Money Demand Regressions and Monetary Targeting Theory and Stylized Evidence*

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"After the thunderstorm of recent years,
it is with peculiar diffidence and even
apprehension that one ventures to open
one's mouth on the subject of money."
John Hicks, 1934

1. Introduction

The question whether the aggregate demand for money is a stable function of a few macroeconomic variables is one of the most important issues in the theory of monetary policy. The stability and predictability of this function is regarded a necessary condition for money, i.e. the central bank's monetary policy, to exert a predictable influence on the economy.

Because stability is merely an empirical matter, it is not surprising that a whole body of literature has been published especially since more sophisticated econometric methods have emerged. In 1973 Stephen *Goldfeld* examined the empirical issues of the demand for money systematically, and established what is still the standard money demand specification. Since *Goldfeld*'s seminal paper was published his specification has been criticized on several grounds. Indeed, when the specification is used for extrapolation purposes it doesn't seem to be very stable, and in different countries it seemed to break down around the mid-1970's, after having been pretty stable in the 1950's and 1960's. A couple of arguments have been found for explaining this instability. Most prominent among them were regulatory changes, financial innovations and the use of different definitions of right hand variables.[1]

This paper criticizes the *Goldfeld* approach in a somewhat different tradition, a tradition which emphasizes the role of monetary policy and (exogenous) money supply changes on *Goldfeld*-type specifications.[2] It is argued that the dissemination of a monetarist philosophy among central bankers in the early 1970's and the resulting switch to monetary targeting in a couple of countries of the industrialized world did not pass in silence over traditional empirical money demand specifications.

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[1] See *Judd/Scadding* (1982) or *Laidler* (1985) for an overview.

[2] On this literature, see, for example, *Gordon* (1984) and *Laidler* (1985a), among others.

After laying down the conventional set up (Section 2), Section 3 develops some theoretical arguments why *Goldfeld*-type regressions may have been influenced by the switch in monetary policy regimes in the mid-1970's. Section 5 presents the results of some regressions and stability tests for a pre- and a post-1973 sample with data from Switzerland. We have chosen this example because we regard monetary policy in Switzerland as a prototype to some extent, a point that is clarified in Section 4. We then try to gather some stylized evidence on the role of monetary policy in the two samples, i.e. regimes, with the help of vector-autoregressions and innovation simulations (Section 6). The last section is reserved for a summary and the conclusions.

2. The Conventional Specification

It is the usual practice when deriving an aggregate demand for money function to start with an individual liquidity preference equation:

$$m_{it}^{*} = \phi_i(x_{it}) + p_t \tag{1}$$

where m_{it}^{*} denotes the logarithm of money balances which an individual i wishes to hold at the end of period t. x is a vector of factors, like interest rates and some indicator for real income or wealth, that together determine the demand for real balances, and p is the logarithm of the general price level. Equations like (1) are generally referred to as desired or long-run demand for money.

Allowing for the possibility that individuals might be "off" their long-run demand function from time to time and assuming that this can be modelled with the help of a partial adjustment process, we get:

$$m_{it}^{d} = m_{it-1}^{d} + \gamma(m_{it}^{*} - m_{it-1}^{d}) \tag{2}$$

with

$m_{it}^{d} =$ log of actual or short-term demand in t
$\gamma =$ coefficient of adjustment

By inserting (1) into (2) we get an expression for the short-run demand for money (i.e. the amount of money an individual plans to hold at the end of period t):

$$m_{it}^{d} = \gamma\{\phi_i(x_{it}) + p_t\} + (1-\gamma)m_{it-1}^{d} \tag{3}$$

The short-run demand is again a function of the x's, the general price level, and the amount of money held at the beginning of the period.

The adjustment parameter γ can be given a pretty nice, although rather arbitrary structural interpretation. It can be shown to be a function of parameters

that are derived through a cost-minimizing procedure in which "costs of being out of equilibrium" and "costs associated with changes in the portfolio" are taken into account.[3]

Furthermore it should be noted that the partial adjustment assumption made above is only one of several ways with which to get the lagged endogenous variable into a reduced-form money demand equation.[4] This point is emphasized because lagged money has proven crucially important in money demand regressions although its theoretical justification stands on rather loose grounds.[5]

Equations like (3) make, as *Laidler* (1982) puts it, "... perfectly good economic (and econometric) sense. The price level and nominal interest rates are quite beyond the individual's control, and so is real income ... (B)eginning of period money is also exogenous from the point of view of current period behavior" (p. 45). Consequently there is only one variable which is under the individual's control, i.e. endogenous, and this is the individual's money holdings.

Things are different in a macro-economic context. In the macro literature *Chow*'s (1966) suggestion is usually followed that the aggregate demand for money can be modelled in a similar way as the demand for durable goods and therefore the aggregate demand for money is just assumed to be the sum of individual money holdings. This results in the following aggregate long-term relationship:

$$(m_t - p_t)^* = \phi(x_t), \tag{4}$$

where real balances now appear on the left-hand side leaving room for eventual adjustment of money market disequilibria through the general price level, and the assumption that people are more interested in real than in nominal money stocks. By assuming a partial adjustment scheme in real terms, i.e.

$$(m-p)_t^d = (m-p)_{t-1}^d + \psi\{(m-p)_t^* - (m-p)_{t-1}^d\} \qquad 0 \leq \psi \leq 1 \tag{5}$$

which shows, again, how much of the gap between actual and desired money holdings is closed between t and $t-1$, we get

$$(m-p)_t^d = \psi\phi x_t + (1-\psi)(m-p)_{t-1} \tag{6}$$

The demand for money is per se unobservable. This problem is in empirical applications usually resolved with the assumption of a permanent equilibrium in the money market, i.e. with the assumption that the demand for money at every point in time equals the actual money stock. The resulting money demand regression then looks as follows:

$$(m-p)_t = \psi\phi_1 y_t + \psi\phi_2 i_t + (1-\psi)(m-p)_{t-1}, \tag{7}$$

[3] See, e.g. *Feige* (1967).
[4] See again *Feige* (1967).
[5] See, e.g. *Laidler* (1982, 1984).

where the vector x is now broken up into its main determinants real income (y) and nominal interest rate (i). Identification problems encountered by estimating equations like (7) have until recently often not been dealt with explicitly.[6]

Equations like (7) are called *Goldfeld* equations after two seminal papers by Stephen *Goldfeld* (1973, 1976) whose general finding was that "... an equation in which the real stock of money balances (is) a function of real GNP, interest rates ..., and a lagged dependent variable ... both produced sensible parameter estimates and exhibited sufficient stability to be useful for extrapolation purposes" (1976, 685).[7]

Indeed, when such equations are estimated using data generated from relatively tranquil economic periods, such as from the early 1950's to the early 1970's, they provide results that are quite in accord with economic theory. This is in sharp contrast to estimation results with data from the mid-1970's onwards. This period which brought the advent of flexible exchange rates, high and volatile inflation, huge supply shocks and accordingly erratic swings in economic activity, and in which the major central banks began to adopt a monetarist sort of philosophy towards monetary policy, results in money demand regressions that cast doubt on specifications like (7).

Similar problems with conventional money demand regressions have emerged in a number of countries in the 70's and 80's. According to *Judd/Scadding* (1982) they have led to two strands of research on money demand. The first has emphasized the role of financial innovation and banking deregulation on money demand behavior and has tried to reformulate the conventional money demand regressions to incorporate the respective developments.[8] The second strand has "reopened the pre-1973 agenda" on empirical money demand issues and has developed different alternative lines of arguments. One of these was to put emphasis on the role of money supply shocks and the "buffer stock" notion as emphasized by e.g. *Carr/Darby* (1981), *Laidler* (1984) or *Knoester* (1984). Another line presented theoretical models as alternatives to the *Baumol/Tobin* approach on which the conventional specification is, in principle, based.[9] Finally there is a third line of inquiry which explicitly deals with general specification problems of

[6] See *Cooley/Leroy* (1982) or *Laidler* (1985a). Earlier studies supported the tendency to ignore these identification issues by reporting income and interest rate elasticities of money demand equations that were estimated within complete structural models. The respective elasticities were practically identical to the estimates from single equation regressions.

[7] Some authors have objected to the use of an adjustment mechanism in real terms as in (5), because it implies a lagged adjustment of money demand to changes in income and interest rates but an instantaneous adjustment to a price level change (*Goldfeld*, 1976). Such authors often argue in favor of a nominal adjustment process. The resulting short-term money demand function in such a framework is only slightly different from (7). The difference is related to the last term which becomes $(m(t-1)-p(t))$ instead of $(m(t-1)-p(t-1))$.

[8] Papers that belong into this group are, e.g. *Goldfeld* (1976), *Lieberman* (1978), *Porter/Offenbacher* (1983), *Enzler/Johnson/Paulus* (1976), *Porter/Mauskopf* (1978), and *Hafer/Hein* (1982), to name just a few. For more exhaustive references on this strand of the literature, see *Roley* (1985) or *Judd/Scadding* (1982).

[9] E.g. *Akerlof* (1979), *Santomero/Seater* (1981), among others.

the *Goldfeld* approach like identification, use of alternative endogenous variables, the general role of monetary policy and so on.[10]

Whereas the first strand of literature in resolving the often mentioned "missing money puzzle" has broadly been discussed in papers e.g. by *Laidler* (1980) or *Roley* (1985), the purpose of the next section is mainly to discuss some of the issues brought forward by the second strand and especially the role of monetary policy in estimating money demand regressions.

3. Specification Problems

The first issue originates in the procedure of treating money demand functions in macro-variables as though they were simply aggregates of the micro-relationships. Criticism of this procedure is far from new. Indeed *Walters* (1967) argues that

> "It is clear that micro-relations, when aggregated to the macro-equation, must have their chain of causation reversed; independent variables become dependent variables, and the dynamic adjustments must be reversed." (p. 293)

He further argues that a (conventional) aggregate money demand regression is in the correct form as long as transactors as a whole can get as much money as they want at current income and interest rates. Although *Walters'* arguments are not fully applicable to the *Goldfeld* specification, since the latter is usually expressed in real terms, it is quite clear that the *Goldfeld* specification is not meant to be a price equation and that conventional models of monetary economics do not assume a fully passive role of monetary authorities and the money stock as implicitly assumed in the conventional set-up. In these analyses money is largely the independent variable and the chain of causation is primarily from the money stock to income and interest rates and not vice versa.[11]

These arguments might have been less important under a monetary regime with fixed exchange rates and interest rate targeting like in the 50's and 60's where changes in the money stock were often induced through the commitment to defend a certain exchange rate. But they have probably become much more important with the advent of flexible exchange rates and the subsequent emergence of a monetary policy philosophy that defines monetary targeting as its centerpiece. Through this the money supply – and to a great extent the real money stock, too – might have become much more exogenous (in a statistical sense) then is consistent with *Goldfeld*-type equations. This might be one of

[10] Some of the work that might belong in this group is *Walters* (1967), *Laidler* (1980), *Cooley/Leroy* (1981), *Gordon* (1984), *Goodfriend* (1985) or *Andersen* (1985).

[11] St. Louis-type equations are one point in this line of arguments. Others are mentioned in, e.g. *Gordon* (1984).

several reasons why the conventional specification may have gone off the track in the mid-1970's.

Another reason to explain some of the money demand puzzles encountered in the 1970's and 1980's is based on the "buffer stock" notion as summarized for example by *Knoester* (1984) or *Laidler* (1984). The core of this theory rests on the assumption that money holdings might not only serve as a buffer against real shocks as recognized in the precautionary motive, but also as an absorbing device for monetary shocks, so that the money market might remain in disequilibrium for a certain period of time. Empirical work in this tradition tries to identify such money supply shocks and to include them as separate regressors into *Goldfeld*-type regressions.[12] Monetary shocks can emerge in every sort of monetary environment, even in a strict price regime. We believe, however, that they have become much more important since the advent of monetary targeting because very often a strict target has in fact been declared but is disregarded in favor of monetary wavering.[13] The major point is that if monetary shocks result in money market disequilibria that are not instantaneously eliminated through changes in the arguments of the demand function or the aggregate price level (i.e. if money is a buffer), this necessarily results in shifts and/or statistical instabilities of conventional money demand regressions that must be interpreted as instability of the public's liquidity preference. The more such disturbances occur, the less stable the demand for money seems to be.

The above considerations with regard to the *Goldfeld* equation are merely based on intuitive reasoning about money demand behavior. On the following pages a simple model is presented to reveal what implications a switch from a price rule (i.e. exchange rate or interest rate stabilization policy) to a monetary base rule might have for *Goldfeld*-type money demand regressions.[14]

Take the following money market model:

$$m_t^d - p_t = \alpha_1 y_t + \alpha_2 i_t + \varepsilon_t^d \tag{8}$$

$$m_t^s = \beta_1 b_t + \beta_2 i_t + \varepsilon_t^s \tag{9}$$

$$m_t^s = m_t^d \tag{10}$$

$$\alpha_1, \beta_1, \beta_2 > 0; \quad \alpha_2 < 0 \tag{11}$$

[12] For a brief description of empirical work in this tradition see *Andersen* (1985).

[13] The intuition for the existence of monetary shocks in e.g. a regime of interest rate stabilization stems from *Brunner/Meltzer* (1976). If apart from money and commodity markets a distinct market for bonds (credit) exists, an exogenous increase in the demand for credit by private enterprises might raise the money supply because of the upward pressure on interest rates. This change in the money supply is considered an exogenous shock because it is not accommodated in the short run by any change in the demand for money. For a further discussion of this point see *Judd* (1983), *Judd/Scadding* (1982).

[14] The approach was suggested in *Gordon* (1984). Similar approaches were used in *Roley* (1985) or *Roley/Walsh* (1985).

(8) is a conventional demand function for real balances (ε_t^d is an error term, and the other arguments are the same as above). (9) is the money supply function in which the nominal money stock (m_t) is related to the monetary base (b) and the interest rate (ε_t^s is a supply specific error term; m and b are, as all variables in the model except the interest rate, in logarithmic form). (10) and (11) contain the equilibrium condition and the parameter signs, respectively.

A price regime can be represented by assuming that the central bank fixes the interest rate at some desired value (i^*), i.e.

$$i_t = i_t^* + \varepsilon_t^i, \tag{12}$$

where the error term ε_t^i is to indicate that the central bank cannot control the market rate perfectly at every moment in time.

Inserting (8) und (9) into (10) and implementing the interest rate rule (12) yields, with some rearrangements:

$$m_t^s - p_t = \alpha_1 y_t + \alpha_2 i_t^* + \varepsilon_t^d + \alpha_2 \varepsilon_t^i \tag{13}$$

with the parameter signs as in (11). (13) is a sort of conventional equation with the real money stock being fully endogenous with respect to the arguments and the error term of the demand equation (8) plus the error term of the interest rate equation. Apart from possible estimation problems that might result from correlation between the error terms ε_t^i and ε_t^d (*Gordon*, 1984, 417), a single-equation regression like (13) would in this monetary environment allow the identification of the parameters of the demand function.

Such a procedure becomes critical if a central bank pursues a feedback rule through the monetary base as will be shown below. If we assume that the monetary base responds to output and inflation in a countercyclical way, we can write:

$$b_t^* = \psi_1 y_t + \psi_2 (p_t - p_{t-1}) \tag{14}$$

with $\psi_1, \psi_2 < 0$ and b^* the desired base.

Due to information problems for the central bank, we might furthermore assume a partial adjustment of the actual base to the desired value, i.e.

$$b_t - b_{t-1} = \phi (b_t^* - b_{t-1}) \quad 0 \leq \phi \leq 1 \tag{15}$$

Inserting (14) into (15) yields:

$$b_t = \phi \{\psi_1 y_1 + \psi_2 (p_t - p_{t-1})\} + (1 - \phi) b_{t-1} \tag{16}$$

Using (9) to substitute for b_{t-1} in (16) we again get, after some rearrangements, an expression that determines real balances:

$$(m_t^s - p_t) = \gamma_1 y_t + \gamma_2 i_{t-1} + \gamma_3 p_{t-1} + \gamma_4 (p_t - p_{t-1}) + \gamma_5 (m_{t-1}^s - p_{t-1}) + \gamma_6 \varepsilon_t^s + \gamma_7 \varepsilon_{t-1}^s + \gamma_8 \varepsilon_t^d \tag{17}$$

with the following parameter restrictions:

$$\gamma_1 = \xi\left(\beta_1 \phi \psi_1 - \frac{\alpha_1}{\alpha_2}\right)$$

$$\gamma_2 = \xi[\beta_2(1-\phi)]$$

$$\gamma_3 = \xi\phi$$

$$\gamma_4 = \xi(1 - \beta_1 \phi \psi_2)$$

$$\gamma_5 = \gamma_7 = \xi(1-\phi)$$

$$\gamma_6 = \xi = \left(1 - \frac{1}{\alpha_2}\right)^{-1}$$

$$\gamma_8 = -\xi \alpha_2^{-1}$$

Real balances are again determined by the variables that appear in the *Goldfeld* equation – real output, interest rates, prices and lagged money. The difference between (17) on the one hand and (7) or (13) on the other is that the former includes the inflation rate as an additional regressor and a much more general lag structure – points that have been suggested elsewhere in the literature, too (see, e.g. *Andersen*, 1985; *Gordon*, 1984).

The parameter restrictions in (17) show that the coefficients of a single-equation regression cannot be used to identify the parameters of the money demand function. Other than in (13), they now depend on the parameters both of the demand and the supply function, so that a single-equation approach would not identify the demand for money but some mixture of demand and supply function. An inspection, for example, of the income coefficient in (17) shows that this parameter can become negative under special circumstances, and the other coefficients can just as easily have signs that might seem counterintuitive when a sort of *Goldfeld*ian world is taken as a basis.

The implications seem obvious. *Goldfeld*-type regressions in which the real (or nominal) money stock is regressed on interest rate and real income or wealth variables and lagged money, can identify the demand for money only as long as a passive monetary policy in the sense of a price – i.e. interest or exchange rate stabilization – policy is pursued. As soon as the money stock is explicitly considered a policy variable and the price level is not perfectly flexible, the real money stock is not as endogenous as the *Goldfeld* approach assumes. Therefore statistical instabilities of *Goldfeld*-type regressions do not necessarily indicate

instabilities in the public's liquidity preference. They are as likely to tell us about shifts in monetary policy.

This result conforms well with the implications of, for example, *Goodfriend*'s (1985) "measurement error view" or the points discussed in papers like *Cooley/Leroy* (1981) or *Laidler* (1985a) that concentrate on identification issues.

4. Swiss Monetary Policy in the 70's and 80's: an Exceptional Case

Although the above arguments limit the usefulness of conventional money demand regressions under monetary targeting in general, the degree of limitation is probably dependent upon the operating regime pursued for money stock control.

Unlike most central banks in the West, the Swiss National Bank (SNB) has been targeting the monetary base since 1975.[15] By using the base as an (exogenous) policy instrument the SNB explicitly accepts the resulting interest rate fluctuations which, by international standards, are considerable in Switzerland. Most other central banks that follow money stock control procedures try to attain their targets by fixing a supply price or general interbank market conditions. Under such circumstances the monetary aggregates are still much more endogenous than in the Swiss case and the above criticism of the *Goldfeld* specification is less obvious.[16]

The switch to monetary targeting became technically possible with the advent of flexible exchange rates in 1973. Until then the Swiss money stock was – in the above terms – a fully endogenous variable even in the short run. The obligation to defend a fixed exchange rate implied that the money stock changed whenever the public so desired. The then non-existence of a relevant short-term credit market, i.e. the lack of adequate weapons for neutralizing newly created money, implied that the SNB simply had to accept the macroeconomic consequences of exchange rate pegging.[17]

In January 1973 the SNB stopped intervening in the foreign exchange market and allowed the Swiss franc to float. The SNB management and the Federal Council agreed that a continued pegging of the exchange rate especially against the US dollar would have required further and exceptionally large purchases of

[15] From 1975 to 1978 the published target was M1, but even then it was the monetary base which was used as the prime instrument of monetary policy. Since 1980 the target itself has been set in terms of the monetary base. We shall come back to these issues below.

[16] For a comparison of such "base" versus "price regimes" for money stock control, see *von Hagen* (1986).

[17] A review of the monetary situation of Switzerland in the 1960's and early 1970's is given in *Yeager* (1981).

foreign currency resulting in a further expansion of the domestic money supply and corresponding consequences for inflation.[18]

This about-face was a significant political event. It put the SNB firmly in control of the domestic money stock and strengthened its ability to fight inflation. Or, as representatives of the SNB put it:

> "After the fetters of the fixed exchange rate had been removed, the SNB was able to put teeth into its restrictive monetary policy." (*Rich/Beguélin*, 1982)

The SNB's record of monetary targeting over the last 15 years is quite impressive, at least compared with the success of some other central banks.[19]

Problems were encountered between 1978 and 1981, and now again to some extent in 1987. The massive undervaluation of the US dollar in spring and summer 1978 posed the danger of a dramatic slump in economic activity in Switzerland (exports account for about 40 % of GNP in Switzerland!). In order to avert a recession the SNB reluctantly decided to replace temporarily the target for M1 by an exchange rate target. This resulted in an immediate explosion of the domestic money stock and induced the bank not to announce an M1 target for 1979. Furthermore the SNB changed its strategy in the following years and switched from an M1 target to a target for the monetary base. Although the monetary base is more or less under the full control of the SNB, it (again) did not succeed in hitting the target in 1980 and 1981. These deviations apparently stemmed from underprediction of the inflationary consequences of the monetary expansion in 1978, but the SNB emphasizes that "... all the deviations from the target reflect *explicit policy decisions* rather than imperfections in the control procedure" (*Rich/Beguélin*, 1982, 16, emphasis added).

The point to be emphasized in our context is that Swiss monetary policy over the last 20 years provides two rather different monetary regimes with a clearcut change from a sort of price regime to a quantity regime. In the first period (pre-1973) – to come back to our main theme – a traditional formulation of the short-run demand for money function appears to be reasonable since the supply of money passively accommodated itself to changes in demand. In the second regime (post-1974), a period with flexible exchange rates and growth and feedback rules for monetary aggregates, the conventional specification probably makes much less sense because the real money stock was just not the fully endogenous variable the *Goldfeld* specification wants it to be.

[18] To quote a few numbers, foreign exchange market interventions resulted in money supply growth figures of 36.2 % annual rate in the fourth quarter of 1971, and the inflation rate was 7 % in 1972, 9 % in 1973 and reached double digit numbers in 1974.

[19] From a technical point of view the SNB was in a good position to conduct a monetarist sort of policy because it had relatively tight control over the whole banking system in Switzerland. For a detailed description of Swiss monetary policy over the last 15 years, see *Rich/Beguélin* (1982) or *Rich* (1984). For technical details see *Kohli/Rich* (1985) or *Lusser* (1985).

Conventional money demand regressions have probably been influenced in most countries of the western world by the change in monetary policy philosophy that took place around the mid-1970's.[20] But this is presumably most obvious in a case like Switzerland, where (i) the record of monetary targeting is relatively long and successful, and (ii) the target aggregate, i.e. the monetary base, is under full control of the central bank and is set regardless of possible interest rate changes.

5. Empirical Results I: the Conventional Approach

In order to check whether the data generating process for the real money stock has indeed changed with the move to monetary targeting in Switzerland, we have first estimated *Goldfeld*-type regressions for an overall period ranging from 1965 to 1984, and then for two subperiods i.e. regimes, ranging from 1965 to 1972 and 1973 to 1984, respectively. We have then checked the stability properties of these equations using some conventional stability tests like rolling regressions, *Chow* tests and Cusum/Cusum-Square statistics.

In order to further examine some of the instabilities that seemed to appear in the second subperiod, we then looked at whether alternative specifications that have been recommended in the literature to deal with the instabilities in US money demand, could handle some of the problems in the Swiss case, too. All the exercises were performed separately with monthly and with quarterly data. The following pages provide some of the main results.[21]

The first tests that were carried out were based on the following (*Goldfeld*) specification:

$$\log\left(\frac{M1}{P}\right)_t = \alpha_0 + \alpha_1 \log(Y)_t + \alpha_2 IS_t + \alpha_3 IL_t + \alpha_4 \log\left(\frac{M1}{P}\right)_{t-1} \tag{18}$$

Table 1 contains the regression results for quarterly data and the three sample periods. P is the GNP deflator (PDEF) and the indicator for real income or wealth (Y) is either real GNP (BSPR) or the index of industrial production (IP).[22]

The table exhibits rather conventional results for the overall sample period and especially for the first subsample from 1965 to 1972. In the latter period we get significant income elasticities of which the long-run values are not too

[20] A recent OECD study for example says: "Where instabilities of money demand were clearly identified, they seem often to have been associated with those aggregates which were importantly affected by changes in the techniques of monetary control ..." (*Blundell-Wignall* et al., 1984, 17).

[21] Space limitations forbid a presentation of all the results in this paper. Interested readers are referred to *Heri* (1986).

[22] Details about the data and their sources are given in the appendix.

Table 1

Conventional money demand regressions with quarterly data

Brackets below the coefficients contain the standard errors. * (**) denote significant coefficients at 90 % (95 %) significance level. The ε denote the long run elasticities, h is *Durbin*'s h and P is the adjustment lag for 90 % adjustment.

Sample Period	BSPR	IP	IS	IL	$(\frac{M1}{PDEF})_{t-1}$	R^2	h	ε_Y	ε_{IS}	ε_{IL}	P
65/2-84/4	0.049 (0.040)		-0.006** (0.001)	-0.003 (0.004)	0.831** (0.049)	0.93	1.33	(0.30)	-0.04	(-0.02)	12.4
		0.114** (0.047)	-0.006** (0.001)	-0.007 (0.005)	0.765** (0.056)	0.94	1.47	0.49	-0.03	(-0.03)	8.6
65/2-72/4	0.475** (0.128)		-0.003 (0.002)	-0.030* (0.010)	0.504** (0.120)	0.97	0.26	0.90	(-0.01)	-0.06	3.4
		0.456** (0.126)	-0.004** (0.002)	-0.037* (0.016)	0.485** (0.127)	0.97	0.52	0.89	-0.01	-0.07	3.2
73/1-84/4	-0.103 (0.131)		-0.003 (0.004)	-0.013 (0.004)	0.778** (0.072)	0.92	0.20	(-0.47)	(-0.02)	(-0.06)	9.2
		0.064 (0.103)	-0.007* (0.003)	-0.007 (0.007)	0.791** (0.069)	0.92	0.67	(0.31)	-0.03	(-0.03)	10.0

far from unity, and small negative interest rate (semi-)elasticities. The coefficient of around .5 for lagged money implies reasonable small adjustment lags of less than one year for 90 % adjustment. All these parameters seem reasonable and they are in accordance with results of earlier work for this period.[23]

The regression results for the second subsample (1973 to 1984) require quite a different interpretation. From the six coefficients (other than the ones for lagged money) that appear in the above table only one remains (slightly) significant. The coefficient for the lagged money stock is around .8 and the adjustment lag is tripled compared with the first subsample.[24] From all these results and from further regressions with monthly data which cannot all be reproduced here, one gets the feeling that something is basically wrong with *Goldfeld*-type specifications in the second subperiod.

For a further examination of this hypothesis we conducted a couple of stability tests. Most of the results of these tests which are given in detail in *Heri* (1986) are unambiguous and point again towards significant structural changes in the relationships investigated. This impression is furthermore strengthened by a look at ex ante forecasts which result in similar "missing money puzzles" as reported

[23] See *Vital* (1978).

[24] Use of M2 and M3 instead of M1 resulted in similar results for the second period. But for the first the results were much worse, with adjustment lags of around 40 quarters. Practically identical results as above were attained when assuming partial adjustment in nominal instead of real terms.

in *Goldfeld* (1976) for US money demand, and in the results of so-called "rolling regressions".

The results presented so far seem to suggest clearly that there is something basically wrong with a *Goldfeld*-type equation for modelling the real money stock in Switzerland between 1974 and 1984. Interestingly enough, however, regressions that are based on a period encompassing the fixed exchange rate regime (like the ones for the overall period from 1965 to 1984 in the above tables) often do not perform that badly and seem to confirm a *Goldfeld*-type procedure. This is the reason why other investigators of Swiss money demand over the last 20 years who used sample periods encompassing both regimes and did not check explicitly for a structural change around 1974 are much less skeptical about the conventional set-up than we are.[25]

Although we expose some problems with conventional specifications above, the results per se give no indication whatsoever as to the source of these problems. In the next section we try to shed some light on this question.

6. Empirical Results II: Stylized Evidence from Vector-Autoregressions

To deal with the "missing money" and other puzzles in US money demand the literature has produced several suggestions that have been tried out for Switzerland, too. Most prominent among these suggestions are the inclusion of exchange rate expectations in the conventional specification to deal with the so-called currency substitution arguments[26], the use of a rate of return on real assets like the dividend/price ratio[27], or a specification in first differences as in *Hafer/Hein* (1982). None of these alternatives resolve the problems of Swiss money demand regressions in specifications like (17).[28] Furthermore, different "buffer stock" specifications were tested. In these, the shock variable has proven to be highly significant and bears the right sign in every case. However, the results for the other variables were practically unchanged. Due to this and due to the technical problems with such an approach (see *MacKinnon/Milbourne*, 1984) we do not attach too much weight to these regressions and do not present them here.

As an alternative, a rather unstructural approach has been pursued here. In order to learn "what the data are trying, to tell us", we have estimated relatively unrestricted vector-autoregressions (VAR) for the two different sample periods,

[25] See, for example, *Kohli* (1985a) whose regressions are based on the period from 1968/1 to 1982/4.

[26] See *Miles* (1978), *Brittain* (1981), *Cuddington* (1982, 1983), among others.

[27] *Hamburger* (1977). See, however, *Hafer/Hein* (1979).

[28] See *Heri* (1986).

i.e. regimes. In order to get some clue as to what the role of the supply side might be in determining the money stock in the two regimes, we have included, in addition to the variables in the regressions above, the monetary base as a VAR system variable. Furthermore, we have calculated variance decompositions and response functions for money to impulses coming from other macroeconomic variables.[29] These VARs are under no circumstances supposed to find anything like a correct specification of a demand for money regression. All they do is compare the multivariate time series properties of the money stock in the two regimes, and thereby shed light from an empirical point of view on the question whether simple *Goldfeld*-type specifications can be used equally well in both regimes, in order to get to know what the underlying liquidity preference might look like. The method is designed explicitly to "view" or characterize a dynamic system without a priori forcing particular patterns of interactions among a set of variables. As such it seems to fall outside a *Popper*-type analysis. There are no specific theories to be tested, and thus there are no "crucial" experiments by which a theory can be falsified. However, the empirical regularities uncovered by a VAR can give interesting information on points such as the ones discussed above.

Technically, a VAR is a tool for compactly summarizing the relationship among different economic time series at different lags. It is not a single regression equation but a system of regressions with one equation for each variable in the system. Estimation of the system consists of nothing more than a set of OLS regressions with the current value of each variable regressed on the lagged values of all the variables in the system. If, for example, a VAR consists only of two economic time series x and y, the system looks as follows:

$$\begin{bmatrix} 1-F^{11}(L) & -F^{12}(L) \\ -F^{21}(L) & 1-F^{22}(L) \end{bmatrix} \begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \varepsilon_{x_t} \\ \varepsilon_{yt} \end{bmatrix} \tag{19}$$

where F^{ij} are coefficient polynomials in the lag operator and ε_{xt}, ε_{yt} are innovations, i.e. the changes in the left hand variable in each equation that can neither be attributed to its own history nor to the history of the other variable.[30]

The variables used in our analyses were the money stock (either real or nominal, in which case the price level is a separate variable), real income, long and short-term interest rates and the monetary base. The regressions were performed with monthly data for the two sample periods 1965/7 to 1972/12 and 1974/1 to 1984/12, separately.

[29] For a thorough discussion of the methods used, see, for example, *Litterman* (1979), *Sims* (1980), *Bessler* (1984, 1984a), *Porter/Offenbacher* (1983).

[30] Note that current values of variables never appear explicitly on the right-hand side of any equation in a VAR system.

Table 2

Vector-autoregressions with the real money stock

	M1R	BSPR	IS	IL	MB
M1R	0.000**	0.001**	0.190	0.272	0.075
BSPR	0.010**	0.000**	0.066*	0.743	0.011**
IS	0.571	0.398	0.000**	0.001**	0.052*
IL	0.397	0.560	0.073*	0.000**	0.338
MB	0.509	0.816	0.181	0.136	0.000**

	M1R	BSPR	IS	IL	MB
M1R	0.000**	0.012**	0.022**	0.004**	0.097*
BSPR	0.194	0.000**	0.031**	0.010**	0.146
IS	0.039**	0.024**	0.000**	0.021**	0.501
IL	0.000**	0.659	0.121	0.000**	0.095*
MB	0.001**	0.150	0.898	0.066*	0.000**

Table 3

Vector-autoregressions with the nominal money stock

	M1	BSPR	CPI	IS	IL	MB
M1	0.000**	0.001**	0.010**	0.586	0.716	0.123
BSPR	0.000**	0.000**	0.339	0.219	0.850	0.023**
CPI	0.062*	0.215	0.000**	0.312	0.079*	0.495
IS	0.006**	0.281	0.094*	0.000**	0.000**	0.257
IL	0.585	0.245	-0.161	0.084*	0.000**	0.634
MB	0.006**	0.447	0.579	0.137	0.079*	0.000**

	M1	BSPR	CPI	IS	IL	MB
M1	0.000**	0.002**	0.039**	0.397	0.312	0.391
BSPR	0.352	0.000**	0.004**	0.104	0.045**	0.332
CPI	0.694	0.205	0.000**	0.001**	0.038**	0.741
IS	0.129	0.142	0.035**	0.000**	0.015**	0.644
IL	0.007**	0.679	0.013**	0.584	0.000**	0.714
MB	0.054*	0.068	0.021**	0.421	0.323	0.000**

Comments for Tables 2 and 3:

Test of marginal predictive power of row variables for column variables. Entry (i, j) is the significance level of the F-test of the hypothesis that variable i has no predictive power for variable j. A low value indicates rejection of the hypothesis. The respective upper matrices are for the 1965/7 – 1973/12 sample and the respective lower matrices are for the 1974/1 – 1984/12 sample.

Tables 2 and 3 provide summary statistics for all the equations estimated.[31] They show the marginal significance levels of the F-values that test for excluding each variable as explanatory variable from each regression. I.e., the tables contain (*Granger*-)causality tests for the variables involved.

We mainly want to concentrate on the first columns, i.e. the equations that determine the money stock. The process determining the real money stock seems indeed to be different in the two regimes (Table 2). The only variable that (*Granger*-)"causes" the real money stock in the first regime is the real income variable. None of the other variables and especially not the monetary base had any sort of *Granger* influence on the real money stock. This conclusion is reversed in the second sample where all variables, except the income indicator, *Granger* cause the real money stock. One of the most important variables here is the monetary base, the central bank's policy variable.

A similar sort of regime change emerges when the regressions are performed using the nominal money stock and the price level separately (Table 3). Whereas in the first sample all variables except the long-term interest rate are significant, only the long-term interest rate and the monetary base seem to be important in the second regime. Furthermore, the base seems to be fully exogenous in the "base regime".

Since no current values of variables appear on the right-hand side of the VAR regressions the correlation matrix of the innovations should be consulted before drawing definite conclusions on whether money was more demand or more supply driven in the two regimes. Table 4 shows these matrices for the nominal and the real approach, respectively. The entries below the diagonal contain the correlations for the first subperiod and above the diagonal are the ones for the second subperiod.

As is obvious, the implications drawn above with respect to the first sample period (sub-diagonal) are not changed at all. The only significant correlation which relates to money (first column) is the long-term interest rate in the nominal specification, which completes the variables usually thought to be important in such equations.[32]

The interpretations for the second subsample are again different to some extent. Most important is the very high significant positive correlation between the monetary base and the money stock M1 (real or nominal), which is given in

[31] The amount of output (first sample: 5 equations with 35 coefficients each, second sample: 5 equations with 65 coefficients each) makes a presentation of all the results impractical. As usual under such circumstances all equations performed extremely well in terms of overall fit and only one seemed to indicate slight residual autocorrelation (based on *Box/Pierce-Q*).

In order to determine the appropriate lag lengths in the two regimes we estimated VARs with 3, 6, 9 and 12 lags and compared them using the likelihood ratio test as suggested in *Sims* (1980). This criterion recommended an optimal lag length of 6 for the first and 12 for the second sample.

[32] It should be noted, however, that these correlations cannot be given any causal interpretation. They only reflect contemporaneous correlations.

Table 4

Correlation matrix of VAR innovations

	M1R	BSPR	IS	IL	MB
M1R	-	-0.231**	-0.127	-0.097	0.415**
BSPR	0.037	-	0.033	-0.011	0.017
IS	-0.140	0.170*	-	0.512**	-0.344**
IL	-0.139	0.097	0.330**	-	-0.169*
MB	-0.022	-0.220**	-0.451**	-0.092	-

	M1	BSPR	CPI	IS	IL	MB
M1	-	-0.273**	0.115	-0.195**	-0.116	0.575**
BSPR	0.033	-	0.075	-0.041	-0.022	0.129
CPI	-0.033	0.079	-	0.077	0.379**	0.231**
IS	-0.028	0.258**	0.271**	-	0.472**	-0.357**
IL	-0.186*	0.253**	-0.010	0.336**	-	-0.098
MB	-0.027	-0.172*	-0.136	-0.517**	-0.200**	-

The upper matrix shows the correlations for the real approach and the lower matrix the ones for the nominal approach. Lower diagonal entries in each matrix contain the estimates for the first subperiod (1965/7 – 1973/12), and the upper diagonal entries are the ones for the second subperiod (1974/1 – 1984/12).

the respective first row. This is a relationship which does not appear to be of relevance in the first sample. A further interesting result is the significant negative correlation between real income and the money stock. This might point to some

sort of feedback rule as discussed in Section 3. It should, however, be interpreted cautiously due to the data problems mentioned above.

Together with the SNB's interpretation of its own policy stance since the transition to flexible exchange rates and monetary targeting, the above results clearly lend support to the view that money has become much more supply determined in the mid-1970's to mid-1980's than it was before. In this case, the rather disappointing results we have gained from conventional money demand regressions over this period should not be all that surprising.

In order to gain insights into the dynamic properties of the VAR system used, we have calculated impulse responses of the money stock to innovations in the other variables of the system.[33]

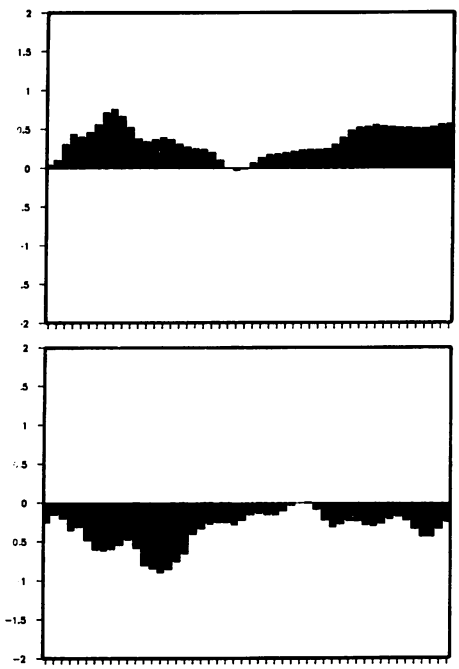
Several caveats are in order, however, with this exercise. The most important relates to the contemporaneous correlations. For simulation purposes these correlations must be given a causal interpretation, i.e. it must be decided on a priori grounds which variable is exogenous vis-à-vis another variable within one period.[34] Caveats are in order since the so-called ordering is somewhat arbitrary and can influence the results. The ordering chosen here was ((CPI), BSPR, IS, IL, MB, M1 (R)) which gives the conventional regression approach the benefit of the doubt even under the control regime. On the other hand the ordering is not crucial in our example since the contemporaneous correlations are not very high and different orderings therefore resulted in similar results.[35]

When calculating impulse response functions we investigate the responses of the money stock to innovations in the other system variables. This exercise is interesting since differing impulse responses to some of the shocks might be expected if the regime change hypothesis is correct. In a world of passively accommodating money the response of the money stock to a shock in real income, for example, should be positive since the income elasticity of the demand for money is positive. The inverse should be expected for a shock in the interest rate since the interest rate elasticity is usually thought to be negative. Under monetary targeting the reaction of the money stock after an income shock is not so clear. From a theoretical point of view it could easily be zero or even negative if a feedback rule like the one discussed in Section 3 is pursued. Furthermore, a regime with base targeting should result again in a much greater influence of the monetary base than ought to be the case in a passive sort of regime.

[33] See *Sargent* (1983), *Litterman* (1979) or *Porter/Offenbacher* (1983).

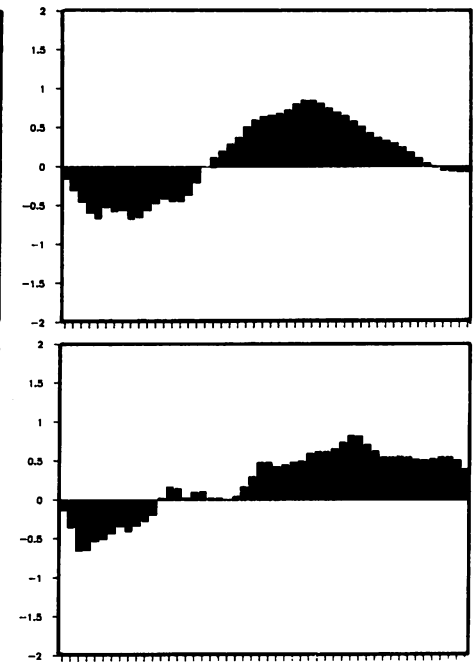
[34] This means that the matrix of innovations has to be triangularized and that the innovations of the variables ordered on top are supposed to be exogenous with respect to the innovations of variables ordered lower in the list. The second variable's innovations are assumed exogenous again with respect to the variable's innovations placed later in the list but dependent on the innovations of the first variable and so on. For details see, for example, *Gordon/King* (1982).

[35] We have experimented with alternative orderings, but the results were practically identical. For a further discussion of this point, see *Heri* (1984).



Graph 1

Impulse responses of real money to a shock in real income over 50 periods in the two regimes



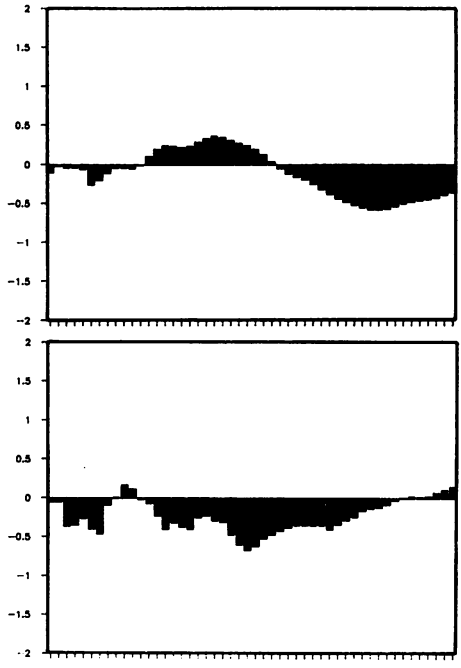
Graph 2

Reaction of real money stock to a shock in the short-term interest rate in the two regimes

Notes: The graphs display the response of the money stock to a one-standard-deviation shock in real income, the two interest rates and the monetary base, respectively, in the two regimes. That is, the upper chart in graph 1, for example, plots the response of the money stock over 50 periods to a one-time-only shock in real income in the period 1965/7 – 1973/12. The lower chart displays the same for the second regime from 1974/1 to 1984/12. The size of the shock is always one standard deviation of the historical forecast error for the respective variable from the vector autoregression as summarized in Table 2, 3 and 4.

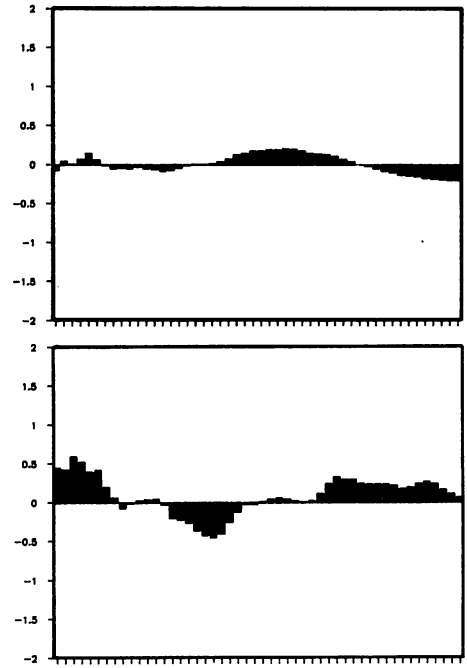
Graphs 1 to 4 depict the impulse responses of the real money stock to a one-standard-error shock in real income, the two interest rates and the monetary base, respectively, in the two regimes.

The clearest difference is depicted in Graph 1 which contains the reaction of the real money stock to a shock in real income. The upper part contains the reaction in the first regime – it is clearly positive – and the lower part depicts the reaction in the second regime – a clearly negative response.



Graph 3

Reaction of the real money stock to a shock in the long-term interest rate in the two regimes



Graph 4

Reaction of the real money stock to a shock in the monetary base in the two regimes

The reactions to interest rate shocks do not differ considerably in the two regimes. The reaction on a monetary base shock is practically nil in the first sample period and clearly positive, at least in the short run, under monetary targeting.

Overall the results of this exercise, too, are in line with the results of the conventional regressions and point to the importance of the supply side of the money market in determining the real money stock over the last 10 years.

7. Summary and Conclusions

Since the mid-1970's doubts have emerged about the stability of the demand for money. These doubts were prompted by the observation that the traditional empirical specification which worked quite well in the 50's and 60's – the so-called *Goldfeld* specification – seemed to have gone badly off track in a number of countries since about 1974.

The behavior of the demand for money is crucial for the formulation and implementation of monetary policy. Therefore the presumed instabilities have stimulated an immense scientific effort to restore the stable demand function.

In this paper we have investigated whether the new sort of monetary policy philosophy that has become popular around the beginning of the 1970's might account for some of the problems encountered with conventional money demand regressions at about the same time. The concrete empirical environment chosen for our analysis was Switzerland. The reason for choosing this example is that the recent monetary history of Switzerland provides two different sorts of prototypical monetary regimes. The first, up until the early 1970's, was one in which the money stock was fully demand determined due to a regime of fixed exchange rates and interest rate targeting. The second, in effect since about 1974, is characterized by "pragmatic monetarism", i.e. growth rules for monetary aggregates.

The point is that if money is (more or less) exogenous with respect to the traditional demand variables – as might be the case under a regime of strict monetary targeting – and the general price level is not perfectly flexible, then it does not seem to be sensible to estimate the elasticities and to check the stability of the public's liquidity preference by simply running *Goldfeld*-type regressions that assume money to be fully endogenous.

With respect to our empirical case this amounts to saying that up until the early 1970's the conventional formulation might be reasonable since under fixed exchange rates and interest rate targeting the money supply to a great extent accommodates demand changes. In the post-1974 sample, a period with flexible exchange rates and spreading monetarist philosophy among central bankers, such a formulation makes less sense since the left-hand variable in the traditional regression is not necessarily the dependent variable anymore. Since Switzerland has pursued a relatively strict base target policy and was relatively successful, we regard this case as exceptional to some extent and believe that if monetary targeting has any influence on *Goldfeld*-type regressions at all this should come out in the Swiss case.

After developing some theoretical concepts to show why a change in monetary regime might result in problems with conventional regressions, we actually run such regressions for the two different sample periods, i.e. regimes, with monthly and quarterly data. The results attained indeed cast doubt on the hypothesis

that the two data samples are drawn from the same population. Not only the regression results but also a whole cluster of stability tests confirm that something is wrong with *Goldfeld*-type regressions after 1974.

In order to get some insights into what might be responsible for these problems in the second versus the first regime we have run several vector-autoregressions with inclusion of a money supply indicator, the monetary base, as system variable.

The empirical regularities pinpointed with the VAR exercises were all similar. Most importantly, they confirmed and to some extent explained the instabilities of conventional money demand regressions encountered in Section 5. The VAR estimations indicate clear changes of the multivariate time series properties of real and nominal money when a pre-1974 and a post-1974 sample period are compared. The variable chosen as monetary target by the Swiss National Bank after 1974 has proven to be a highly relevant determinant of the money stock in the second subsample, whereas it was practically irrelevant during the more or less passive monetary regime that was in effect until 1973. This sort of stylized evidence was also confirmed by innovation exercises like impulse response functions. It was shown that the money stock reacted as if it were driven by the classical demand variables in the first period, and as expected from a more or less exogenous policy variable in the second.

The conclusions that can be drawn form this *stylized sort of results* is that if the money stock is more or less exogenously driven by monetary policy considerations in the short run and/or if money acts as a short-run buffer in the hands of the private sector, then it does not seem to be sensible to run conventional, i.e. *Goldfeld*-type regressions in order to get to know what the public's liquidity preference might be or whether it is a stable function of a few macroeconomic variables. One should not be surprised if the conventional specification breaks down when the monetary regime changes from a price to a quantity rule. Such a break does not necessarily imply that something is wrong with a stable demand for money, it can equally well point towards the regime change or instabilities in the central bank's reaction function.

Evidence in favor of this hypothesis has been found in a sample that might be interpreted as prototype (although the regimes in Switzerland were mixed, too, to a certain degree). This does not mean that the conclusions are only relevant under such circumstances, but it does mean that elasticity estimates calculated from regressions over periods with even more mixed regimes are equally flawed, although this might not come out as clearly as in the Swiss case.

The results above also do not mean that it would not have been possible to find regressions to validate the conventional approach after a bit of specification search, as everybody involved in money demand regressions knows. However, if we do not want to risk the imputation of what *Cooley/Leroy* would call "a low

or zero signal-to-noise ratio" to empirical work in monetary economics, we had better concentrate on the general characteristics the data "try" to tell us.

Data: Definitions and Sources

Monetary Aggregates:

M1: Definition 1976 of the Swiss National Bank. Source: Monthly Bulletin of SNB. For M2 and M3 after 1975, dito. For the construction of the M2 and M3 series before 1975, see *Heri* (1986). Monetary Base: Corrected base from the SNB's tape of monetary statistics.

Income Indicators:

- Real GNP from the Quarterly National Account Statistics, Basle Business Cycle Research Group. Monthly data were generated through cubic spline interpolation from quarterly data.
- Index of Industrial Production from IMF, International Financial Statistics. Monthly data were generated through cubic spline interpolation from quarterly data.
- Index of Import Volumes: Since 1974 this series has been collected monthly by the National Bureau of Trade. The data from 1965 to 1973 have been generated through cubic spline interpolation from quarterly data. The source is Monthly Trade Statistics.

Prices:

For the quarterly regressions we have used the GNP Deflator from Quarterly National Account Statistics, Basle Business Cycle Research Group. For monthly regressions we have used the Consumer Price Index. The source is "Volkswirtschaft".

Interest Rates:

Long Term Rates: Government Bond Yields from IMF, International Financial Statistics.
Short Term Rates: 3 Month Eurodeposit Rates, IMF, International Financial Statistics.

References

Akerlof, G. A. (1979): Irving Fisher on His Head: The Consequences of Constant Threshold-Target Monitoring of Money Holdings. Quarterly Journal of Economics *93*, 169–187.

Andersen, P. S. (1985): The Stability of Money Demand Functions: An Alternative Approach. BIS Economic Papers, No. 14.

Bessler, D. A. (1984): Relative Prices and Money: A Vector Autoregression on Brazilian Data. American Journal of Agricultural Economics *66*, 545–556.

Bessler, D. A. (1984a): An Analysis of Dynamic Economic Relationships: An Application to the US Hog Market. Canadian Journal of Agricultural Economics *32*, 109–124.

Blundell-Wignall, A. / Rondoni, M. / Ziegelschmidt, H. (1984): The Demand for Money and Velocity in Major OECD-Countries. OECD Economics and Statistics Department Working Paper No. 13.

Brittain, B. (1981): International Currency Substitution and the Apparent Instability of Velocity in Some Western European Economies and the United States. Journal of Money, Credit and Banking *13*, 135–155.

Brown, R. L./Durbin, J./Evans, J. M. (1975): Techniques for Testing the Constancy of Regression Relationships over Time. Journal of the Royal Statistical Society, Series B, *37*, 149–192.

Brunner, K./Meltzer, A. H. (1976): An Aggregate Theory for a Closed Economy. In: *J. Stein* (Ed.): Monetarism. North Holland, Amsterdam.

Carr, J./Darby, M. R. (1981): The Role of Money Supply Shocks in the Short Run Demand for Money. Journal of Monetary Economics *8*, 183–199.

Chow, G. C. (1966): On the Long and Short Run Demand for Money. Journal of Political Economy *74*, 111–131.

Cooley, T. F./LeRoy, S. F. (1981): Identification and Estimation of Money Demand. American Economic Review *71*, 825–844.

Cuddington, J. T. (1982): Currency Substitution: A Critical Survey from a Portfolio Balance Perspective. Federal Reserve Bank of San Francisco – Conference Supplement Economic Review, Fall 1982, 37–63.

Cuddington, J. T. (1983): Currency Substitution, Capital Mobility and Money Demand. Journal of International Money and Finance *2*, 111–133.

Enzler, J./Johnson, L./Paulus, J. (1976): Some Problems of Money Demand. Brookings Papers on Economic Activity, 1976/1, 261–280.

Feige, E. L. (1967): Expectations and Adjustments in the Monetary Sector. American Economic Review *57*, 462–473.

Fomby, T. B./Hill, R. C./Johnson, S. R. (1984): Advanced Econometric Methods. Springer, New York/Berlin.

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

Goldfeld, S. M. (1976): The Case of the Missing Money. Brookings Papers on Economic Activity, 1976/3, 683–730.

Goodfriend, M. (1985): Reinterpreting Money Demand Regressions. Carnegie-Rochester Conference Series on Public Policy *22*, 207–242.

Gordon, R. J. (1984): The Short Run Demand for Money: A Reconsideration. Journal of Money, Credit and Banking *16*, 403–434.

Gordon, R. J./King, S. R. (1982): The Output Cost of Disinflation in Traditional and Vector Autoregressive Models. Brookings Papers on Economic Activity, 1982/1, 205–244.

Granger, C. W. J./Newbold, P. (1977): Forecasting Economic Time Series. Academic Press, New York.

Hafer, R. W./Hein, S. E. (1979): Evidence on the Temporal Stability of the Demand for Money Relationship in the United States. Federal Reserve Bank of St. Louis Review *61*, 3–14.

Hafer, R. W./Hein, S. E. (1982): The Shift in Money Demand: What Really Happened. Federal Reserve Bank of St. Louis Review *64*, 11–16.

von Hagen, J. (1986): Alternative Operating Regimes for Money Stock Control in West Germany. mimeo, University of Bonn.

Hamburger, M. J. (1977): The Behaviour of the Money Stock: Is there a Puzzle? Journal of Monetary Economics *3*, 265–288.

Heri, E. W. (1984): Buffer Stocks, Monetary Policy and the Short Run Demand for Money. Memorandum No. 266, Center for Research in Economic Growth, Stanford University.

Heri, E. W. (1986): Theorie und Empirie der Geldnachfrage: Das Beispiel der Schweiz. Springer, New York/München/Berlin.

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

Knoester, A. (1984): Theoretical Principles of the Buffer Mechanism, Monetary Quasi-Equilibrium and its Spillover Effects. Kredit und Kapital *17*, 243–260.

Kohli, U. (1985a): Exogenous Money, Monetary (Dis)Equilibrium and Expectational Lags. Paper presented at the Konstanz Seminar on Monetary Theory and Policy, June 1985.

Kohli, U./Rich, G. (1985): Monetary Control: The Swiss Experience. Mimeo, Schweizerische Nationalbank Zürich.

Laidler, D. E. W. (1980): The Demand for Money in the United States – Yet Again. Carnegie-Rochester Conference Series on Public Policy *12*, 219–271.

Laidler, D. E. W. (1982): Monetarist Perspectives. Phillip Allen, Oxford.

Laidler, D. E. W. (1984): The Buffer Stock Nation in Monetary Economics. The Economic Journal *94*, Suppl., 17–34.

Laidler, D. E. W. (1985): Expectations and Adjustments in the Monetary Sector Revisited: A Comment. Carnegie-Rochester Conference Series on Public Policy *22*, 243–254.

Laidler, D. E. W. (1985a): Comment on "Money Demand Predictability" by Vance Roley. Journal of Money, Credit and Banking *17*, 647–652.

Lieberman, C. (1978): Structural and Technological Change in Money Demand. American Economic Review *69*, 324–329.

Litterman, R. B. (1979): Techniques for Forecasting Using Vector Autoregressions. Federal Reserve Bank of Minneappolis, Research Department Paper No. 115.

Lusser, M. (1985): Wirtschaftspolitik in der Schweiz und in der Bundesrepublik Deutschland. Auf unterschiedlichen Wegen zu ähnlichen Zielen. Geld, Währung und Konjunktur, Quartalsheft 4/1985 der SNB, 293–300.

MacKinnon, S. G./Milbourne, R. D. (1984): Monetary Anticipations and the Demand for Money. Journal of Monetary Economics *13*, 265–274.

Miles, M. A. (1978): Currency Substitution, Flexible Exchange Rates and Monetary Independence. American Economic Review *68*, 428–436.

Offenbacher, E. K. (1981): Two Papers on Money Demand. Special Studies Paper, Division of Research and Statistics, No. 157, Federal Reserve Board, Washington, D.C.

Porter, R. D./Offenbacher, E. K. (1983): Empirical Comparisons of Credit and Monetary Aggregates Using Vector Autoregressive Methods. Federal Reserve Bank of Richmond, Economic Review *69*, 16–29.

Rich, G. (1984): Ist die schweizerische Geldpolitik wirklich monetaristisch? Geld, Währung und Konjunktur. Quartalsheft der Schweizerischen Nationalbank, No. 3/1984, 53–60.

Rich, G./Beguélin, J. P. (1982): Swiss Monetary Policy in the 1970s and 1980s. Mimeo, Schweizerische Nationalbank.

Roley, V. V. (1985): Money Demand Predictability. Journal of Money Credit and Banking *17*, 611–641.

Roley, V. V./Walsh, C. E. (1985): Monetary Policy Regimes, Expected Inflation, and the Response of Interest Rates to Money Announcements. Quarterly Journal of Economics *99*, in Press.

Santomero, A. M./Seater, J. J. (1981): Partial Adjustment in the Demand for Money: Theory and Empirics. American Economic Review *71*, 566–578.

Sargent, T. J. (1983): Estimating Vector Autoregressions Using Methods not based on Explicit Economic Theory. Federal Reserve Bank of Minneapolis, No. 3/1983.

Sims, C. (1980): Macroeconomics and Reality. Econometrica *48*, 1–48.

Vital, C. (1978): Geldnachfragegleichungen für die Schweiz. Verlag Industrielle Organisation, Zürich.

Walters, A. A. (1967): The Demand for Money – The Dynamic Properties of the Multiplier. Journal of Political Economy *75*, 293–298.

Yeager, L. B. (1981): Experiences with Stopping Inflation. American Enterprise Institute.

Summary

Money Demand Regressions and Monetary Targeting. Theory and Stylized Evidence

Doubts have been voiced since around the mid-70's about the stability of the demand for money – a function which is usually investigated empirically using the conventional *Goldfeld* specification. This paper reports on a study of whether such problems are encountered in Switzerland and what the most plausible explanations would be. The paper presents arguments and evidence to the effect that estimates produced by *Goldfeld* equations are not necessarily relevant in an environment of explicit money stock targeting. Where such a monetary strategy is being followed, the instability of a *Goldfeld* equation cannot simply be interpreted as instability in the underlying demand for money, because the latter could be explained just as satisfactorily by changes in the reaction function on the part of the central bank.

Zusammenfassung

Geldnachfrageschätzungen und Geldpolitik

Seit Mitte der siebziger Jahre sind Zweifel an der Stabilität der Geldnachfragefunktion – empirisch untersucht üblicherweise mit Hilfe der konventionellen *Goldfeld*-Spezifikation – laut geworden. In der vorliegenden Arbeit wurde untersucht, ob diese Probleme auch in der Schweiz anzutreffen sind und welche Erklärungen sich dafür aufdrängen. Es wird argumentiert und empirische Evidenz dafür geliefert, dass Schätzungen von *Goldfeld*-Gleichungen in einem Environment der expliziten Geldmengensteuerung nicht unbedingt sinnvoll sind. Wenn solche geldpolitischen Strategien verfolgt werden, dann kann Instabilität einer *Goldfeld*-Gleichung nicht einfach als Instabilität der zugrundeliegenden Geldnachfrage interpretiert werden, diese kann dann ebenso gut auf Änderungen der Reaktionsfunktion der Zentralbank hinweisen.

Résumé

Estimations de la demande de monnaie et politique monétaire

Depuis le milieu des années 70 des doutes ont surgi quant aux variations de la fonction de demande de monnaie examinée de manière empirique à l'aide de la spécification conventionnelle dite de *Goldfeld*. Dans cet article nous avons voulu vérifier si ce problème se posait également en Suisse et, le cas échéant, quelles sont les explications qui s'imposent. On a pu y mettre en évidence de manière empirique que des estimations d'équations de *Goldfeld* effectuées dans un environnement à masse monétaire explicitement dirigée ne sont pas nécessairement judicieuses. Si de telles stratégies en matière de politique monétaire sont appliquées, on ne peut interpréter la variabilité d'une équation de *Goldfeld* comme une simple instabilité de la demande de monnaie, cette dernière pouvant tout autant être imputée à une modification de la fonction de réaction des banques centrales.