COMMODITY PRICES AS PREDICTORS OF AGGREGATE PRICE CHANGE*

Roy H. Webb

Many analysts have advocated using commodity prices as a guide for monetary policy.[1] The basic reasoning can be simply put: "Money creation is intended to promote price stability and is best guided by an index of prices set in real markets." [*Wall Street Journal,* 1988] The rationale for stabilizing commodity prices can also be expressed in three propositions. First, inflation is a monetary phenomenon that should be eliminated. Second, commodity prices are determined in auction markets; they will therefore change quickly in response to monetary policy actions. Third, changes in commodity prices are good predictors of future aggregate price change. If all three propositions are accepted, then commodity prices might well be a useful guide for monetary policy, possibly serving as an intermediate target or at least as an important indicator variable.

This paper examines the third proposition: commodity prices are good predictors of aggregate price change. Other economists have reported varying results. Alan Garner [1988, p. 12], for example, found "broad commodity price indexes are always useful in predicting consumer price inflation." Joseph Whitt [1988] found that commodity price indexes had substantial predictive value in the volatile post-1975 period, and Philip Klein [1985] found a commodity price index to be a useful leading indicator. Aguais et al. (1988, p. 14], however, found "there is no evidence that [commodity price indexes] provide any information [for predicting movements in the general price index] beyond what is already contained in wages and supply conditions." Bennett McCallum [1988] also found that two commodity indexes had little predictive value. Most of the authors used Granger causality tests to reach their conclusions.

This paper also examines the relation of commodity and aggregate prices by using Granger causality tests. Those tests, however, are implemented somewhat differently than in other studies in order to avoid several potential pitfalls. In addition, this study is broadened to include a multivariate forecasting procedure, to examine multistep forecasting, and to investigate forecasting performance around turning points. It therefore goes beyond related work in examining the proposition that commodity price indexes are useful predictors of aggregate price measures.

Indexes Examined

Many indexes are used to measure aggregate and commodity prices. The most useful measures for analysis should have relatively long track records, so that statistical results are not dominated by the peculiarities that exist in short intervals. In addition, the indexes should be well understood by economists so that the results can be evaluated with respect to the known strengths and weaknesses of particular indexes.

The Consumer Price Index for all urban consumers (CPI) is used below as the measure of the aggregate price level. It is available monthly, is seasonally adjusted by the Bureau of Labor Statistics, has been calculated for 70 years, and has been subjected to substantial professional examination and comment.[2] One commodity price index that has attracted much attention is the *Journal of Commerce* Materials Index (JOCI), designed by Geoffrey H. Moore and his associates at the Center for International Business Cycle Research. They have constructed monthly values as far back as 1948. It includes 18 industrial commodities and was specifically designed to help

* An earlier version of this paper was presented to the Southern Economics Association, November 20, 1988. The author received helpful comments from T. Humphrey, F. Joutz, R. Keleher, Y. Mehra. and B. Portes. The views and opinions expressed in this article are solely those of the author and are not necessarily those of any other person employed by or associated with the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] For example, Irving Fisher [1920] presented a detailed strategy for stabilizing an index of 75 commodity prices. More recent proposals that have attracted considerable attention have been made by Wayne Angell [1987], James Baker [1987], and Manuel Johnson [1988].

[2] For further information, the U.S. Bureau of Labor Statistics publishes numerous references, including [1978].

predict changes in aggregate price measures.[3] Another widely used index is the Spot Price Index (SPI) published by Knight-Ridder's Commodity Research Bureau. It includes 10 foodstuffs and 13 raw industrial commodities, and is also available monthly from 1948. Before 1981 it was compiled by the Bureau of Labor Statistics[4].

Charts 1 and 2 show twelve-month changes in both commodity price indexes and the CPI. Both indexes have been much more volatile than the CPI throughout the postwar period. Casual interpretation of commodity price movements is therefore difficult and potentially misleading. Commodity price volatility should also be kept in mind when interpreting the more formal statistical results below.

[3]For further information, see *Journal of Commerce* [1986].

[4]John Rosine [1987] provides a useful discussion of the construction of commodity price indexes.

Testing for Granger Causality

To test for Granger causality, one can examine whether lagged values of one series add statistically significant predictive power to another series' own lagged values for one-step ahead forecasts. If so, the first series is said to Granger-cause the second. Consider the equation

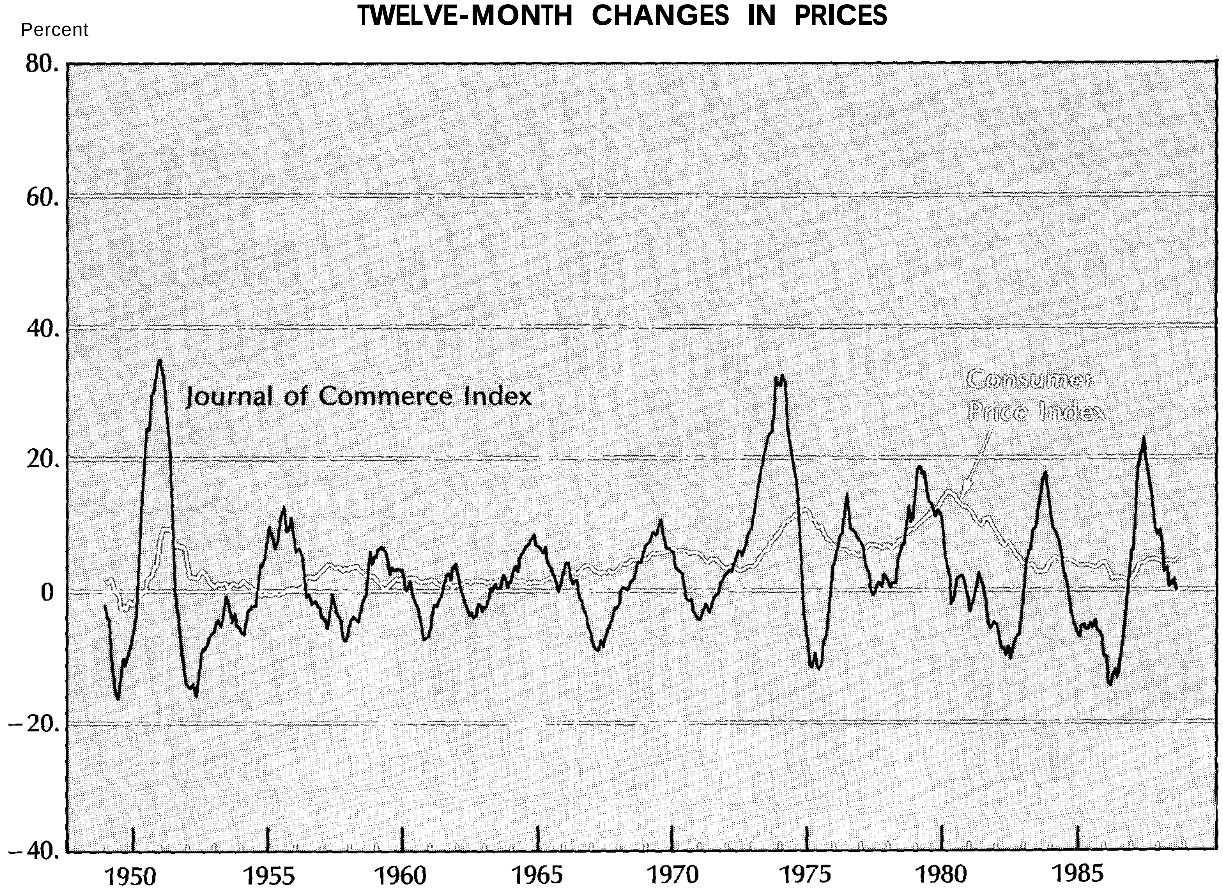
$$P_t = \alpha + \sum_{i=1}^{l} \beta_i P_{t-i} + \sum_{i=1}^{l} \gamma_i Q_{t-i} + \epsilon_t \qquad (1)$$

where P and Q are series of macroeconomic variables, α, the β_is and the γ_is are regression coefficients, ϵ_t is a white noise error term, and *l* is an integer representing the lag length. If an F test finds the estimated y_is to be statistically significant, then the series Q Granger-causes P.

Several decisions are necessary in order to implement a Granger causality test using equation (1). What lag lengths should be used? Should the series

Chart 1

TWELVE-MONTH CHANGES IN PRICES



Note: *Each series contains the percentage change in the monthly value of the price index from the monthly value twelve months earlier. The chart extends from January 1949 through October 1988.*

be differenced? What diagnostic test should be used to determine whether the residuals are serially correlated? Are the results sensitive to the starting and ending dates? The answers to each question are important since each choice can affect the final result.

First, consider the choice of the lag length. Nelson and Schwert [1982] found that heavily paramaterized forms of equation (1)-that is, unnecessarily large values of the lag length *l*- can result in a serious loss of power in causality tests. To guard against overly profligate parameterization, a model selection statistic, the Schwarz Criterion, is used below to set the lag length. Choosing the lag length for which the Schwarz Criterion is minimized leads to a relatively parsimonious specification in most cases below.[5]

The next choice, whether the series should be differenced, can be made by using tests designed to examine series for unit roots. Yash Mehra [1988] noted that the presence of a unit root in time series can cause F statistics to have nonstandard distributions. In equation (1), therefore, if either series had a unit root the typical F test might not be meaningful.

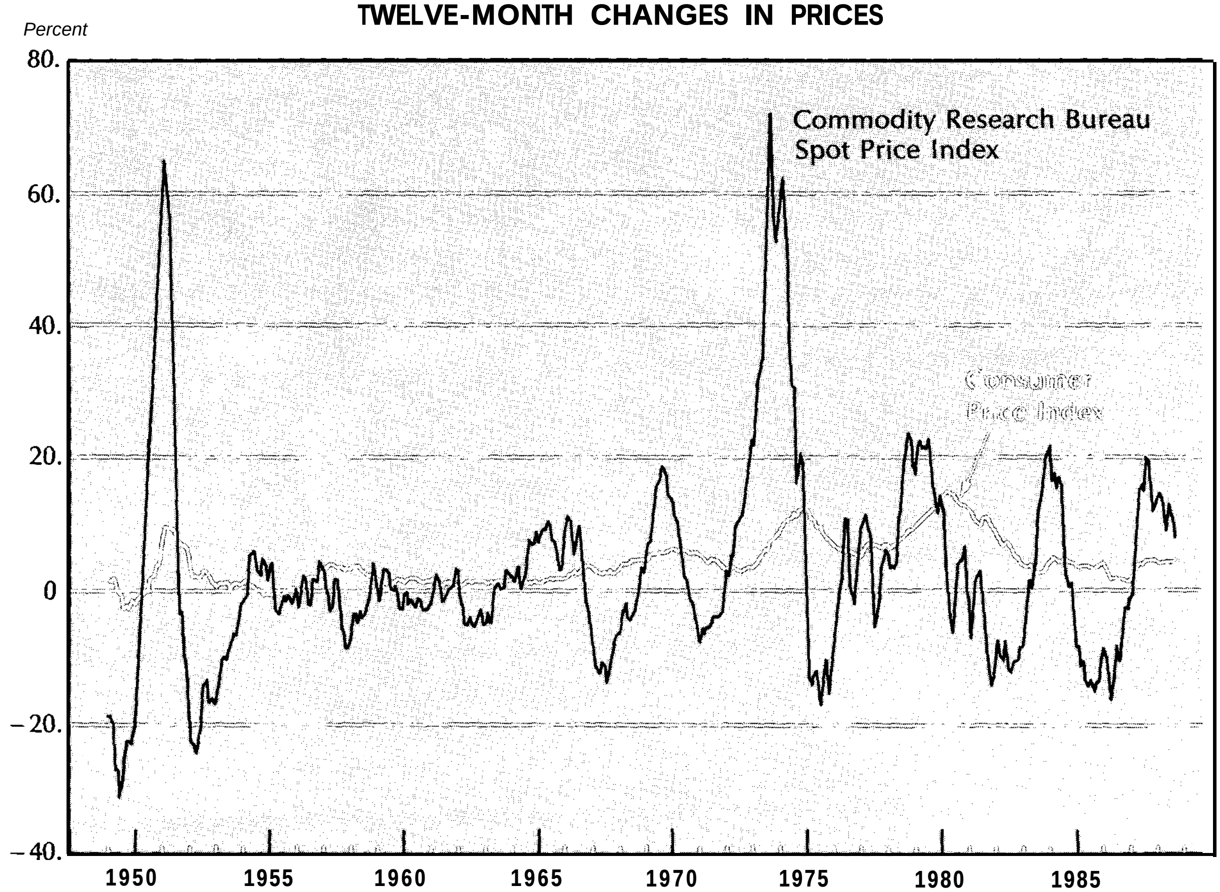
Unit Root Test To guard against that problem, (logs of) the CPI, JOCI, and SPI series were first tested for unit roots. The test, as proposed by Dickey

[5] Priestly [1981] discusses the relative merits of several model selection statistics. The Schwarz Criterion (SC) is given by $S = n \log \hat{\sigma}^2 + q \log n$ where n is the number of degrees of freedom, q is the number of parameters estimated, and $\hat{\sigma}^2$ is the residual variance. It can be seen that although adding an additional coefficient to an equation can lower the first term of the SC by lowering the residual variance, the additional coefficient also raises the second term.

In practice, the SC usually reaches a well-defined global minimum with a fairly parsimonious parameterization. Yi and Judge [1988] compare SC with two popular alternatives, finding that both alternatives asymptotically overestimate the true size of a model with a positive probability, whereas the SC's asymptotic probability of overestimating the true size is zero.

Chart 2

TWELVE-MONTH CHANGES IN PRICES



Note: Each series contains the percentage change in the monthly value of the price index from the month/y value twelve months earlier. The chart extends from January 1949 through October 1988.

and Fuller [1979], involves estimating the coefficients in the following equation:

$$\Delta X_t = \alpha_0 + \alpha_1 T + \beta X_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta X_{t-i} + \epsilon_t \qquad (2)$$

where X is the series being tested for a unit root, A is the first difference operator, T is a time trend, and e_t is a white noise error term. Under the null hypothesis that there is a unit root in the series X, the coefficient ß should be zero. The standard t statistic is used for testing whether ß is significantly different from zero; critical values, however, are not standard but are given by Fuller [1976].

The results of unit root tests are given in Table I. In each case the lag length was set at the value that minimized the Schwarz Criterion. The first three equations can be used to test whether the series in log-level form is appropriate. In all cases the null hypothesis-the existence of a unit root-is not rejected by examining the t statistic for the estimated coefficient ß.

It is possible that there are multiple unit roots, and consequently differences of the series are not stationary. The last three equations can be used to test for a unit root when the series in first difference form-that is, the series X in equation (2) is ΔCPI, ΔJOCI, or ΔSPI. In each case the null hypothesis is rejected; it therefore appears that there is no unit root in first differences of the series.

Since both commodity price indexes are not seasonally adjusted, autocorrelations of the differenced series were examined. In neighborhoods of the 12th and 24th lags the autocorrelations were close to zero. The series therefore do not appear to suffer from seasonal autocorrelation.

Granger Causality Test Results The tests for unit roots support testing for Granger casuality with each series in first differences (of logs). In equation (1), let the series P be the first difference of the CPI and the series Q be the first difference of either the JOCI or the SPI. Table II contains the results of those tests. For the SPI an F test rejected the null hypothesis that the coefficients on the lagged values of commodity prices are zero. In other words, over the sample period the SPI Granger-caused the CPI. Since the F test is derived by assuming white noise residuals, a Lagrange multiplier test proposed by Godfrey [1978] was used to look for either autoregressive or moving average errors. The null hypothesis, the absence of AR or MA errors, was not rejected at conventional levels using a Chi-squared test.

For the JOCI an F test also rejected the null hypothesis that coefficients on lagged commodity prices are zero. The Lagrange multiplier test did, however, reject the null hypothesis and thus indicated that the residuals were consistent with either an AR or MA process. After experimentation equation (1)

Table I

UNIT ROOT TEST STATISTICS

Time bounds: January 1954 to July 1988

Equation: $\Delta CPI_t = \alpha_0 + \alpha_1 T + \beta CPI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta CPI_{t-i} + \epsilon_t$

Lag length l: 2 $\bar{R}^2$ = .52 Schwarz Criterion: −4920

Test statistic for $\hat{\beta}=0$: −2.16

Equation: $\Delta JOCI_t = \alpha_0 + \alpha_1 T + \beta JOCI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta JOCI_{t-i} + \epsilon_t$

Lag length l: 1 $\bar{R}^2$ = .22 Schwarz Criterion: −3698

Test statistic for $\hat{\beta}=0$: −1.86

Equation: $\Delta SPI_t = \alpha_0 + \alpha_1 T + \beta SPI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta SPI_{t-i} + \epsilon_t$

Lag length l: 1 $\bar{R}^2$ = .31 Schwarz Criterion: −3202

Test statistic for $\hat{\beta}=0$: −1.98

Equation: $\Delta^2 CPI_t = \alpha_0 + \alpha_1 T + \beta \Delta CPI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta^2 CPI_{t-i} + \epsilon_t$

Lag length l: 1 $\bar{R}^2$ = .37 Schwarz Criterion: −4934

Test statistic for $\hat{\beta}=0$: −6.22

Equation: $\Delta^2 JOCI_t = \alpha_0 + \alpha_1 T + \beta \Delta JOCI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta^2 JOCI_{t-i} + \epsilon_t$

Lag length l: 1 $\bar{R}^2$ = .26 Schwarz Criterion: −3695

Test statistic for $\hat{\beta}=0$: −10.01

Equation: $\Delta^2 SPI_t = \alpha_0 + \alpha_1 T + \beta \Delta SPI_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta^2 SPI_{t-i} + \epsilon_t$

Lag length l: 1 $\bar{R}^2$ = .31 Schwarz Criterion: −3200

Test statistic for $\hat{\beta}=0$: −11.99

Note: For the tests above the 5 percent and 1 percent critical values are -3.42 and - 3.98, respectively.

Table II

GRANGER CAUSALITY TEST STATISTICS

Time bounds: January 1954 to July 1988

Equation: $\Delta CPI_t = \alpha + \sum_{i=1}^{l} \beta_i \Delta CPI_{t-i} + \sum_{i=1}^{l} \gamma_i \Delta SPI_{t-i} + \epsilon_t$

Lag length l: 9	$\bar{R}^2$ = .59	Schwarz Criterion: −4733
Test statistic for $\Sigma\hat{\gamma}_i = 0$: 5.36		Significance level: 10^{-7}
LM test statistic: 2.40		Significance level: .12

Equation: $\Delta CPI_t = \alpha + \sum_{i=1}^{l} \beta_i \Delta CPI_{t-i} + \sum_{i=1}^{l} \gamma_i \Delta JOCI_{t-i} + \epsilon_t$

Lag length l: 2	$\bar{R}^2$ = .52	Schwarz Criterion: −4919
Test statistic for $\Sigma\hat{\gamma}_i = 0$: 5.67		Significance level: .0038
LM test statistic: 6.66		Significance level: .0099

Equation: $\Delta CPI_t = \alpha + \sum_{i=1}^{l} \beta_i \Delta CPI_{t-i} + \sum_{i=1}^{l} \gamma_i \Delta JOCI_{t-i} + \epsilon_t + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2}$

Lag length l: 2	$\bar{R}^2$ = .57	Schwarz Criterion: −4927
Test statistic for $\Sigma\hat{\gamma}_i = 0$: 16.7		Significance level: 10^{-8}
LM test statistic: 4.84		Significance level: .089

Note: The test for zero coefficients is a conventional F test. The LM test for first order AR or MA residuals is $X^2(1)$.

was estimated assuming that residuals followed a second order moving average process. Again an F test rejected the null hypothesis, thereby indicating that the JOCI Granger-caused the CPI. The Lagrange multiplier test did not indicate significant remaining residual correlation at the 5 percent level.

A note of caution is in order: several results mentioned above are sensitive to the lag lengths employed. For example, with a lag length of twelve in the unit root test for ΔCPI, the t statistic for $\hat{\beta}$ is -2.37; the null hypothesis in that instance is not rejected for first differences of the CPI. And in the Granger causality test for the JOCI with a lag length of eight, the F statistic is 1.24, thereby failing to reject the hypothesis that coefficients on the lagged values of the JOCI are zero. Although the results of Nelson and Schwert strongly support the relatively parsimonious specifications reported in Tables I and II, the sensitivity of the results to the lag length does cause one to question the amount of information conveyed by these tests.

In addition, although both commodity price indexes add statistically significant explanatory power to lagged values of the CPI, the actual reduction in the standard error of estimated residuals (SEE) was quite small. Comparing the final regression equation reported in Table II with one omitting the lagged JOCI, the annualized SEE was increased from 2.72 to 2.82 by omitting lagged JOCI terms. Similarly, with nine lagged values, the SEE was increased from 2.61 including the SPI to 2.77 without it. In short, the incremental predictive value of both indexes was small over the sample period.

Perhaps the incremental predictive value has increased over time; the results over the whole sample would thus understate the current effect. In particular, it is possible that the incremental predictive value increased after the United States abandoned the gold standard[6]. To test that possibility the sample was split at 1971 Q3 and equation 1 was estimated for the early and late subperiods as well as the entire sample. An F test was then used to test the hypothesis that regression coefficients were equal in both subperiods. For the SPI the F value was 1.50; the null hypothesis was therefore not rejected at the 5 percent level. But for the JOCI an F value of 2.90 indicates that the null hypothesis was rejected at the 1 percent level.

As anticipated, the JOCI did not Granger-cause the CPI in the early period, but did Granger-cause the CPI in the late period. The incremental predictive value of the JOCI remained small, however. Omitting the JOCI from the late period equation only increased the SEE to 3.13 from 2.95. Focusing only on the later observations, therefore, does not alter the conclusion that commodity prices add little for predicting the CPI one step ahead.

A Broader Framework

That commodity prices Granger-cause aggregate price change is not sufficient to establish their total value in prediction. Granger causality traditionally

[6]The author is indebted to Robert Keleher for this suggestion.

measures *one-step ahead* prediction in a *bivariate* environment. As policy indicators, multistep predictions would be much more valuable than one-month forecasts. Also, it may be that other macroeconomic variables add substantial predictive value; including those other variables could alter the incremental predictive value of commodity prices.

Model Description A vector autoregressive (VAR) model provides a convenient framework for examining both properties. Small VAR models have been found to provide forecasts of macroeconomic variables that are often competitive with forecasts from much larger models.[7] Containing no exogenous variables, VAR models can be used to produce forecasts as many periods ahead as desired.

Three VAR models will be used in this section. The first, VAR1, will include the CPI and JOCI plus the 90-day Treasury bill rate (RTB), the capacity utilization rate in manufacturing (CU), the foreign exchange value of the dollar (EVD), and the monetary base (MB).[8] The CPI, JOCI, and MB are logged and differenced to provide stationary series. The second model, VAR2, substitutes the logged and differenced SPI for the JOCI. The third model omits any measure of commodity prices. Forecasts from each model can then be compared to examine any differences.

Just as overly paramaterized equations can reduce the power of statistical tests, overly parameterized VAR models can reduce the accuracy of forecasts. Consider first the equation for the CPI from the unrestricted form of the VARl model:

$$CPI_t = \alpha + \sum_{i=1}^{l} \beta_{1,i} CPI_{t-i} + \sum_{i=1}^{l} \beta_{2,i} JOCI_{t-i} + \ldots + \sum_{i=1}^{l} \beta_{6,i} MB_{t-i} + \epsilon_t \quad (3)$$

where α is a constant term, l is the common lag length, i represents the coefficient for variable v at lag i, and ϵ_t is a white noise disturbance term. The model contains six equations, each with the same independent variables: with $l = 6$ for example, there are six lagged values for each of six variables plus a constant, resulting in 37 estimated coefficients per equation.

In order to improve forecasting performance the number of estimated coefficients is reduced by using a simplified version of a strategy proposed in Webb [1985]. Instead of using a common lag length as in equation (3), lag lengths are set as in the equation below:

$$CPI_t = \alpha + \sum_{i=1}^{l_1} \beta_{1,i} CPI_{t-i} + \sum_{i=1}^{l_2} \beta_{2,i} JOCI_{t-i} + \ldots + \sum_{i=1}^{l_6} \beta_{6,i} MB_{t-i} + \epsilon_t \quad (4)$$

where l_v is the lag length for variable v in the CPI equation. The lag lengths are set in each equation to minimize the Schwarz Criterion, yielding a substantial reduction in the number of parameters estimated.[9] VAR1 and VAR2 thus consist of six equations of the form of equation (4); lag lengths are presented in Table III below. VAR3 is VAR1 minus the equation for commodity prices and all lagged commodity price terms in other equations.

Forecasting Results Each model was estimated using data through June 1975; forecasts were computed for each month through June 1976. The forecasts for July 1975 were compared with actual data and the resulting one-step ahead errors were recorded; forecasts for August were used for two-step ahead errors; and similarly, forecast errors up to twelve steps ahead were calculated. Then the process was updated one month, with the model estimated through July 1975 and forecasts made through July 1976. The process of estimation and forecasting was repeated each month through May 1988. The resulting forecast errors were tabulated and summary statistics are displayed in Table IV,

[7] For examples using traditional measures of forecast accuracy, see Lupoletti and Webb [1986] or McNees [1986].

[8] MB is from the Federal Reserve Bank of St. Louis. EVD is the Federal Reserve Board's nominal trade-weighted index from 1967, extrapolated before 1967 using movements in dollar exchange rates with the Canadian dollar, British pound, and German mark. RTB and CU are both published by the Federal Reserve Board.

Why were these particular variables chosen? MB, EVD, RTB, and CU are part of a larger quarterly VAR model used by the author to forecast GNP and its components on a regular basis. It was suspected that each would help predict the CPI. The only experimentation with the model's composition was the addition of the change in outstanding federal debt, which can be thought of as a rough measure of fiscal actions. Adding that variable to VAR3 did not improve forecasts of the CPI; model statistics are therefore not included.

[9] The exact strategy for selecting the lag lengths in an equation is as follows. (1) Iterate over a large number of possibilities and choose a pair of integers I and J that minimizes the Schwarz Criterion, where I is the lag length for the dependent variable and J is a common lag length for the independent variables. (2) If there is at least one independent variable for which all lagged values are not significantly different from zero at the 10 percent level, drop the least significant independent variable from the equation. (3) Repeat step (2) until all variables are significantly different from zero or the Schwarz Criterion increases.

Table III

LAG LENGTHS IN 2 VAR MODELS

VAR 1

Dependent Variable	Independent Variable CPI	JOCI	RTB	CU	EVD	MB
CPI	2	1	1	1	1	1
JOCI	-	6	3	-	3	-
RTB	-	1	3	-	1	1
CU	-	1	1	2	-	-
EVD	-	-	1	-	2	-
MB	-	-	-	1	1	3

VAR 2

Dependent Variable	Independent Variable CPI	SPI	RTB	CU	EVD	MB
CPI	2	1	1	1	1	1
SPI	6	6	6	6	6	6
RTB	-	1	2	-	-	1
CU	-	1	1	2	-	-
EVD	-	-	1	-	2	-
MB	-	-	-	1	1	3

including the traditional mean absolute error statistic (expressed in percentage points, annualized). As expected, those errors increase over the forecast horizon.

Also included are Theil U statistics, which are equal to the ratio of root mean squared error of the model forecasts to the root mean squared error from a no change forecast. Values less than unity indicate that the model forecast outperformed a naive no change forecast. One can meaningfully compare forecast errors for a stationary series with the no change forecast; however, for nonstationary series it is trivial to achieve a low U value. As shown in Table IV, both models do better than simple extrapolation of current conditions for all variables. In some cases the relative accuracy increases with the forecast horizon. Most importantly, the forecast statistics indicate little difference between the accuracy of CPI forecasts from the three models. At each forecast horizon, including those not shown in the table, the difference in mean absolute error between VAR3 and each of the larger models is less than 0.10[10]. The value of including a measure of commodity prices in this forecasting environment is therefore quite small.[11]

[10] It is of course possible that this result is due to some feature of the model used. In particular, some analysts prefer to use VAR models in level form, even if some series appear to have unit roots. To see whether this particular model might perform better in level form, lag lengths in VAR3 were reset with the CPI and monetary base in log levels. The forecasting experiment described in Table IV was then repeated. The accuracy of forecasts of the percentage change in the CPI deteriorated: one-month ahead forecasts had a mean absolute error of 2.23 (versus 2.15 in VAR3); six-months ahead, 2.83 (versus 2.71); and twelve-months ahead, 3.11 (versus 2.95).

[11] Furlong [1988] found similar results. He first found that the JOCI added statistically significant explanatory power in a regression equation for the CPI. In his VAR model (substantially different from the models examined in this paper) the JOCI improved forecast accuracy by only a rather small increment. Finally, he found that the SPI was inferior to the JOCI in multiperiod forecasts.

Table IV

FORECAST RESULTS FROM 3 VAR MODELS

VAR1 ERROR STATISTICS

Variable	1 Step Mae	Theil U	6 Step Mae	Theil U	12 Step Mae	Theil U
CPI	2.14	.87	2.67	.82	2.86	.81
RTB	0.44	.81	1.44	.93	1.86	.89
CU	0.44	.85	1.73	.81	2.63	.75
EVD	1.61	.92	6.25	.95	11.02	.99
MB	2.91	.69	3.06	.75	3.07	.76
JOCI	9.94	.79	12.54	.78	13.09	.70

VAR2 ERROR STATISTICS

Variable	1 Step Mae	Theil U	6 Step Mae	Theil U	12 Step Mae	Theil U
CPI	2.15	.87	2.77	.85	2.88	.83
RTB	0.46	.84	1.32	.94	1.70	.89
CU	0.45	.85	1.72	.79	2.76	.76
EVD	1.61	.92	6.25	.95	10.95	1.00
MB	2.91	.69	3.06	.75	3.07	.76
SPI	17.70	.75	22.91	.75	21.76	.72

VAR3 ERROR STATISTICS

Variable	1 Step Mae	Theil U	6 Step Mae	Theil U	12 Step Mae	Theil U
CPI	2.15	.88	2.71	.83	2.95	.83
RTB	0.43	.82	1.45	.94	1.93	.91
CU	0.46	.87	1.78	.83	2.95	.80
EVD	1.61	.92	6.27	.95	11.09	1.00
MB	2.91	.69	3.06	.75	3.08	.76

Note: Each model was estimated from January 1967 to June 1975, and forecasts generated for each month up to 12 months ahead. Each model was then reestimated through July 1975 and a new set of forecasts was produced. The procedure was repeated through May 1988. The resulting forecasts were compared with the actual data, and the resulting error statistics are displayed in this table.

Accuracy Near Turning Points Traditional statistics such as those presented in Table IV may not completely reveal the value of observing commodity prices. Proponents of commodity price indexes often stress their value in predicting major changes in the rate of inflation. With only a few major changes of inflation trends in the sample period studied above, however, it is possible that a substantial positive effect at a few critical periods was obscured by the noise from many other periods.

Analysts at the Center for International Business Cycle Research have identified a set of turning points for major changes in the rate of growth of aggregate prices. The idea is similar to the traditional use of peaks and troughs for separating expansions and recessions in business cycle analysis. The resulting set of inflationary turning points defines broad phases of advancing and declining inflation rates. Unfortunately (for the analyst, that is) there are few turning points in the entire sample period. With VAR1 (which predicted the CPI more accurately than VAR2) estimated through June 1975, the post-sample forecasts can be evaluated over a period including three turning points: troughs in June 1976 and April 1986, and a peak in March 1980.

Table V contains forecast results for the CPI from the VAR1 and VAR3 models when forecasts were made near inflationary turning points. While one-month **ahead forecasts made near turning points were** less accurate than those made over the entire sample, the results are mildly surprising at longer horizons. In both models, six-month ahead forecasts were roughly as accurate near turning points as at other times, and twelve-month ahead forecasts were actually more accurate near turning points.

Comparing the VAR1 and VAR3 models, for one-month forecasts the model without the JOCI was very slightly more accurate. For six-month forecasts, the model containing the JOCI was slightly more accurate. But for twelve-month forecasts, the model containing the JOCI was more accurate by 0.25 percent. This is the largest gain from using the JOCI found in this article; it is still rather small.

Table V

FORECAST ACCURACY NEAR TURNING POINTS

Mean Absolute Errors

Turning Point	VAR1			VAR3		
	1 step	6 step	12 step	1 step	6 step	12 step
June 1976	1.59	1.24	1.49	1.59	1.39	1.58
March 1980	2.45	3.92	3.87	2.48	4.02	4.41
April 1986	3.06	2.69	1.61	3.00	3.01	1.72
Average	2.37	2.61	2.32	2.36	2.71	2.57

Note: Forecast errors were collected for forecasts made in the month of a turning point, in the 6 previous months, and in the 6 following months, for a total of 13 forecasts around each turning point.

Conclusion

This article examined the ability of the *Journal of Commerce* Materials Index and the Commodity Research Bureau Spot Price Index to improve forecasts of inflation, which was measured by changes in the Consumer Price Index. Although Granger causality tests indicated statistically significant effects, the magnitude of improvement was very small and the test result for the JOCI was sensitive to the lag length employed.

Each commodity price index was next included in a small VAR model designed to predict the CPI. Again, while adding the JOCI to the model improved forecasts of the CPI at each horizon, the: magnitude of improvement was small. Adding the SPI to the model had mixed results, only improving forecasts by a small amount for twelve-month forecasts. Examining errors made **by** forecasts **dated near** inflationary turning points again revealed only a small improvement in forecast accuracy when including the JOCI.

Since only one aggregate price index and two commodity price indexes were examined, these results are only suggestive. It would certainly be useful to study other indexes, other time periods, and data from other countries. With that important qualification in mind, it is difficult to see a major role for commodity prices in the conduct of monetary policy. That commodity prices added a *small* amount of predictive power suggests that a *small* improvement in anti-inflation policy could be achieved by using them as an indicator variable. None of the results presented in this paper, however, suggest that slightly more accurate inflation forecasts by themselves would have allowed policymakers to avoid the sixfold increase in the CPI in the post-World War II period.

References

Aguais, Scott D., Robert A. DeAngelis, and David A. Wyss. "Commodity Prices and Inflation." *Data Resources U.S. Review* (June 1988) pp. 11-18.

Angell, Wayne D. "A Commodity Price Guide to Monetary Aggregate Targeting." Address to the Lehrman Institute, New York, December 10, 1987.

Baker, James A. Speech at Annual Meeting of the International Monetary Fund, Washington, September 1987.

Dickey, D.A., and W.A. Fuller. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." *Journal of the American Statistical Association* 74 (June 1979): 427-31.

Fisher, Irving. *Stabilizing the Dollar.* New York: Macmillan, 1925.

Fuller, Wayne. *An Introduction to Statistical Time Series.* New York: Wiley, 1976.

Furlong, Frederick T. "Commodity Prices as a Guide for Monetary Policy." Federal Reserve Bank of San Francisco *Economic Review* (Winter 1989). Forthcoming.

Garner, C. Alan. "Commodity Prices: Policy Target or Information Variable?" Research Working Paper, RWP 88-10. Federal Reserve Bank of Kansas City, November 1988.

Godfrey, L.G. "Testing Against General Autoregressive and Moving Average Error Models When the Regressors Include Lagged Dependent Variables." *Econometrica* 46 (November 1978): 1293-1302.

"Goodbye Gift." *Wall Street Journal,* June 17, 1988.

"Guide to Inflationary Trends." *Journal of Commerce,* 1986.

Johnson, Manuel H. "Current Perspectives on Monetary Policy." Speech at the Cato Institute, Washington, February 25, 1988.

Klein, Philip A. "Leading Indicators of Inflation in Market Economies." Working Paper FB-85-04. Columbia University, September 1985.

Lupoletti, William H., and Roy H. Webb. "Defining and Improving the Accuracy of Macroeconomic Forecasts: Contributions from a VAR Model." *Journal of Business* 59 (April 1986, part 1): 263-85.

McCallum, Bennett T. "Targets, Indicators, and Instruments of Monetary Policy." Carnegie Mellon University, September 1988. Typescript.

McNees, Stephen K. "The Accuracy of Two Forecasting Techniques: Some Evidence and an Interpretation." Federal Reserve Bank of Boston *New England Economic Review* (March/April 1986), pp. 20-31.

Mehra, Yash P. "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests Reevaluated." Working Paper 87-Z. Federal Reserve Bank of Richmond, August 1987.

Nelson, C.R., and G.W. Schwert. "Tests for Predictive Relationships between Time Series Variables: A Monte Carlo Investigation." *Journal of the American Statistical Association* 77 (March 1982): 11-18.

Priestly, M.B. *Spectral Analysis and Time Series.* California: Academic Press, 1981, pp. 370-80.

Rosine, John. "Aggregative Measures of Price and Quantity Change in Commodity Markets." Working Paper 81. Board of Governors of the Federal Reserve System, December 1987.

U.S. Bureau of Labor Statistics. *The Consumer Price Index: Concepts and Content Over the Years.* Washington, May 1978.

Webb, Roy H. "Toward More Accurate Macroeconomic Forecasts from Vector Autoregressions." Federal Reserve Bank of Richmond *Economic Review* 71 (July/August 1985): 3-11.

Whitt, Joseph A. "Commodity Prices and Monetary Policy." Working Paper 88-8. Federal Reserve Bank of Atlanta, December 1988.

Yi, Gang, and George Judge. "Statistical Model Selection Criteria." *Economic Letters* 28 (1988): 47-51.

SIC: SWITZERLAND'S NEW ELECTRONIC INTERBANK PAYMENT SYSTEM*

Christian Vital and David L. Mengle

EDITOR'S PREFACE ***In the United States, bankers and the Federal Reserve System have attempted to control risk on large-dollar wire transfer networks by means of quantitative limits. Net debit caps, as the limit.. are called, restrict the extent to which an institution can incur daylight overdrafts on Fedwire and net debits on the CHIPS network. The Federal Reserve is now considering additional steps such as reducing caps and pricing daylight overdrafts.***

In contrast, Switzerland took the bold step of prohibiting daylight overdrafts when it instituted its new wire transfer system, Swiss Interbank Clearing (SIC), in mid-1987. The following article, which details the Swiss experience and approach to daylight overdrafts, should be an important contribution to payment system policy discussions in the United States.

Of course, certain institutional features of large-dollar wire transfer in the United States are different from those in Switzerland. For example, the number of participating depository institutions is far larger on Fedwire (almost 7,000) than on the Swiss system (156). In addition, Swiss banking is far more concentrated than is banking in the United States. But even so, the Swiss experience does suggest a new alternative that could be considered for the future of wholesale wire transfer in the United States.

Introduction

In Switzerland, as in other countries in which the financial sector plays a prominent part, banks' funds transfer operations are characterized by large values and a high rate of turnover. An average of over 250,000 payments per day totalling more than 100 billion Swiss francs (=$68.5 billion)[1] are currently processed through the interbank payment system. The daily average turnover is over thirty times the volume of banks' deposits at the Swiss National Bank.

Until 1987 most funds transfers were carried out through the Bank Clearing System developed by the banks in the early 1950s.[2] Payment orders were sent by means of paper vouchers and magnetic tapes. The orders were forwarded to the receiving banks through a central computer center operated by Telekurs AG, a company jointly established by the banks. In the computer center, individual orders were added up to arrive at credit and debit totals for each individual bank; they were then entered in the giro (or reserve) accounts of the participant banks at the Swiss National Bank. (Banks' giro accounts are the equivalent of reserve accounts in the United States. Funds in giro accounts do not earn interest.)

The transmission and processing stages of the Bank Clearing System could extend over several days. This created uncertainty in planning and monitoring liquidity and thus involved the risk of misguided decisions. In view of today's substantial volumes of funds, such decisions could entail considerable costs.[3] Furthermore, the system could not keep pace with rising demands for bank payment services. Finally, it limited the ability to integrate the banks' in-house information systems with the external funds transfer system. Such integration was essential to streamlining the processing of payments.

The call for virtually lag-free information transmission and processing could only be met by resorting to electronic communication and processing technology. And because it was a centrally organized

* The article is an adaptation of C. Vital, "Das elektronische Interbank-Zahlungsverkehrssystem SIC: Konzept und vorläufige Ergebnisse," *Wirtschaft und Recht,* vol. 40, May 1988. It is offered here by permission of the publisher. Dr. Vital is Director of General Processing and Back Office Operations at the Swiss National Bank in Zurich. Dr. Mengle is a Research Officer with the Federal Reserve Bank of Richmond.

[1] All conversions of Swiss francs to dollars assume an exchange rate of 1.46 Swiss francs to one dollar.

[2] See Bank for International Settlements (1985) or Lehmann (1986) for a survey of the Swiss interbank payment system. At the end of 1987, 342 banks with a total of 2,894 branch offices participated in the Bank Clearing System. The remaining banks executed their payments through the giro system of the Swiss National Bank, through correspondent banks, or through the Postal Giro System.

[3] Fischer and Hurni (1988).

institutional framework, the Bank Clearing System seemed well suited for the introduction of an electronic funds transfer system. First steps in this direction were undertaken in the 1970s. Owing to cost factors and unsolved conceptual problems, however, the efforts failed to achieve their end. In. 1980 a study group of large Swiss banks initiated a new project under the name of "Swiss Interbank Clearing" (SIC). The new system was developed between 1981 and 1986 by Telekurs AG in cooperation with the banks and the Swiss National Bank. It began operation in June 1987. The remarks below provide an overview of the conceptual problems in interbank payment systems, the solution designed for SIC, and the experience gained with the new system during its first year of operation.

Interbank Payment Mechanisms

Gross settlement and net settlement systems Funds transfer systems are susceptible to credit and fraud risks as well as to operational risks. In interbank payment systems the magnitude of the value of funds to be processed poses special credit risk problems. In this context, it is useful to distinguish between "gross settlement" systems and "net settlement" systems.[4]

In gross settlement systems payment takes place by means of an irrevocable and final transfer of deposits from the sending bank's account at the central bank to the receiving bank's account. The payment act (the transfer of the payment medium) and the settlement act (the transfer of central bank money) are linked in these systems.

In the United States, Fedwire is an example of a gross settlement system. Transfers of funds through Fedwire are final, but executing a payment order does not depend on the availability of the funds. Temporary overdrafts on accounts, also known as "daylight overdrafts," are on the order of $50 billion per day, that is, about 10 percent of the average daily value of funds processed through the system.

In net settlement systems the notification of payment received by the receiving bank represents a claim on the sending bank. The claims are accumulated up to a specified time (for example, up to the end of the day) and are subsequently settled by means of a transfer of central bank money from the net debtors to the net creditors. All payments effected during the settlement period are made subject to the final settlement transfers. They are thus also termed "provisional" payments.

In the United States, the Clearing House Interbank Payments System (CHIPS) is an example of a net settlement system. Payments made through CHIPS are subject to the condition that at the end of the day participants' net positions are settled through accounts held at the Federal Reserve Bank of New York. Should a participating bank not be in a position to meet its net liabilities, CHIPS regulations provide for the reversal of all payments executed in the course of that particular day affecting the defaulting participant. If such a situation were to occur, other participants might also become unable to pay. To date, such an eventuality has never arisen. If and when it does, the Federal Reserve System as lender of last resort might feel compelled to come to the aid of the defaulting participant by granting it credits. Total daily net credits recorded in the CHIPS system are of the same magnitude as the daylight overdrafts in Fedwire.

The Swiss Bank Clearing System was also a net settlement system. Payments made through this system were settled several times a day via participants' giro accounts at the Swiss National Bank. The accounts could be overdrawn during the day at no cost and to a practically unlimited extent. In contrast to the CHIPS system, the Swiss National Bank explicitly guaranteed settlement up to the limit of the collateral held by Bank Clearing participants with the Swiss National Bank. But the collateral, which served as the sole security against losses, was modest compared with the volume of daily overdrafts which averaged 20 to 30 billion Swiss francs ($13.7 to $20.5 billion).

Risk aspects Since payments in gross settlement systems are final, a receiving bank may dispose of the funds credited to its account without incurring a risk. A sending bank incurs a credit risk when it executes payments on behalf of a customer in excess of the customer's credit balance. The central bank runs a credit risk if it allows a sending bank to overdraw its reserve account. As a rule, gross settlement systems have permitted overdrafts that are both free of charge and unlimited in quantitative terms during the day (but not overnight). Measures designed to avoid or limit overdrafts are a problem insofar as they could severely disrupt payment flows (given the large volumes of funds recorded in interbank payment transactions). Further, such measures could impose a cost burden on system participants and thereby induce them to switch to alternative funds transfer networks.

[4] Not all wire transfer networks provide settlement of payments among banks. The Society for Worldwide Interbank Financial Telecommunications (SWIFT), for example, only transmits payment instructions. Actual payments take place by means of transfers of correspondent balances.

In net settlement systems like CHIPS, all payments are made subject to the condition that settlement take place at a predetermined time, usually before opening of the next business day. Despite this reservation, a participant may allow his customers to use incoming funds prior to settlement; the receiving bank thus assumes a credit risk vis-à-vis the bank ordering the payment. If a participating bank is not in a position to meet its net liabilities at the end of a day, it may affect the ability to pay of other participants, their customers, and ultimately the entire economy. The risk of such a chain reaction is known as systemic risk.

In gross settlement systems like Fedwire, finality of payment is guaranteed in formal terms by the relevant regulations and in actual practice by the central bank's money-creating powers. No systemic risk is inherent in such systems because participating banks do not enter into credit relationships with one another. Any credit relations arising in gross settlement systems in connection with the processing of payments are overdrafts on reserve accounts; the risks involved have to be borne by the central bank and do not affect the other participants.

Elimination of systemic risk is a decided advantage that gross settlement networks have over net settlement networks. But the practice usually followed in traditional gross settlement systems of allowing overdrafts on accounts without penalty restricts the flexibility of the central bank, as the extent of such overdrafts can only be monitored and controlled imperfectly. Moreover, gross settlement systems lack the incentives inherent in net settlement systems for a participant to take into account the solvency of other participants and to reduce credit risks by means of credit limits. It must therefore be expected that the total amount of overdrafts in a gross settlement system is greater than the total of net credits in a net settlement system under otherwise identical circumstances.

Regulatory measures Balance sheets drawn up according to conventional methods show the level of assets and liabilities at the end of the day. They do not show credit risks arising in the interbank payment system through daylight overdrafts and net debits because they are only incurred during the day and disappear by the end of the day. Moreover, owing to a lack of suitable data such risks can only be vaguely assessed in traditional funds transfer systems. Accordingly, in most countries supervisory authorities have so far paid little attention to such risks. One exception is the United States, where the question has been the subject of extensive studies for a number of years.[5]

In recent years the credit exposures observable in the large-dollar networks increased to such an extent that they were considered a threat to the stability of financial markets.[6] In 1986 the Federal Reserve System therefore issued a policy statement requiring Fedwire and CHIPS participants to use a system of net debit caps to restrict any further expansion (in quantitative terms) of the credit relationships resulting from payment processes.[7] Moreover, endeavors are being made to establish and ensure the finality of CHIPS payments through rules that require participants to somehow guarantee settlement.

Main Features of the Swiss Interbank Clearing System[8]

Demands on the system In general, the introduction of electronic systems for interbank payment transactions has three goals:

1) creating optimum conditions for the planning and monitoring of liquidity by providing real-time information transmission and processing,
2) expediting and improving the quality of payment transactions, and
3) rationalizing the processing and settlement of payments by means of large-scale automation.

The SIC system had a fourth goal: creating a gross settlement system-a funds transfer system in which each payment is made irrevocably and finally through participants' accounts at the Swiss National Bank-that would guarantee a smooth processing of the payment flow even if no overdrafts were allowed on reserve accounts. This would make it possible to avoid the credit risks connected with overdrafts on gross settlement systems or provisional payments on net settlement systems. The solution arrived at was simple: Do not release a payment that will cause an overdraft until covering funds have arrived.

Account overdrafts can be the result of insufficient reserve account balances in relation to the participants' volume of payments or a lack of synchronization of incoming and outgoing payments.

---

[5] Stevens (1984), Mengle (1985), Smoot (1985) Dudley (1986), Humphrey (1986, 1987), Mengle et al. (1987), Corrigan (1987), and Belton et al. (1987).

[6] Corrigan (1987).

[7] Belton et al. (1987).

[8] Buomberger (1987), Granziol (1986), Lehmann (1984, 1986), Meyer (1985), Müller (1986), SIC (1986), Telekurs (1987).

Given the current daily volume of payments to the tune of over 100 billion Swiss francs ($68.5 billion), prohibitively high costs would be imposed on participants if they were required to increase their non-interest-bearing reserve account balances or to coordinate the timing of incoming and outgoing payments so as to prevent any overdrafts from occurring. The experience of the United States seems to indicate quite clearly that the problem of overdrafts cannot be properly solved on the basis of caps or payment coordination by participants alone[9]. A less costly solution might result if the funds transfer system itself were to help solve the synchronization problem. The SIC attempts to relieve participants as far as possible from the synchronization task by automatically guaranteeing an optimum synchronization of incoming and outgoing payments.

In order to take due account of increasingly sophisticated customer requirements and to lower the cost of each individual payment transaction, it was further planned to send not only large-value payments through SIC but also to provide for the processing of a substantial proportion of bulk payments. Because under these conditions a total of more than 400,000 payment transactions might have to be reckoned with on peak days, it was specified that SIC should have a settlement capacity of 90,000 payments per hour.

Components The requirement that each payment must be settled finally and irrevocably on SIC implies that participants' clearing accounts must be the reserve accounts managed by the Swiss National Bank. But actual operation of SIC by the Swiss National Bank would have meant a fundamental change in the allocation of responsibilities among the banks, Telekurs AG, and the Swiss National Bank from the pattern existing in the Bank Clearing System. It would have been impossible for the Swiss National Bank to implement such a major project within a reasonable time because it lacked the necessary technical capabilities and experience. The major banks and Telekurs AG, however, had gained ample experience in the course of their own research and development work. For this reason, it was decided that SIC would operate on the computer systems of Telekurs AG. The objective of administering participants' reserve accounts held with the Swiss National Bank with the aid of this system was achieved by means of an agreement on the allocation of functions: Telekurs AG would operate the SIC computer center on behalf of the Swiss National Bank, while the Bank would manage the accounts.[10]

The chief components of SIC are shown in Figure 1.[11] At the center is the computer system in which participants' "SIC accounts" are administered. The computer systems of the Swiss National Bank and of the participants are linked to the SIC computer either directly or by communication computers.[12] SIC also has a magnetic tape interface with the postal checking system permitting transfers from postal checking accounts to the reserve accounts and vice versa. Moreover, magnetic tape interfaces to service applications provide for the processing of customer-related payment transactions (such as check clearing and cash dispensers) and for securities clearing with traditional net settlement methods.

In accordance with contractual agreements, participating banks' SIC accounts take the form of reserve accounts at the Swiss National Bank. In addition, every participant has a traditional reserve account which is administered on the computer system of the Swiss National Bank and bears the designation "master account." Legally, both accounts form a single unit and carry the same rights and obligations, though physically they are managed separately.

The SIC account is used for processing SIC transactions, while the master account is used for all other transactions (such as cash withdrawals). At the beginning of a clearing day the Swiss National Bank transfers balances from the master account to the SIC account. At the end of the day the total debits and credits on the SIC account are transferred to the master account so the master account again shows the full reserve balance of a participant. The participating bank decides how the balance is to be divided up between the two accounts. In so doing, it must bear in mind that payments are made from the two accounts only if there are sufficient funds in the accounts. Transfers from the master account to the SIC account and vice versa are possible at any time during the day.

Processing of payments SIC is a credit transfer system. That is, it does not in principle allow debit transactions. Payment transactions entered by the Swiss National Bank on the instructions of a participant are an exception, but take place only in unusual

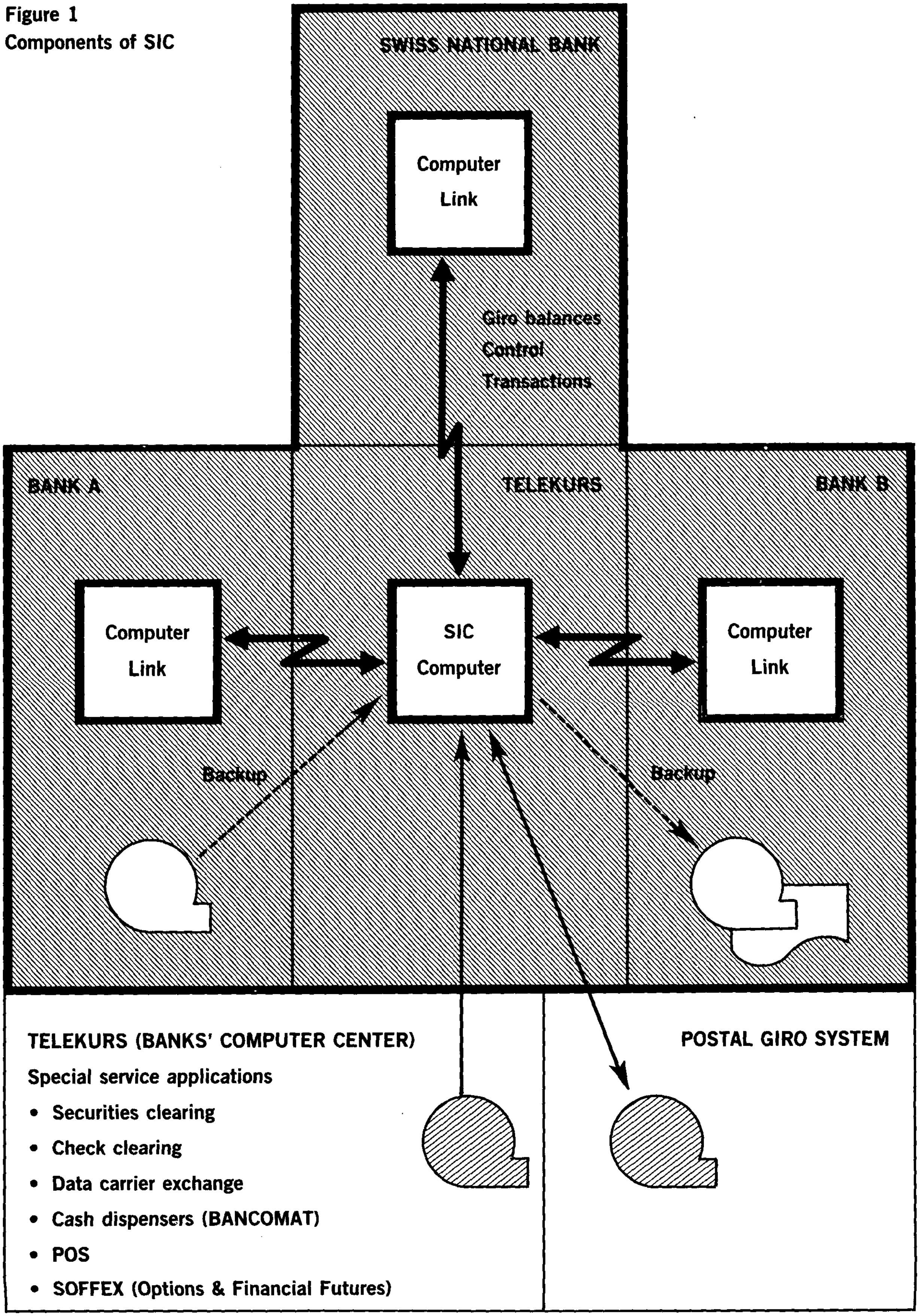
[9] "Since there probably are limits as to how far efforts to reduce daylight overdrafts can go, the current daylight overdraft control program would have to be augmented by some combination of clearing balance requirements for major users of Fedwire and explicit charges for daylight credit . . ." Corrigan (1987), p. 31. See also Belton et al. (1987).

[10] See Hess (1988) on the contractual basis.

[11] See Telekurs (n.d.) on the hardware concept.

[12] See Birchler (1987) on the communication concept.

Figure 1
Components of SIC



circumstances such as computer breakdowns. In addition, payments for the special services shown in Figure 1 are settled by debit transactions.

The planned volume of transactions makes high demands on the processing capacities of the participating banks' systems and the SIC computer system. SIC therefore provides a 24-hour service on bank working days. Payment orders may be entered around the clock, either through the network or on magnetic tape, for settlement on the day of input or on one of the following ten bank working days. Payment orders not due for settlement on the day of input are stored in the "pre-value date file" and are automatically executed on the due date. Settled payments are delivered to the recipient through the network, on magnetic tape, or on paper. The magnetic tape and paper interfaces are reserved primarily for backup purposes.

The processing of payments to be settled on the day of input is shown in Figure 2. The payment message entered by Bank A is first "validated" by SIC. That is, the system checks whether the message complies with the formal requirements listed in the SIC standards, whether it has not already been input (double entry check), and whether it is compatible with the master data stored for the bank. If the validation result is positive the sending bank receives an "OK" message and the payment message continues to be processed. Otherwise the sending bank receives an "NOK" message (not OK) and the payment message must be entered again. Validated payment messages are then passed on to the SIC settlement mechanism. This is the central component that automatically ensures synchronization of incoming and outgoing payments.

A payment order is settled, that is, the account of the sending bank ordering the payment (Bank A) is debited and the account of the receiving bank (Bank B) is credited if there are sufficient funds ("cover") in the sending bank's account to be debited. If desired, the sending bank is advised of the result of the check by means of an "EX" or a "NEX' (executed or not executed) message. Settled payments are delivered to the receiving bank, which in turn has to acknowledge receipt to the SIC system.

If sufficient cover is not available the payment order is transferred to a "waiting queue" and kept pending until sufficient funds have accumulated in the clearing account as a result of incoming payments. Once sufficient funds are available the settlement process is initiated automatically. The sequence of settlement is determined by the "first-in-first-out" (FIFO) principle, that is, by order of input.[13] No daylight overdrafts can occur.

It is possible that some payments cannot be settled by the end of the day owing to lack of cover. In such an event the payments involved are cancelled during end-of-day processing and must be entered again by the sending bank on the following day.

The settlement of a payment is final and irrevocable. The receiving bank can thus dispose of the incoming amounts without incurring any risk. But unlike settled payments, payment transactions stored in the waiting queue or in the pre-value-date file may be cancelled by the sending bank at any time. The purpose of allowing cancellation is to discourage receiving banks from releasing pending payments (similar to provisional payments on CHIPS) prior to settlement.[14] That is, receiving banks are less likely to allow customers access to provisional funds if there is a possibility the payment could be cancelled before settlement.

Inquiries A bank participating in SIC can monitor any settled incoming and outgoing payments or payments stored in the waiting queue and pre-value-date file that concern it. Similarly, it can monitor the actual balance in its SIC account and the balance including any payments not yet settled for all valid value dates. All information entered in the system is thus immediately available to the participant concerned.

The Swiss National Bank has access to the same information, but for all SIC accounts. For individual payment messages, access is restricted to settlement-related data (sending and receiving bank, amount, date).

Daily schedule A SIC day begins at around 6 p.m. and ends at approximately 4:15 p.m. of the following bank working day. Between 6 p.m. of the first working day and 3 p.m. of the following day the entering of payment messages is not restricted.

At 3 p.m. "Cutoff One" takes place. Any payments entered after Cutoff One for same-day settlement automatically have their value date changed to the next day. The sole exceptions are "cover payments," which may be entered until "Cutoff Two" (4 p.m.) for same-day settlement. The intervening hour between Cutoff One and Cutoff Two is intended to

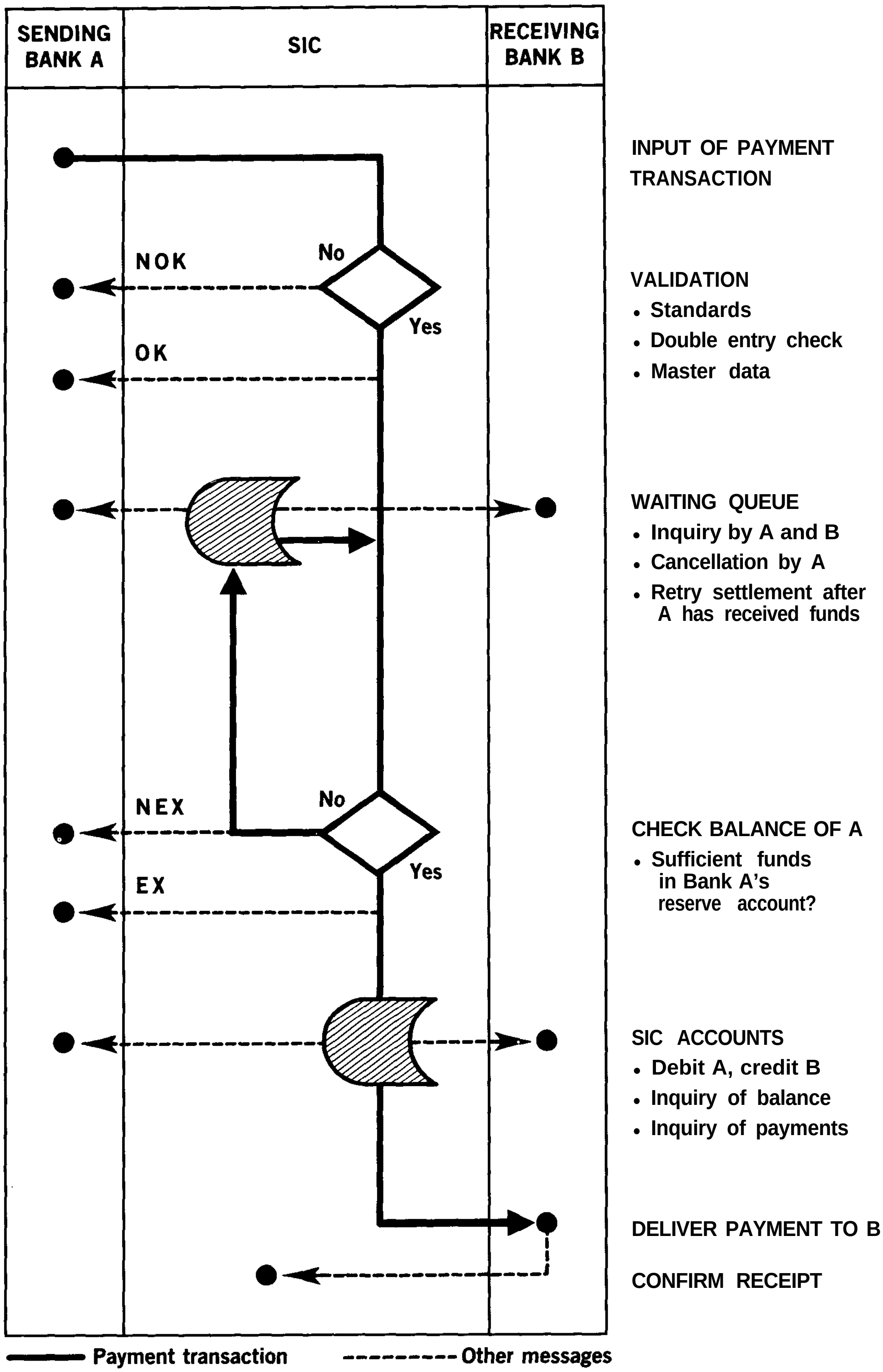
---

13 The settlement mechanism described applies to all SIC payment transactions including payments between two branches of the same bank.

14 Incentives of this kind are also reduced to a minimum by the rule that payments are not delivered to the recipient immediately after being entered but are withheld until settlement has taken place.

Figure 2

Processing of Payments for Same-Day Settlement



permit participants whose payments have not been carried out prior to Cutoff One owing to lack of cover to procure the funds necessary for settlement. After Cutoff Two only cover payments entered by the Swiss National Bank are accepted for same-day settlement until end-of-day processing begins. This is a backup measure in case a participating bank is not able to enter cover payments itself because of technical difficulties.

At around 4:15 p.m. end-of-day processing begins. All pending transactions are cancelled and the total credits and debits on each SIC settlement account are transferred to the master accounts. A new SIC day begins at approximately 6 p.m.; the settlement process for the new day starts with the transfer of reserve account balances from the master accounts to the SIC settlement accounts at approximately 7:30 p.m.

It cannot be ruled out that a participant might fail to enter all its transactions for same-day settlement prior to Cutoff One because of, say, technical difficulties. Nor can it be ruled out that payments may remain in the waiting queue due to lack of cover until end-of-day processing begins. In either case considerable costs may arise, both for the participant concerned and other participants, in the form of interest on delayed payments. If the amounts involved are substantial and if there is any possibility of the problems finding a solution within a reasonable time, a postponement of cutoff times and of end-of-day processing will be considered.

Security and reliability measures[15] In addition to measures for limiting credit risks, the architecture of an interbank payment system includes measures to protect against fraud and operational risks. In particular, operational difficulties can set off chain reactions that may jeopardize payment processing and therefore the timely fulfillment of obligations running into billions of Swiss francs. Understandably, then, an interbank payment system must provide a high degree of security and reliability.

There are two types of security measures to protect against infiltration, falsification, and tapping of messages by unauthorized third parties. First, authentication protects message transmission between participants and the SIC computer by means of a mathematical procedure that verifies the authenticity and integrity of a transaction. Second, encryption is available to prevent messages from being tapped. Encryption is not compulsory, but all participants are advised to use it.

With regard to operational reliability, there are backup facilities in the SIC computer center and in a remote backup center to serve as standbys in the event of failures of the SIC computer system or the central network equipment. But SIC encompasses not only the central SIC system, but more than 150 participant computer systems as well. While the reliability of data processing and communication facilities has reached a high standard in recent years, a system with such a large number of complex components cannot be expected to operate without any failures at all. The robustness of the overall system thus depends largely on the availability of suitable backup facilities in the event of breakdowns.

If time were needed to recover from failures of a participant's computer system or of the central system, cutoff could be postponed. In addition, any participant who is unable to communicate with SIC can resort to an exchange of data by means of magnetic tapes. In the event of serious disruptions provision is made for the Swiss National Bank to input large-value payments or totals of payments into the SIC system or enter them through the master accounts.

Introduction of SIC[16]

SIC was developed between 1981 and 1986 and was subjected to extensive tests from September 1986 to May 1987. The introduction of such a system could be costly and could involve high risks, since it would not be possible to test such a complex facility for every detail under all conceivable circumstances. Moreover, participating banks would have to install their systems and have them functioning on schedule. Finally, the banks would have to reorganize operational procedures that had become firmly established over the years.

In order to limit the risks involved in the introduction of the system and also because it was hardly to be expected that all participants would be able to complete all the preparations and conversions by a certain date, it was decided to introduce the new system step by step within the space of a year. The introduction was to be gradual in regard to both number of links and volume of transactions. But this led to the problem of payments accumulating on the accounts of participants not yet linked to the system. Potentially, this could cause settlement to come to a virtual standstill. The problem was solved by requiring that all "large" payments (exceeding one million Swiss francs) be processed through SIC as

[15] See also Walder (1987).

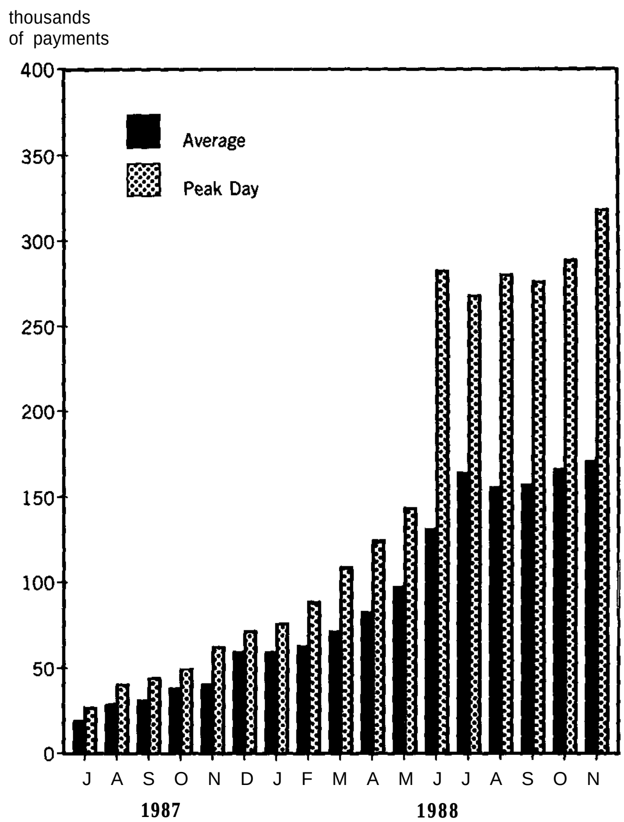
[16] For a first progress report see Vital (1987).

soon as it began operation. The Swiss National Bank assumed responsibility for entering such payments on behalf of any institutions not yet linked to the system.

SIC began operation on 10 June 1987. During the following months of operation the functional viability of the overall system was established. If one were to take into account the system's complexity and that its development meant breaking new ground, the introduction may be regarded as smooth and successful. As was to be expected, a few technical difficulties did occur both in the central system and with a number of participants. Each day, however, the settlement books were properly closed. No conceptual shortcomings were revealed in the course of the practical operations of the SIC system. The technical problems that did arise showed that the backup plans provided the necessary immunity from operational disruptions.

It was further revealed in the first few months that the SIC settlement mechanism worked satisfactorily. Transaction volume fluctuated between 60 and 140 billion Swiss francs ($41.1 to $95.9 billion) every day during that time. Even so, reserve account overdrafts, which had amounted to between 20 and 30 billion Swiss francs daily in the old Bank Clearing System, were permanently eliminated at one stroke when SIC came into operation without causing any disruptions in the interbank payment flow.

Figure 3
Number of SIC Payments Per Day
July 1987-November 1988



Experience since the Introduction of SIC[17]

Participants and payment volumes When SIC began operation on 10 June 1987, eight participating institutions were linked to the system. On that first day, 13,300 payments totalling 80 billion Swiss francs ($54.8 billion) were processed. By the end of November 1988 the number of participants linked on-line to SIC had risen to 156. (In comparison, CHIPS has 136 participants and Fedwire serves almost 7,000 depository institutions.) Further, the number of transactions per day approached 170,000 and the maximum peak day volume had increased to over 300,000 payments (Figure 3). But the expansion of average daily *value* of payments over the same period seems less dramatic in comparison because large payments, which account for the major part of the volume of funds, have been executed through SIC from the very first day (Figure 4). Still, peak day volume surpassed 200 billion Swiss francs for the first time in November 1988.

SIC will completely replace Bank Clearing in January 1989. If a bank not linked on-line to SIC wishes to make a payment through SIC, it does so through a correspondent linked to SIC.

Distribution of payment size While all large (one million Swiss francs or more) payments have been processed through SIC since June 1987, the proportion of small (up to 5,000 Swiss francs) payments has increased in terms of number of transactions as more participants have been added to SIC. In September 1987 small payments constituted almost SO percent of transactions, but by November 1988 their proportion had grown to about 77 percent. At the same time, the proportion of large payments had fallen from 23 percent to about 5 percent of the total number of transactions.

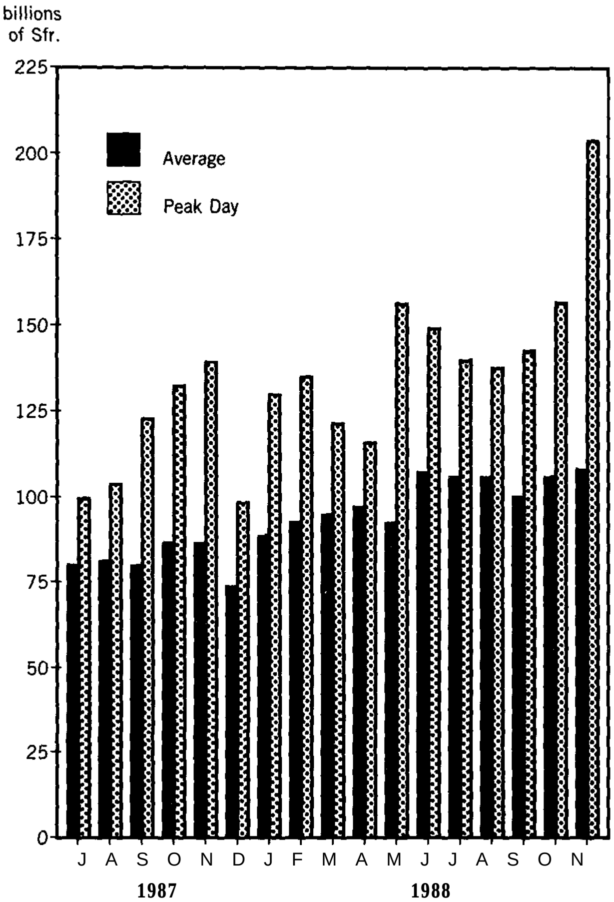
But in terms of value, only large payments are of any importance. Further, the distribution of values of payments has not changed markedly over time. Specifically, in September 1987 large payments comprised about 99 percent of total payment value, while by November 1988 the proportion had only fallen slightly to just under 98 percent.

[17] The Appendix treats the subject of this section in more detail.

Figure 4

Value of SIC Payments Per Day

July 1987-November 1988



On United States holidays, SIC payment volumes in terms of value fall to levels of less than 10 percent of average daily volumes. This shows that large payments derive chiefly from foreign exchange transactions. It also shows that comprehensive risk analyses and risk measures must take into account the interdependence of the various national funds transfer systems.

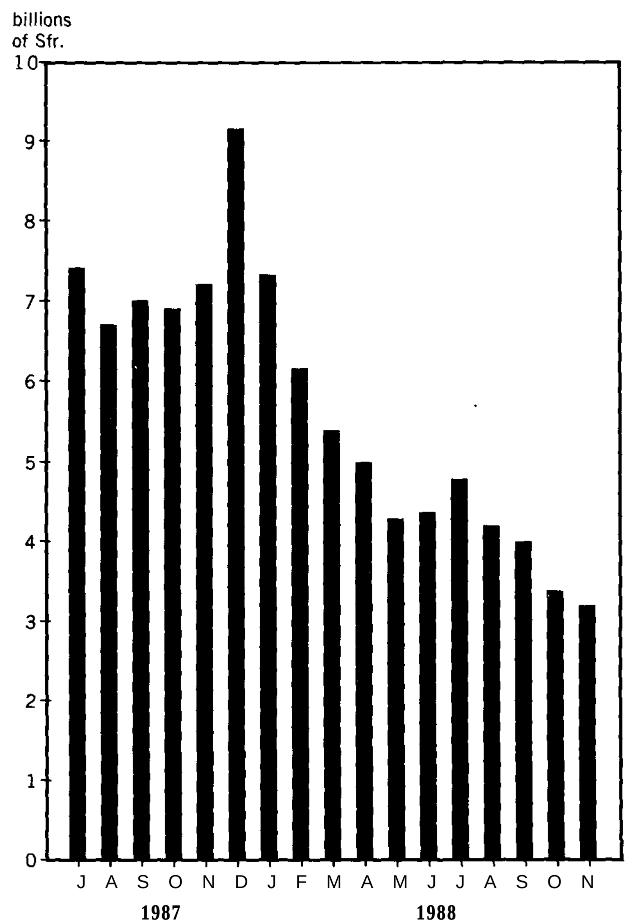
Use of reserve account balances It is difficult to determine the effect of SIC on the demand for reserve account balances because new liquidity regulations took effect on 1 January 1988.[18] Essentially, reserve requirements in Switzerland are now fulfilled by banks holding cash along with deposits with the Postal Giro System. Thus the deposits banks hold with the Swiss National Bank are for all practical purposes excess reserves. The results are shown in Figures 5 and 6. The level of reserve account balances held by SIC participants with the Swiss National Bank declined from over 7.0 billion Swiss francs in January 1988 to 3.2 billion Swiss francs by November 1988 (or from $4.8 billion to $2.2 billion). The ratio of daily value of SIC payments to the level of reserve account balances (that is, daily turnover) increased during the same period from approximately twelve to well over thirty.

Changes in input and settlement times Since the introduction of SIC input behavior has changed in favor of earlier times of input as additional participants have been linked to the system and payment volumes have expanded. Further, on 1 April 1988 a new transaction price stucture was introduced. The receiving bank pays a flat fee for each message received, and the fee does not change during the day.

Figure 5

Reserve Balances of SIC Participants

July 1987-November 1988



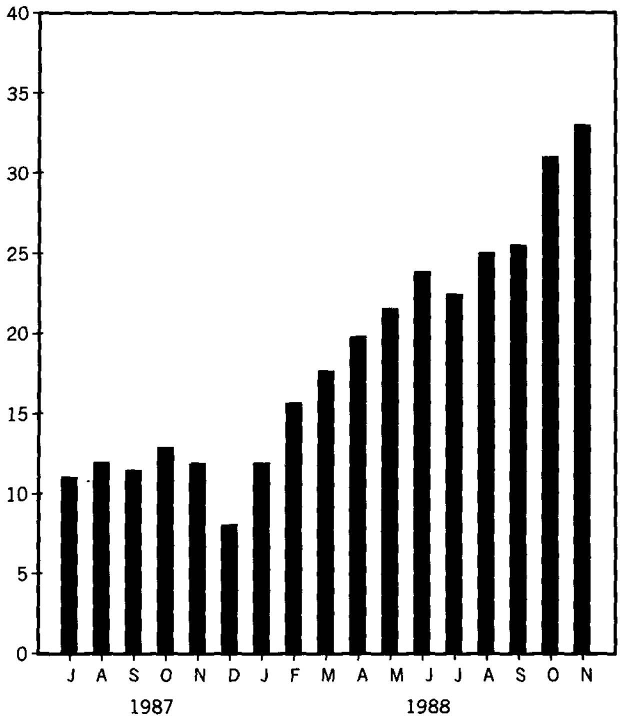
Note: Balances are monthly averages of daily figures.

[18] Birchler (1988).

Figure 6

Turnover of Reserve Balances of SIC Participants Per Day

July 1987-November 1988



Note: Turnover is the ratio of average daily payment value to average daily reserve balances.

In addition, the sending bank is charged a two-part price for each transaction, and each part increases at specified times during the day. One part of the price is based on time of input, the other on time of settlement. For example, a payment entered and settled before 8 a.m. would carry the lowest price, while a payment entered before 8 a.m. but not settled until after 8 a.m. would carry a higher price. The highest price would be charged for payments input and settled after 2 p.m.

By charging sending banks lower prices for payments entered and settled early in the day, it was hoped that participants would enter their payments a little sooner and thereby contribute to improved coordination of incoming and outgoing payments. While the new prices may have helped the move to earlier input times, settlement times have not become appreciably earlier. In fact, as reserve balances are reduced the settlement times are increasingly squeezed toward the end of the day.

Speed of processing Outgoing payments have to wait for incoming payments unless the bank synchronizes payments in such a way that available reserve account balances are sufficient for immediate settlement. The "waiting time" is the intervening period between the receipt of a payment by SIC and its settlement. If sufficient funds are available to settle a payment, the waiting time is about 30 seconds. If sufficient funds are not available, payments can be stored in the waiting queue for minutes or even hours.

The speed with which processing takes place in SIC depends on the value distribution of the payment flow, the level of participants' reserve account balances, and the degree of synchronization of incoming and outgoing payments. Speed may be increased for a given payment flow by raising the level of reserve account balances, by improving coordination between outgoing and incoming payments, or by exchange of intraday funds among the participants. But such measures involve costs that must be weighed against the advantages of a higher processing speed.

In November 1988, approximately 30 percent of all transactions were settled within ten minutes and approximately 55 percent within two hours of having been entered. This is a decrease from the corresponding figures of 43 percent and 79 percent a year earlier. More noticeable has been the drop in payments settled within five hours of input. While 99 percent of payments were settled within five hours, in November 1987, the proportion had **declined to** about 85 percent by a year later.

In electronic funds transfer systems that execute payment orders unconditionally, payments are processed without any significant delays. In the SIC system, in contrast, delays of up to a few hours may occur. This is the price to be paid for avoiding account overdrafts in the payment process. Compared with the Bank Clearing System, however, processing through SIC is much quicker. Consequently, delays have never been mentioned as a shortcoming of SIC.

Payment gridlock Related to use of reserve balances and speed of processing is the issue of payment gridlock, a situation in which no payments move over a system because they are all awaiting incoming funds for cover. Gridlock becomes more likely as reserve balances fall. The level of SIC reserve balances at which gridlock becomes a frequent problem depends on the number and value of large payments and the input behavior of participants. The question is: Are there incentives that prevent the transaction demand for reserves from dropping to the gridlock level? If not, then SIC could conceivably degenerate into a system with input in real-time but settlement in batch mode at the end of the day unless administrative measures were taken to force participants to hold sufficient reserves.

But there are factors that should prevent reserves from dropping to levels that threaten gridlock. First, since payments are not delivered to receiving banks unless settlement has occurred, receiving banks and their customers may exert pressure for higher reserve balances. Second, the costs associated with the squeezing of settlement times toward the end of the clearing day-or, in the extreme case, the costs associated with a gridlock-should deter banks from allowing their reserve balances to decline to unsafe levels. In addition, the Swiss National Bank's lending policies and the way in which rules (such as delays of cutoffs) are enforced will help shape banks' reserve demand.

Overall Assessment

SIC is a centralized gross settlement system created to process interbank payment transactions with no daylight overdrafts and therefore no systemic risk or Swiss National Bank intraday credit risk.

Experience shows that the objectives of implementing the system have been achieved: First, it provides an infrastructure that supports liquidity planning and monitoring in real time. Second, it expedites and improves the quality of payment transactions, Finally, it rationalizes the processing of payments by means of the unretarded transmission and processing of information.

Compared with the traditional Bank Clearing System, SIC offers considerable advantages both to participants and to the Swiss National Bank. Experience has shown that at least in Switzerland the main problem arising in connection with gross settlement systems, the elimination of account overdrafts, can be solved. Liquidity problems cannot be avoided even with this system. It does ensure, however, that in such cases the Swiss National Bank has the flexibility to decide whether or not it wishes to provide support as lender of last resort.

References

Bank for International Settlements (1985): *Payment Systems in Eleven Developed Countries.* Rolling Meadows, Illinois: Bank Administration Institute.

Belton, T.M., M.D. Gelfand, D.B. Humphrey, and J.C. Marquardt (1987): "Daylight Overdrafts and Payments System Risk," *Federal Reserve Bulletin* 73, November, pp. 839-52.

Birchler, U.W. (1988): "Neue Liquiditatsvorschriften und Geldpolitik," *Geld, Währung und Konjunktur, Quartalsheft der Schweizrischen Nationalbank* 6, pp. 75-81.

Birchler, W. (1987): "Swiss Interbank Clearing bewältigt bis zu 50'000 Transaktionen pro Stunde," *Fides Mitteilungen,* no. 54, March.

Buomberger, P. (1987): "SIC-eine positive Innovation auf dem Finanzplatz Schweiz," *SBG Wirtschafts-Notizen,* July, pp. 11-13.

Corrigan, E.G. (1987): "Financial Market Structure: A Longer View," Federal Reserve Bank of New York, *Annual Report*, 1986, pp. 3-54.

Dudley, W.C. (1986): "Controlling Risk on Large-Dollar Wire Transfer Systems," in *Technology and the Regulation of Financial Markets,* pp. 121-35. Edited by A. Saunders and L.J. White. Lexington, Massachusetts: Lexington Books.

Fischer, F. and W. Hurni (1988): "Erste Erfahrungen mit dem Schweizerischen Interbank-Clearingsystem (SIC) aus der Sicht einer Grossbank," *Wirtschaft und Recht* 40, pp. 50-62.

Granziol, M.J. (1986): "Notenbankpolitische Aspekte des Zahlungsverkehrs," *Geld, Währung und Konjunktur, Quartalsheft der Schweizerschen Nationalbank* 4, pp. 263-69.

Hess, M. (1988): "Die Rechtsgrundlagen des Swiss Interbank Clearing (SIC)," *Wirtschaft und Recht* 40, pp. 31-49.

Humphrey, D.B. (1986): "Payments Finality and Risk of Settlement Failure," in *Technology and the Regulation of Financial Markets,* pp. 97-120.

________. (1987): "Payments System Risk, Market Failure, and Public Policy," in *Electronic Funds Transfers and Payments: The Public Policy Issues*, pp. 83-109. Edited by E.H. Solomon. Boston: Kluwer-Nijhoff.

Lehmann, G.D. (1984): "Das neue schweizerische Bankenclearing System," *Oesterrichisches Bankarchiv* 32, pp. 423-28.

________. (1986): *Zahlungsverkehr der Banken.* Zurich: Verlag des Schweizerischen Kaufmännischen Verbandes.

Mengle, D.L. (1985): "Daylight Overdrafts and Payments System Risks," Federal Reserve Bank of Richmond, *Economic Review* 71, May/June, pp. 14-27.

Mengle, D.L., D.B. Humphrey, and B.J. Summers (1987): "Intraday Credit: Risk, Value, and Pricing," Federal Reserve Bank of Richmond, *Economic Review* 73, January/February, pp. 3-14.

Meyer, H. (1985): "Die Rolle der Schweizerischen Nationalbank im Zahlungsverkehr," *Bank und Markt,* no. 9, pp. 5-9.

Müller, R. (1986): "SIC als Meilenstein im Zahlungsverkehr," *Schweizer Bank,* January, pp. 53-57.

SIC (1986): "Das Online-Clearingsystem der Schweizer Banken," IBO 915010, October.

Smoot, R.L. (1985): "Billion-Dollar Overdrafts: A Payments Risk Challenge," Federal Reserve Bank of Philadelphia, *Business Review*, January/February, pp. 3-13.

Stevens, E.J. (1984): "Risk in Large-Dollar Transfer Systems," Federal Reserve Bank of Cleveland, *Economic Review*, Fall, pp. 'Z-16.

Telekurs (1987): "Das Online-Clearingsystem SIC, Update," *Informationsbu/letin der Telekurs AG*, January.

————. (n.d.): "Das Rechenzentrum der Banken."

Vital, C. (1987): "Das neue Interbank-Zahlungsverkehrssystem SIC," *Neue Zürcher Zeitung*, 26 August 1987.

Walder, R. (1987): "SIC: Das Online-Clearingsystem ist in Betrieb," *Der Schweizer Treufänder*, October, pp. 421-24.

APPENDIX: Survey of SIC Transactions

The growth of SIC transactions and of participation are shown in Table I. The large spread between daily average volume and peak day volume is attributable to the bulk payment transactions that are concentrated at the end of the month. By November 1988, peak day value of transactions passed 200 billion Swiss francs. Table II shows that the distribution of both number and value of payments transacted through SIC has been very uneven. While small payments have grown as a percentage of number of transactions, large payments have predominated in terms of value from the beginning of the system.

Tables III and IV give an overview of input behavior and the settlement of daily SIC payment flows from September 1987 to October 1988 in the form of monthly averages of daily figures. Table III lists percentages of daily volume in terms of the number of entered and settled payments for various times of the day. Table IV lists the corresponding percentages in terms of value. The tables show that

Table I

SIC PARTICIPANTS AND TRANSACTIONS

July 1987-October 1988

Year Month	Number of on-line participants	Number of Transactions: Monthly total	Number of Transactions: Daily figures Average	Number of Transactions: Daily figures Peak day	Value of Transactions[1]: Monthly total	Value of Transactions[1]: Daily figures Average	Value of Transactions[1]: Daily figures Peak day
1987							
J	17	391,169	17,007	22,797	1,870	81	99
A	34	522,863	24,898	40,278	1,722	82	103
S	55	615,255	27,966	43,276	1,773	81	123
O	73	822,221	37,374	50,624	1,917	87	132
N	82	918,249	43,726	62,358	1,824	87	139
D	95	1,247,903	56,723	72,029	1,603	73	97
1988							
J	105	1,118,389	55,919	76,839	1,774	89	130
F	112	1,279,421	60,925	88,258	1,953	93	136
M	125	1,645,989	71,565	106,255	2,187	95	120
A	133	1,568,299	82,542	122,442	1,862	98	115
M	149	1,930,068	96,503	144,945	1,843	92	154
J	154	2,885,069	131,140	281,352	2,328	106	147
J	155	3,423,815	163,039	267,350	2,213	105	140
A	156	3,398,110	154,460	279,369	2,322	105	136
S	156	3,428,466	155,839	274,943	2,205	100	143
O	156	3,475,424	165,496	288,955	2,207	105	154
N	156	3,729,613	169,528	318,816	2,345	107	203

[1] Billions of Sfr.

Table II

VALUE DISTRIBUTION OF SIC PAYMENT FLOW

(Proportions in terms of number and value)

Year Month	Size of Payment Transactions (Sfr)					
	1-4,999		5000-999,999		1 million and above	
	Number	Value	Number	Value	Number	Value
1987						
S	49.8	0.02	27.3	1.2	22.9	98.9
O	54.1	0.03	25.7	1.4	20.2	98.6
N	59.0	0.03	26.1	1.6	14.9	98.4
D	63.1	0.06	26.2	2.0	10.7	97.9
1988						
J	60.7	0.05	24.7	1.6	14.6	98.3
F	62.5	0.05	24.1	1.6	13.4	98.4
M	65.9	0.06	22.3	1.6	11.8	98.3
A	68.6	0.07	21.7	1.7	9.8	98.3
M	72.1	0.09	19.7	1.8	8.2	98.1
J	74.5	0.11	18.4	1.8	7.1	98.1
J	76.6	0.14	17.9	2.1	5.5	97.8
A	77.1	0.13	17.2	2.0	5.8	97.9
S	77.5	0.14	17.4	2.0	5.1	97.8
O	77.4	0.15	17.3	2.1	5.3	97.8
N	76.8	0.14	17.8	2.1	5.4	97.8

Table III

NUMBER OF PAYMENTS BY TIME OF DAY

(Percentage share of total)

Year Month	Time of Day							
	08:00 a.m.		10:00 a.m.		12:00 a.m.		02:00 p.m.	
	Input	Settlement	Input	Settlement	Input	Settlement	Input	Settlement
1987								
S	27.3	2.1	44.2	24.5	72.1	49.6	90.3	81.2
O	26.8	7.4	42.1	20.0	69.0	48.6	89.0	79.0
N	26.1	10.5	41.6	23.4	69.3	49.3	89.1	81.5
D	29.3	19.5	45.1	37.2	70.1	62.3	89.1	82.4
1988								
J	29.4	14.1	44.0	26.9	69.8	55.5	88.0	82.7
F	29.7	14.2	45.1	28.0	70.4	57.2	89.3	84.5
M	31.0	15.4	45.7	27.5	69.7	53.2	88.5	82.7
A	32.2	15.7	46.7	28.6	71.5	56.8	88.3	82.4
M	33.3	14.1	48.1	24.7	72.1	50.7	88.9	76.8
J	41.9	17.7	54.5	26.5	73.6	45.9	89.0	73.2
J	49.6	22.4	60.3	33.7	76.1	57.1	90.1	78.8
A	49.5	18.8	61.4	29.2	78.5	55.0	92.5	86.5
S	49.3	19.4	59.8	30.4	77.9	52.1	91.7	80.2
O	47.2	18.1	58.1	27.2	76.9	45.1	92.1	75.2
N	48.0	18.2	59.4	27.9	78.0	43.5	92.5	70.7

Note: Monthly average of daily figures.

Table IV

VALUE OF PAYMENTS BY TIME OF DAY

(Percentage share of total)

Year Month	Time of Day 08:00 a.m. Input	08:00 a.m. Settlement	10:00 a.m. Input	10:00 a.m. Settlement	12:00 a.m. Input	12:00 a.m. Settlement	02:00 p.m. Input	02:00 p.m. Settlement
1987								
S	30.2	3.8	54.2	29.5	81.4	56.9	95.1	89.6
O	29.0	8.1	50.6	24.4	79.5	56.7	94.6	88.7
N	33.7	13.8	54.8	29.0	80.6	55.8	95.3	90.0
D	37.6	26.4	59.0	46.9	83.4	74.4	95.1	92.2
1988								
J	36.1	17.4	56.1	32.4	83.5	65.3	96.1	91.7
F	35.8	16.2	57.5	31.6	82.8	67.4	96.0	93.2
M	36.7	15.3	58.0	30.2	83.5	62.8	96.4	93.1
A	33.5	14.5	55.3	27.4	82.6	62.4	95.6	90.1
M	34.7	11.2	56.7	19.6	82.9	51.1	95.5	82.2
J	37.7	13.5	56.1	24.1	81.2	52.7	95.2	78.2
J	42.4	20.5	60.7	34.8	82.3	56.7	94.0	80.4
A	46.1	15.7	63.1	30.0	84.5	60.7	95.7	88.5
S	47.1	14.5	64.9	29.2	85.5	55.9	95.0	82.8
O	47.9	13.9	63.7	24.3	85.2	47.9	95.9	76.4
N	48.1	14.2	63.3	22.3	83.1	42.8	94.6	65.5

Note: Monthly average of daily figures.

almost half of all payments are entered before 8 a.m. on the settlement day, either at night or on previous days in the form of payment orders with pre-stated value dates. But up to that time less than half these payments have actually been settled. By 2 p.m. (one hour prior to Cutoff One) over 90 percent of the transaction volume and almost 95 percent of the value have been input, although only about 70 percent of the transactions have been settled.

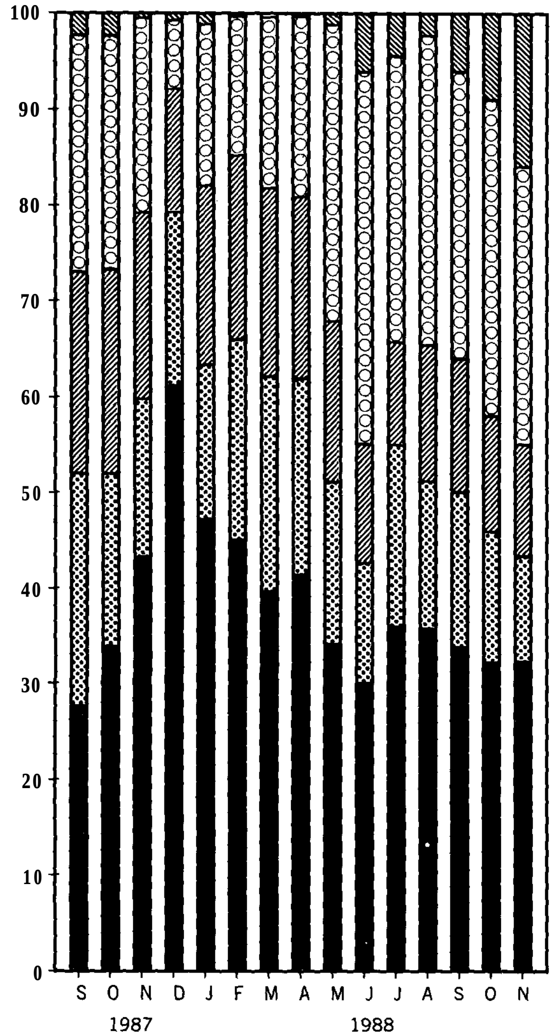
Waiting time is the period between receipt of a payment by SIC and its settlement. Figures A. 1 and A.2 show percentage shares of the overall volume in terms of number and value for different waiting time classes. Since the processing speed observed during normal working hours is of primary interest, all payments settled before 8 a.m. are considered to have a waiting time of zero.

Figure A. 1 shows that approximately 30 percent of all transactions are settled within ten minutes and approximately 55 percent within two hours of having been entered. Some transactions may remain in the waiting queue for several hours. The figures for value of transactions are lower (Figure A.2). Processing time for large payments is a little longer than that for small payments. Note that the percent of transactions taking more than five hours to settle increased during the second half of 1988. This corresponds to the decline in reserve balances held with the Swiss National Bank.

Figure A1

Time Lag Between Input and Settlement of the SIC Payment Volume

Percentage Share of Total



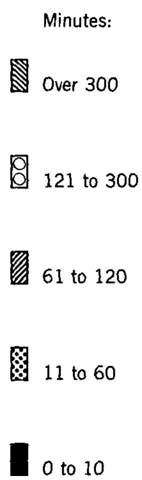
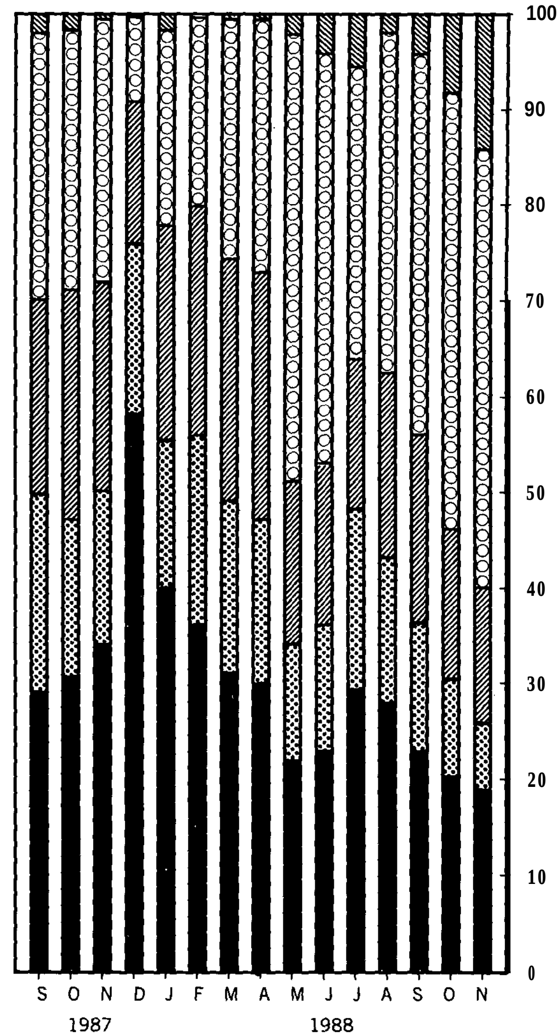


Figure A2

Time Lag Between Input and Settlement of the SIC Payment Value

Percentage Share of Total



INTERNATIONAL RISK-BASED CAPITAL STANDARD: HISTORY AND EXPLANATION

*Malcolm C. Alfriend**

Introduction

A business firm's capital is expected to serve a variety of purposes. In the case of a bank, capital helps establish a level of confidence sufficient to attract enough deposits to fund its operations. Further, capital serves as a cushion to absorb unforeseen losses so that the bank can continue in business. Agreement on what constitutes sufficient capital, however, is not always easy to reach. In fact, from the earliest attempts to measure capital adequacy bankers and regulators have disputed what constitutes "capital" and what is "adequate."

During the last two decades banks have expanded into new activities. There have also been inroads by nonregulated, nonbank financial institutions into traditional banking activities and increased "globalization" of banking and finance. These developments have made the proper measurement of capital adequacy an urgent matter.

In late 1987, the Basle Committee on Banking Regulations and Supervisory Practices, composed of representatives of the central banks of major industrialized countries under the aegis of the Bank for International Settlements (BIS), developed a risk-based framework for measuring capital adequacy. The Committee's objective was to strengthen the international banking systems and to reduce competitive inequalities arising from differences in capital requirements across nations.

This article sketches the historical evolution of attempts to measure capital adequacy leading to the Basle accord. It also reviews how capital measures of U.S. banks would change under the risk-based framework and how the new guidelines would affect the larger banking organizations headquartered in the Fifth Federal Reserve District.

* Malcolm C. Alfriend is Examining Officer at the Federal Reserve Bank of Richmond.

Historical Perspective

Until World War II, the Federal bank regulatory agencies[1] measured capital adequacy as a percent of total deposits or assets. Prior to the great depression of the 1930s, the capital-to-deposit ratio was used. This ratio measured bank liquidity. During the depression the emphasis shifted to measures of solvency, centered around the capital-to-asset ratio.

During World War II bank assets expanded rapidly, primarily as a result of investments in U.S. government bonds. The Federal Reserve, in seeking a way to avoid penalizing banks for investing in these low-yield and "riskless" assets, devised a new ratio of capital to risk assets. For this purpose, risk assets were defined as total assets excluding cash, balances due from other banks, and U.S. government securities. Initially, a 20 percent standard for this ratio was established as "sufficient" capital. Thus, beginning in the mid-1940s the concept of capital adequacy became associated with the risks inherent in the earning-asset portfolio.

In 1952 the Federal Reserve adopted an adjusted risk asset approach to measuring capital. All assets were categorized according to risk with separate capital requirements assigned to each category. The minimum total capital required was the sum of the capital requirements of each category. Banks that exceeded this minimum by 25 percent rarely had their level of capital questioned.

In 1956 the Fed further refined its capital standard by coupling the adjusted risk asset approach with a liquidity test. The FDIC and OCC followed the lead of the Fed and also adopted this principal for measuring capital. This test required more capital from less liquid banks. It also considered some off-balance sheet items. The new standard assigned dif-

[1] The three Federal regulatory agencies having responsibility for commercial banks are the Federal Reserve System (Fed), Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC).

ferent percentages of capital to the various categories of assets and liabilities. These percentages were used to derive the total amount of capital needed to protect the bank from losses on investments and from reductions in deposits and other liabilities. A ratio of actual capital to required capital was calculated and if the ratio was less than 80 percent, a bank was generally considered undercapitalized.

In 1962 the Comptroller of the Currency abandoned the risk assets standard on the grounds that it was arbitrary and did not consider factors such as management, liquidity, asset quality, or earnings trends. Moreover, the Fed, FDIC, and OCC disagreed over what constituted capital. The Fed continued to define capital as equity plus reserves for loan losses. In contrast, the FDIC and OCC allowed some forms of debt to count as capital. Thus, in the early 1960s regulatory opinion on capital adequacy became divided. The FDIC relied on a capital to average total asset ratio excluding fixed and substandard assets. The Federal Reserve continued to use risk assets as the denominator in its capital ratios although it frequently revised its definition of risk assets. For the remainder of the 1960s and '70s, the Federal bank regulators continued to use different definitions of capital and methods of measuring capital adequacy.

In 1972 the Fed capital standard was revised again. Asset risk was separated into "credit risk" and "market risk" components. In addition, banks were required to maintain a higher capital ratio to meet the test of capital sufficiency. Further, the Fed reintroduced both the capital to total asset and capital to total deposit ratios. This time, however, the former ratio was based on total assets less cash plus U.S. government securities, a rough "risk asset" adjustment. In practice, bankers and analysts used the FDIC and Fed standards more than those of the OCC.

None of the agencies established a firm minimum capital ratio. Instead, the capital positions of banking institutions were evaluated on an individual bank basis. Particular attention was directed toward smaller banks whose loan portfolios were not as diversified and whose shareholders were fewer in number than those of larger institutions. It was reasoned that small or "community banks" might have a hard time raising capital in times of difficulty and therefore should be more highly capitalized at the start than larger institutions. Table 1 shows the banking industry's capital-asset ratios from 1960 to 1980. The table shows that there was a steady downward drift in the ratio, which can be explained by a number of factors. Chief among these would be the attractiveness of increased leverage in banking and reliance on other techniques to manage balance sheets, e.g., liability management.

Table I

RATIO OF EQUITY CAPITAL TO TOTAL ASSETS

1960-1980

(Percent)

Year-end	All banks
1960	8.1
1965	7.5
1970	6.6
1975	5.9
1980	5.8

In late 1981 the three Federal bank regulatory agencies announced a new coordinated policy related to bank capital. The policy established a new definition of bank capital and set guidelines to be used in evaluating capital adequacy. The new definition of bank capital included two components: primary and secondary capital.

Primary capital consisted of common stock, perpetual preferred stock, surplus, undivided profits, mandatory convertible instruments (debt that must be convertible into stock or repaid with proceeds from the sale of equity), reserves for loan losses, and other capital reserves. These items were treated as permanent forms of capital because they were not subject to redemption or retirement. Secondary capital consisted of nonpermanent forms of equity such as limited-life or redeemable preferred stock and bank subordinated debt. These items were deemed nonpermanent since they were subject to redemption or retirement.

In addition to the new definition of capital, the agencies also set a minimum acceptable level for primary capital and established three zones for classifying institutions according to the adequacy of their total capital. As shown in Table II, different standards were applied to "regional" and "community"

Table II

ACCEPTABILITY ZONES FOR TOTAL CAPITAL ESTABLISHED IN 1981

Zone	Regional organizations	Community organizations
1	Above 6.5%	Above 7%
2	5.5% to 6.5%	6% to 7%
3	Below 5.5%	Below 6%

banking organizations. "Multinational" banks were excluded from the measurement system altogether. Multinational organizations were defined as those with consolidated assets above $15 billion. There were seventeen such organizations in 1981. Regionals were defined as organizations with assets from $1-$15 billion while community organizations included all companies under $1 billion.

The Fed and OCC established minimum ratios of primary capital to total assets of 5 percent and 6 percent for the regional and community organizations, respectively. If an institution's primary capital exceeded the minimum and total capital was in Zone 1, its capital was assumed to be adequate. For organizations with capital ratios in Zone 2, other factors such as asset quality and the level and quality of earnings entered the determination of capital adequacy.

The FDIC's capital adequacy guidelines set a 5 percent minimum for the equity capital ratio, defined as capital minus 100 percent of assets classified as loss and 50 percent of assets classified as doubtful at the most recent examination. In addition, the FDIC excluded limited-life preferred stock or subordinated debt from its definition of capital. These items must be repaid and-unlike true capital, they are not available to absorb losses.

In 1983 the Fed amended its guidelines to set a minimum capital ratio of 5 percent for multinational organizations. It also expanded the definition of secondary capital to include unsecured long-term debt of holding companies and their nonbank subsidiaries. In 1985 the Fed guidelines were amended once again when the uniform minimum primary capital ratio was set at 5.5 percent and uniform total capital at 6 percent. In addition, new zones for measuring the adequacy of total capital were adopted, namely, greater than 7 percent, 6 to 7 percent, and less than 6 percent.

In reaction to the use of a simple capital-to-asset ratio, banks began to adjust their portfolios increasing the share of higher yielding assets but requiring no more capital than lower yielding assets. In particular, some banks switched from short-term, low-yield, liquid assets to higher yielding but riskier assets (i.e., loans). Also, since the capital requirements only applied to assets carried on the balance sheet, banks began to expand off-balance sheet activities rapidly. Some institutions attained their ratios by packaging assets and selling them to investors, reducing their risk in the process.

While the ratio of capital to total assets served as a useful tool for assessing capital adequacy for a time, it became increasingly apparent that the type of risks being assumed by banks required a new approach to measuring capital. Accordingly, in February 1986, the Fed proposed standards for measuring capital on a risk-adjusted basis. The proposal, followed shortly by a similar proposal from the OCC, was designed to: 1) address the rapid expansion of off-balance sheet exposure; 2) reduce incentives to substitute higher-risk for lower-risk liquid assets; and 3) move U.S. capital policies more closely into line with those of other industrialized countries.

Under the Fed proposal, assets and certain off-balance sheet items were assigned to one of four broad risk categories and weighted by their relative riskiness. The sum of the weighted asset values served as the risk asset total against which primary capital was to be compared. The resulting ratio was to be used together with the existing primary and total capital-to-total asset ratios in determining capital adequacy.

Before the 1986 proposal could be put into effect, however, the U.S. bank regulators requested public comment on a revised risk-based capital framework for banks and bank holding companies. This proposal, announced in January 1987, was developed jointly by U.S. and Bank of England authorities. During the comment period on the revised proposal, the U.S. bank regulators continued to seek international agreement on the proposal, an effort that led in December 1987 to still another framework for risk-based capital that had been developed jointly with representatives from 11 other leading industrial countries.[2] This proposal has undergone continued refinement and final guidelines were adopted officially in December 1988.

The Risk-Based Capital Framework

The risk-based capital (RBC) framework, which was adopted as an international standard addresses primarily credit risk. It has four broad elements as follows:

1. A common international definition of capital. Core or Tier 1 capital consists of permanent shareholders' equity. Supplemental or Tier 2 capital is a "menu" of internationally accepted non-common equity items to add to core capital. Each country has some latitude as to what supplemental components will qualify as capital.
2. Assigning one of four risk weights (0, 20, 50, and 100 percent) to assets and off-balance sheet

[2] Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, United Kingdom, United States, Switzerland, and Luxembourg.

items on the basis of broad judgments of relative credit risk. These categories are used to calculate a risk-based capital ratio. Off-balance sheet items are also assigned a credit conversion factor that is applied before the risk weight.[3]

3. A schedule for achieving a minimum 7.25 percent risk-based capital ratio by the end of 1990 (3.625 percent from Tier 1 items) and 8 percent by the end of 1992 (4 percent from Tier 1 items).
4. A phase-in period, from 1990 to 1992, during which banking organizations can include some supplemental capital items in Tier 1 capital on a temporary basis.

The RBC framework focuses on credit risk only. As such, the proposal does not take into account other factors that affect an organization's financial condition, such as liquidity and funding. Also overlooked are factors such as interest rate risk, concentrations of investments and loans, quality and level of earnings, problem and classified assets, and quality of management. These factors must also be considered in measuring financial strength and they will continue to be assessed through the examination process. Further, the Fed Board of Governors has indicated that it may consider incorporating interest rate risk before the new RBC takes effect.

Risk-based and traditional capital policies The international risk-based capital standard differs in some respects from all the previous risk-based capital proposals made by U.S. regulators. It reflects changes suggested by banking supervisors in foreign countries and comments received from the public. An important aspect of the implementation of the RBC standard in the United States is that it will apply to *all* banks, not just international banks as required by the Basle accord. Further, the Fed has determined that a risk-based ratio similar to the risk-based capital framework for banks will be applied to bank holding companies on a consolidated basis. The difference in the capital framework for banks and the framework for bank holding companies rests with a slightly broader definition of capital for bank holding companies. The following is a brief review of the principal differences between the RBC framework and traditional capital guidelines that have been used in the United States.

Core and supplemental capital components The RBC standard like the 1987 U.S./U.K. proposal, divides capital into two components: core capital (Tier 1) and supplemental capital (Tier 2). After an initial phase-in period, core capital will consist entirely of permanent shareholders' equity, which is defined in Table III. This is in contrast to the current definition used by U. S. banking regulators which includes both common and perpetual preferred stock, mandatory convertible debt instruments, and allowance for loan and lease losses. While mandatory convertible debt instruments may be included in core capital to a limited degree during the phase-in period, after 1992 these components can be used only as supplemental capital.

In the case of bank holding companies, both cumulative and noncumulative perpetual preferred stock are included in core capital. The aggregate amount of perpetual preferred stock included cannot exceed 25 percent of core capital, however. Perpetual preferred stock in excess of this percentage can be included in Tier 2 without limit.[4] By allowing bank holding companies to include some cumulative perpetual preferred stock in core capital, the Fed is giving bank holding companies more flexibility in raising capital while recognizing the value of perpetual preferred stock in the holding companies' capital structure. At the same time, the limits on the maximum amount of preferred stock included in Tier 1 are meant to protect the integrity of a holding company's common equity capital base.

The Fed also may designate certain subsidiaries whose capital and assets may be excluded from capital requirements. Securities affiliates of bank holding companies fall into this category. However, to be excluded the Fed has specified that strong barriers between affiliates, adequate capitalization of nonbank subsidiaries, and any other protections that it deems necessary must first be in place to safeguard the health of affiliated banks.

Table IV shows the results of applying the concept of RBC core capital to the 35 largest banking organizations in the Fifth District, i.e., those organizations with total assets greater than $500 million as of mid-1988. The calculations are estimates only, inasmuch as the information necessary for

[3] Each balance sheet item is multiplied by the appropriate risk weight to arrive at the credit equivalent amount. For example, cash is assigned a zero weight. Similarly, off-balance sheet items would be multiplied by a credit conversion factor and then by the appropriate risk factor. For example, a long-term loan commitment to a private corporation has a conversion factor of 50 percent and a risk category of 100 percent.

[4] "Dutch Auction" preferred stocks are those types of preferred stock (including remarketable preferred and money market preferred) on which the dividend is reset periodically to reflect current market conditions and an organization's current credit rating. These stocks are excluded from Tier 1 but may be included in supplemental capital without limit.

Table III

RISK-BASED CAPITAL COMPONENTS

Core Capital

Common stock, at par value

Perpetual preferred stock (preferred stock having no stated maturity date and which may not be redeemed at the option of the holder)

Surplus (amounts received for perpetual preferred stock and common stock in excess of its par or stated value but excluding surplus related to limited-life preferred stock, capital contributions, amounts transferred from retained earnings and adjustments arising from Treasury stock transactions)

Minority interest in consolidated subsidiaries

Retained earnings

Less: Treasury stock (the cost of stock issued by the institution and subsequently acquired, but that has not been retired or resold)

Goodwill (excess of cost of an acquisition over the net asset value of the identifiable assets and liabilities acquired)

Supplemental Capital

Limited-life preferred stock including related surplus

Reserve for loan and lease losses

Perpetual debt (unsecured debt not redeemable at the option of the holder prior to maturity, but which may participate in losses, and on which interest may be deferred)

Mandatory convertible securities (equity commitment and equity contract notes-subordinated debt instruments maturing in 12 years or less. Holders may not accelerate the payment of principal. Must be repaid with common or preferred stock or proceeds from the sale of such issues)

Subordinated debt (with an original maturity of not less than 5 years)

precise calculation of the ratios is not currently available. For example, some of the items including capital components are not currently reported by banking organizations and a breakdown of risk assets and off-balance sheet items is not currently available.

Table IV

ESTIMATED RISK-BASED CAPITAL POSITION BY SIZE GROUP FOR FIFTH DISTRICT BANK HOLDING COMPANIES

(Percent weighted average)

June 30, 1988

Asset Size	Primary Capital to Total Assets	Tier 1	Tier 1 plus Tier 2
Over $15 billion	7.5	7.0	9.5
$5-$15 billion	7.7	7.3	9.8
$1-$5 billion	8.5	10.2	12.0
$500 million-$1 billion	8.0	10.1	11.7

Further, data are not available to calculate the relative share of first mortgages on 1-4 family properties in the loan portfolio and there is not enough information to measure the percentage of loan commitments having original maturities exceeding one year. Likewise, a breakdown of standby letters of credit by use is unavailable. With these limitations in mind, the estimates show that all 35 of these organizations are currently **above** the 4 percent minimum guideline for Tier 1 capital and the 8 percent minimum standard for total capital required by the end of 1992.

Allowance for loan losses The RBC Standard defines general loan loss reserves as charges against earnings to absorb future losses on loans or leases. Such reserves are not set aside for specific assets. Under the RBC guidelines, the general reserve for loan losses is relegated to supplemental capital, but no limit is placed on the total general loan loss reserve. After 1990, however, the reserve is limited to 1.5 percent of weighted risk assets. After 1992 the reserve may not represent more than 1.25 percent of weighted risk assets.5 This represents a major departure from earlier U.S. capital guidelines in which the reserve for bad debts counted as primary capital.

When originally proposed, the limitation on the amount of eligible reserves seemed critical for U. S. banks, some of which had used the one-time provision in 1987 in connection with loans to less developed countries (LDCs) to build up reserves well in excess of the allowable RBC percentages. Based on June 30, 1988 data, seven of the 35 Fifth District companies included in the study would not be able to fully use their reserve for loan losses. All seven companies would, however, still be above the proposed final minimum total capital standard of 8 percent. Thus, it appears the limitation may only affect the large multinational companies,

Treatment of intangibles Intangible assets arise when the stock of a company is acquired for cash. In a cash transaction, accounting rules require that the assets of the acquired company be assigned a market value. In banking, a value is also assigned to core deposits (demand deposits and interest bearing deposits under $100,000) under the rationale that these deposits are valuable to the acquiring company. The values assigned to core deposits and balance sheet assets are denoted as identifiable intangibles. The amount paid for a bank in excess of revalued assets and identifiable intangibles is known as goodwill.

Goodwill must be deducted from capital in computing the risk-based capital ratio. Identifiable intangibles, however, may or may not require the same deduction. Different Federal bank regulators will treat these items in compliance with their respective proposed guidelines.

For bank holding companies, the Fed will exempt until December 31, 1992, any goodwill existing prior to March 12, 1988, after which time it must be deducted from capital. Any goodwill arising from an acquisition on or after March 12, 1988, will be deducted from capital immediately. An exception to this rule may be made for goodwill arising from the acquisition of a failed or problem bank. At the present time, the Fed does not plan to deduct automatically any other intangible assets from the capital of state member banks or bank holding companies. It will, however, continue to monitor the level and quality of intangibles, particularly where such intangibles exceed 25 percent of Tier 1 capital.

Term and subordinated debt Under current guidelines, banks are allowed to count subordinated debt with an original average maturity of seven years as secondary capital. Similarly, bank holding companies may include as secondary capital unsecured term and subordinated debt meeting the same criterion. Under the RBC standard, only subordinated debt instruments with an original average maturity of five years may be included as supplemental capital. While initially there is no limitation on the amount of such debt that may be included in Tier 2 capital, after 1992 a limitation applies; instruments includable in Tier 2 will then be limited to 50 percent of core capital. According to the RBC standard, all unsecured term debt issued by bank holding companies prior to March 12, 1988, and qualifying as secondary capital at the time of issuance, will be grandfathered and included in supplemental capital. Bank holding company term debt issued after that date must be subordinated to qualify as supplementary capital for the holding company.

By including subordinated debt in supplemental capital, the Fed recognizes that subordination does afford some protection for depositors in the event of failure. At the same time, subordinated debt of bank holding companies provides a cushion to senior creditors, and thus promotes stability in funding operations. The debt, however, is not permanent; it must be repaid and is therefore not available to absorb losses. In recognition of these factors the Fed established a five-year original maturity requirement as the minimum period necessary to provide stable funding. In addition, a five-step amortization schedule is used to discount subordinated debt and limited-life preferred stock as they approach maturity.

Application to All banks

The Federal banking regulators have agreed that the information necessary to calculate capital will be collected routinely from institutions with assets over $1 billion. Examiners will monitor the risk-based capital positions of smaller institutions during on-site examinations and inspections. Institutions with assets under $1 billion may be required to report limited information between examinations, but the plan is to hold such reporting requirements to a minimum.

Summary

The adoption of an international risk-based capital standard under the Basle accord reduces some of the deficiencies in measurement of capital adequacy that

[5] The Basle Committee on Banking Regulations and Supervisory Practices has agreed to attempt to resolve the question of what constitutes a general reserve for loan and lease losses. If an agreement can be reached, then general reserves would be included in Tier 2 without limit. Otherwise, the limitations noted above will apply.

have emerged in the 1980s. The new RBC standard represents a major step in establishing uniform capital standards for major international banks. The accord should contribute to a more stable international banking system and help reduce competitive inequalities among international banks stemming from differences in national supervisory requirements. The application of the RBC standard to large Fifth District banking organizations shows that these organizations exceed the minimum guidelines that will be required in 1992. Therefore, it does not appear that Fifth District banks organizations will be among those who will need to undertake special efforts to either raise more capital or shed assets to meet the new standard. In this regard, however, it should be noted that the standards are intended as minimums and that rapidly expanding organizations are expected to stay above the minimums. A number of Fifth District bank holding companies have grown rapidly in recent years and a continuation of this growth will necessitate the generation of new capital. The RBC standard does not, however, take account of all the risks to which banking organizations are exposed, specifically, risks associated with management, liquidity, funding, and asset quality. These risks will continue to be assessed by examiners and will be taken into account before a final supervisory assessment of an organization's capital is made. Further, the Federal Reserve is studying the feasibility of expanding the standard to address interest rate risk.