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INTEREST RATE CHANGES AND COMMERCIAL  
BANK REVENUES AND COSTS

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Abstract

This paper estimates statistical cost and revenue curves for a cross-section of banks in the years 1962-75. The primary data cover reported accounting or book rates of return. Approximations are also made to estimate economic or total returns. These approximations take into account changes in capital values during the year as a result of movements in interest rates measured by market yields of government securities of the proper duration.

Book rates of return and costs adjust towards each other so that marginal rates received or paid for different activities tend to equalize. On the other hand, the rates of adjustment are slow. While movements in the cost of demand and time deposits correlate well with changes in market rates, not all of the advantages of interest rate ceilings are given up to depositors.

Movements in interest rates cause sharp fluctuations in total returns. These movements are sharp enough so that in several years economic losses occurred rather than reported book profits. Furthermore, over this period the net economic returns of classes of assets were poorly correlated with their risks (their variance of returns).

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INTEREST RATE CHANGES AND  
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As part of an overall investigation of risk and capital adequacy in banks, we have examined the magnitudes by which interest rate movements may alter reported rates of costs and returns for a typical commercial bank. At the same time, we have attempted to measure the manner in which banks adjust their loans and costs over time in reaction to shifting markets and rates.

A critical analytical question in the study of financial markets is the degree and rapidity with which financial institutions react to new information and shift funds among asset and liability classes so as to equalize marginal costs and returns. Many analysts assume that markets are efficient, that transaction and information costs are negligible or unimportant, and that borrowing and lending, hedging and arbitrage are simple and available at or close to risk-free rates. As a result, they believe that they can successfully predict the results of all types of market actions and reactions without concern for institutional forces.

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On the other hand, large numbers of observers believe that the markets within which financial institutions operate are so far removed from these assumptions that different theories and analysis must be applied. This is particularly true with respect to competition, legal and institutional restrictions, and information and transaction costs.

Our results fall between the extreme views. Rates of returns and costs adjust towards each other as they should in a competitive market. On the other hand, the rates of adjustment are slow, particularly if we estimate total (in contrast to book) returns. Average book returns for classes of assets over the past 14 years are not too far apart, but this is not true for total returns. Furthermore, no indication exists that over this period the net returns of classes of assets were related to their risk (their variance of returns).

Since corrections for operating costs as well as defaults and losses are included, it does appear that institutions adjust rather readily to costs which they record on their books. The major exception to such adjustment is found in the low indicated return on non-home mortgages, particularly from 1973 to 1975. This would seem to be an obvious result of the general euphoria and speculation which characterized this sphere in the early 1970's.

While major problems arise in measuring year to year fluctuations in actual returns caused by shifting interest rates, such movements have been significant. In critical years such as 1969, 1973, and 1974, for example, the rate of return on earning assets for an average bank fell 100 to 500 basis points below that reported based on book values. Since net book returns (before taxes) as a percent of loans and investments for

an average bank were about 1.20 percent of assets in this period, in these years the typical bank probably ran a true deficit and up to 3.0 percent of assets. Such losses must be evaluated in light of a capital asset ratio of 9 percent which the average bank held during this period.

Since such losses tended to decrease or even reverse in the next year for a typical bank, they were not too critical. However, the same is not true for banks which varied far from the average in either their portfolio or in capital. The variation in net returns or losses among classes of assets in a year can be large. In the past, many institutions were in jeopardy from interest rate movements. In the future, for those with unbalanced portfolios or low capital, potential dangers would appear to be sizable.

#### The Basis of the Estimates

Our study is based upon estimated statistical cost and revenue curves for a cross-section of banks in the years 1962-75 (with the exception of 1969). These estimates are of net rates of income and costs based upon book values of assets. The rates are net of servicing, processing, overhead costs, etc. The rates are estimated in each year from the fact that each individual bank holds a somewhat different mix of assets and liabilities. When the differing assets and liabilities are regressed on actual costs and revenues, the regression coefficients estimate the effect on rates of return of placing a dollar in a particular class of assets or liabilities under the economic circumstances of the given year. Net rates are obtained by subtracting the costs for an

asset from its estimated gross revenues. The estimated cost and revenue curves are shown in Table 1.

These statistical cost and revenue curves for a cross-section of banks follow a technique used and explained in detail in studies by Hester and Zoellner (1966) and Hester and Pierce (1975). This study differs from theirs by using a national sample over a large number of years and in the methods of estimation.

The basic model used in estimation consists of two equations:

$$(1) \quad \frac{R_i}{A_i} = \frac{b_0}{A_i} + b_1 \frac{A_{1i}}{A_i} + \dots + b_k \frac{A_{ki}}{A_i} + \frac{e_i}{A_i}$$

$$(2) \quad \frac{C_i}{A_i} = \frac{c_0}{A_i} + c_1 \frac{A_{1i}}{A_i} + \dots + c_k \frac{A_{ki}}{A_i} + c_{k+1} \frac{L_1}{A_i} + \dots + c_{k+j} \frac{L_{ji}}{A_i} + \frac{u_i}{A_i}$$

The first equation shows the gross revenues ( $R_i$ ) from earning assets in a given year from a particular bank (i) related to the book value for each class (k) of assets ( $A_{ki}$ ) for that bank in that year. The second equation relates the operating expenses ( $C_i$ ), including actual net loan losses less income from deposit service charges, to the book value for categories of assets ( $A_{ki}$ ) and liabilities ( $L_{ji}$ ). The coefficients of the equations are estimates of the gross revenues and costs for each type of asset and liability. The difference between costs and revenues for an asset is its net return.

In each case, the variables on both sides have been divided through by the level of assets in the year to correct for the heteroskedastic nature of banks with their widely varying sizes. This correction means that with the exception of the first right-hand variable, which is

Table 1. Rates of book returns and costs of classes of assets and liabilities for a sample of commercial banks (in percent per year).

Class of asset or liability	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
<u>Securities</u>														
U.S. Treasuries and agencies	3.43	3.50	3.77	3.86	4.30	4.54	4.57		5.62	5.60	5.43	5.42	5.91	6.00
Federal funds and other securities	2.34	3.35	2.17	2.36	3.50	4.70	3.50		5.04	4.19	4.83	7.46	9.14	6.10
State and local securities	3.38	3.13	3.29	3.36	3.27	3.69	4.16		5.02	4.55	4.74	4.79	5.35	6.13
<u>Loans, net</u>														
1-4 family mortgages	3.89	4.00	3.98	4.08	4.55	4.61	4.77		5.43	5.70	5.49	5.20	5.66	5.57
Other mortgages	3.79	3.43	4.01	3.72	4.15	4.34	4.56		5.03	5.61	5.26	5.54	4.45	4.19
Com'l, ind'l, fin'l, farm, other loans	3.85	4.00	3.87	3.79	4.13	4.58	4.92		5.28	5.22	5.17	5.62	6.57	6.17
Consumer loans	3.23	3.76	4.09	4.06	4.56	4.85	5.44		4.66	5.30	5.42	5.84	6.00	5.73
<u>Liabilities</u>														
Demand deposits	1.45	1.53	1.61	1.52	1.73	2.01	2.21		2.37	2.72	2.73	2.84	3.24	3.93
Time & saving deposits	3.18	3.43	3.44	3.47	3.85	4.11	4.31		4.66	4.84	4.77	4.79	5.23	5.16
Purchased money, incl. federal funds									4.22	3.52	3.49	6.25	8.48	4.75
<u>Loans, gross</u>														
1-4 family mortgages	5.03	5.12	5.28	5.43	5.61	5.41	5.53		6.03	6.21	6.64	6.82	6.86	6.89
Other mortgages	6.94	6.24	6.56	6.50	6.41	6.85	6.88		7.29	8.32	8.04	8.83	9.46	9.21
Com'l, ind'l, fin'l, farm, other loans	5.63	5.86	6.02	6.01	6.29	6.52	6.98		8.44	7.57	7.15	8.56	10.60	8.90
Consumer loans	8.18	8.21	7.83	7.86	8.13	8.23	8.92		9.87	10.41	10.10	10.46	10.78	11.57
Rate on 3-month Treasury bills	2.77	3.16	3.54	3.95	4.86	4.29	5.34	6.68	6.39	4.33	4.07	7.03	7.84	5.80

Based on data from an FDIC 980 bank sample. Rates are the coefficients from a regression of loans and investments on revenues and liabilities on costs.

$1/A_i$ , all other variables are expressed as a percentage of total assets. A Goldfeldt-Quandt test (1965) for heteroskedasticity was employed and the assumption of homoskedasticity could not be rejected.

While OLSQ run separately on equations (1) and (2) would give unbiased estimates of the coefficients and standard errors, they would not be efficient. It is known that the error terms across equations for corresponding observations are likely to be correlated. Variables that influence bank behavior, but which are not included as independent variables and so show up in the error terms, are likely to be partly the same for both equations. This knowledge can be used and efficiency increased by taking account of the correlation across equations. This has been done by using Zellner's Seemingly Unrelated Equation Estimation (1962). The differences from OLSQ are rarely large, but they are significant.

#### The Data

The data used in this study come from the Federal Deposit Insurance Corporation's (FDIC) stratified sample of Reports of Condition and Income. This sample covers 978 identical banks for the period 1961-68 and a somewhat different group of 980 banks for 1969-75. It includes the end-of-the-year and mid-year call reports. There was a change in reporting between the 1968 and 1969 reports which has some influence on the choice of variables and causes the omission of much data from the analysis for 1969.



In 1975 the sample contains 186 banks with over \$500,000,000 in assets; 195 banks between \$200,000,000 and \$500,000,000; 196 between \$50,000,000 and \$200,000,000; 252 between \$10,000,000 and \$50,000,000; and 151 banks under \$10,000,000 in assets. The sample is approximating random within categories with some adjustments to insure continuity. Such a sample, it is well known, gives unbiased estimates.

The income data cover the entire year as reported in the annual Reports of Condition (calls), the asset data are weighted averages of the final and mid-year reports for the designated year and the final report for the previous year with weights of  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and  $\frac{1}{4}$ , respectively. Cash, bank balances, and items in process have been subtracted from reported demand deposits as an estimate of net demand deposits.

The data were run for the entire sample and for five sub-classes by size. Chow tests indicated that one could not reject the hypothesis that there were no significant differences in net revenues and costs among the different size groups. The results for the smallest size group is more erratic than for the others and also on the whole shows higher revenues and costs, but they still fall within the normal distribution for the entire sample.

Various problems are known to exist with the data which cause less than ideal results. Most important is the fact that the data report book income, costs, and asset values. These differ from economic variables because rates of return and the amount of assets are not corrected for changes in market values. Furthermore, economic periods of adjustment are unlikely to equal a year. Table 5 and the discussion of it show how rough corrections can be made to get actual economic returns and the considerable difference in analysis which results.

Because of window dressing, reported assets on call dates are known to be biased estimates of daily averages. The biases are small for most assets and liabilities, but they are significant for items such as federal funds. Miscellaneous assets or liabilities have been grouped together to decrease this problem, but biases almost certainly remain for these items. Total estimated rates of return and costs are perhaps 2 percent (about 5 to 10 basis points) less as a result of this problem.

Some sources of income and expense cannot be directly related to items on the balance sheet. This is true, for example, of income from fiduciary activities. To correct partially for such income and related costs, we have used as gross revenue the sum of all income reported for each type of earning asset. We have subtracted this amount from reported income to estimate that from other sources and have then subtracted this sum from both revenues and expenses. In effect, this assumes that banks break even on their miscellaneous activities and that costs and revenues for their loan and investment activities can be estimated with only minor biases from this correction. Since this gross correction is less than 7 percent of the total, any bias arising from a net difference between costs and revenues for these miscellaneous items is likely to be small.

A related problem arises in attempting to allocate investment expenses among classes of securities. From other sources we find that expenses for portfolio investments are less than one-tenth of one percent of the total. The difficulties of estimating the distribution of this small sum are great enough so that we exclude the costs of managing the

securities' portfolio from our estimations, even though this means that net revenues from securities are over-estimated by 3 to 10 basis points. This may approximately offset the opposite bias from use of call dates, but there will be small variations from year to year.

The most important difference between the data for 1962-68 and 1970-75 is in the treatment of sales and purchases of federal funds. In the earlier period, such sales are included in commercial and other loans while in the later period they are included in federal funds and other securities owned. This is done to follow bank reporting which included sales of federal funds as part of loans to financial institutions in the earlier period, but reported them separately in the later period. Purchases of federal funds in the earlier period were included in other liabilities. This causes a major difference in estimates of purchased money for the earlier period and for this reason the results are not shown. Other minor definitional changes also occurred in 1969, but their impact is believed to be slight.

### Results

Tables 1, 2, and 3 report the results of the statistical analysis of book returns. Table 1 shows the net and gross revenues for seven classes of assets, three classes of liabilities, and the market rates on three-month Treasury bills, by year. Table 2 shows the means and standard deviations for each asset, both for the entire period and for the two sub-periods. There was a major shift in the level of rates between the two periods. Thus, even though they cover a shorter period,

Table 2. Average rates of book returns and costs for classes of assets and liabilities.

Class of asset or liability	1962-1968		1970-1975		1962-1975*	
	Mean	S.D.**	Mean	S.D.	Mean	S.D.
<u>Securities</u>						
U.S. Treasuries and agencies	4.00	.475	5.67	.243	4.77	.941
Federal funds and other securities	3.13	.906	6.13	1.869	4.51	2.069
State and local securities	3.47	.349	5.10	.573	4.22	.955
<u>Loans, net</u>						
1-4 family mortgages	4.28	.350	5.51	.179	4.85	.701
Other mortgages	4.00	.390	5.01	.587	4.47	.705
Com'l, ind'l, fin'l, farm, other loans	4.16	.428	5.67	.577	4.86	.918
Consumer loans	4.29	.731	5.49	.486	4.84	.870
<u>Liabilities</u>						
Demand deposits	-1.72	.284	-2.98	.547	-2.30	.765
Time & saving deposits	-3.68	.414	-4.92	.231	-4.25	.727
Purchased money, incl. federal funds			-5.12	1.935		
<u>Loans, gross</u>						
1-4 family mortgages	5.34	.212	6.58	.366	5.91	.697
Other mortgages	6.62	.267	8.53	.802	7.50	1.130
Com'l, ind'l, fin'l, farm, other loans	6.18	.452	8.54	1.202	7.27	1.481
Consumer loans	8.19	.360	10.53	.601	9.27	1.298
Rate on 3-month Treasury bills	3.99	.917	5.91	1.490	4.88	1.530

\*1969 was not included in the calculations.

\*\*Standard deviation.

Table 3. Correlation between book rates of returns on U.S. securities (governments and agencies) and other assets and liabilities.

Class of asset or liability	Actual			First Differences	
	1962-68	1970-75	1962-75*	1963-68	1971-75
<u>Securities</u>					
U.S. Treasuries and agencies	1.00	1.00	1.00	1.00	1.00
Federal funds and other securities	.71	.40	.81	.34	.16
State and local securities	.73	.87	.94	-.19	.50
<u>Loans, net</u>					
1-4 family mortgages	.97	.59	.98	.53	.75
Other mortgages	.90	-.91	.73	.67	-.70
Com'l, ind'l, fin'l, farm, other loans	.84	.81	.94	.18	.70
Consumer loans	.95	.32	.88	.07	-.20
<u>Liabilities</u>					
Demand deposits	-.91	-.79	-.93	-.39	-.49
Time and saving deposits	-.97	-.86	-.97	-.41	-.83
Purchased money, incl. federal funds		-.41			-.29
<u>Loans, gross</u>					
1-4 family mortgages	.85	.34	.93	-.03	-.75
Other mortgages	.33	.58	.87	.35	.26
Com'l, ind'l, fin'l, farm, other loans	.93	.70	.89	-.05	.56
Consumer loans	.53	.78	.94	.27	.34
Rate on 3-month Treasury bills	.92	.37	.78	-.06	.15

\*1969 was not included in the calculations.

the data for 1970-75 appear of greater interest and more relevant at the present.

Table 3 shows the correlations between the returns on U.S. securities and the various other rates both for the entire period and for the two sub-periods.

Several facts stand out from the tables. (It should be recalled that all results in these tables are for book income.)

1. While net returns to a class of assets differ considerably from year to year, they are fairly close together when a number of years are averaged together.
2. These convergences in net returns occur despite wide divergences in gross returns. The higher gross payments reflect higher costs. This is particularly true for consumer loans and non-home mortgages.
3. Some classes of assets with high risks (for example, non-home mortgages) have among the lowest returns. Decisions are based on expectations which can turn out to be very wrong.
4. Except for federal funds and other securities, there is no obvious relationship between book rates of return and the standard deviation or variance of these returns.
5. The correlation among the assets and liabilities and even their year to year changes tend to be high. There are two major exceptions. Again, non-home mortgages stand out. It has an inverse correlation in recent years. But recently movements of returns on consumer loans also have not moved with the others.

6. In the recent period, the year to year movements of rates on three-month Treasury bills have been far more volatile and have not been well correlated with movements of other rates. Part of this difference occurs because the other returns are reported on a book rather than market basis. These book data tend to even out some of the year-to-year fluctuations in actual returns. This averaging process does not affect the return on the short-term Treasury bills.

7. In recent years, the rate of return on Treasury bills has been higher than on any class of assets except for the closely related returns on federal funds. These first three tables show this comparison on a book basis, but as we shall see, this fact is even clearer when corrections are made for changes in market prices.

8. While movements in the costs of demand and time deposits correlate well with changes in market rates, the effect of regulation Q in holding these costs down is evident. Not all of the advantages of Q to banks are given up to depositors or borrowers.

The average rate of return for the entire period for holdings of U.S. government securities, for all loans, and for Treasury bills are surprisingly close. While significant differences occur on a year-to-year basis, they average out.

The sharpest year-to-year movements occur in the cost and revenues for federal funds and other securities, and in the cost of borrowed money which in the later period is dominated by purchases of federal funds (certificates of deposit are included in time and saving deposits). These returns move with changes in short-term treasuries. Superficially it would appear that in recent years lending federal funds is the most profitable activity for a bank. This may well be true, but unfortunately

these numbers have considerable bias since the asset numbers are heavily influenced by window-dressing on call dates.

Among the other assets, the main divergence is for the returns on non-residential mortgages. This class of loans shows low returns, particularly in the last two years of the period. As noted, this reflects the fact that investment decisions are based on expectations which can be heavily influenced by market sentiments and which can turn out to be very wrong. Banks as a group were carried away by the real estate investment boom. Such errors with a lag led to the low returns of 1974-75 as losses, caused by the prior over-enthusiastic lending, had to be charged off.

The lower reported return for state and local securities is expected, the only unusual feature being the high returns in 1975. Such very high returns are shown in the reports of individual banks. They appear to be related to the special trades and restructuring of New York City's debt which occurred in that year.

Costs of money move with interest rates. This is particularly true for purchased money, but market rates also influence the costs of time and saving deposits. Regulation Q was completely removed for large certificates of deposit in 1973 and did not apply to most large certificates after mid-1970. Of course, during the earlier period, the ceilings were at times above market rates.

On the other hand, regulation Q apparently does hold the costs for demand deposits through services granted well below amounts paid for other funds. It is not true that costs adjust so that demand deposits have the same marginal costs as other funds. Whether because the ceiling



acts as a form of price leadership or because of other oligopolistic features, banks do not compete away completely the advantages they gain from interest rate ceilings.

An examination of asset returns also makes it appear that the advantages gained through Q are not given up in the form of lower returns on loans to particular classes of borrowers. There is no evident difference between the net rates earned on separate classes of loans. Net income earned from customers who would be expected to hold large balances do not differ greatly from rates charged those who walk in to borrow over the counter. Banks as a whole appear to be competitive in their loan terms even if not in payments on demand deposits.

On the other hand, a relationship exists between the general level of rates on loans and the fact that banks need to attract deposits. Loan rates as measured in these tables do not appear to compensate fully for their additional risk of possible losses in comparison to the rate of return on Treasury securities. If they could have obtained the same amounts of funds without having to be in the loan business, banks would have earned more money with less risk by investing primarily in government securities. As noted shortly, however, these differences in returns may also reflect the fact that during the entire period lenders and investors were poor forecasters. The anticipated rates of return may have been in accordance with expected risks and returns. Because of large unanticipated movements, the ex post relationships probably do not reflect those held by lenders at the time decisions to lend were made.

Over this period, despite the fact that loans earned less particularly in comparison with risks, banks continually increased the

percent of their loans and decreased the share of government securities in their assets. U.S. government and agency securities fell from over 25 percent of the total in 1961 to about 13.5 percent by 1975. Loans rose from 45 to 52.5 percent of the total. Whether this shift occurred because there is a significant interrelationship between types of assets and liabilities, or simply because rates of return differed from expectations, is not clear. Most bankers assume that if they made fewer loans they would attract fewer depositors.

#### Total Returns

The returns discussed thus far are accounting or book returns as reflected in reported balance sheets and income statements. For many purposes, however, we would like to know what happened from year to year in actual or total or market-corrected returns. The return on an asset may be positive or negative. It equals the sum of an interest component, plus any change in the present value of future cash flows due either to a shift in market interest rates or in the observed probability of default.

For an asset traded in an active market such as a listed common stock or bond, the measurement of actual return is simple. To the dividend or coupon payments received during the year, we add or subtract changes in the market price to get the total return to the asset. If we were able to get the change in market values during the year for each of a bank's assets or class of assets we would be able to estimate total returns in this same manner. Unfortunately, we cannot. Therefore,

in order to obtain some idea of how risks and returns have varied, we must construct rough approximations of such numbers.

What we have done is to assume that the market value of each class of assets changes in accordance with the average "duration" of the class multiplied by the change in market yields of government securities of the same approximate duration. These estimates follow from the known general relationship that the change in price of a bond or loan is equal to the change in expected market interest rates for similar bonds times the negative of its duration, or:

$$(3) \quad \frac{d \text{ Price}}{\text{Price}} = \frac{d(1+r)}{(1+r)} \cdot -\text{Duration},$$

where  $r$  is the rate of interest or yield to maturity (Boquist et al., 1975). A bond or loan's duration is simply the time until its payments will on average have been received. Thus duration is the average of the present value of each future interest or principal payment times the length of the period until it will be received.

There are well recognized difficulties with this formulation. No allowances are made for variations in uncertainty or the risk related to the specific asset class. No adjustments are made for changes in the term structure of interest rates. We have not taken into account the fact that some changes in value may have been taken into the books during the year through the sale or purchase of assets. We have not accounted for changes other than interest rates.

While recognizing that all of these factors can affect the value of an asset, we have been forced to work primarily with those changes which result from movements in the basic interest rate. However, it

should be noted that changes in defaults and related costs are already reflected in the estimated book returns for the year. Moreover, a number of simulations of the total impact of changes in market values indicates that movements in the interest rate on governments usually account for most value changes.

As important as these other factors is the lack of exact estimates of the duration of the typical bank's assets. Duration has been estimated in a rough manner from the balance sheets of several banks. The most that can be claimed is that these estimates probably are in the proper rank order and that the magnitudes are in the right ball park. To avoid any sense of undue accuracy, we have rounded the estimated durations to full years. By happenstance, this results in the duration for assets of different types being roughly spaced from one to six years. The assigned duration in years are as follows: Consumer Loans (1); Commercial and Industrial (2); U.S. Government and Agencies (3); Non-home Mortgages (4); Home Mortgages (5); and State and Local Bonds (6). It is also assumed that rates of return and costs of Federal Funds, other securities, and purchased money equal the market rates on Federal Funds and that the duration for these categories is insignificant.

Changes in interest rates are measured from the end of the year prior to that for which the rates of return have been estimated to the end of the year covered by the income data. In each case, the rate for the particular yield to maturity is taken from yield curves estimated for the last business day of the year by McCulloch's cubic-spline term structure curve-fitting program for U.S. treasuries (McCulloch, 1975).

Table 4 shows the estimated changes in capital values for each class of asset. This is in accordance with Equation (3). The percent change in the yield to maturity at the assumed duration for the class of assets is multiplied by the duration of that class.

Table 5 is the result of combining the estimated book rates of return in Table 1 with the year-to-year changes in capital values of Table 4. Thus it is an estimate of the total return to a class of assets by year. As noted, these may differ from actual changes in values, since the durations may not be accurate, since the specific risks of the different classes may have altered, and since changes in the assets held during the year may have meant that some of the reported book returns reflected changes in the assets.

In contrast to the tendency of book rates of return for classes of assets to adjust towards each other under competitive pressures, there is a much greater dispersion among the actual returns on assets. Movements in current yields are not sufficient to offset the losses or gains which result from the effect of interest rate movements on assets with longer durations.

More significantly it appears that over the entire period the assets with the largest risks and variances have had the smallest rather than the highest returns. This was a period dominated by unexpected increases in both long- and short-term interest rates. With only a few exceptions, rates at every maturity rose each year from 1963 through 1969. From that year through 1975, increases were less universal and were decidedly smaller, but yields on all maturities of three years and over were higher in December 1975 than in December 1969.

Table 4. Changes in capital values by class of assets for banks, by years (in percent per year).

Class of asset or liability	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
<u>Securities</u>														
U.S. Treasuries and agencies	.75	-1.62	-.84	-1.11	-3.12	-.24	-.03	-5.76	5.19	1.02	-1.77	-2.54	-1.94	-.22
Federal funds and other securities	0	0	0	0	0	0	0	0	0	0	0	0	0	0
State and local securities	.98	-2.27	-.69	-2.36	-4.36	-2.90	-.34	-8.45	5.42	1.62	-.68	-3.39	-5.11	-2.34
<u>Loans, net</u>														
1-4 family mortgages	1.10	-1.93	-.72	-1.97	-3.78	-2.28	-.48	-7.85	5.73	1.18	-.76	-3.3	-4.08	-1.81
Other mortgages	.92	-1.84	-.80	-1.56	-3.52	-1.16	-.32	-6.73	5.72	1.16	-1.48	-3.00	-2.96	-1.04
Com'l, ind'l, fin'l, farm, other loans	.35	-1.24	-.70	-.72	-2.10	-.06	-.16	-3.52	4.46	.56	-1.06	-2.12	-1.02	.37
Consumer loans	-.02	-.69	-.40	-.31	-.97	-.27	-.05	-1.94	2.48	.41	-.65	1.96	.05	1.04

Table 5. Rates of total returns for classes of assets for a sample of commercial banks (in percent per year).

Class of asset or liability	1962	1963	1964	1965	1966	1967	1968	1969*	1970	1971	1972	1973	1974	1975																																																	
<u>Securities</u>																																																															
U.S. Treasuries and agencies	4.18	1.88	2.93	2.75	1.18	4.30	4.54	-0.66*	10.81	6.62	3.67	2.90	4.00	5.78																																																	
Federal funds and other securities	2.34	3.35	2.17	2.36	3.50	4.70	3.50	4.27*	5.04	4.19	4.83	7.46	9.14	6.10																																																	
State and local securities	4.36	.87	2.60	1.00	-1.09	.79	4.50	-3.85*	10.45	6.20	4.07	1.40	.25	3.79																																																	
<u>Loans, net</u>																																																															
1-4 family mortgages	4.90	2.17	3.26	2.11	.78	2.33	5.25	-2.75*	11.17	6.87	4.73	1.90	1.59	3.76																																																	
Other mortgages	2.87	1.59	3.21	2.16	.63	3.18	4.89	-1.94*	10.76	6.78	3.77	2.54	1.48	3.14																																																	
Com'l, ind'l, fin'l, farm, other loans	3.51	2.76	3.17	3.07	2.03	4.52	4.79	-1.58*	9.68	5.77	4.10	3.51	5.85	6.53																																																	
Consumer loans	3.21	3.07	3.70	3.75	3.59	4.58	5.39	3.11*	7.13	5.71	4.76	3.88	5.94	6.78																																																	
Total portfolio of assets & liabilities	2.44	0.21	1.10	0.76	-0.34	1.04	2.17	-2.97*	6.30	2.44	0.49	-0.12	-0.31	1.13																																																	
Rate on 3-month Treasury bills	2.77	3.16	3.54	3.95	4.86	4.29	5.34	6.68	6.39	4.33	4.07	7.03	7.84	5.80																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Means</th> <th colspan="2">Standard deviations</th> </tr> <tr> <th>1962-75</th> <th>1970-75</th> <th>1962-75</th> <th>1962-75</th> </tr> </thead> <tbody> <tr> <td>U.S. Treasuries and agencies</td> <td>3.96</td> <td>5.13</td> <td></td> <td>2.63</td> </tr> <tr> <td>Federal funds and other securities</td> <td>4.51</td> <td>6.13</td> <td></td> <td>1.99</td> </tr> <tr> <td>State and local securities</td> <td>2.52</td> <td>4.68</td> <td></td> <td>3.46</td> </tr> <tr> <td>1-4 family mortgages</td> <td>3.46</td> <td>5.00</td> <td></td> <td>3.16</td> </tr> <tr> <td>Other mortgages</td> <td>3.22</td> <td>4.74</td> <td></td> <td>2.95</td> </tr> <tr> <td>Com'l, ind'l, fin'l, farm, other loans</td> <td>4.12</td> <td>5.91</td> <td></td> <td>2.55</td> </tr> <tr> <td>Consumer loans</td> <td>4.61</td> <td>5.70</td> <td></td> <td>1.37</td> </tr> <tr> <td>Rate on 3-month Treasury bills</td> <td>5.00</td> <td>5.91</td> <td></td> <td>1.55</td> </tr> </tbody> </table>																Means		Standard deviations		1962-75	1970-75	1962-75	1962-75	U.S. Treasuries and agencies	3.96	5.13		2.63	Federal funds and other securities	4.51	6.13		1.99	State and local securities	2.52	4.68		3.46	1-4 family mortgages	3.46	5.00		3.16	Other mortgages	3.22	4.74		2.95	Com'l, ind'l, fin'l, farm, other loans	4.12	5.91		2.55	Consumer loans	4.61	5.70		1.37	Rate on 3-month Treasury bills	5.00	5.91		1.55
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\*There are no data for book returns in 1969. The estimates are the average of 1968 and 1970 book returns plus the estimated change in capital values for 1969.

For the entire period, total returns were negatively correlated with an asset's duration. The rates of return on consumer loans, federal funds, and on three-month bills, were the highest, and on municipals the lowest (although perhaps not on an after-tax basis). Since the end of 1969, however, with smaller increases in market interest rates the correlation is not as exact. In a period not as heavily dominated by interest rate movements, other factors become more important. The table indicates that total net returns for commercial and industrial loans since 1969 have equaled those on T-bills. The after-tax return on municipals might well be the highest of all even though their duration is the longest. The return on house mortgages again exceeded that of the shorter-term other real estate loans.



Portfolio Losses

The risk of any bank losing all of its capital and having a negative net worth depends upon both the amount of its initial capital and on the risks it assumes by its selection of assets and liabilities. We can divide the risks into two parts for analysis.

The first is called the "wealth effect." This is the change in the value of the portfolio caused by changes in the rate of discount applied to the initial expected cash flows from both assets and liabilities. Thus at the end of one year, the value of assets and liabilities and of the bank depends upon the projected cash flows (based upon loan agreements, expected defaults, expected processing costs, etc.) and the discount rates applicable to these future cash flows. During the course of the year, these rates of discount will change as a result of movements in spot interest rates, in forward rates, and the risk premia for each class of assets and liabilities. Thus the wealth effect depends upon the distribution of assets in the initial portfolio and the way each one's rate of discount alters.

The "income effect" on the portfolio's values results from changes in the expected cash flows. These are influenced by movements in the macroeconomy. During the course of the year, cash flows will differ from those expected at the start because market interest rates will apply to new or refinanced loans or investments, because cost of operations will alter, default rates and non-accruing loans may increase, and the amount of effort required to collect on loans may differ, and because liquidity problems may lead to transaction costs to liquidate part of the portfolio.

In addition, future cash flows will alter because the amounts of each type of asset and liability in the portfolio may differ. The rate of expansion or decline in holdings of the portfolio will react to movements in interest rates, in the money supply, in the gross national product, and to competitive pressures. How banks react to these movements will differ depending upon such factors as the bank's type of customers, its region, past commitments, and the way in which different categories of assets and liabilities react to the economy.

Our study gives rough estimates of these two influences on banks with different weights of assets and liabilities. Our estimates are inexact because in Table 4 we have not included estimates of shifts in risk premia or of those within the term structure, but instead have used the concept of duration and yield to maturity.

As examples of wealth effects for an average bank, the losses in capital values as a percent of its total earning assets were 4.8 percent in 1969, 2.4 percent in 1973, and 1.9 percent in 1974. These are the weighted average of typical portfolios in those years times the rate of loss shown in Table 4. These losses would have been increased to the extent risk premia widened and decreased to the extent that the value of existing deposits rose. However, Table 1 shows that the cost of deposits rose at about the same rate as the value of money during this period. As a result, since deposits had but a slight impact, we can estimate that in these years the net wealth effect reduced capital values somewhat more than would be estimated from the impact of government interest rates alone.

In contrast to wealth effects, those from changes in income effects on the capital of the average bank seem to be small. However, again our data are incomplete. We do not have estimates of shifts in duration from operations, and as noted earlier, because of changes in the reporting forms we lack information on changes in book income in 1969. What we do have are estimates of changes in value arising from alterations in the mix of assets and liabilities and from movements in book earnings for the other years.

The income effects on a bank's capital value turn out to be rather minor because of offsetting pressures. Earnings on newly purchased rolled-over loans and investments rise, as do costs of liabilities. The chief danger to a bank is likely to be from a need to borrow at much higher rates while the return on assets is moving up more slowly. For the average bank, this problem was not great. Its costs for demand time and savings deposits rose at roughly the same rate as returns on assets. The costs of purchased money rose rapidly and their share of total liabilities rose also, but an average bank does not have a large ratio of these liabilities. As a result, average net earnings on assets fell from 1.07 percent in 1972 to 1.04 percent in 1973, and then rose to 1.18 percent in 1974.

The income and wealth effects have been combined for an archetypical bank. The line in Table 5 labeled "Total portfolio of assets and liabilities" is an estimate of how a bank holding a portfolio of average duration and average composition would have fared in this period. The portfolio estimate combines information from Tables 1 and 5 using mean weights from banks' distribution of assets and liabilities.

In contrast to reported book year-to-year earning movements of about five basis points, the table indicates that the economic return on net earning assets fluctuated widely. Although exact data are not available for 1969, the shift in returns from 1969 to 1970 was probably over 9 percent. This shift reflects the fact that the three-month Treasury bill rate was 5.92 percent in December 1968, 7.72 percent in December 1969, and 4.86 percent in December 1970.

While not extreme for the average bank, losses would rise rapidly if a bank maintained a portfolio with far above average duration. Furthermore, it should be noted that the shift in returns for an average bank from interest rate risks far exceeded variations in defaults or loan losses for even those banks at the high end of the loan loss distribution.

## REFERENCES

- Boquist, J. A., G. A. Racette, and G. G. Schlarbaum, "Duration and Risk Assessment for Bonds and Common Stocks," Journal of Finance, Vol. XXX, No. 5 (December 1975), pp. 1360-1365.
- Goldfeld, S., and R. Quandt, "Some Tests for Homoscedasticity," Journal of the American Statistical Association, Vol. 60 (1965), pp. 539-554.
- Hester, D., and J. Pierce, Bank Management and Portfolio Behavior (New Haven: Yale University Press, 1975).
- Hester, D., and J. Zoellner, "The Relationship between Bank Portfolios and Earnings: An Econometric Analysis," Review of Economics and Statistics (November 1966), pp. 372-386.
- McCulloch, J. Huston, "The Tax-Adjusted Yield Curve," The Journal of Finance, Vol. XXX, No. 3 (June 1975), pp. 811-830.
- Zellner, A., "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," Journal of the American Statistical Association, Vol. 5 (1962), pp. 348-368.

## APPENDIX

We need to differentiate among four separate approaches to estimating costs and revenues of banks.

1. As noted, this study is based upon statistical cost and revenue curves. Differing amounts of assets and liabilities for each unit in the cross-section are regressed on its reported costs and revenues. The regression coefficients estimate the effect on returns of placing a dollar in one class rather than in another.

Thus the estimated rates of return are closely related to marginal revenue and costs with the estimated variations in returns depending upon differences among classes. This technique specifically accounts for the interrelationship among the banks' assets and liabilities. The influences of all assets and liabilities are considered simultaneously. One estimates the effect on revenues of placing funds in loans rather than investments in securities while simultaneously considering the effect of such differences on costs. Overhead and partially variable costs are distributed among assets and liabilities in accordance with the way in which they cause costs and revenues for classes of assets and liabilities to vary among banks rather than in an arbitrary manner.

2. Closely related to this study are the operating data reported by the FDIC and the Federal Reserve in their annual Bank Operating Statistics. Reported data in those publications are unweighted averages of individual banks. This gives a decided bias because most banks are small while most assets are held by large banks. The sample we used is weighted more heavily to banks with more deposits, but it results in unbiased coefficients. The

Fed-FDIC studies show average costs and revenues for aggregated assets, for specific types of costs, and for gross and net income before and after various types of adjustments. They do not show the interrelationship of costs and revenues. They do not show the net returns for loans or categories of loans. They do not estimate the cost of demand deposits. On the whole, estimates for the few comparable series in this study and Bank Operating Statistics are in general agreement. In 1975, however, this study shows a higher return on municipals and lower costs for time and saving deposits. The reason is unclear, but may be related to the special impact of New York City bonds.

3. Similar types of data to that of the Fed-FDIC but with more complete breakdowns, are found in the annual reports of larger banks. These are the kinds of data used by stock analysts and those in the market concerned with rating the safety of individual banks. Analysis of annual reports tends to emphasize net interest earned or the relationships between rates of interest earned on assets (including the effect of volume and rate changes) and the costs of money available for lending. Payments of interest are estimated for time and saving deposits and for other purchased money. Net interest earned is then compared with the non-interest costs of operating the banks.

4. An entirely different approach is followed by the studies of "Functional Cost Analysis" performed by and for Federal Reserve member banks. This approach uses especially prepared detailed cost accounting information. Banks in a sample period report information about personnel and other types of costs assigned to specific functions such as check clearing, account maintenance, lending, etc. The specific cost functions for four types of loans, for investments, and for types of deposits are

estimated. Overhead costs are allocated to each. Gross yields and expenses are then estimated.

To obtain net revenues by class of assets, the FCA studies subtract the average cost of funds from the gross revenue after expenses for a specific class of assets. Similarly, gross revenues after specific expenses are calculated for the entire portfolio and the average income is credited to each class of liability to get an estimate of net earnings by type of liability and asset.

The basic differences between the cost and revenue data in this study in contrast to the others is that the allocations of revenues and costs depend upon the total relationships among classes of assets and liabilities. The estimates are made statistically by regression so that a best estimate is obtained as to how costs and revenues vary in accordance with the manner in which sums earned and spent relate to differing distribution of assets and liabilities among the 980 banks in the sample. In almost all cases (the exceptions being noted by asterisks in Table 1), the resulting estimated coefficients are highly significant (at a 99 percent level).