



A Linear Programming Model for Bank Balance Sheet Management

S GÜVEN¹

Middle East Technical University, Ankara, Turkey

E PERSENTILI

Sabancı Holding, Istanbul, Turkey

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Bank balance-sheet management which involves the determination of the size and composition of a bank's assets and liabilities over a multiperiod planning horizon is one of the most prominent issues in bank strategic planning. Not only management policy choices, but legal restrictions and minimum safety requirements, dictated by the economic and political environment operated in, mean a balance has to be struck between the conflicting objectives of profitability, liquidity and risk. Bank balance-sheet management is further complicated by the fact that decisions made at any point in time affect profits, liquidity and risk, not only at the time they are made, but in the periods that follow. This paper discusses a multiperiod linear programming model constructed for a commercial bank in Turkey, that takes into consideration this systematic relationship in the legal, financial and institutional setup of Turkey over the period 1987–1990. Sensitivity analysis results demonstrate the relevance of the model for informed policy choice, and the use of the model as a planning tool. © 1997 Elsevier Science Ltd

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1. INTRODUCTION

THE DETERMINATION of the size and composition of the sources from which bank funds are to be collected, and how they should be distributed to the various uses is termed Bank-Balance Sheet or Bank Asset and Liability Management. Bank balance-sheet management is a complex problem, with multiple and conflicting objectives.

The first complexity arises from the time frame to be covered and the frequency or the length of time periods for which the balance sheet values have to be determined. This choice is dictated by, as well as determining, the decision variables of the model. Decisions concerning the management of funds over short periods of time are governed by considerations different from the management of funds over

medium and longer time periods. However, choice of the time frame based on these considerations alone may not be enough since the economic environment operated in, through its effect on the flow of funds, might necessitate the incorporation of reasonably short periods into a medium-term model. This is of special importance in countries like Turkey and some Latin American countries, where not only annual but monthly inflation rates are high, and therefore impose changes on interest rates, maturity structure of deposits, loans and securities which are often unpredictable.

Models developed to date vary in the time perspective covered, ranging from one period models, annual models with quarterly time periods, to medium term nested linear programming models consisting of interrelated models

spanning different horizons [1]. Computational feasibility as well as the economic and legal environment operated in governs this choice. Mostly, deposits and interest rates are treated as known or determined by some other econometric model and assets such as cash, various maturity loans, securities and investments are solved for by the model. The major reason for this is that factors affecting the magnitude and maturity structure of deposits such as the quality of service, number of branches, etc are different from those that affect assets, and they are controllable in the long run rather than in the short or medium run. Most of the models in which deposits are treated as uncontrollable variables are deterministic linear programming models [2–4]. For handling uncertainty in deposits stochastic linear programming models were proposed as early as the 1960s [5], but appear to have become computationally feasible only recently [6]. Nonlinear models that treat both interest rates and size and type of assets as controllable variables are avoided for computational feasibility reasons as they are not very practical planning tools in real applications.

A second problem of bank balance-sheet management arises from a conflict of objectives. Commercial banks aim at maximizing returns both in the short, medium, and long runs to ensure competitiveness and survivability. This requires fund collection with minimum cost and investment into the highest return alternatives having minimal risk, while meeting depositor and borrower demands for cash at all times. However, attraction of additional funds usually necessitates incurring additional costs, and of course higher yield investments often bear higher risk. In countries like Turkey, Central Banks impose liquidity regulations on commercial banks limiting the percentage of funds to be invested into profitable alternatives. Resolution of such conflicts may be attempted with the help of goal programming [7, 8], but having to provide subjective utility functions that define the preference ordering of the decision maker between objectives, or the importance accorded by him to the degree of over or underachievement of specific objectives, renders the implementability of these models difficult [9, 10].

We describe in this paper a multi-period LP model constructed for a Turkish bank. The model takes into consideration the interactions

between maturity and cost structures of the bank's liabilities, and the composition of its assets, where the entire balance sheet of the bank is treated as the portfolio for which financial planning is undertaken. The context is the legal, financial, and institutional setup of Turkey over the period 1987–1990. This economic and legal background is described first. Situation analysis, the model, basic assumptions, and the data used are discussed next, and finally the retrospective analysis of the bank's policy choices over the period 1987–1990 and how the model can be used as a planning tool are presented.

2. INSTITUTIONAL BACKGROUND

Banks in Turkey operate in an oligopolistic market. Of the several commercial and specialized banks some are private and some are state owned but subject to the rules and regulations set by the Central Bank (CB) and the Association of Banks. Before 1988, the CB set the ceiling for the interest rates of deposits, and the individual banks then set their rates accordingly. In 1988, this regulation changed and individual banks were free to set their rates without CB imposed ceilings. The result was an immediate price war between the banks which led to a drastic increase in the interest rate of deposits. As banks use a cost plus basis in setting the interest rate for loans, the increase in the interest rate of deposits resulted in a corresponding increase in the interest rate charged for loans. The demand for loans, which was already decreasing owing to the slowing down of the economy decreased further with the increase in the lending rates. Thus after a few months the damage of price competition was realized and since the end of 1988, a small group of banks acting as price leaders set the rates which are followed by others within a $\pm 5\%$ range. So in the period under consideration (1987–1990) competition among banks was not based on price, but on other long term factors such as the number of branches, quality of service, etc.

However, it must be noted that these factors were not very effective in significantly increasing or decreasing the deposit share of individual banks due to the distortions introduced by other CB and government regulations. In Turkey public institutions and other institutions are not

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