International Finance Discussion Papers

Number 210

June 1982

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by

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Since the breakdown of the Bretton Woods system and the change to flexible exchange rates, the Swiss franc has come to play an increasingly important role on international financial markets. The Swiss franc is generally included among the group referred to as "newly-emerging reserve currencies," and the Swiss National Bank (SNB) is often cited as an example for others to follow in prudent monetary policy management. Since 1975 the SNB has chosen to formulate its policy objective in terms of a monetary aggregate and has, as a result, raised the international importance of fluctuations in the Swiss money supply.

For Switzerland, as for other countries, there is no one measure that corresponds to "the" money supply; there are now three publicly-held aggregates regularly published by the SNB. To understand the observed fluctuations in these monetary aggregates, it is necessary to have knowledge of the structure underlying the demand for several Swiss assets. In this paper I propose to contribute to that knowledge by formulating and then estimating econometrically a model of the demand for Swiss monetary aggregates. These estimates are of general interest because of the intrinsic importance of the Swiss franc on international financial markets, because within Switzerland (as elsewhere) issues of the appropriate definition of monetary aggregates and subsequent choice of an intermediate target for monetary policy arise, and because these estimates will contribute to the on-going debates of international comparisons of the stability of the demand for money (see, for example, Boughton) and of the existence of economically important cross-country substitution of currencies within private portfolios (see Brittain).[1/]

The questions of which aggregate accurately reflects the thrust of monetary policy, which better predicts the future path of nominal spending or

prices, and which performs best as an intermediate target for policy makers would not be of great concern if all the monetary aggregates tended to move together. In fact their movements during the past decade have been extraordinarily dissimilar, particularly during recent years. From March 1979 to July 1980, Swiss M1 fell by 17 percent while M2 grew by 20 percent. While perhaps extreme, this episode is not unique. Table 1 gives the December to December annual rate of change for the Swiss monetary aggregates in 1973-1980. From year to year the rates of change of the aggregates frequently move in opposite directions, and in some years the rates are even of opposite sign.

These differences in behavior over time of the narrow and broad money measures are even more startling when one remembers that the broad money aggregates contain the narrow money measure. Thus it must be the case that the underlying components of the aggregates are moving in even more extreme ways. That this has been the case for Switzerland is shown in Table 2. There the growth rates for the four basic components of the aggregates are given for 1973-1980. As expected, the differences across components of their behavior over time are even more extreme.

Inspection of Table 2 suggests a tendency for demand deposits and term deposits to move inversely to one another. Such movement could well be the result of shifts between deposit categories induced by interest rate changes. If such behavior is stable and predictable, it would mean that actual declines in M1 at the same time as rapid growth in M2, as we observed during 1979 and 1980, are not in any economic sense contradictory. At the same time, however, serious questions would remain about the appropriate role of either aggregate in the policy-making process.

Table 1

Swiss Monetary Aggregates
Percent change - December over December

	M1	M2	M3
1973	2.0	5.9	7.6
1974	1.1	7.8	6.0
1975	5.9	0.7	7.8
1976	8.1	1.6	7.4
1977	4.1	5.6	8.1
1978	22.9	10.2	10.4
1979	-7.0	12.2	8.8
1980	-0.2	13.7	4.3

This paper will seek to determine whether or not there exist (on the basis of econometric evidence) a set of stable structural relationships which can explain the observed behavior of the Swiss monetary components during the 1970s and what the properties of these relationships are. The period since 1978 is of particular importance with respect to the issue of stability. During 1978 the world-wide demand for assets denominated in Swiss francs was such that the franc appreciated very sharply. This appreciation induced a response in the policy of the SNB. It does not necessarily follow that the structure of the relationships describing the demand for Swiss assets shifted or was unstable at this time. Nevertheless, 1978 marks the beginning of a period during which the Swiss franc has played a somewhat more conspicuous international role than it did earlier. Thus the question of a possible structural change in 1978 will be examined in detail.

Table 2

Switzerland
Percent change - December over December Year Earlier

	M_3			
	M_2			
	M_1		Term Deposits + * Foreign Currency Deposits of Residents	Thrift Deposits
	Currency	Demand Deposits		
1973	10.2	-2.2	14.3	9.4
1974	7.9	-2.9	20.7	4.1
1975	-1.1	10.5	-7.8	15.8
1976	3.6	10.7	-10.4	13.0
1977	2.5	4.6	9.4	10.3
1978	10.6	29.9	-17.0	10.4
1979	4.0	-12.0	72.7	6.0
1980	3.0	-2.0	37.6	-4.1

* Throughout the remainder of the paper this component will be referred to simply as term deposits.

Estimation

The information revealed in Table 2 indicated that there was no à priori reason for believing that the same structural equation was appropriate for any two, three, or all four of the monetary components. Therefore the research strategy used was that of modeling the demand for each component asset rather than for the aggregates as currently defined. In principle these four asset demand schedules are part of a much larger system of asset demand functions, including those for long-term financial assets, stocks, physical capital, real estate etc. A general formulation of such a system would include all rates of return in each demand schedule. In the estimations that follow, that was not done. In part this is because all the appropriate data are not available. In part it results from prior judgment that the assets in question are sufficiently poor substitutes for the short-term financial assets being studied here that it is not economically important to include their rates of return. Because these four demand schedules are just part of a larger system, no "adding-up" constraints or cross-equation restrictions apply.

The period of observation selected was 1973-1980. This interval seems to be one in which the exchange rate regime was stable, and thus shifts in asset demand because of changes in international monetary arrangements are unlikely. The model was estimated on a monthly basis in order to take full advantage of all the information available about changes in money holdings.[2/]

Two basic versions of each equation were considered: one that would be appropriate if the set of assets available to Swiss portfolio-holders consisted entirely of domestic assets, another for the case that foreign assets were also available. The bank deposit data reported by the SNB includes only deposits held by Swiss residents with banks in Switzerland. Thus special characteristics

of the non-resident demand for Swiss franc deposits (such as those that might follow from the special taxes levied on such deposits in the late 1970s) need not be modeled here as both the demand and supply refer to holdings by Swiss residents. An exception to this, of course, is currency outstanding, which will in general include both resident and non-resident holdings. This distinction should be kept in mind when the two alternative estimations are discussed below. Since the authorities took actions which heavily penalized foreignors who sought to increase their holdings of franc deposits within Switzerland during most of the period 1978-1980, it is unlikely that significant international substitution into Swiss franc assets took the form of non-resident deposits at Swiss banks.

Although the four demand schedules were viewed as part of one system, they were estimated separately with judgments concerning structural form made on a equation by equation basis. Since the model was a monthly one, it seemed unreasonable to impose total adjustment within the period. Thus a partial adjustment structure, with the lagged dependent variable included among the explanatory variables, was used (see Santomero and Seater). The monthly period of observation also dictated that the variable included to capture the role of total income or wealth be retail sales. While this measure à priori appeared reasonable for currency demand, it seemed less appropriate for the other components. Neither industrial production nor GNP are measured monthly in Switzerland and the latter is not even available quarterly.

All equations were estimated in both level and semi-logarithm form. The criteria applied in order to choose amongst alternative versions of the same demand schedule were the absence of serial correlation in the residuals, estimated coefficients of the expected sign, and reasonable values for the lagged adjustment parameter. The dependent variable and retail sales variable in all

cases were first deflated by the Swiss consumer price index. Since the money supply data (and the retail sales series used) are not seasonally adjusted, all equations contained eleven monthly dummy variables as additional explanatory variables. All estimates were done using an instrumental technique, with all Swiss rates of return treated as endogenous variables.[3/]

Results

Table 3 contains the estimates for the currency equation which are obtained when one regards the Swiss economy as "closed" in the sense that only domestic monetary assets are considered as alternatives by Swiss portfolio-holders.[4/] The two short-term interest rates, the thrift deposit rate and the 3-month term deposit rate, are the own rates of return for the thrift deposit and term deposit components, respectively, but are opportunity cost measures for currency and demand deposits. Both rates were tried individually and jointly in all four functions. Household use of currency (rather than credit cards or checks) is greater in Switzerland than in the United States. Thus there was a prior expectation that households for the most part substitute between currency and thrift deposits while firms substitute between demand deposits and term deposits. The estimated results (discussed below) somewhat confirmed this characterization.

The currency equation is the only one of the four that consistently performed better when estimated in level rather than semi-logarithmic form. As a result in Table 3 (and again in Table 7) the dependent variable, lagged dependent variable and retail sales variable are in (deflated) level form for the currency equation.

The coefficient for the thrift deposit interest rate is always negative and strongly significant in the equation for currency while including that for 3-month term deposits (equation 2) contributes no significant explanatory power to the equation. (Substituting the 3-month term deposit rate for the thrift rate yields estimates that are clearly inferior to those reported in Table 3.) This finding lends support to the hypothesis discussed above concerning the asset substitution behavior of households.

The coefficient on real retail sales is positive (as expected) but generally not statistically significant by the usual criteria. In part this is probably because retail sales does not exactly correspond to the concept of a transactions variable called for by theory. In addition, the retail sales variable displays a strong seasonal pattern over time. Indeed, one reason we expect currency holdings to vary seasonally is precisely the seasonal variation in retail sales. When the seasonal dummies (which vary across the months and are all significant) are omitted from the currency equation, the coefficient on retail sales becomes larger and much more significant. However, clear evidence of serial correlation in the errors in that case suggests that something systematic has been omitted from the equation. It thus seems that the seasonal dummies belong in the equation but that those variables and retail sales are jointly capturing the effects of seasonal variation in transactions.

Comparison of equations 1 and 2 indicates that the 3-month term deposit rate does not play an important role by itself and that its presence affects the coefficients on other variables very little. On this ground, equation 1 was selected and tested for two further alternatives in the closed-economy form, the presence of a trend term and of a shift in 1978. Equation 3 shows the results obtained when a trend term is included. The trend term is not significantly different

Table 3

Switzerland
Estimated Currency Demand Equations: 1973-80

	Dependent Variable: Level of Real Currency Holdings			
	Equation 1	Equation 2	Equation 3	Equation 4
Variable				
Constant	6.776 (4.032)	4.177 (5.390)	6.834 (4.119)	8.634 (4.190)
Lagged Dependent Variable	.872 (.038)	.891 (.046)	.875 (.042)	.844 (.042)
Thrift Deposit Rate	-.610 (.171)	-.519 (.209)	-.623 (.205)	-.499 (.182)
3-Month Term Deposit Rate		-.051 (.073)		
Thrift Deposit Rate Shift 1978-80				.237 (.149)
Real Retail Sales	3.840 (2.295)	4.262 (2.398)	3.510 (3.136)	4.727 (2.355)
Trend			-.0013 (.0087)	
S.E.	.877	.879	.883	.873
$\bar{R}^2$	.968	.968	.968	.969
h	-0.230	-0.530	-0.277	-0.206
n	96	96	96	96

Note: Figures in parenthesis are standard errors. Coefficients for seasonal dummy variables are reported in the appendix.

from zero, but this may in part be due to the fact that the equation is linear in levels not logs and so the trend specification is not equivalent to a constant growth rate. The structural shift of most interest that might lie behind the very large changes in growth rates from 1977 to 1978 of Swiss currency, demand deposits, and term deposits (see Table 2) is that of a change in the interest rate response of demanders for these assets. For this reason, equation 1 was reestimated with a dummy shift variable included for the thrift deposit rate from 1978 to 1980. The results, reported in equation 4, suggest that currency demand became less interest sensitive after 1977. This rather surprising result is far from firmly established since the coefficient on the dummy shift term is of rather low order significance. While I do not reject the findings of equation 4 and believe some further work on the question of a shift is warranted, I regard equation 1 as the most successful of those reported in Table 3 and as a representative expression of the demand for Swiss currency.

The equations for the demand for demand deposits are reported in Table 4. The 3-month term deposit rate is negative and strongly significant in all of the specifications that were tried. When the thrift deposit interest rate is included in the equation, its estimated coefficient does not appear to be significant and the coefficient for the term deposit rate changes almost not at all. Comparison of equation 2 in Table 3 to that of Table 4 reveals rather powerful evidence that the two component assets, currency and demand deposits, are sensitive to different short-term interest rates. The estimated coeffcients are consistent with the characterization given above of households substituting between currency and thrift deposits and firms, between demand deposits and term accounts. Equation 1 was modified as before to test for a shift in the interest rate coefficient in 1978. As can be seen in equation 3, no significant evidence for such a shift was found.

Table 4

Estimated Demand Deposit Equations: 1973-80

	Dependent Variable: Log of Real Demand Deposit Holdings		
	Equation 1	Equation 2	Equation 3
Variable			
Constant	.714 (.191)	.820 (.290)	.739 (.191)
Lagged Dependent Variable	.871 (.034)	.855 (.048)	.866 (.035)
3-Month Term Deposit Rate	-.0099 (.0023)	-.0092 (.0023)	-.0097 (.0028)
Thrift Deposit Rate		-.0056 (.0083)	
3-Month Term Deposit Rate 1978-80			-.0011 (.0034)
Trend	.0004 (.0002)	.0002 (.0002)	.0005 (.0003)
Real Retail Sales	.152 (.082)	.123 (.083)	.167 (.083)
S.E.	.022	.022	.022
$\bar{R}^2$	.974	.974	.974
h	0.843	1.144	.748
n	96	96	96

Note: Figures in parenthesis are standard errors. Coefficients for seasonal dummies are reported in the appendix.

Real retail sales and the trend term both contribute positively to demand deposit holdings. The coefficients for both appear somewhat sensitive to the specification of the rest of the equation. Retail sales is probably less suitable as a scale variable in this equation than it was in the currency equation, particularly in view of the distinction suggested above in household versus firm behavior. Demand deposit behavior is far less seasonal in its fluctuations than is currency (see appendix).

Table 5 contains the estimated equations for the demand for term deposits. Because of data limitations, these equations can be estimated only over the period June 1975 to December 1980. In these equations the lagged dependent variable has a consistently lower coefficient than is the case on Tables 3 and 4. This implies a more rapid speed of adjustment in term deposit holdings, an intuitively plausible finding since these deposits tend to be held by firms, who are presumably more sophisticated in their asset management than households.

For these deposits, the term deposit rate is the own rate of return. In equation 1 it can be seen that term deposits clearly are strongly positively related to the own rate of return. Tests of the dummy shift variable for this rate (equation 2) yielded evidence that such a shift had occurred, thereby raising the own-interest sensitivity of term deposits in 1978. Because of this finding, subsequent tests of the term deposit equation were done including the shift term. Comparison of Tables 4 and 5 confirms the proposition that a rise (fall) in the term deposit rate leads asset-holders to switch from (into) demand deposits into (from) term deposits.

Table 5

Estimated Term Deposit Equations: 6/75 - 12/80

	Dependent Variable: Log of Real Term Deposit Holdings			
	Equation 1	Equation 2	Equation 3	Equation 4
Variable				
Constant	1.412 (.251)	1.917 (.305)	1.834 (.305)	1.718 (.315)
Lagged Dependent Variable	.689 (.052)	.602 (.059)	.643 (.069)	.647 (.061)
3-Month Term Deposit Rate	.046 (.007)	.037 (.008)	.034 (.008)	-.013 (.022)
3-Month Term Deposit Rate 1978-80		.027 (.010)	.030 (.011)	.020 (.011)
Thrift Deposit Rate			-.017 (.020)	
Euro-Swiss Franc 3-Month Rate				.045 (.019)
Trend	.0009 (.0003)	-.0005 (-.0006)	-.0015 (.0014)	-.0002 (.0006)
Real Retail Sales	-.110 (.208)	-.077 (.201)	-.076 (.200)	.028 (.213)
SE	.034	.033	.033	.034
$\bar{R}^2$	.980	.982	.982	.980
h	1.449	.433	.052	.842
n	66	66	66	66

Note: Figures in parenthesis are standard errors. Coefficients for seasonal dummies are reported in the appendix.

For an interest-bearing asset such as term deposits, one (or more) cross rate of return measure should be included in addition to the own rate of return. Equations 3 and 4 are the results obtained when rates of return on alternative Swiss-franc denominated assets are added to the equation. In equation 3 the thrift deposit rate enters with the expected negative sign, but the estimated standard error is very large relative to the coefficient. The roles of the other variables do not appear to be affected by the inclusion or exclusion of the thrift deposit rate. In equation 4 the effect of including the 3-month Euro-Swiss franc rate is quite different. In that equation the Euro-rate enters with a positive, significant coefficient and the 3-month term deposit rate variable largely breaks down. From mid-1976 these two rates are highly collinear. There is then first a question of whether there is enough independent variance of the two rates in the sample for the separate (and presumably opposite) roles of the two in determining demand for term deposits to be estimated. Secondly, it may be that these two assets are close, almost perfect, substitutes. In that case, the demand for term deposits given the Euro-Swiss franc rate does not have the structure of equation 4 at all, but rather is essentially infinitely elastic at the going Euro-Swiss franc rate. Equation 4 would then be the result of estimating a misspecified equation. A demand equation with the structure of those in Table 5 would then exist for the aggregate of term deposits plus Euro-Swiss franc deposits. The lack of monthly observations on Euro-Swiss deposits (held primarily at London banks) prevented further exploration of this possibility. Until further research resolves these issues, a reasonable interpretation of equations 1, 2, and 3 would be that the term deposit rate coefficient is capturing the impact on term deposit holdings of joint movements in the term deposit and Euro-Swiss franc rates.

From the results reported on Table 5 it would seem that no true residual trend effects are significant in the equation. The trend term in equation 1 reflects the effects of omitting the dummy shift variable. Real retail sales appear to be a poor proxy for the appropriate scale variable and have essentially a zero effect.

The final component asset examined in this study is thrift deposits. Estimated equations for the demand for these deposits are reported in Table 6. For these equations the thrift deposit rate is the own rate of return while the term deposit rate is a cross rate. While the thrift deposit rate enters positively in equation 1, it is clear from the statistics reported for that equation that problems arise with that specification. In equation 2 several of these problems appear resolved; the lagged adjustment coefficient falls below one to a level similar to that for currency and demand deposits, and there is no longer clear evidence of serial correlation in the residuals. Unfortunately, when the term deposit rate is included in the equation, the coefficient on the own rate measure switches to negative. If one regards equation 1 as a constrained version of equation 2, the evidence clearly rejects the constraint in favor of the specification in equation 2. This negative relationship to the own rate of return cannot be dismissed as some kind of spurious statistical result because of collinearity between the two rates. The two rates do not in fact move closely together over this interval and were both included in equations reported on Tables 3 and 4 without difficulty.

While the negative estimated coefficient on the thrift deposit rate is troublesome, other aspects of equation 2 do tend to support the notion that households systematically substitute between currency and thrift deposits. Real retail sales are negatively related to thrift deposits, a property which is consistent with the interpretation that increased retail sales cause households to

Table 6

Switzerland
Estimated Thrift Deposit Demand Equations: 1973-80

	Dependent Variable: Log of Real Thrift Deposit Holdings		
	Equation 1	Equation 2	Equation 3
Variable			
Constant	-.491 (.262)	1.185 (.314)	1.178 (.318)
Lagged Dependent Variable	1.075 (.040)	.816 (.048)	.818 (.049)
Thrift Deposit Rate	.0074 (.0047)	-.013 (.005)	-.013 (.005)
Thrift Deposit Rate 1978-1980			-.00015 (.0010)
3-Month Term Deposit Rate		-.0047 (.0007)	-.0047 (.0008)
3-Month Term Deposit Rate 1978-1980			-.00017 (.0008)
Trend	-.0003 (.00007)	.0003 (.0001)	.0003 (.0001)
Real Retail Sales	-.088 (.021)	-.037 (.018)	-.034 (.020)
SE	.0063	.005	.005
$\bar{R}^2$	.998	.999	.999
h	2.67	.246	.296
n	96	96	96

Note: Figures in parenthesis are standard errors. Coefficients for seasonal dummy variables are reported in the appendix.

demand more currency and lower thrift deposit balances. In addition, thrift deposits are second only to currency in the strength of the seasonal factors (see appendix). Moreover, the seasonal factors for the thrift deposit equation are in a very loose sense the opposite of those for the currency equation.

It may be that the inclusion of additional rates of return on alternative assets would yield an estimated thrift deposit equation with a positive coefficient on the own rate of return. Further research on this problem is clearly called for but beyond the scope of this paper.

Summary of "closed" economy results

Tables 3-6 present a set of similar traditionally structured relationships that can explain the monthly movements of Swiss monetary assets in the 1970s. While there are some unresolved problems and further research is likely to prove fruitful, it does appear that these relationships can be estimated successfully and that their private offer potentially useful insights into the process of Swiss money demand and monetary control. Moreover these results establish that there is a great deal to be gained by estimating demand functions for the component assets rather than for the aggregates. The demand functions for the components differ from each other in many important respects, and these underlying structural differences are lost when one considers only the aggregated measures.

The demands for the various Swiss monetary components are all interest sensitive, but they are sensitive to different rates and in different degrees. In addition these asset demands appear to have different adjustment speeds, different seasonal properties, and to have been affected differently by structural shifts in the 1970s. Because of the lagged adjustment specification, there is

not just one interest semi-elasticity for each asset. There is a short-run (one-month) effect given by the interest rate coefficient, and there is the final very-long term effect that results after all adjustment through the lagged dependent variable has occurred. For example, the coefficients on Tables 4 and 5 imply that a one percentage point rise in the term deposit rate after 1978 would, within the first month, decrease demand deposits by about one percent but increase term deposits by about six percent. The speeds of adjustment implied by the coefficients on the lagged dependent variable differ in the two equations, with adjustment occurring much faster in term deposit holdings. The long-run impact of such a change in the term deposit rate is about a seven percent decrease in demand deposits and a sixteen percent rise in term deposits. This change in relative values occurs because the impact effect of the interest rate change on term deposits represents a much larger fraction of the total effect than is the case for demand deposits.

Foreign-Currency Denominated Assets

In an economy without capital controls limiting the acquisition of foreign assets or the sale abroad of domestic assets, there is no reason to limit the consideration of alternative assets to those denominated in domestic currency alone. Swiss portfolio-holders were free to substitute short-term nominal assets denominated in other currencies for short-term Swiss franc monetary assets. They would thereby acquire comparable liquidity, slightly different transactions services, and a yield which would consist of a capital gain or loss due to exchange rate change plus, if relevant, the foreign market rate of interest. If such substitution was empirically important during the 1970s, then measures of expected exchange rate change and foreign interest rates should be included as explanatory variables in the demand functions for Swiss monetary assets. (Recall that except for currency, the dependent variable in each case is the Swiss

residents' holding of the particular asset. For currency, it would be appropriate to include as well measures of foreign prices, transaction scale and/or wealth; but it is not clear how this could be done with presently available data.) I shall refer to this entire issue of foreign rate of return variables playing a significant role in determining, in this case Swiss, demand for monetary assets as the issue of currency substitution, although some may prefer to restrict that term to the case where strictly non-interest bearing assets denominated in foreign currency are effective substitutes for domestic assets. (See Girton and Roper for a theoretical model of currency substitution and Miles for an empirical discussion with respect to the Canadian dollar.)

The demand for Swiss asset i in the case of currency substitution can be written as:

$$(1) \quad D_i = \alpha_i r_i - \alpha_j r_j - \alpha_{FC}(-e) - \alpha_{FD}(R-e) + \beta Z + u$$

where D_i is the demand for Swiss asset i, r_i is the rate of return on that asset (which may be zero), r_j is the rate of return on a competing Swiss franc asset, e is the expected rate of appreciation of the Swiss franc, R is the foreign rate of interest, and Z is a vector of all other variables included in the equation. Each of the coefficients, including α_{FC} (for foreign currency) and α_{FD} (for foreign interest-bearing deposits) is assumed to be positive. The difficulties of estimating (1) are that there are in fact numerous alternative foreign currencies, not just one, and that it is not possible to observe e (either bilateral or weighted-average) directly. If a single R were chosen and e could be measured directly, then (1) would simplify to:

$$(2)\quad D_i = \alpha_i r_i - \alpha_j r_j + (\alpha_{FC} + \alpha_{FD})e - \alpha_{FD} R + \beta Z + u.$$

Notice that in (2) one would expect a negative coefficient on the foreign interest rate, R, and a positive coefficient on the expected rate of Swiss franc appreciation, e, that is a composite of the effects from foreign currency and foreign deposits.

If the foreign asset is a very close (even perfect) substitute for an interest bearing Swiss asset, then a possible measure of e would be given by

$$(3)\quad e = R - r_j.$$

Expression (3) is the open interest arbitrage condition that would hold exactly only if the foreign asset were viewed as a perfect substitute for the Swiss asset by portfolio holders. Substitution of (3) into (1) yields:

$$(4)\quad D_i = \alpha_i r_i - (\alpha_j + \alpha_{FC} + \alpha_{FD}) r_j + \alpha_{FC} R + \beta Z + u.$$

In (4) the expected sign of the coefficient on the foreign interest rate is positive and the coefficient represents the impact of the yield on foreign currency on demand for the domestic asset. The coefficient on the alternative Swiss asset, j, is now the sum of all the cross effects, domestic and foreign, and is expected to be negative.

Estimates of both form (2) and (4) were calculated for each of the four Swiss monetary assets examined in this study. For currency and demand deposits r_i was set equal to zero. For term deposits, expression (3) was replaced by

$$(3')\quad e = R - r_i.$$

In effect, the foreign asset became the only alternative asset, and r_j equalled zero. (Recall the discussion above of the Euro-Swiss franc rate in the closed-economy version of the term deposit equation.) Substitution of (3') into (1) would yield an expression with a composite coefficient on r_i, but with the coefficient on R still α_{FC} as in (4). The open-economy specifications were also modified to allow for shifts in the coefficients of rate of return variables in 1978 and estimated in that form.

Table 7 reports the most successful of these open-economy specifications for each of the four assets. The dollar exchange rate and Eurodollar interest rate were chosen as representative foreign variables. While ambiguities and difficulties are clearly present, the evidence is suggestive of some currency substitution behavior being relevant as part of the explanation of the demand for Swiss monetary assets. The specifications reported in Table 7 in effect use different measures for e. The variable defined as a direct measure of e was a proxy based on the assumption that the expected value of the rate of appreciation (over a three-month horizon) would differ from the realized value by forecast errors that were independent of any information available to portfolio holders at time t. Thus the actual rate of appreciation (expressed at an annual rate) could be used as a measure of the expected rate. The expected rate of appreciation is implicitly determined simultaneously with the asset demands and rates of return modeled here, and therefore the forecast error is not independent of the contemporaneous values of the endogenous variables. As a result, the proxy measure of the actual rate of change of the exchange rate was regarded as an endogenous variable and an instrumental technique was used for it (see footnote 3).

Table 7

Switzerland

Estimated Demand Functions - "Open-Economy" Case

Variable	Currency	Demand Deposits	Term Deposits	Thrift Deposits
Constant	16.973 (6.753)	.858 (.236)	2.369 (.429)	1.112 (.406)
Lagged Dependent Variable	.778 (.063)	.843 (.043)	.519 (.082)	.828 (.063)
Thrift Deposit Rate	-.791 (.194)			-.012 (.006)
3-Month Term Deposit Rate		-.012 (.003)	.037 (.009)	-.005 (.001)
3-Month Term Deposit Rate 1978-80			.048 (.015)	
3-Month Eurodollar Rate	.106 (.056)	.0016 (.0015)	-.0046 (.0034)	-.001 (.0004)
Expected Rate of Swiss Franc Appreciation			.0006 (.0003)	
Trend		.0004 (.0002)	-.0007 (.0007)	.0003 (.0001)
Real Retail Sales	4.055 (2.262)	.159 (.082)	-.049 (.220)	-.035 (.020)
SE	.864	.022	.036	.005
R^2	.969	.974	.978	.999
h	.291	.952	1.109	.230
n	96	96	66	96

Note: Figures in parenthesis are standard errors. Coefficients for seasonal dummy variables are reported in the appendix.

The estimates on Table 7 suggest that currency demand responds to foreign rate of return variables (including that on foreign currency). Recall that currency is the one component asset measured inclusive of non-resident holdings. For demand deposits and term deposits the results are less persuasive, but indicate that further work on this question might be fruitful. For thrift deposits, the estimates which included alternative specifications of the foreign variables never yielded any indication of significant roles for those variables. The additional inclusion of shift variables (1978-1980) for the foreign rate of return variables succeeded only in producing estimates in which the standard errors for all foreign rate of return variables were very large relative to the estimated coefficients.

The results reported here clearly do not exhaustively test the issue of currency substitution as it applies to Swiss franc-denominated assets. Improved measures of e and the consideration of non-dollar denominated foreign alternatives are two obvious areas where further work appears warranted but is beyond the scope of this paper.

Estimation of M1 Demand Functions

In order to compare the success of the disaggregated approach taken in this paper in predicting M1 to that of the standard money demand for M1 approach, the estimates on Table 8 were calculated. In these regressions the dependent variable is the log of real M1. The explanatory variables were chosen in the light of what had been learned about Swiss money demand in the disaggregated estimates reported above. The specification and structural differences between the component assets that had been revealed in the disaggregated equations were suppressed in these equations, however, as the underlying assumption of such an equation is that a single behavioral structure explains the movement in M1.

Equation 1 in Table 8 contains all the variables that appeared to be significant in the "closed" versions of the demand for currency and for demand deposits. Despite the fact that the evidence reported on Table 3 indicates the importance of the thrift deposit rate in currency demand, that rate does not come through as significant for M1 demand in equation 1 here. For the purposes of comparison, equation 2 was calculated. Omitting the thrift rate had negligible effect on the remaining coefficients. Equation 3 is the more successful of the two versions of the "open" economy specification, as described above. While it is reasonable to suppose that a researcher seeking an estimated M1 equation could improve upon the equations reported in Table 8, they are typical of the kind of M1 equations found in the literature. They do reflect the strong negative interest elasticity found for the Swiss component assets and imply approximately the same speed of adjustment.

Because of the specification of the dependent variables on Tables 3 and 4, i.e., currency is in levels and demand deposits in log form, one cannot simply compare the residuals of the equations on Table 8 to the (appropriate) sum of those on Tables 3 and 4. (Indeed, since log is not a linear operator, the disaggregated equations could not be simply summed to obtain a "predicted" value for the log of real M1 even if currency were in log form.) Instead, the fitted values of the currency, demand deposit, and M1 equations were transformed back to the implied nominal levels for these assets. The predicted levels of currency and demand deposits so-calculated were then summed to form an M1 value. Equation 1 from Table 3 and from Table 4 produced in this way a vector of M1 values to compare with those implied by Equation 2 on Table 8, i.e., a "closed" economy comparison. The appropriate equations on Table 7 were used to calculate an "open" economy version of M1 that could be

Table 8

Switzerland

Estimated M1 Demand Equations: 1973-80

Variable	Dependent Variable: Log of Real M1 Holdings Equation 1	Equation 2	Equation 3
Constant	.705 (.267)	.628 (.185)	.778 (.233)
Lagged Dependent Variable	.879 (.043)	.891 (.031)	.864 (.040)
Thrift Deposit Rate	-.003 (.006)		
3-Month Term Deposit Rate	-.006 (.001)	-.006 (.001)	-.008 (.002)
3-Month Eurodollar Rate			.001 (.001)
Real Retail Sales	.089 (.058)	.108 (.057)	.114 (.057)
Trend	.0002 (.0002)	.0003 (.0001)	.0003 (.0001)
SE	.015	.015	.015
$\bar{R}^2$	.977	.977	.977
h	1.558	1.300	1.398
n	96	96	96

Note: Figrues in parenthesis are standard errors. Coefficients for seasonal dummy variables are reported in the appendix.

compared to the values implied by Equation 3 of Table 8. Each of the four series of "predicted" M1 were then compared to the actual levels, and the root mean square error was calculated. Table 9 contains these figures.

Table 9

Root Mean Square Error:	Closed Version	Open Version
$\hat{M1}$ formed from disaggregated estimates	733	725
$\hat{M1}$ formed from M1 equations on Table 8	751	744

One might expect that currency and demand deposits are very close substitutes for portfolio-holders and that the variables which induce substitution between them are not explicitly captured in the estimated equations but are, rather, in the context of these models, random shocks. In that case it would follow that the sum of currency plus demand deposits would behave in a more stable, easily predictable manner than would the components. This does not appear to be the case in Switzerland, at least during the 1970s. In both the "closed" and "open" specifications of the demand functions, the M1 path implied by the disaggregated equations had a lower RMSE than did that implied by the M1 equation of Table 8. The additional information contained in the disaggregated equations about the differences between the demand for currency and that for demand deposits appears to be more important than whatever gains are achieved in reducing the net size of the stochastic shocks by aggregating.

Because term deposit, and thus M2, data were available for only the later part of the sample period, I did not calculate a similar comparison for predicted M2. That would seem to require, even for this ad hoc, indicative comparison, a reestimation of the equations of Tables 3 and 4 over the same period that demand for M2 could be estimated. In view of the pronounced differences between the estimates of Table 5 and those of Table 3 and 4, I believe it is extremely likely that the additional information provided by the disaggregated equations would again prove to be most important.

Summary and Conclusions

The results obtained in this study clearly show that it is possible to model and estimate the demand for Swiss monetary assets and that these estimates offer some very interesting insights. Except for thrift deposits, each of the monetary assets appears to be related to Swiss interest rates in the expected way. The interest rate effects are strong, but different across the assets. Indeed, different rates figure in different equations. In addition, the demand functions appear to have different underlying structures and very different seasonal patterns of behavior.

Because of the lagged adjustment specification, there is no single interest semi-elasticity implied by the results for each asset. The short-run effects of an increase in the term deposit rate are substantial for both demand deposits and term deposits, especially after 1978. While in both cases the implied long-run response exceeds that in the short-run, the long-run effects do tend to converge somewhat. Overall the interest rate coefficients confirm the hypothesis of substitution between demand deposits and term deposits and between currency and thrift deposits. These coefficients appear to have remained stable in the late 1970s except for the term deposit shift.

The currency substitution hypothesis is far from resolved in the Swiss case by the results of this study. Inclusion of opportunity cost measures based on the Eurodollar appear to improve the ability of estimated equations to fit the sample data. Individual estimated coefficients and the fact that on Table 9 the "open" specification has a lower RMSE than the closed for both calculated M1 series suggest that further work on this question is warranted in the Swiss case.

The estimates reported in this paper show the value of the disaggregated approach to money demand modeling. This lesson seems particularly valuable now when the divergent behavior of various monetary aggregates is a problem confronted by policy makers in several industrial countries. For the Swiss M1 case the predictive power of this approach appears as good or better than that of the single equation technique and much additional information is gained. Because of the pronounced differences between the estimated structures of the currency and demand deposits functions on the one hand and that of term deposits on the other (particularly with regard to the speed of adjustment) it seems questionable to me whether there is an economic justification for aggregating these assets to form Swiss M2 and unlikely that a stable, well-defined single behavioral function of the usual sort exists for M2 demand. While tradition and international comparability dictate somewhat standard definitions of the monetary aggregates, these definitions are by no means uniform across countries or unchangeable by the respective central banks. Indeed, U.S. and Swiss procedures with respect to forming M2 and M3 are, loosely speaking, opposite. Results of the sort reported here are the first steps necessary for a more conceptual, original approach to the problem of defining aggregates and suggest that such work would be worthwhile.

The choice of a particular monetary aggregate as the focus of monetary policy depends on the linkage between a given aggregate and the path of nominal GNP (as well as issues such as the degree of control by the central bank over that aggregate). Therefore empirical knowledge of the demand for money is not necessarily enough by itself to allow one to draw conclusions about the merits of alternative aggregates or targets for some. In the Swiss case this study has shown that changes in term deposit rates induce movements in M1 and M2 in the opposite directions.[5/] It may be that changes in the term deposit rate are a major channel by which monetary policy affects nominal GNP and that, for example, a smooth growth rate for M1 would imply a path for that rate that yields a smooth path for nominal GNP. I suspect that it is more likely, however, that the term deposit rate is one of several very flexible short-term money markets rates (e.g. inter-bank rates) whose movements do not in any simple, direct way bear on the path of nominal GNP. In that case a rise in this rate will induce changes in the outstanding stock of monetary assets that overstate (substantial decline in M1) or even contradict (increase in M2) the degree of monetary tightness. In this regard it is interesting to note that Swiss officials abandoned their M1 target in 1979; and, when they resumed a policy of targeting a monetary aggregate in 1980, they chose instead to target on a monetary base measure.

Appendix

Sources of data

All Swiss currency, demand deposit, term deposit, and thrift deposit data were taken from the Swiss National Bank Monthly Bulletin (Table 9) as reported through mid-1981. Back data were obtained from the special August 1975 supplement. All Swiss interest rates (end of month observations) were likewise from the SNB Monthly Bulletin. The term deposit rate used was the rate on 3-month deposits at large Zurich banks. The Eurodollar rate was the 3-month rate on interbank deposits as reported by the U.S. Federal Reserve. The Swiss consumer price index, discount rate and monetary base were available in the SNB Monthly Bulletin. Swiss retail sales were taken from the OECD, Main Economic Indicators. The data were not seasonally adjusted.

Definitions of Swiss monetary variables

Currency - notes and coin in the hands of the non-bank public (including non-residents).

Demand deposits - Swiss franc checkable accounts (sight deposits) at banks due to non-bank residents.

M1 = Currency + demand deposits.

Quasi-money - Swiss franc term deposits plus foreign currency - denominated sight deposits due to non-bank residents.

M2 = M1 + Quasi-money.

Thrift deposits - interest-bearing Swiss franc savings deposits due to non-bank residents.

M3 = M2 + thrift deposits.

These measures are all end-of-month, not seasonally adjusted.

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 3 - Demand for Real Currency

	Equat. 1	Equat. 2	Equat. 3	Equat. 4
SD-F	6.752 (.489)	6.904 (.534)	6.743 (.497)	6.656 (.491)
SD-M	5.721 (.504)	5.834 (.527)	5.739 (.518)	5.575 (.511)
SD-A	6.023 (.508)	6.131 (.528)	6.044 (.526)	5.868 (.515)
SD-M	4.952 (.493)	5.070 (.519)	4.969 (.505)	4.820 (.498)
SD-J	6.301 (.497)	6.424 (.525)	6.317 (.510)	6.149 (.504)
SD-J	4.151 (.480)	4.287 (.517)	4.151 (.483)	4.058 (.482)
SD-A	5.910 (.508)	6.092 (.569)	5.909 (.512)	5.785 (.512)
SD-S	6.881 (.510)	7.069 (.574)	6.881 (.513)	6.761 (.513)
SD-O	5.304 (.507)	5.450 (.545)	5.324 (.523)	5.158 (.513)
SD-N	7.978 (.571)	8.115 (.600)	8.024 (.641)	7.750 (.587)
SD-D	10.219 (.919)	10.218 (.921)	10.341 (1.207)	9.841 (.947)

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 4 - Demand for Log of Real Demand Deposits

	Equat. 1	Equat. 2	Equat. 3
SD-F	.00199 (.01344)	-.00133 (.0136)	.00347 (.01353)
SD-M	.0244 (.0110)	.0236 (.0111)	.0241 (.0110)
SD-A	-.0025 (.0110)	-.00270 (.0110)	-.00289 (.0110)
SD-M	-.0087 (.0109)	-.00945 (.01095)	-.00884 (.0109)
SD-J	.0189 (.0109)	.0179 (.0110)	.0188 (.0110)
SD-J	-.0107 (.0122)	-.0131 (.0123)	-.00982 (.0123)
SD-A	.00305 (.01323)	-.00056 (.0135)	.00415 (.0133)
SD-S	.0364 (.0130)	.0325 (.0135)	.0374 (.0130)
SD-O	.0309 (.0110)	.0297 (.0112)	.0307 (.0111)
SD-N	.00446 (.01238)	.00618 (.0124)	.0030 (.0126)
SD-D	-.0176 (.0281)	-.00878 (.0283)	-.0227 (.0286)

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 5 - Demand for Log of Real Term Deposits

	Equat. 1	Equat. 2	Equat. 3	Equat. 4
SD-F	-.0312 (.0297)	-.0233 (.0287)	-.0243 (.0288)	-.0306 (.0302)
SD-M	-.0027 (.0217)	-.0004 (.0209)	-.0017 (.0210)	-.0275 (.0248)
SD-A	.0406 (.0217)	.0449 (.0209)	.0442 (.0210)	.0121 (.0259)
SD-M	-.0160 (.0218)	-.0052 (.0214)	-.0061 (.0214)	-.0346 (.0256)
SD-J	-.0156 (.0224)	-.0011 (.0223)	-.0021 (.0223)	-.0137 (.0238)
SD-J	.0111 (.0276)	.0270 (.0273)	.0277 (.0273)	.00324 (.0303)
SD-A	-.0174 (.0308)	.0027 (.0306)	.0027 (.0306)	-.0036 (.0320)
SD-S	-.0124 (.0325)	.0068 (.0321)	.0073 (.0321)	-.0161 (.0349)
SD-O	-.0150 (.0223)	-.00003 (.0222)	.0003 (.0222)	-.0236 (.0251)
SD-N	-.0196 (.0235)	-.0089 (.0230)	-.0064 (.0233)	-.0471 (.0287)
SD-D	.0116 (.0656)	.0084 (.0631)	.0117 (.0633)	-.0263 (.0673)

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 6 - Demand for Log of Real Thrift Deposits

	Equat. 1	Equat. 2	Equat. 3
SD-F	-.0109 (.0039)	-.0066 (.0031)	-.0062 (.0033)
SD-M	-.0074 (.0032)	-.0089 (.0025)	-.0089 (.0026)
SD-A	-.0022 (.0032)	-.0049 (.0026)	-.0049 (.0026)
SD-M	-.0096 (.0032)	-.0107 (.0025)	-.0107 (.0026)
SD-J	-.0151 (.0032)	-.0165 (.0026)	-.0165 (.0026)
SD-J	-.0096 (.0038)	-.0099 (.0030)	-.0097 (.0031)
SD-A	-.0125 (.0041)	-.0109 (.0033)	-0106 (.0034)
SD-S	-.0153 (.0041)	-.0140 (.0033)	-.0137 (.0034)
SD-O	-.0055 (.0033)	-.0098 (.0027)	-.0098 (.0028)
SD-N	-.0004 (.0034)	-.0073 (.0028)	-.0076 (.0030)
SD-D	.0445 (.0068)	.0248 (.0061)	.0238 (.0069)

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 7 - "Open"-Economy Demand Functions

	Equat. 1	Equat. 2	Equat. 3	Equat. 4
	6.141	.0020	-.0180	-.0062
SD-F	(.582)	(.0134)	(.0316)	(.0033)
	5.085	.0223	-.0076	-.0088
SD-M	(.602)	(.0112)	(.0234)	(.0025)
	5.382	-.0042	.0316	-.0048
SD-A	(.606)	(.0111)	(.0243)	(.0026)
	4.395	-.0093	-.0216	-.0107
SD-M	(.570)	(.0109)	(.0249)	(.0025)
	5.684	.0175	-.0169	-.0164
SD-J	(.591)	(.0110)	(.0257)	(.0026)
	3.540	-.0119	.0224	-.0094
SD-J	(.575)	(.0123)	(.0301)	(.0034)
	5.074	.00057	.0093	-.0104
SD-A	(.671)	(.0134)	(.0339)	(.0038)
	6.014	.0333	.0153	-.0134
SD-S	(.683)	(.0133)	(.0357)	(.0038)
	4.482	.0275	.0093	-.0094
SD-O	(.666)	(.0115)	(.0252)	(.0031)
	7.063	.0012	-.0039	-.0071
SD-N	(.746)	(.0128)	(.0258)	(.0029)
	9.452	-.0225	.0061	.0243
SD-D	(.993)	(.0285)	(.0691)	(.0064)

Seasonal Dummy Coefficients
(figures in parenthesis are standard errors)

Table 8 - Demand for Log of Real M1

	Equat. 1	Equat. 2	Equat. 3
SD-F	.0214 (.0094)	.0239 (.0091)	.0234 (.0091)
SD-M	.0347 (.0079)	.0354 (.0077)	.0335 (.0079)
SD-A	.0178 (.0078)	.0180 (.0077)	.0164 (.0079)
SD-M	.0100 (.0078)	.0106 (.0076)	.0097 (.0077)
SD-J	.0326 (.0078)	.0333 (.0077)	.0319 (.0078)
SD-J	.0050 (.0086)	.00679 (.00840)	.0055 (.0085)
SD-A	.0194 (.0095)	.0219 (.00906)	.0197 (.0093)
SD-S	.0445 (.0095)	.0472 (.0089)	.0445 (.0093)
SD-O	.0374 (.0080)	.0383 (.0077)	.0354 (.0082)
SD-N	.0303 (.0089)	.0294 (.0089)	.0264 (.0093)
SD-D	.0281 (.0200)	.0222 (.0198)	.0182 (.0202)

Footnotes

* Economist, Board of Governors of the Federal Reserve System. The views expressed in this paper are those of the author and do not necessarily reflect the views of the Board of Governors or other members of its staff. I wish to thank David Howard for his many helpful comments and suggestions.

1/ For a general discussion of the recent behavior of the various monetary aggregates in the major OECD countries and a more detailed comparison of the Swiss and United Kingdom experience, see Howard and Johnson.

2/ See the appendix for more complete definitions of the monetary assets and a listing of the sources for the data.

3/ Contemporaneous Swiss retail sales and consumer prices were assumed to be statistically exogenous for the problem under consideration. All Swiss rate of return variables, including the exchange rate capital gain defined below, were treated as endogenous. The instruments used in the two-stage calculation included: the exogenous and predetermined variables in the equation, lagged values of the respective Swiss interest rates, and the exogenous variables that could be expected to appear in the money supply/central bank reaction function. The latter were the Eurodollar rate, the recent rate of Swiss inflation, the discount rate, and the monetary base.

4/ The specific variables listed on Table 3 and subsequent tables are further defined in the appendix.

Footnotes (continued)

5/ A change in the term deposit rate produces opposite movements in demand deposits and term deposits. Whether the latter exceed the former (and thus move M2 opposite to M1) depends on the size of outstanding deposit balances at the time (which in turn depends on the level of interest rates). In January 1979 demand deposits were over twice the size of term deposits. Nevertheless, the impact effect of a one percentage point rise in the term deposit rate, ceteris paribus, at that time would have been a fall in demand deposits by 455 million Swiss francs but a rise in term deposits of 1280 million, for a net rise in M2.

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