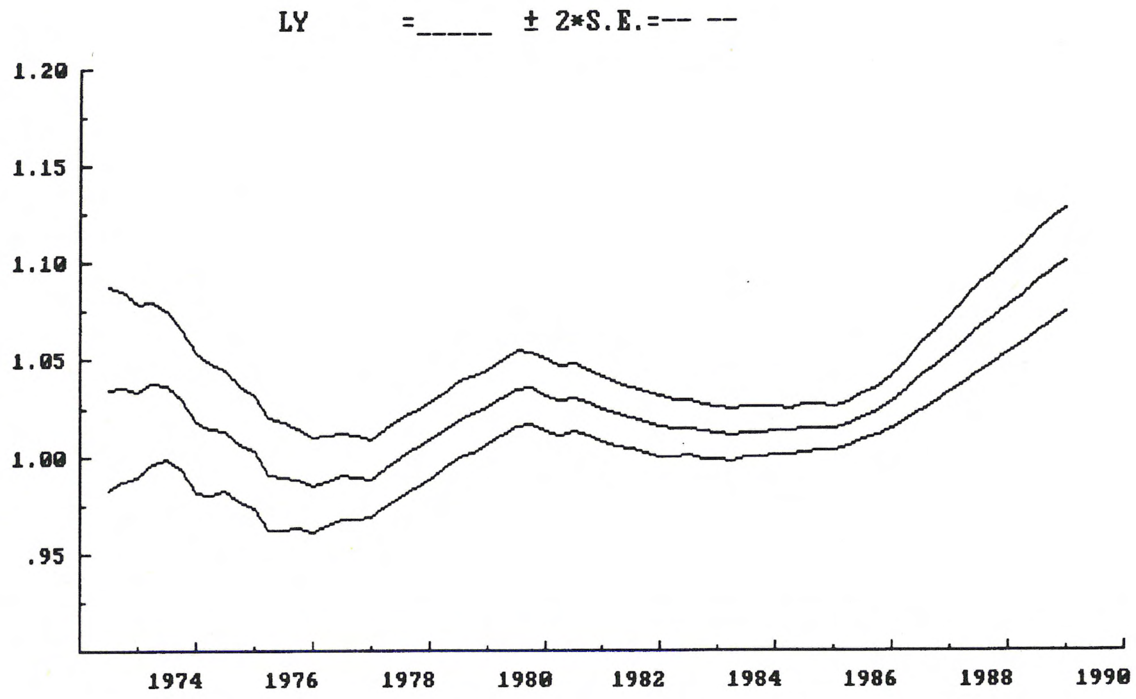

Figure 12. Recursive estimates of α_1 in the KA equation in the simple model, Table 4 (C4).

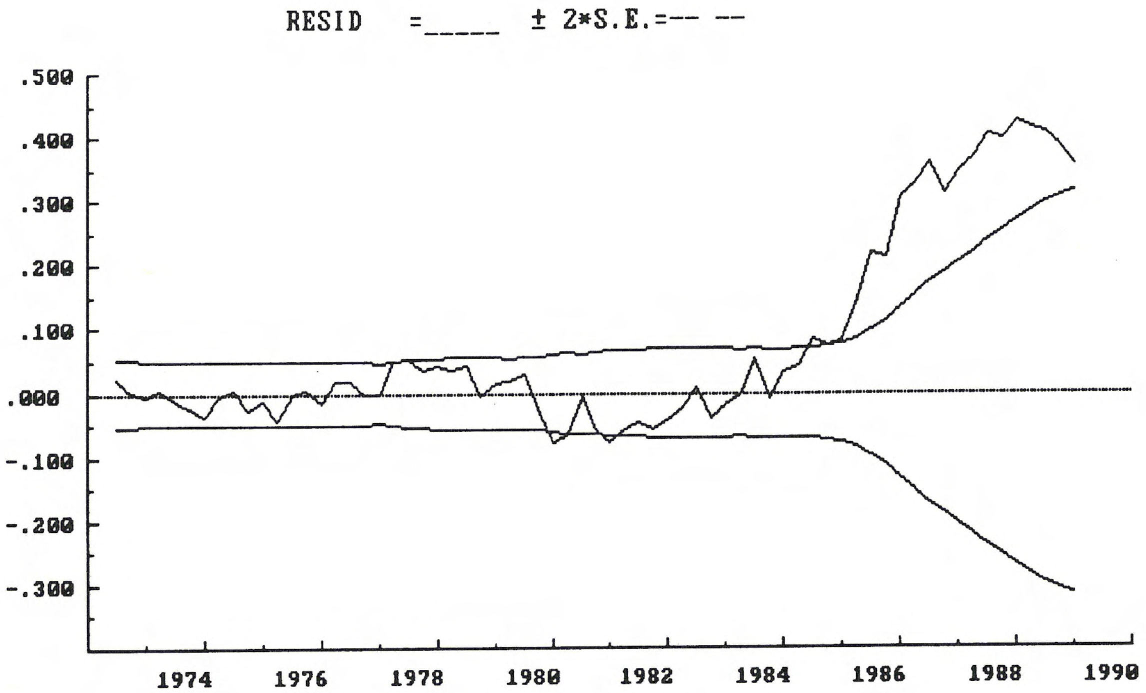

Figure 13. One—step residuals from the KB equation in the simple model, Table 4 (D4).

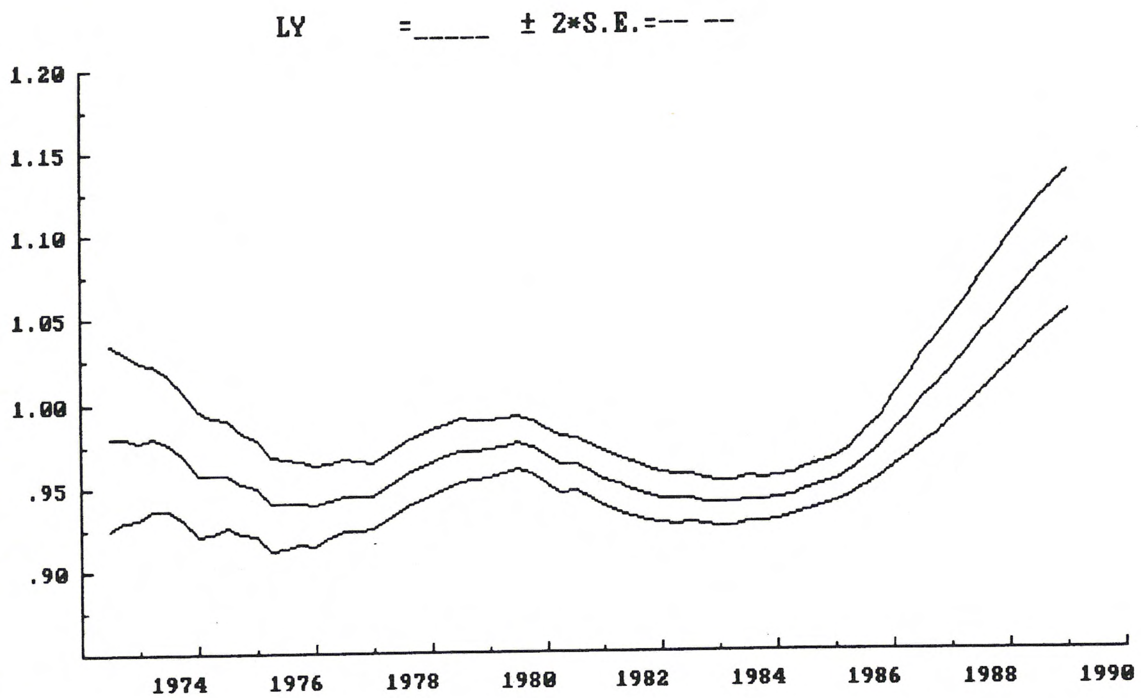

Figure 14. Recursive estimates of α_1 in the KB equation in the simple model, Table 4 (D4).

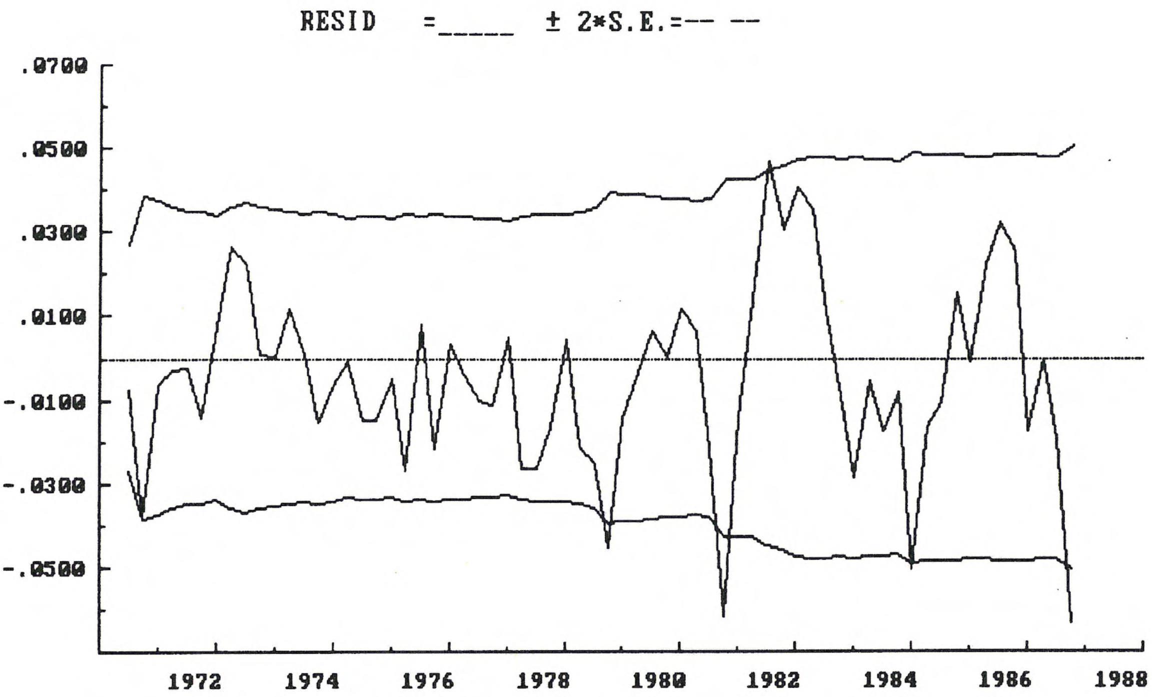

Figure 15. One–step residuals from the M1 equation in the augmented model, Table 5 (A4).

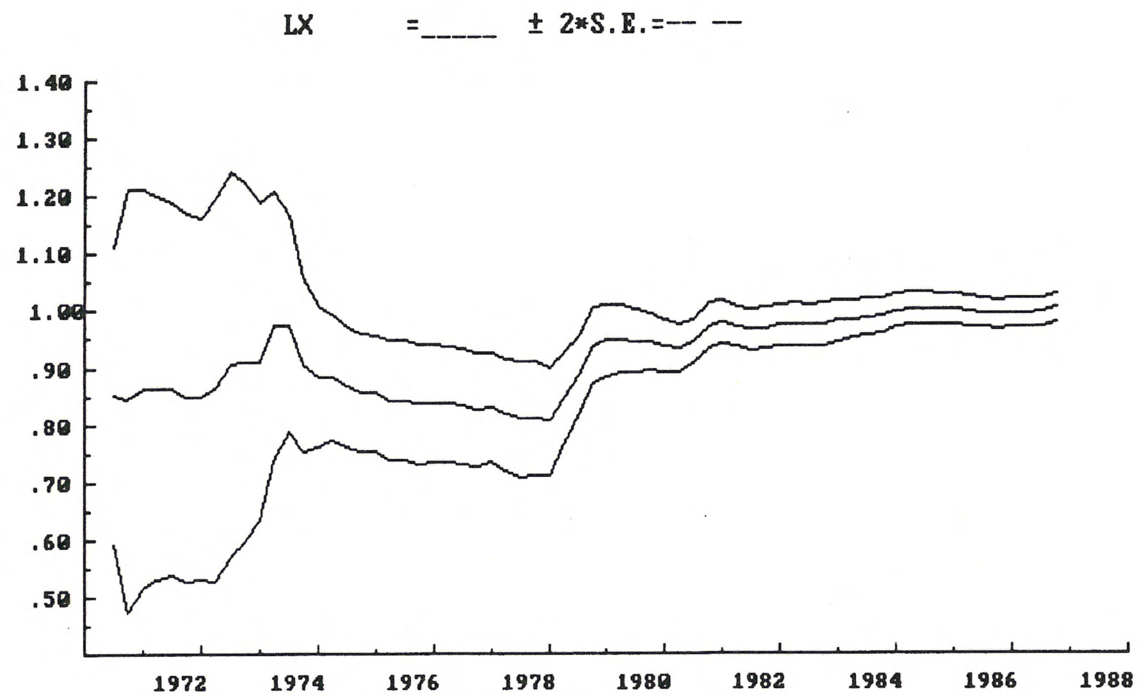

Figure 16. Recursive estimates of α_2 in the M1 equation in the augmented model, Table 5 (A4).

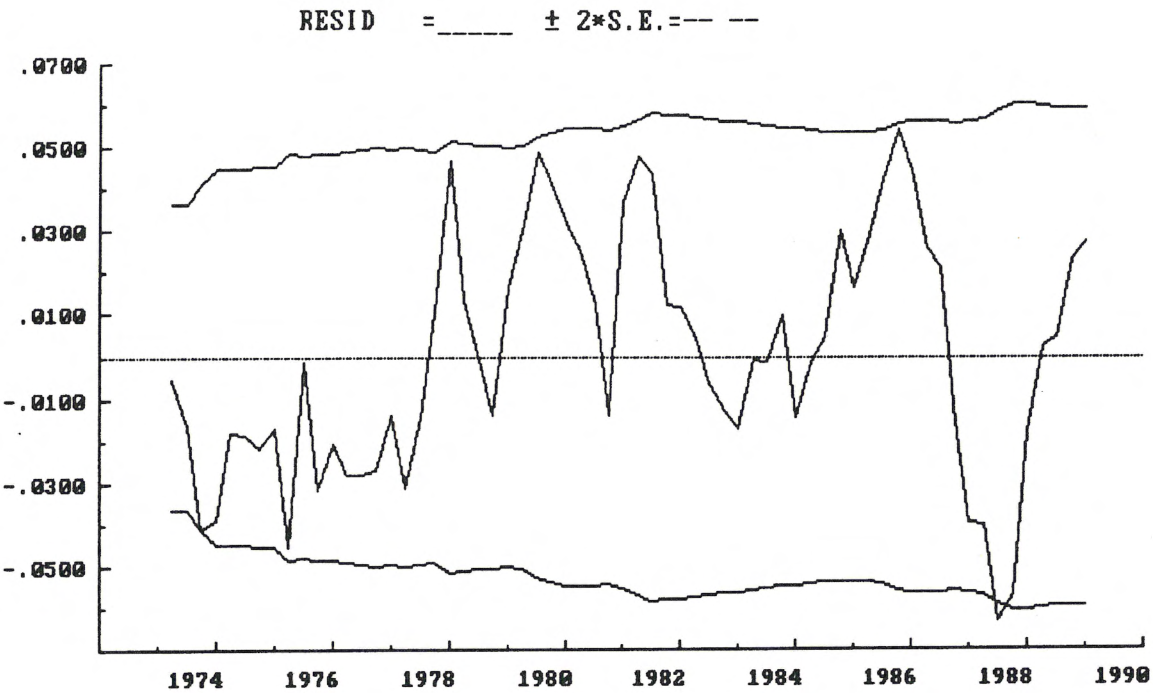

Figure 17. One–step residuals from the M2 equation in the augmented model, Table 5 (B4).

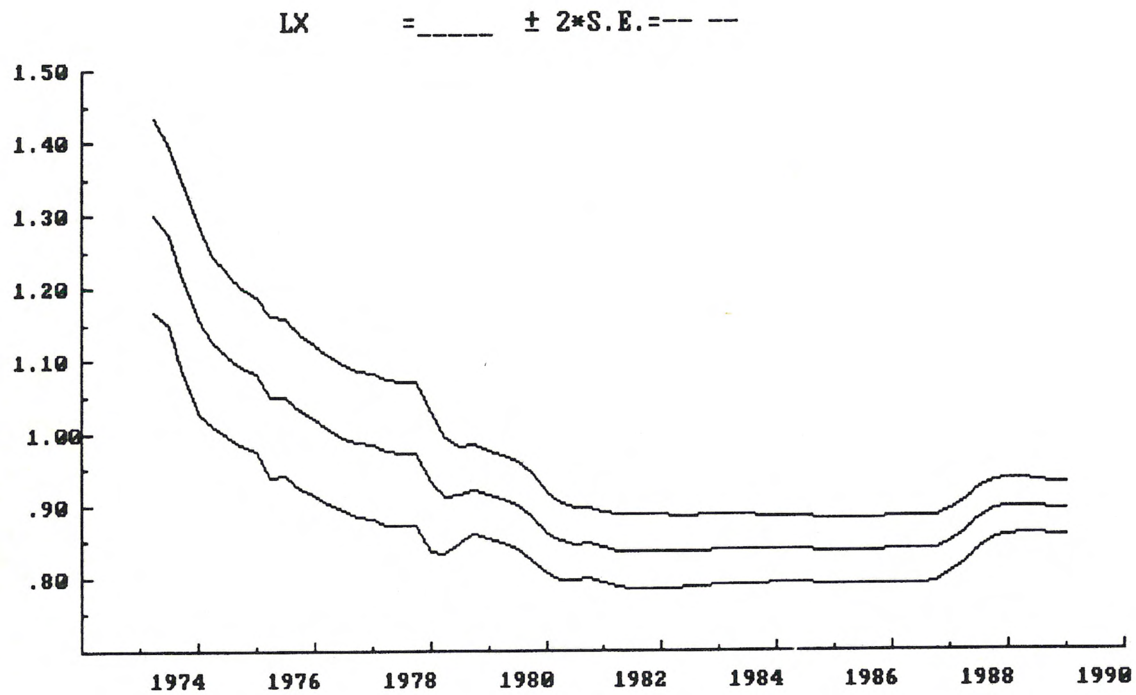

Figure 18. Recursive estimates of α_2 in the M2 equation in the augmented model, Table 5 (B4).

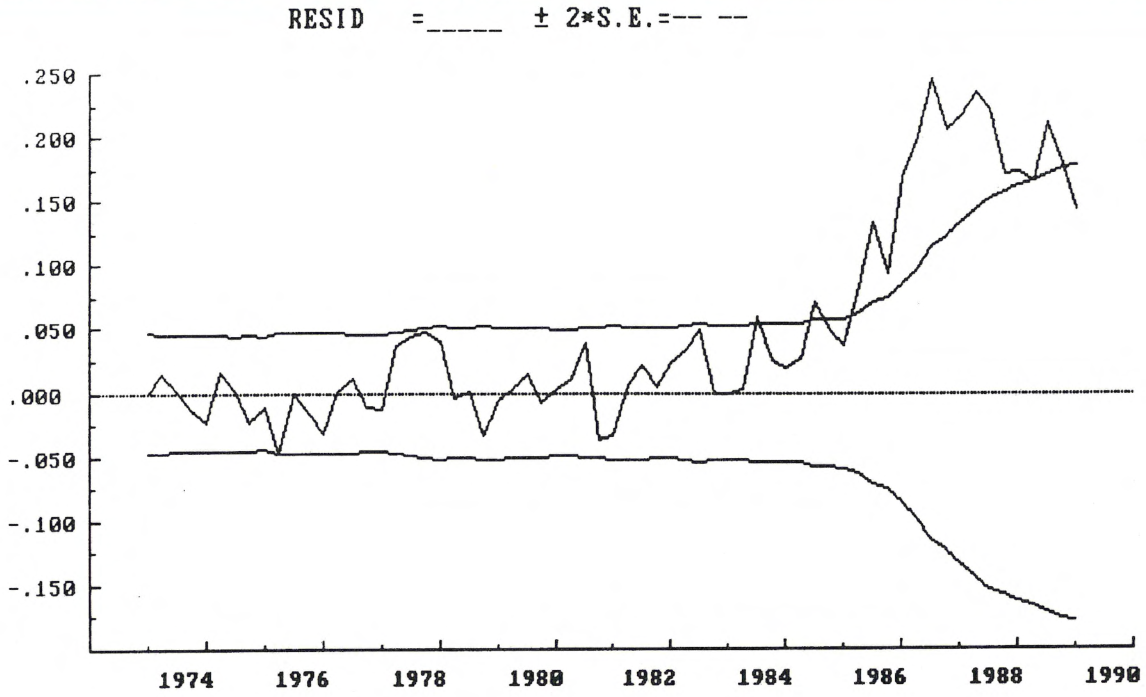

Figure 19. One–step residuals from the KA equation in the augmented model, Table 5 (C4).

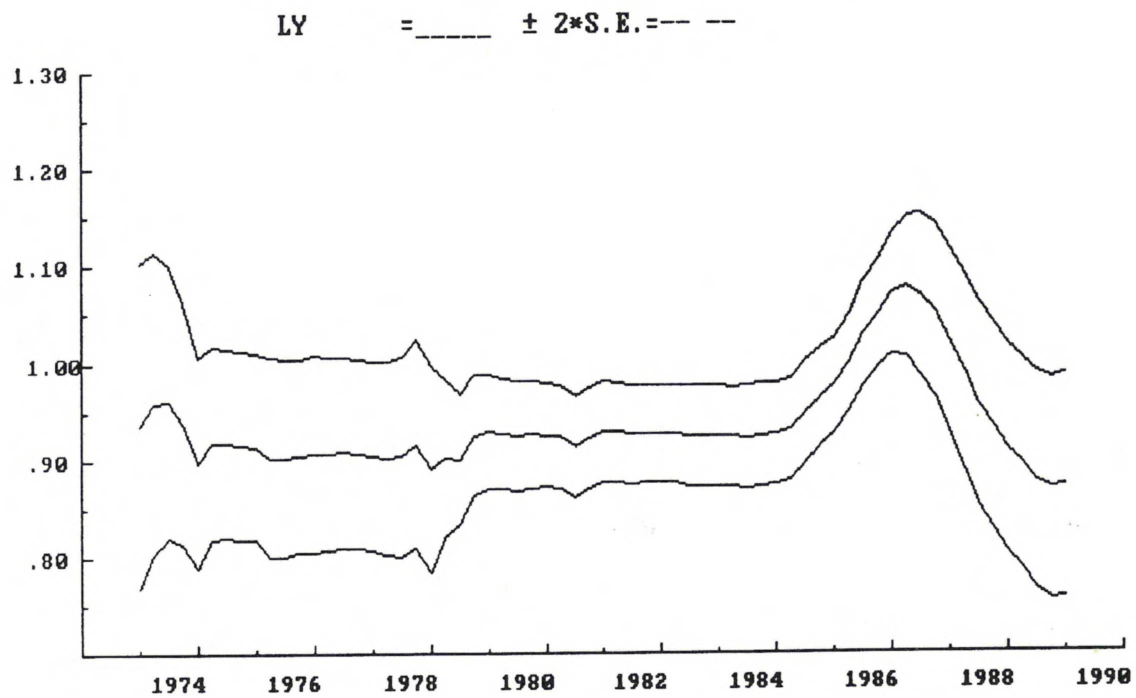

Figure 20. Recursive estimates of α_2 in the KA equation in the augmented model, Table 5 (C4).

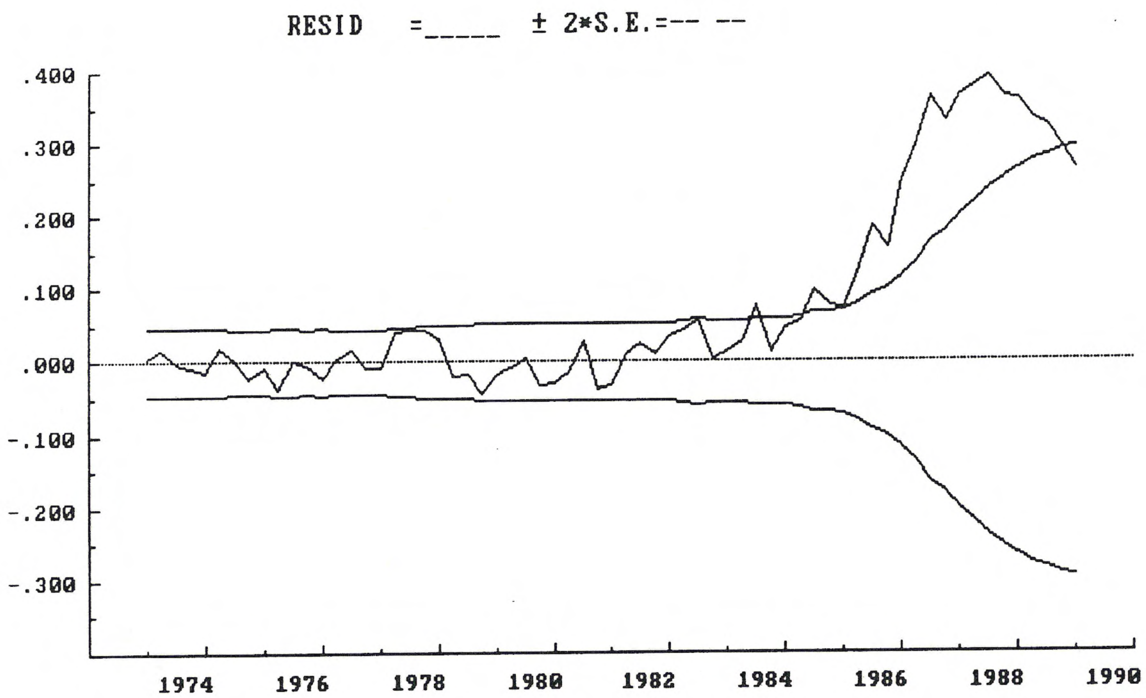

Figure 21. One–step residuals from the KB equation in the augmented model, Table 5 (D4).

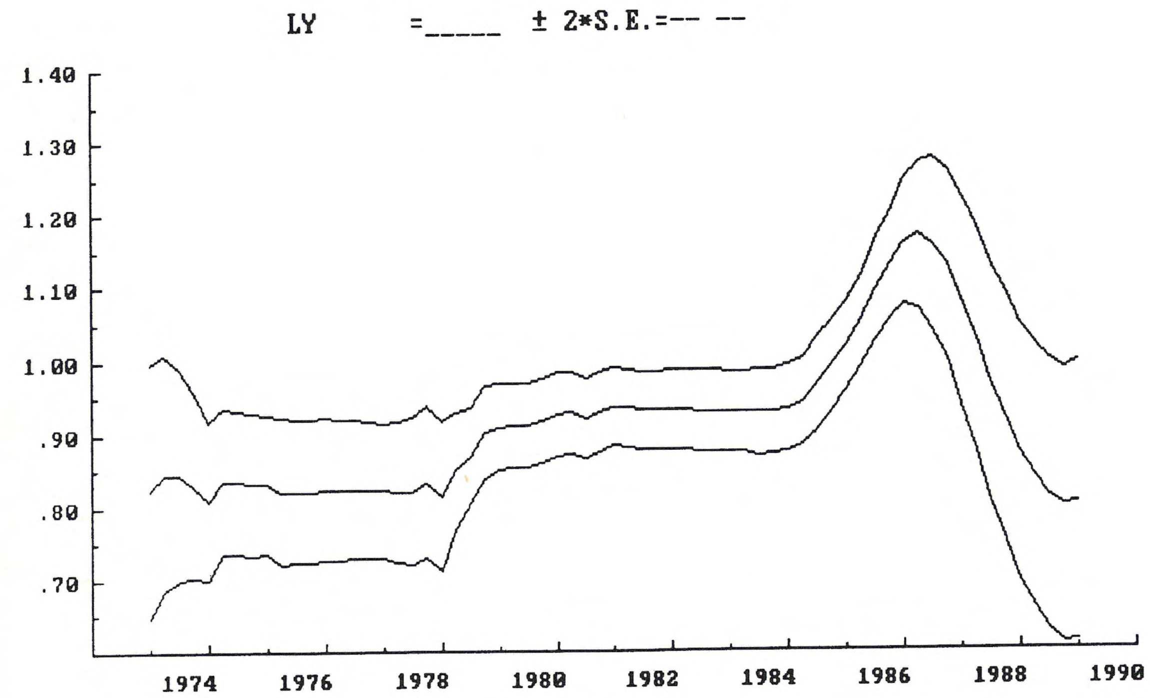

Figure 22. Recursive estimates of α_2 in the KB equation in the augmented model, Table 5 (D4).