THE USE OF A SIMULATION MODEL IN THE PLANNING AND EVALUATION OF COMMERCIAL BANK OPERATIONS

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ABSTRACT

The objective of this study was to develop m simulation model of a commercial bank's operations. The model will be designed to accomplish the following:

1. develop a yearly forecast of net income for m period of 1 to 4 years with consideration of liquidity requirements, capital adequacy, and operations management;

2. calculate m total forecasted net income over the 4 year horizon period;

3. generate a record of the results by way of a balance sheet, an income statement, and m supporting report of the intermediate accumulated net income figures for each trial.

This research effort establishes two hypotheses. First a model which simulates m commercial bank's operations can be constructed, run, and evaluated against operating management strategies. Second, the derived benefit of such a modeling process will provide comprehensive insight into the relationship of the balance sheet, the income statement, and various operating decision variables.

INTRODUCTION

Commercial banking is currently experiencing one of the most challenging eras in its history. An expanding economy, a growing population, improvements in transportation and communication, and integration of business into large national corporations have demanded that the banking system provide new and improved banking services. Many banking services common today, from drive-in tellers to account reconciliation, were unheard of forty years ago. While the extension of credit remains a basic banking service, the forms midvarieties of loan arrangements have greatly multiplied. To serve a dynamic economy, the banking system must remain flexible and must find resources, primarily of management and organization, to meet even more challenging demands in the future.

Competition is a major challenge facing bankers. The commercial banking system competes with other financial institutions to provide banking and financial services. Many banking forecasters believe that banking will become increasingly a funds-gathering business, with particular emphasis on the consumer market. [1] Good loans will be easy to make in the face of m strong and rising demand for credit and a limited growth in the supply of money. Although the demand for credit is rising, bank management must strive to balance desired rates of return against anticipated levels of risk, which is difficult to achieve because of the uncertainties of future interest rates.

The predicament facing bank management is one of forecasting the future and making plans and policies that consider future expectations ms well as current conditions.

Those plans and policies focus on the following:

1. asset quality,
2. liquidity,
3. capital adequacy, and
4. operations management.

Asset quality normally refers to the degree of risk associated with a specific volume of financial assets. Sufficient liquidity must be preserved to take advantage of expansion opportunities as they might develop. Capital adequacy is influenced by the prevailing and expected economic conditions of the entire economy and of the local area served by the bank, by the quality and liquidity of the bank's assets, and by the quality of bank management. Efficiency of operations management is required in the achievement of profit objectives. This requires specific programs in the management of staff, variable expenses associated with changes in the volume of business transacted, and the fixed costs of providing the space and equipment required for bank operations.

PROFIT PLANNING

Profit plans are derived from forecasts of the volume of the bank's assets and liabilities. When volume and activity have been projected, they can be combined with other managerial projections to form an estimate of expenses and revenues to forecast earnings before and after taxes. For many years commercial banking has been primarily m funds-using business. The major focus of bank policy has been on asset management and how to lend or invest m surplus of deposits. The allocation of funds to various asset categories must provide adequate liquidity, serve the credit needs of the bank's customers, and maximize the income from its investment.

Prof it planning requires analyzing the objectives of asset quality, liquidity, capital adequacy and operations management policies and developing a strategy coordinated to achieve an expected rate of return. In some institutions, the profit planning function is accomplished through an executive management committee composed of senior bank officers. Committee members contribute by drawing upon professional experiences and observations of the current and expected economic environment as well as historical data. The complex inter-relationships concerning commercial banks precludes detail consideration of a substantial number of alternative strategies. However, the planning method may be supplemented with simulation modeling.

SIMULATION MODELING

Simulation modeling offers bank management a timely technique which they may use to evaluate alternative policies and plans of action in striving for a consistent mix of asset quality, liquidity, capital adequacy, operations management, and lastly, earnings. It is important to note that simulation models neither create plans nor make decisions; they do, however, provide structured information to aid these processes. Manage-

ment must have a means for reducing the time required to react to change, to take longer looks into the future, and to evaluate alternatives with a full knowledge of pertinent factors. When it becomes necessary to accelerate activities to meet planned objectives, the need for structured information increases. Simulation models provide answers in a short period of time and at a relatively low cost. For instance, bank operations are not interrupted and results can be obtained in a shorter time than if facilities or procedures had to be installed or tested. in addition, once the model is operational, little manpower is required to obtain a projection, thus encouraging bank management to experiment, at will, with various operating, investment and lending alternatives.

DESCRIPTION OF THE SIMULATION MODEL

The underlying concept used in the construction of this simulation model is that a commercial bank is a buyer and seller of funds. The spread between the cost of funds purchased and revenue from funds sold represents the bank's profit. This relationship is illustrated in Figure 1. This model makes the assumption that the cost of funds can be projected but that the forces controlling those costs are unchangeable. Since in reality the cost of funds are capable of being influenced through the interest rate being offered, this assumption limits the model in addressing the funds-gathering problem. However, by intelligent allocation of available funds, the model is programmed to achieve superior profits than would be realized through m random allocation process.

FIGURE 1

RELATIONSHIP OF SOURCES AND USES OF FUNDS
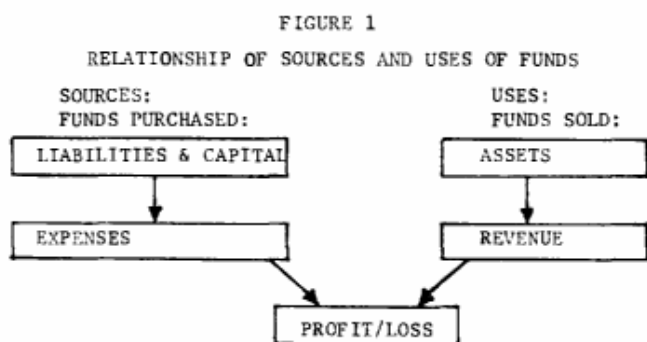
One objective of this planning model is to provide m means of analyzing simulated alternative profit potentials based on given sets of data with a 1 to 4 year planning horizon. Another objective of the model is to provide bank management various versions of their balance sheet and income statement which result from the model's allocation of funds subject to legal, managerial philosophy, and earnings constraints. Accomplishing these objectives supplies bank management with a useful tool in planning and anticipating future profit potential. The model allows bank management to play the "what If" game with asset and liability variables ms well as with the rates of demand and growth of assets and liabilities.

Decision Variables

The BANKSLM model is a translation of m commercial bank's operations into formulas and sets of logical instructions. BANKSIM's users are provided with the capability to specify and alter data and decision variables that are used in those formulas and instructions. The distinction between data and decision variables is that data refers to projected numbers of accounts, forecasted dollar volumes, and interest rates which are stochastically selected during the simulation process, while

decision variables refer to discrete values in formulas and discrete measures used in evaluating the allocation of funds. Being able to alter decision variables enables the user to artificially construct different operating environments and consequently evaluate many different management practices. Twenty different decision variables have been included in the model. These 20 decision variables are divided into eight decision categories: (1) income statement, (2) reserve requirement, (3) liquidity, (4) capital adequacy, (5) total loans, (6) variable assets, (7) Federal funds, and (8) total deposits. An explanation of each of the 20 variables is listed in Table 1.

TABLE 1

DECISION VARIABLES

Income Statement Variables.
Estimated maximum number of demand deposit accounts that can be serviced by one employee. Estimated maximum number of demand deposit and time deposit that can be serviced by one employee. Estimated maximum number of demand deposit, time deposit, and loan accounts that can be serviced by one employee.
Percentage that salaries are of total variable employee expense.

Reserve Requirement Variables.
Percentage that uncollected demand deposit amount is of total demand deposits.
Percentage of total demand deposits less float and Due-From-Banks balances needed to satisfy Federal Reserve requirements.
Percentage of savings, savings certificates, and consumer certificates necessary to satisfy Federal Reserve requirements.
Percentage of certificates of deposit required to satisfy Federal Reserve requirements.

Liquidity Variable.
Required ratio of two liquidity measures defined by $LIQUIDITY_1$ and $LIQUIDITY$,

Capital Adequacy Variables.
Percentage of total assets less cash and other investments that is required to satisfy the minimum capital requirement. Percentage of total assets that is required to satisfy the total asset component of the minimum capital requirement.
Percentage of total assets less certain liquid ms- sets required to satisfy the second component of the minimum capital requirement.
Percentage of total loans required to satisfy the minimum capital requirement.
Percentage of total deposits that is required to satisfy the total deposit component of minimum capital requirement.
Percentage of total assets less certain liquid ms- sets that is required to satisfy that component of the minimum capital requirement.
The weight given to the sun of the given minimum capital requirements.

Total Loans Variable,
Number of times greater that total loans may be than total capital.

Variable Assets Variable.
Maximum percentage that variable assets may be of total capitol.

FED Funds Variable.
Maximum percentage that the difference between purchased and sold FED FUNDS may be of total assets.

Total Deposits Variable.
Maximum number of times that total deposits may be greater than total capitol.

Data Requirements

The user must specify certain data before using BANKSIM. The data requirements consist of the following items.

1. Specify the actual amount of each item on the balance sheet of the base year.
2. specify the percentage of the amount of each asset category in investment securities and loans that must be carried forward to the next simulation period.
3. For each liability category, specify three rates of growth, which describe pessimistic, most likely, and optimistic expectations; for each asset category specify similar rates.
4. For each asset category, specify three values for rates earned which describe pessimistic, most likely and optimistic expectations; for each liability category specify similar values for rates paid.
5. specify the number of demand deposit, time deposit and savings, and loans accounts for the base year.
6. For each category of account given above, specify three rates of growth, which describes pessimistic, most likely, and optimistic expectations; for each bank operation data item which contributes to variable expenses, specify four rates which describe actual base year, pessimistic, most likely, and optimistic expectations.
7. specify the year of the base year.

Model Flow

BANKSIM begins execution by requesting from the user the number of years to be used in the simulation horizon, the name of the data file which contains user specified data, and the number of trials to be run. BANKSIM reads the file and initializes variables with base year actual values. Ranges of projected rates are stored for later random sampling. An income statement using base year values is calculated. The purpose of the initial calculation, which should give a close approximation of actual values, is to verify the accuracy of user specified data. Next, all balance sheet and income statement values and corresponding rates are projected using random numbers from a triangular probability distribution generator.

Output

BANKSIM produces three reports which show the effects of its internal processes. The first report is an income statement which illustrates the resultant income calculated from the base year data as well as the results from the simulated periods. The simulated figures are averages produced from totaling corresponding figures from each replicated trial and then dividing those aggregate totals by the number of trials. A second report produced by BANKSIM is the balance sheet. Again user submitted base year data is given merely to establish its accuracy. The remaining columns reflect average values that were calculated in the same way as the income statement figures. The base year data is not modified by the program whereas the other simulated periods reflect the result of projection and allocation. The third report lists the accumulated net income results for each replicated trial. The mean and standard deviation of the accumulated net income is calculated and printed as the last entry on this report.

BANKSIM was tested for accuracy via two procedures. First, the calculations of the model were verified against hand calculated results. The logic of the model was thoroughly checked out using a sample set of data which contained readily identifiable values. Initially, the model was tested as a deterministic model in that all projected variables had a fixed rate of increase or decrease. The rates were fixed so that the model's performance could be verified for consistency. Then the stochastic process was incorporated into the model. The results of the randomly generated samples were printed and verified for each variable.

Second, BANKSIM was checked for predictive accuracy by gathering actual historic values for each variable for the years 1972 through 1976. The actual data was gathered from actual balance sheets and income statements for each year of the test. This information was generously supplied by a local bank in Fort Worth, Texas. The actual values used for the base period, 1972, consist of end of year averages for the pertinent balance sheet entries. The income and expense rates used to derive the 1972 net income figure represent the actual rates experienced by that bank. Thus, the balance sheet and income statement figures supplied by the model for 1972 correspond to actual bank figures.

TESTING PLAN

Testing the model was approached with two objectives. First, validation testing was performed to measure the model's predictive accuracy against actual values. This testing required two tests described as ACCURACY TEST I (4 Year Planning Horizon, Actual Valued Decision Variables, 50 trials) and ACCURACY TEST II (4 Year Planning Horizon, Actual Valued Decision Variables, 100 trials). These two tests differed in that a different number of trials and a different random number seed were used for each test.

Secondly, BANKSIN was tested for its sensitivity to different values of decision variables. In each sensitivity test, a single decision variable was modified while holding the other decision variables constant. This type of testing established the model's creditability as a tool to simulate and evaluate alternative management decisions.

Predictive Accuracy Testing

ACCURACY TEST 1 (4 Year Planning Horizon, Actual Valued Decision Variables, 50 Trials) tests the model's predictive accuracy using actual data. Data preparation required researching historical balance sheets and income statements to provide actual values and projected rates for the period 1972 through 1976. All twenty decision variables were set to values actually experienced in 1972. Accumulated Net Income was selected from the test results and compared against corresponding actual data in order to evaluate this test of the model's predictive accuracy.

Accumulated Net Income was picked for comparison between test and actual results because the evaluation of total net income over the entire planning horizon is a major consideration of the modeling process. A significant question that BANKSIM attempts to clarify is the effect of the economic environment and the effect of management decisions on Accumulated Net Income.

The results of the validation tests are shown in Figure 2. These results demonstrate the model's ability to accurately reflect actual operating results. Increasing the number of trials from 50 to 100 did not significantly affect the results.

FIGURE 2

COMPARISON OF ACTUAL AND SIMULATED
ACCUMULATED NET INCOME
FOR ACCURACY TEST I & II

REFERENCES

Crosse, Howard D. and George H, Hernpel. Management Policies for Commercial Banks (New Jersey: Prentice Hall, 1973).
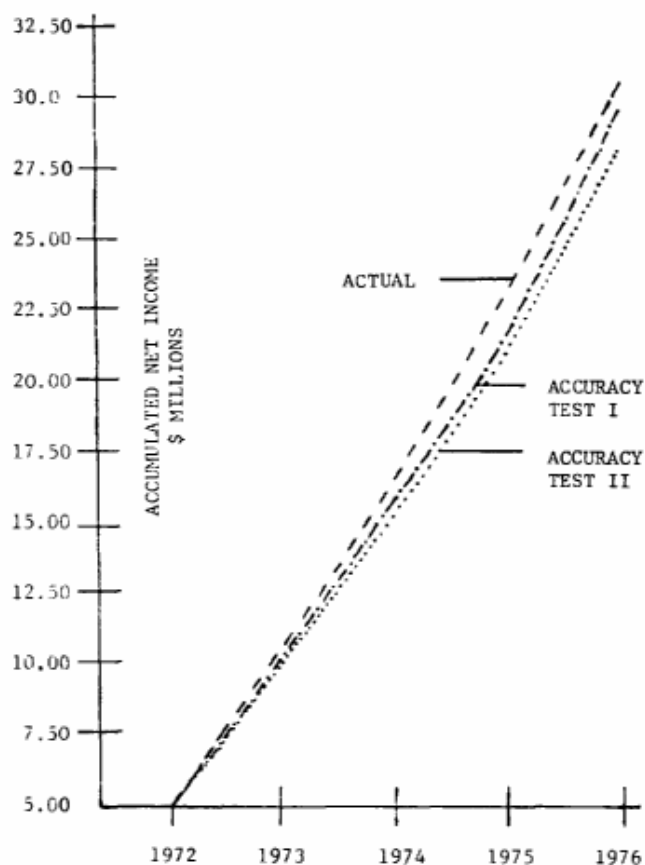
Sensitivity Testing

The next phase of testing the model involved investigating its sensitivity to changes in various decision variables. Five sensitivity tests were conducted. Sensitivity test I was designed to observe the effects on the income statement resulting from changes in the Federal Reserve requirements. Sensitivity test II was designed to measure the effect of the liquidity ratio on the balance sheet. Sensitivity test III investigated the effects of the total loans decision variable on the balance sheet and income statement. The fourth sensitivity test analyzed the impact of the variable assets decision variable while sensitivity text IV measured the effect of the FED FUNDS variable on total assets. In each of the sensitivity tests, BANKSIM produced results that were consistent with anticipated results.

CONCLUSIONS

The results of this study indicate that BANKSIM produces highly accurate results and can be used to evaluate various operating management strategies. The simulation model is designed with a great deal of flexibility for modifying input data and decision variable strategies. As such, BANKSIM provides insight into the relationship of the balance sheet, the income statement, and various operating decision variables.