Exogenous Money, Monetary (Dis)equilibrium and Expectational Lags*

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I. Introduction

As *David Laidler* (1982) has noted, few macroeconomic relationships have received as much attention in applied economic analysis as the aggregate demand-for-money function.[1] And there is little doubt that the *Chow* (1966) equation occupies a predominant position in much of that work. The Chow specification has been widely used, and it is generally viewed as giving very satisfactory results.

Recently, however, a number of authors have criticized the use of the *Chow* equation during periods of monetary control.[2] They have argued that the partial adjustment hypothesis (which is the cornerstone of the Chow specification) may be inconsistent with the view that the quantity of money is exogenous. This has led to a regain of interest in the topic of monetary disequilibrium and the concept of buffer stocks.[3] Indeed, much of the recent work on the demand for money which abandons the Chow framework explicitly assumes that the money market may remain out of equilibrium for extended periods of time. This line of research has produced some very encouraging results. The purpose of this paper is to examine some of these issues with the help of Swiss data. More broadly, the paper can be viewed as an attempt to estimate demand-for-money functions with data that encompass periods of monetary control. For most of the last ten years the Swiss

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1 See *Goldfeld* (1973), for instance.

2 See *Laidler* (1982, 1984), and *Bordo*, *Choudhri*, and *Schwartz* (1984), among others.

3 The concept of money as a buffer stock has been extensively investigated in empirical work by *Jonson* [see Jonson (1976), Jonson et al. (1977) and his subsequent work] and other authors who generally argue in favor of a system-wide approach. This paper is less ambitious in its undertaking and uses exclusively single-equation techniques.

National Bank has adhered to monetarist principles, and has kept a tight control over the supply of money, mostly the monetary base. Hence, the conventional approach to estimating demand-for-money functions, where the quantity of money is implicitly assumed to be demand determined, may be invalid. Nevertheless, we find that the Swiss data do not support the monetary-disequilibrium hypothesis. We argue that some of the results which at first seem to support the notion of monetary disequilibrium can in fact be interpreted in a way consistent with the assumption that the money market clears at all times.

II. Partial Adjustment and Monetary Disequilibrium

As our starting point, we consider the following long-run demand for money function:

$$(1) \qquad m^* = \alpha + \beta y + \gamma r \qquad \beta > 0, \gamma < 0.$$

All variables are measured in logarithms. m^* is desired real cash balances, y is real income, and r is a short-run rate of interest.

Assume now that the actual demand for real balances (m) adjusts only slowly towards its desired level as a result of adjustment costs of various kinds.[4] Assume, moreover, that the adjustment process is linear:

$$(2) \qquad m - m_{-1} = \lambda (m^* - m_{-1}) \qquad 0 < \lambda < 1$$

where the (–1) subscript indicates a one-period lag. We then get the following short-run demand-for-money function:

$$(3) \qquad m = \alpha\lambda + \beta\lambda y + \gamma\lambda r + (1 - \lambda) m_{-1} = a + by + cr + km_{-1}$$

where $\lambda = 1 - k$, $\beta = b/(1 - k)$ and $\gamma = c/(1 - k)$.

Equation (3) has been estimated for numerous countries and over many different time periods, usually with very satisfactory results. We report in Table 1 OLS estimates of (3) for Switzerland for the period 1968.1 - 1982.4. The money supply is measured by the monetary base, y is approximated by real GDP, and we use the GDP deflator as a price index in calculating m.[5] r is defined as a short-run rate of interest (yield on 3-month deposits at large

[4] See *Chow* (1966).

[5] We use the monetary base as our measure of the money supply since it is this aggregate that the Swiss National Bank currently targets; see *Kohli* and *Rich* (1986) for details. See *Kohli* (1984b) for yearly estimates of (3).

commercial banks). A dummy variable (θ) is included to account for the change in policy that took place in 1973 with the switch to a flexible exchange-rate system. (θ is equal to zero until 1972.4, and it is unity thereafter). On the whole the results are quite promising. All parameters have the expected sign and magnitude (we also report in Table 1 the long-run estimates of the income and interest elasticities, β and γ). Of some concern, however, is the value of *Durbin*'s h statistic which is somewhat on the high side. The problem is not removed if one corrects for first-order or higher-order autocorrelation, and it might therefore be a sign of misspecification.

Some authors have objected to the use of the real adjustment mechanism described by (2) on the grounds that it implies a lagged adjustment to changes in income and interest, but an instantaneous adjustment to changes in the price level.[6] They therefore argue in favor of the nominal adjustment process:

$$M - M_{-1} = \lambda (M^* - M_{-1}) \qquad 0 < \lambda < 1 \tag{4}$$

where M is the nominal money stock, and M^* is desired nominal cash balances. Setting $M^* = m^* + P$ where P is the price level, we can derive the corresponding short-run demand-for-money function by substituting (1) into (4) and solving for m:

$$m = \alpha\lambda + \beta\lambda y + \gamma\lambda r + (1 - \lambda)(M_{-1} - P) = a + by + cr + k(M_{-1} - P) \tag{5}$$

where $\lambda = 1 - k$, $\beta = b/(1 - k)$ and $\gamma = c/(1 - k)$.

The only difference between (3) and (5) concerns the last term on the right hand side, $(M - P)$ in one case, and $(M_{-1} - P)$ in the other.[7] One might think that there is no reason to prefer either one of the two specifications on a priori grounds, and that one should let the data speak out. OLS estimates of (5) are reported in the second half of Table 1. It is apparent that (3) provides a somewhat better fit than (5). On this basis, (2) can be preferred to (4).

Moreover, *Laidler* (1982, 1984) and others have recently argued that even if (5) may be viewed as a reasonable demand function for an individual household, it is meaningless as an aggregate demand function during periods of monetary control when the nominal money supply can best be

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[6] See *Goldfeld* (1976).

[7] Alternatively (5) can be expressed as:

$$m = a + by + cr + d\Delta P + km_{-1}$$

with the constraint $d = -k$. (If this equation is estimated without constraint, d turns out to be insignificant).

Table 1

Partial-Adjustment Hypothesis

i) Equation (3) – Real Adjustment

$$\underset{(0.43)}{m = 0.458} \quad \underset{(3.42)}{+\ 0.493\,y} \quad \underset{(-\ 5.72)}{-\ 0.054\,r} \quad \underset{(-\ 2.65)}{-\ 0.046\,\theta} \quad \underset{(4.92)}{+\ 0.451\,m_{-1}}$$

OLS $n = 60$

$\bar{R}^2 = 0.7982$ SEE $= 0.0422$ DW $= 1.65$ $h = 1.77$

$\underset{(5.99)}{\lambda = 0.549}$ $\underset{(4.60)}{\beta = 0.897}$ $\underset{(7.57)}{\gamma = -\ 0.099}$

ii) Equation (5) – Nominal Adjustment

$$\underset{(0.06)}{m = 0.067} \quad \underset{(3.84)}{+\ 0.538\,y} \quad \underset{(-\ 5.50)}{-\ 0.054\,r} \quad \underset{(-\ 2.99)}{-\ 0.051\,\theta} \quad \underset{(4.78)}{+\ 0.445\,(M_{-1} - P)}$$

OLS $n = 60$

$\bar{R}^2 = 0.7947$ SEE $= 0.0425$ DW $= 1.62$

$\underset{(5.97)}{\lambda = 0.555}$ $\underset{(5.03)}{\beta = 0.969}$ $\underset{(-\ 7.55)}{\gamma = -\ 0.097}$

viewed as exogenous. Indeed, consider a once-for-all change in real income or in interest rates. It makes little sense to expect a slow movement towards a new long-run equilibrium position, supposedly because of nominal adjustment costs, since, if the nominal money stock is supply determined, these adjustment costs are never encountered! Alternatively, consider a once-for-all change in the supply of money. It is hardly reasonable to contemplate a gradual transition towards some new intertemporal equilibrium since no adjustment costs will be met beyond the instant when the shock takes place.[8] That is, adjustment must be instantaneous, and, as argued by *White* (1978), in these conditions the economy must always be on its long-run demand schedule.

While any individual can always vary his nominal holdings of money, this is not possible for society as a whole if the stock of money is supply determined. On the other hand, it is possible for the public, by attempting to modify their cash balances and thereby cutting down or stepping up their demand for goods, to alter the real money supply. Thus, while the nominal

[8] One could perhaps rescue the traditional interpretation by imagining a situation where any increase in the money supply is at first absorbed entirely by commercial banks at the cost of a large initial fall in interest rates. This would lead to an increase in the non-bank private demand for money, but holdings would increase only gradually if the non-banking public faces adjustment costs. As commercial banks decrease their own holdings of money, the rate of interest would increase.

money supply may well be exogenous, the real money supply could nevertheless be endogenous, and (2) becomes much more meaningful than (4). The criticisms leveled at (2), and which led us to consider (4) as an alternative, do not fade away, however, and can be rephrased to mean that it is unreasonable to assume that full adjustment to a change in the nominal money supply is instantaneous, while adjustment to a change in real income or interest rates takes place only gradually. *Laidler* (1982) therefore considers that real cash balances adjust subject to the following price adjustment mechanism:

$$(6) \qquad P - P_{-1} = \lambda (P^* - P_{-1}) \qquad 0 < \lambda < 1$$

where $P^* = M - m^*$.[9] Substituting (1) into (6) and solving for real balances, one gets:

$$(7) \qquad m = \alpha\lambda + \beta\lambda y + \gamma\lambda r + (1 - \lambda)(M - P_{-1}) = a + by + cr + k(M - P_{-1})$$

where $\lambda = 1 - k$, $\beta = b/(1 - k)$ and $\gamma = c/(1 - k)$.

The only difference between (7) and (3) or (5) once again has to do with the last right-hand term. One could think that this difference is rather unimportant. Yet it seems to have far-reaching implications in empirical work. Estimation of (7) for Switzerland gives very poor results (Table 2). In particular, the estimate of the income elasticity systematically turns out to be negative.[10]

There are some conceptual problems with (6) as well. (6) implies that the money market is often out of equilibrium. This proposition might be difficult to accept given the high adjustment speed one generally attributes to asset markets. Moreover, one may have some doubts about the validity of the hypothesis that the money market balances through price movements, rather than through interest-rate movements. These issues have been discussed by *Laidler* (1982, 1984) who argues that the role of the rate of interest is to equilibrate the bond market, and that the bond market does indeed adjust very rapidly, but that there is no guarantee that the rate of interest which equilibrates the bond market will also bring into balance the money

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[9] Note that (6) can also be written as

$$\Delta P = \theta (m - m^*)$$

where $\theta = \lambda/(1 - \lambda)$. That is, prices move in response to excess money. This is essentially the formulation adopted by *Jonson* et al. (1977). Note also that obviously λ does not have the same interpretation as in (2).

[10] For an alternative test of the price-adjustment hypothesis, see *Judd* and *Scadding* (1982), for instance.

Table 2

Monetary Disequilibrium

i) Equation (7) – Price Adjustment

$$m = \underset{(3.45)}{0.827} \underset{(-0.94)}{- 0.033 y} \underset{(-2.60)}{- 0.007 r} \underset{(1.43)}{+ 0.006 \theta} \underset{(38.79)}{+ 0.948 (M - P_{-1})}$$

OLS $n = 60$

$\bar{R}^2 = 0.9898$ SEE $= 0.0095$ DW $= 2.26$

$\lambda = \underset{(2.12)}{0.052}$ $\beta = \underset{(-0.69)}{-0.639}$ $\gamma = \underset{(3.57)}{-0.130}$

ii) Equation (9) – Interest-Rate Adjustment

$$r = \underset{(-0.95)}{-8.501} \underset{(4.46)}{+ 4.930 y} \underset{(-5.41)}{- 4.160 m} \underset{(-3.07)}{- 0.440 \theta} \underset{(6.57)}{+ 0.529 r_{-1}}$$

OLS $n = 60$

$\bar{R}^2 = 0.8229$ SEE $= 0.3572$ DW $= 1.12$ $h = 4.34$

$\lambda = \underset{(5.85)}{0.471}$ $\beta = \underset{(5.35)}{1.185}$ $\gamma = \underset{(-7.37)}{-0.113}$

iii) Equation (11) – Real-Income Adjustment

$$y = \underset{(1.55)}{0.698} \underset{(1.73)}{+ 0.082 m} \underset{(1.33)}{+ 0.007 r} \underset{(0.40)}{+ 0.003 \theta} \underset{(13.38)}{+ 0.851 y_{-1}}$$

OLS $n = 60$

$\bar{R}^2 = 0.9353$ SEE $= 0.0181$ DW $= 2.18$ $h = -0.80$

$\lambda = \underset{(2.34)}{0.149}$ $\beta = \underset{(2.43)}{1.816}$ $\gamma = \underset{(-2.31)}{-0.083}$

market. Any disequilibrium that subsists in the money market must then be corrected by a movement in the price level.

One difficulty with this line of reasoning is that, strictly speaking, (7) is no longer a demand-for-money function.[11] It is essentially a price equation that attempts to describe the working of the economic system as a whole, while including some elements of a demand-for-money function. This last point is not even necessarily true. Indeed, as we shall argue in section 5 below, it is well possible that the parameters of (7), instead of belonging to the demand-for-money function, in fact come from an aggregate absorption function.

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[11] The fact that both (3) and (7) have the same left-hand variable should not fool us. [Note that the current nominal money supply, M, appears on the right hand side of (7)]. As emphasized by *Duguay* (1983), *Judd* and *Scadding*'s (1982) comparison of standard errors of estimates is therefore invalid. (The same point was subsequently made by *Motley* (1984)).

As an alternative to (6), some authors have assumed that it is the rate of interest which does the balancing work.[12] While maintaining the notion of monetary disequilibrium, they have postulated the following adjustment mechanism:

$$r - r_{-1} = \lambda\,(r^* - r_{-1}) \qquad 0 < \lambda < 1 \tag{8}$$

where, as the reader will no doubt have guessed, r^* is obtained by solving (1) for the current money supply.

Substituting into (8), we get the following interest-rate equation:

$$r = \alpha\lambda/\gamma - (\beta\lambda/\gamma)y + (\lambda/\gamma)m + (1-\lambda)r_{-1} = a + by + cm + kr_{-1} \tag{9}$$

where $\lambda = 1 - k$, $\beta = -b/c$ and $\gamma = (1-k)/c$.

Andersen (1985) has estimated this equation for a number of countries, with some very encouraging results. However, several of his equations display disturbingly high h statistics. This led him to evoke the possibility that one or several explanatory variables are missing. Our own results for Switzerland confirm this impression. OLS estimates of equation (9) are contained in Table 2. All parameter estimates are in the expected range, but the high h values seem to leave little doubt that the equation is misspecified.[13]

As a last option we consider the possibility that it is real income that does the balancing. Let y^* be the equilibrium level of income, i.e. the level of income that equilibrates the money market for given r and P, and assume that income adjusts according to:

$$y - y_{-1} = \lambda\,(y^* - y_{-1}) \qquad 0 < \lambda < 1 \tag{10}$$

Thus:

$$y = -(\alpha\lambda/\beta) + (\lambda/\beta)m - (\gamma\lambda/\beta)r + (1-\gamma)y_{-1} = a + bm + cr + ky_{-1} \tag{11}$$

where $\lambda = 1 - k$, $\beta = (1-k)/b$ and $\gamma = -c/b$.

Estimates of (11) are shown at the bottom of Table 2. They are not very satisfactory since they imply a rather large income elasticity for the demand for money. In fact, besides the lagged dependent variable, none of the explanatory variables is significantly different from zero at the 95% confi-

[12] See *Andersen* (1985), for instance.

[13] The problem does not disappear if one attempts to correct for first-order autocorrelation.

dence level. Actually, it is not clear whether the estimated equation is a demand-for-money function, or some kind of aggregate demand function.

To sum up the results of this section, we find the conventional specification (3) produces the most satisfactory results for Switzerland. (5) leads to results which are marginally inferior: moreover, this hypothesis is difficult to justify under periods of monetary control. As to (7), (9), or (11), they must be rejected on statistical grounds; it thus seems that the hypothesis that the money market can remain out of equilibrium for extended periods of time is not supported by the data in the Swiss case.

Nevertheless, we are receptive to the argument that (3) may be an inappropriate description of the money market under periods of monetary control. For a start, of course, if money is supply determined and the rate of interest is endogenous, estimation of (3) by OLS leads to statistically inconsistent results. One way of dealing with this difficulty would be to invert (3) and estimate it as an interest-rate equation. However, there are a number of reasons why this might not be enough. Several authors have argued that such an interest-rate equation, although mathematically correct, is logically faulty, for it requires the rate of interest to overshoot its long-run value in response to certain shocks.[14] While interest-rate overshooting need not be an aberration – it would seem a mistake to exclude this possibility on a a priori basis – we do not wish to place excessive faith in this type of mechanism. Another reason why estimating an inverted version of (3) might not be sufficient is that there often seems to be a need in interest-rate equations to include a lagged dependent variable. It is visible from the estimate of (9) in Table 2 that the coefficient of the lagged interest rate is highly significant. The same holds in most of *Andersen*'s (1985) equations. This variable remains significant even if the lagged money stock is added to the equation as the inversion of (3) would require (see below). Does this lead us back to (9) and the disequilibrium approach? Not necessarily. In what follows we propose an interpretation of our results that is consistent with exogenous money, monetary equilibrium, and, moreover, the absence of interest-rate overshooting.

III. The Permanent-Income Hypothesis Once Again

How can we interpret an equation such as (9) without relying on the assumption of monetary disequilibrium, and how can we justify inclusion, not just of the current money supply, but of its lagged value as well? One

[14] See *Tucker* (1966), for instance.

possible answer is *Friedman*'s (1959) permanent income hypothesis together with the assumption of adaptive expectations.

Consider the following short-run demand-for-money function:

$$m = \alpha + \beta y_p + \gamma r \qquad \beta > 0, \gamma < 0 \tag{12}$$

where y_p is (real) permanent income, and all other variables are defined as before.

We approximate permanent income with the familiar adaptive-expectations mechanism:

$$y_p = y_{p\,(-1)} + \lambda\,[y - y_{p\,(-1)}] \qquad 0 < \lambda < 1 \tag{13}$$

where λ can be interpreted as the elasticity of income expectations. Substituting (13) into (12), and applying *Koyck*'s transformation, we get the following estimating equation:

$$m = \alpha\lambda + \beta\lambda y + \gamma r - \gamma(1-\lambda)\,r_{-1} + (1-\lambda)m_{-1} = a + by + cr + dr_{-1} + km_{-1} \tag{14}$$

where $\lambda = 1 - k$, $\beta = b/(1-k)$ and $\gamma = c$.

Moreover, it is visible from (14) that the parameters of this equation are overidentified since $d = -ck$.[15] (14) could be estimated by nonlinear least squares, or by an iterative procedure such as *Friedman*'s (1959). Instead, for more transparency, we prefer to start by estimating it by OLS without any restriction. This will make it easier to assess the validity of our approach, and to compare our results with our earlier findings. OLS estimates of (14) are reported in Table 3. The equation appears to be well behaved. All parameters have the expected sign, and one sees that the coefficient of r_{-1} is highly significant. Moreover, there is no evidence of any serial correlation. On both counts (14) must be preferred to (3).

We next reestimate (14) by nonlinear least squares, imposing the restriction on the parameters implied by the permanent-income hypothesis, i.e. $d = -ck$. The results are shown in the bottom half of Table 3. A likelihood-ratio test indicates that the restriction cannot be rejected, i.e. Swiss data are consistent with the permanent-income hypothesis.[16] These nonlinear estimates imply a long-run income elasticity that is close to unity; the long-run interest-rate elasticity is found to be approximately -0.09. The estimate of

[15] See *Feige* (1967).

[16] The test statistic is 0.30 for a critical x^2 value of 3.84 at the 95% confidence level with one degree of freedom.

Table 3

Permanent-Income Hypothesis

i) Equation (14) – Unconstrained Estimates

$$\underset{}{m =} \underset{(0.55)}{0.518} + \underset{(1.66)}{0.239y} \underset{(-7.35)}{-0.084r} + \underset{(3.88)}{0.056r_{-1}} \underset{(-1.62)}{-0.026\theta} + \underset{(6.73)}{0.704m_{-1}}$$

OLS $n = 60$

$\bar{R}^2 = 0.8393$ SEE $= 0.0376$ DW $= 1.86$ $h = 0.74$

$$\underset{(2.84)}{\lambda = 0.296} \quad \underset{(2.44)}{\beta = 0.806} \quad \underset{(-7.35)}{\gamma = -0.084}$$

ii) Equation (14) – Constrained Estimates

$$\underset{}{m =} \underset{(0.64)}{0.592} + \underset{(1.63)}{0.232y} \underset{(-7.78)}{-0.086r} + \underset{(5.07)}{0.060r_{-1}} \underset{(-1.56)}{-0.025\theta} + \underset{(6.77)}{0.703m_{-1}}$$

NLLS $n = 60$

$\bar{R}^2 = 0.8414$ SEE $= 0.0374$ DW $= 1.82$ $h = 1.19$

$$\underset{(2.86)}{\lambda = 0.297} \quad \underset{(2.39)}{\beta = 0.781} \quad \underset{(-7.78)}{\gamma = -0.086}$$

λ is approximately 0.30. This is substantially smaller than the value of λ obtained with help of (3), but one must remember that its interpretation here is fundamentally different.

It thus appears that the permanent-income hypothesis gives some very encouraging results, and it is our feeling that it has been rather neglected in the current debate. The adaptive-expectations hypothesis is often criticized for being ad hoc, but one should not overlook its valuable contributions in empirical work. Several authors have argued that there is little role for expectational lags once that adjustment lags have been taken into account. This may well be true for certain countries, or for certain time periods, but it does not appear to be universally true.[17] More to the point, though, it seems to us that it makes littles sense to reject (14) in favor of (3) or (5) on an empirical basis, and then to turn around and reject the adjustment-cost hypothesis on logical grounds. If one really believes that (3) and (5) are flawed, they cannot be treated as an alternative for (14). And if one lets the data speak out, the permanent income hypothesis seems to do a great deal better than any of (7), (9), or (11).

The fact remains that estimation of (14) by OLS will produce inconsistent estimates if the rate of interest is endogenous. To correct for this problem, we solve (14) for r:

[17] See *Feige* (1967), and *Kohli* (1981, 1984a), for instance.

$$r = \alpha\lambda/\gamma - (\beta\lambda/\gamma)y + (1/\gamma)m - [(1-\lambda)/\gamma]m_{-1} + (1-\gamma)r_{-1} \tag{15}$$
$$= a + by + cm + dm_{-1} + kr_{-1}$$

where $\lambda = 1 - k$, $\gamma = 1/c$ and $\beta = -b/[c(1-k)]$.

Furthermore, it is apparent that (15) is overidentified in the parameters since $d = -ck$. (15) is an interest-rate equation that is similar to (9), except that it also contains the lagged value of the real money supply. Moreover, in deriving (15), we have not assumed any disequilibrium in the money market. The upper half of Table 4 contains OLS estimates of (15). One sees that the coefficient of the lagged value of the real money supply is highly significant. Omission of this variable might be one of the sources of misspecification noted by *Andersen* (1985). The lower part of Table 4 contains estimates of (15) obtained by nonlinear least squares subject to the restriction $d = -ck$. A likelihood ratio test reveals that this restriction cannot be rejected, thus giving additional support to the permanent-income hypothesis.[18] The constrained estimates are very similar to the unconstrained ones. It is noteworthy that the estimate of the long-run income elasticity (β) is greater than unity in both cases. More worrysome is the rather large value of the h statistic which indicates that we have not yet succeeded in removing all sources

Table 4

Permanent-Income Hypothesis/Inverse Demand

i) Equation (15) – Unconstrained Estimates						
$r =$	-3.639	$+2.037y$	$-5.925m$	$+4.228m_{-1}$	-0.236θ	$+0.757r_{-1}$
	(-0.46)	(1.69)	(-7.35)	(4.07)	(-1.74)	(8.36)
OLS $n = 60$						
$\bar{R}^2 =$ 0.8620		SEE = 0.3153		DW = 1.56		$h = 2.32$
$\lambda =$ 0.243		$\beta =$ 1.416		$\gamma = -0.169$		
(2.68		(2.28)		(-7.41)		
ii) Equation (15) – Constrained Estimates						
$r =$	$-3.834+$	$1.714y$	$-5.932m$	$+4.588m_{-1}$	-0.218θ	$+0.773r_{-1}$
	(-0.49)	(1.71)	(-7.41)	(6.27)	(1.69)	(9.23)
NLLS $n = 60$						
$\bar{R}^2 =$ 0.8639		SEE = 0.3132		DW = 1.60		$h = 2.09$
$\lambda =$ 0.227		$\beta =$ 1.275		$\gamma = -0.169$		
(2.71)		(2.18)		(-7.44)		

[18] The test statistic is 0.27 for a critical x^2 value of 3.84 at the 95% confidence level with one degree of freedom.

of misspecification from our equation. Comparing the estimates of Table 4 with those contained in Table 3, one cannot help but wondering whether treating m as endogenous and r as exogenous might not be more appropriate than the reverse.

We conclude this section with two additional comments. First, in spite of the negative effect of the lagged money stock in (15), an exogenous change in the money supply does not lead to any interest-rate overshooting in this model. Instead, the rate of interest moves instantaneously to its new long-run equilibrium position. The reason for this is that the negative effect of the lagged money supply is exactly offset by the influence of the lagged dependent variable. A change in income, on the other hand, leads to a gradual change in the interest rate since expectations adjust only slowly.

Second, equation (15) bears a strong resemblance to the equation proposed by *Artis* and *Lewis* (1976). However, there are major differences between their model and ours. For a start, they use a disequilibrium approach (this is how the lagged rate of interest enters their equation), and we do not. Furthermore, they use measured income and permanent interest rates, while we opt for the reverse (and more conventional) solution. In spite of these important theoretical differences, the estimating equations are very similar. *Artis* and *Lewis'* (1976) study has stimulated much additional work and has generated promising empirical findings for a number of countries. It is therefore likely that our approach would also give good results for countries other than Switzerland.

IV. Exogenous Money On and Off

Comparing the linear and nonlinear estimates of (14) and (15) (Tables 3 and 4), we have expressed a preference for the former equation. However, if the money supply was indeed exogenous during the sample period, we must prefer (15) to (14) since the latter estimates would be statistically inconsistent. As an alternative to the estimation of an inverse demand-for-money function, one can estimate (14) directly by 2 SLS, using the left-hand variable as an instrument. As shown by *Kohli* (1985), this procedure yields consistent estimates. Moreover, these estimates are numerically identical to the ones implied by the estimates of the inverse-demand function.

Unfortunately, things are not quite that simple since our sample encompasses periods of fixed as well as of flexible exchange rates; that is, periods during which the money supply can probably best be viewed as demand determined, and others when it was undoubtedly supply determined. Thus, until 1972.4 the exchange rate was fixed, and monetary policy was mostly accommodating. When the Swiss Franc began to float in January 1973, the Swiss National Bank became able to regulate the money supply.[19] It first set out to absorb some of the excess liquidity which had been created in 1972 in a last ditch effort to salvage the fixed-rate regime, and, starting in 1975, it adopted a monetary rule aimed at gradually bringing down inflation to zero. The monetary target was abandoned in 1978.4 amidst a foreign-exchange crisis, and monetary policy was directed at checking the appreciation of the Swiss Franc, particularly against the German Mark. The Swiss National Bank reverted to a monetary target in 1980, and has been following a monetary rule ever since.

At the risk of oversimplifying somewhat, we thus distinguish four subperiods in our sample:

I.	1968.1 - 1972.4	fixed exchange rate
II.	1973.1 - 1978.3	monetary control
III.	1978.4 - 1979.4	exchange-rate target
IV.	1980.1 - 1983.4	monetary control

That is, we view the money supply as being chiefly demand determined in subperiods I and III, and mostly supply determined in subperiods II and IV. In order to derive consistent estimates of the parameters of the demand for money function, we could estimate (14) and (15) separately over the intervals of exchange-rate and monetary control respectively. That is, (14) could be estimated over subperiods I and III, while (15) could be estimated over II and IV. Alternatively (14) could be estimated by OLS over I and III, and by 2 SLS over II and IV. However, this procedure would result in a large loss of degrees of freedom, and in statistically less efficient estimates. Instead, we opt for the approach proposed by *Kohli* (1985), which is to estimate either (14) or (15) by 2SLS over the entire sample period, using the rate of interest as instrument over subperiods I and III, and using the money supply as instrument over subperiods II and IV. The corresponding constrained estimates are reported in Table 5.

It appears that autocorrelation of the residuals is no longer a problem, neither with the direct demand, nor with the inverse-demand function.[20] As expected (14) and (15) now produce very similar results. The elasticity of income expectations is found to be 0.3. The long-run income elasticity is about 0.9, and the long-run interest elasticity is close to -0.1. By comparing these estimates with those reported in Tables 3 and 4, one gets an idea of the

[19] See *Kohli* and *Rich* (1985).

[20] We verified that the autocorrelation coefficients are not significant in either case.

Table 5

Permanent-Income Hypothesis/Mixed-2SLS Estimates

i) Equation (14) – Direct Demand

$$m = \underset{(0.47)}{0.453} + \underset{(1.73)}{0.249y} - \underset{(-6.20)}{0.094r} + \underset{(4.42)}{0.065r_{-1}} - \underset{(-1.66)}{0.027\theta} + \underset{(6.77)}{0.700m_{-1}}$$

Mixed 2SLS $n = 60$

$\bar{R}^2 = 0.8401$ SEE $= 0.0376$ DW $= 1.79$ $h = 1.34$

$\lambda = \underset{(2.90)}{0.300}$ $\beta = \underset{(2.54)}{0.830}$ $\gamma = \underset{(-6.20)}{-0.094}$

ii) Equation (15) – Inverse Demand

$$r = \underset{(0.22)}{2.088} + \underset{(1.80)}{2.505y} - \underset{(-6.37)}{9.363m} + \underset{(5.08)}{6.600m_{-1}} - \underset{(-1.79)}{0.280\theta} + \underset{(6.96)}{0.705r_{-1}}$$

Mixed 2SLS $n = 60$

$\bar{R}^2 = 0.8188$ SEE $= 0.3613$ DW $= 1.75$ $h = 1.54$

$\lambda = \underset{(2.91)}{0.295}$ $\beta = \underset{(2.68)}{0.907}$ $\gamma = \underset{(-6.36)}{-0.107}$

biases that result if one incorrectly assumes that m is either exogenous or endogenous throughout the entire estimation period.

V. Monetary (Dis)equilibrium and the Buffer-Stock Notion

The monetary disequilibrium hypothesis is often viewed as expressing the idea that money acts as a buffer (or a shock absorber). Indeed, the two terms are frequently used almost interchangeably, even though several authors have emphasized that the concepts behind them are not identical. In this section we will attempt to sort out some thoughts about this topic. In particular, we want to examine whether the buffer-stock notion can be incorporated in some simple way into our demand-for-money function.

Much of the credit for the recent regain of interest in monetary disequilibrium and buffer-stocks undoubtedly goes to *Jonson* and to *Laidler*. Jonson's theoretical and empirical work is largely devoted to the concept of monetary disequilibrium, and many of his ideas are built into RBA76, the macroeconometric model of the Reserve Bank of Australia.[21] RBA76 is a medium-size general-equilibrium growth model with some extremely interesting features, one of which being the prevelant role of monetary disequilibrium, for instance in equations similar to (6) above. Jonson's viewpoint is essen-

[21] See *Jonson* (1976), *Jonson* et al. (1977), and more recent papers on RBA76.

tially that there is not short-run demand for money: the public willingly holds whatever quantity of money is available in the short run. However, any discrepency between actual holdings and desired long-run demand sets into motion a number of mechanisms in various parts of the model.

This viewpoint seems to be shared to a large extent by *Laidler* (1982, 1984). As mentioned in Section 2, Laidler (1984) argues that the role of the rate of interest is to balance the bond market, and that any disequilibrium that remains in the money market requires a change in the price level. However, if prices are sticky, monetary disequilibrium may last for a rather long period of time. This adjustment in the price level is described by (6). However, as we suggested in Section 2, this approach may lead to a number difficulties; in particular, it is no longer clear whether the parameters of (7) really belong to the money-demand function, rather than to say, an aggregate absorption function. To illustrate this point, consider a simple model with three goods: money, bonds, and commodities, and let the corresponding (end-of-period) desired demand functions be as follows:

(16) $$m^* = m_0 + m_1 y + m_2 r + m_3 (m + b)$$

(17) $$b^* = b_0 + b_1 y + b_2 r + b_3 (m + b)$$

(18) $$d^* = d_0 + d_1 y + d_2 r + d_3 (m + b)$$

where b^* and d^* denote respectively the desired demand for bonds and desired absorption, and b is the real supply of bonds. Furthermore, for simplicity, all variables in (16) - (22) are expressed in levels, rather than in logarithms. (16) - (18) must satisfy *Walras*' Law:

(19) $$(m^* - m) + (b^* - b) + (d^* - y) = 0.$$

This implies the following restrictions on the parameters of (16) - (18):

(20) $$\begin{aligned} m_0 + b_0 + d_0 &= 0 \\ m_1 + b_1 + d_1 &= 1 \\ m_2 + b_2 + d_2 &= 0 \\ m_3 + b_3 + d_3 &= 1 \end{aligned}$$

Assume now that the bond market always clears, but that the price level adjusts progressively in response to monetary disequilibrium:

(21) $$P - P_{-1} = \gamma (m - m^*) \qquad 0 < \gamma < 1$$

(21) is similar to (6) above, but in view of (19) and of the fact that $b = b^*$, it is clear that (21) can also be written as:

$$P - P_{-1} = \gamma (d^* - y) \tag{22}$$

(22) can hardly be described as a controversial proposition: it merely states that the price level adjusts in response to excess demand in the commodity market. Nevertheless, it is not at all clear whether the coefficients of (7) really belong to the demand for money, rather than to the aggregate absorption function.[22] Moreover, if (7) does capture the effect of excess demand in the commodity market, one can argue that its specification is excessively simple and might be faulty.

So far little has been said about the buffer role of money. *Laidler*'s (1982) argument that if a discrepency exists between actual and long-run desired holdings of money, agents will attempt to move towards their long-run target by altering their current rate of flow of expenditures on goods, services, and assets describes little more than a real balance effect.[23] In this respect money is no different from other assets. Wealth is a buffer in the sense that it allows agents to sustain a steady level of expenditures in the presence of fluctuations in income. If money is to differ from other assets, we must look beyond the real-balance effect. In particular, we must look more closely at portfolio decisions.

It is our opinion that the buffer-stock notion does not need to rely on the assumption of sticky prices; that is, the buffer role of money can be preserved even if the money market clears at all times. The special role of money can probably be modelled in many different ways.

In what follows we attempt to give a simple treatment at the desired-demand level, ruling out adjustment costs of any kind.[24]

Assume that the demand for money, and other assets and commodities depends on expected – or permanent – wealth (w_P). In order for *Walras*' Law to hold, it is then necessary to include transitory wealth (w_T) as well in some of the demand functions. Let the demand for money be as follows:

$$m = m_0 + m_1 y + m_2 r + m_3 w_P + m_4 w_T \tag{23}$$

where $w_T = w - w_P$, w being real current wealth. In our opinion, money acts as a buffer among other assets if m_4 is relatively large, that is, if a relatively

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[22] Of course the parameters of (16) and of (17) are related as indicated by (20).

[23] Similarly, the effect in RBA76 of "monetary disequilibrium" in equations such as the absorption function is equivalent to the real-balance effect. Note also that *Laidler* (1982) does not seem to draw a distinction between the real balance effect and portfolio-adjustment costs.

[24] An attempt to model the special role of money at the level of the portfolio-adjustment process can be found in *Kohli* and *McKibbin* (1982).

large proportion of transitory wealth is held in terms of money. (At the limit, all transitory wealth could be held in cash). This suggests that estimation of (23) should yield a significantly positive estimate of m_4.

We believe that, although this interpretation of the buffer-stock notion does not rely on monetary disequilibrium, it nevertheless seems compatible with *Jonson*'s and *Laidler*'s viewpoint that, in the short run, agents willingly hold any amount of money available to them (this would be the case if the marginal propensity of the demand for money with respect to transitory wealth were unity).

If one specifies an expectation – formation mechanism for w_P (e.g. along the same lines as for y_P), (23) can in principle be estimated. Unfortunately there are no reliable data for wealth available for Switzerland. As a palliative, we assume that the demand for money can be written as a function of permanent income and of transitory income (y_T):

$$m = \alpha + \beta y_P + \phi y_T + \gamma r. \tag{24}$$

Using (13), and the fact that $y_P + y_T = y$, we can eliminate y_P and y_T from (24) to get:

$$m = \alpha\lambda + \beta y + \theta(1-\lambda)\,\Delta y + \gamma r - \gamma(1-\lambda)r_{-1} + (1-\lambda)m_{-1} \tag{25}$$

where Δ is the first-difference operator.[25]

We report in Table 6 three sets of estimates of (25): the equation was first estimated by ordinary least squares without any restriction; next it was reestimated by nonlinear least squares, taking into account the fact that the parameters of (25) are overidentified; finally, it was estimated by the mixed procedure described in Section 4 above.

It is apparent from the estimates in Table 6 that transitory income plays no significant role in equation (25). Although the point estimates of ϕ have the anticipated sign and magnitude in all estimations, they are never statistically significant. The estimation results appear very satisfactory in every other respect.

Thus, we have been unable to detect any particular buffer function for money. This somewhat disappointing result does not mean, of course, that no such role exists. Instead, it could be due to multicollinearity of the data, or it could be the consequence of our use in (24) of permanent and transitory

[25] The inclusion of transitory income in (24) thus results in the presence of Δy in the estimating equation. For a similar treatment in the context of the consumption function, see *Darby* (1974) and *Kohli* (1981).

Table 6

The Buffer-Stock Hypothesis

i) Equation (25) – Unconstrained Estimates

$$m = \underset{(0.64)}{0.616} + \underset{(1.37)}{0.210}\,y + \underset{(0.60)}{0.172}\,\Delta y - \underset{(-7.33)}{0.085}\,r + \underset{(3.87)}{0.059}\,r_{-1} - \underset{(-1.21)}{0.020}\,\theta + \underset{(6.57)}{0.723}\,m_{-1}$$

OLS $n = 60$

$\bar{R}^2 = 0.8374$ SEE $= 0.0379$ DW $= 1.89$ $h = 0.84$

$$\lambda = \underset{(2.52)}{0.277} \qquad \beta = \underset{(2.05)}{0.785} \qquad \gamma = \underset{(-7.33)}{-0.085} \qquad \phi = \underset{(0.61)}{0.239}$$

ii) Equation (25) – Constrained Estimates

$$m = \underset{(0.73)}{0.687} + \underset{(1.34)}{0.201}\,y + \underset{(0.69)}{0.193}\,\Delta y - \underset{(-7.65)}{0.086}\,r + \underset{(4.96)}{0.062}\,r_{-1} - \underset{(-1.16)}{0.020}\,\theta + \underset{(6.64)}{0.725}\,m_{-1}$$

NLLS $n = 60$

$\bar{R}^2 = 0.8399$ SEE $= 0.0376$ DW $= 1.86$ $h = 1.04$

$$\lambda = \underset{(2.52)}{0.275} \qquad \beta = \underset{(1.98)}{0.730} \qquad \gamma = \underset{(-7.66)}{-0.086} \qquad \phi = \underset{(0.71)}{0.266}$$

iii) Equation (25) – Constrained Estimates

$$m = \underset{(0.58)}{0.558} + \underset{(1.41)}{0.216}\,y + \underset{(0.69)}{0.194}\,\Delta y - \underset{(-6.05)}{0.093}\,r + \underset{(4.32)}{0.067}\,r_{-1} - \underset{(-1.24)}{0.022}\,\theta + \underset{(6.61)}{0.723}\,m_{-1}$$

Mixed 2SLS $n = 60$

$\bar{R}^2 = 0.8386$ SEE $= 0.038$ DW $= 1.84$ $h = 1.18$

$$\lambda = \underset{(2.53)}{0.277} \qquad \beta = \underset{(2.12)}{0.779} \qquad \gamma = \underset{(-6.04)}{-0.093} \qquad \phi = \underset{(0.71)}{0.269}$$

income in place of the corresponding wealth components. It is also possible that our lack of success has to with the narrow definition of money which we use in this study.

VI. Concluding Comments

The first objective of this paper was to estimate a demand-for-money function for Switzerland with data covering periods during which the money supply can reasonably be viewed as having been exogenous, and others during which it was undoubtedly endogenous. A second objective was to examine some of the hypotheses which have recently been formulated about the demand for money, and which contend that the money market can remain out of equilibrium for extended periods of time. Our results for Switzerland do not support this view, however. We have argued that much of the evidence which seems to corraborate the disequilibrium hypothesis at first sight can in fact be interpreted in a way consistent with monetary equilibrium. Admittedly, we have tested only a handful of simple expressions of the disequilibrium hypothesis, and it is well possible that more complicated formulations would yield more satisfactory results. Yet, it seems that the equilibrium hypothesis may have been rejected somewhat too hastily during the recent debate, and that the permanent-income hypothesis, be it expressed by (13) or by a more sophisticated representation, still has a role to play in explaining cash-balance decisions.

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Zusammenfassung

Exogene Geldmenge, monetäres (Un-)Gleichgewicht und Erwartungslags

Dieser Aufsatz befaßt sich mit dem Problem der Schätzung von Geldnachfragefunktionen während Perioden monetärer Kontrolle. Wie *David Laidler* kürzlich ausgeführt hat, ist der übliche Ansatz, der einen partiellen Anpassungsmechanismus (die *Chow*-Gleichung) postuliert, nicht haltbar, wenn die Geldmenge exogen ist. Die Schweiz hat sich während der letzten Jahre sehr eng an ein Geldmengenziel gehalten und ließ dadurch wenig Zweifel aufkommen, daß im Falle der Schweiz die Geldmenge exogen ist. Wir geben Schätzungen für die Nachfrage nach Basisgeld in der Schweiz wieder, wobei wir alternativ die Chow-Formulierung gebrauchen, als auch verschiedene Ungleichgewichtshypothesen (einschließlich der von Laidler bevorzugten) und die permanente Einkommenshypothese. In einigen Fällen wird ein neues Schätzverfahren angewendet, um der Exogenität der Geldmenge über einen Teil der Stichprobe Rechnung zu tragen. Unsere Resultate zeigen, daß die monetäre Ungleichgewichtshypothese durch die Fakten nicht bestätigt wird. Schweizer Daten sind mit monetärem Gleichgewicht vereinbar, und das Auftreten einer verzögerten abhängigen Variablen in Geldnachfragefunktionen kann durch Erwartungslags erklärt werden.

Summary

Exogenous Money, Monetary (Dis)equilibrium, and Expectational Lags

This paper addresses the question of the estimation of demand-for-money functions during periods of monetary control. As *David Laidler* has recently pointed out, the standard approach that postulates a partial adjustment mechanism (the *Chow* equation) is untenable if money is exogenous. In recent years, Switzerland has adhered very closely to a monetary base target, thus leaving little doubts that money is exogenous in the Swiss case. We report estimates of Swiss demand for base money functions using alternatively the Chow formulation, various disequilibrium hypotheses (including the one favoured by Laidler), and the permanent income hypothesis. A new estimation procedure is used in some cases to allow for the exogeneity of money during part of the sample. Our results indicate that the monetary disequilibrium hypothesis is not supported by the facts. Swiss data are consistent with monetary equilibrium, and the presence of a lagged dependent variable in money demand equations can be explained by expectational lags.

Résumé

Monnaie exogène, (dés)équilibre monétaire et retards attendus

Dans cet article, l'auteur pose la question suivante: comment estimer les fonctions de demande de monnaie pendant les périodes de contrôle monétaire? Comme *David Laidler* l'a souligné récemment, l'approche courante affirmant qu'il y a un mécanisme d'ajustement partiel (l'équation de *Chow*), est insoutenable si la monnaie est exogène. Ces dernières années, la Suisse a maintenu étroitement un but de base monétaire, ce qui prouve avec beaucoup de certitude que la monnaie est exogène dans le cas de la Suisse. L'auteur rapporte des estimations de la demande suisse de fonctions monétaires de base, en utilisant tantôt l'équation de Chow, tantôt différentes hypothèses de déséquilibre (y compris celle que favorise Laidler) et tantôt l'hypothèse du revenu permanent. Il utilise dans certains cas une nouvelle méthode d'estimation pour tenir compte de l'exogénité de la monnaie pour une partie de l'échantillon. Nous en concluons que l'hypothèse du déséquilibre monétaire n'est pas corroborée par les faits. Les données suisses sont compatibles avec l'équilibre monétaire et on peut expliquer la présence d'une variable dépendante retardée dans les équations de demande monétaire par des retards attendus.