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Chapter 2

A MODEL TO ESTIMATE PRICE DIFFERENCES BETWEEN MARKETS

THE BANK PRICING PROCESS

TO ESTIMATE the effect of market structure on the prices business customers are charged, it is necessary to understand how banks price their services. A pricing model for business services cannot properly be developed in isolation from the other activities of the bank. Strategies for pricing services and determining how many and which services to supply businesses are affected by the total set of opportunities that face the bank and the total set of resources available to the bank. The development of a strategy for pricing business services in this framework requires a model which treats the entire banking firm as a system, but a formal systems model of the bank is beyond the scope of this study.[1] It will be necessary, however, to at least describe the salient features of such a model to develop the required insights

[1] It is worth noting that a number of large banks have developed linear programming (LP) models as a solution algorithm for a similar but somewhat narrower set of decisions. These models have been designed to guide bank asset allocation decisions taking into account the capital constraint under which banks operate. Two examples in the literature of such models are D. Chambers and A. Charnes, "Intertemporal Analysis and Optimization of Bank Portfolios," *Management Science,* July 1961; and K. J. Cohen and F. S. Hammer, "Linear Programming and Optimal Bank Asset Management Decisions," *Journal of Finance,* May 1967. Although these LP models are prototypes of similar models that have been used by banks to make decisions, this chapter contends that they have misspecified the true constraints under which banks operate. Equity capital is not the constrained resource; rather it will be argued that the constraint is liquidity during periods of tight monetary conditions and the requirement that banks meet loan commitments to customers during such periods.

for studying the effects of structure on the bank's pricing strategies.

It can be hypothesized that a bank's pricing decisions begin with the specification of goals. A banker, like other entrepreneurs, may be motivated by a number of objectives. It is assumed, however, that as a single goal the banker strives to maximize the discounted value of the bank's income stream over a planning horizon. If other goals exist, the strategy described could be modified to take these into account. It is further assumed that banks are risk averters, which means the banker must be compensated for any increase in risk. Moreover, the risk aversion of bankers is relatively stronger than that of most other business managers because of the low capital ratios maintained by banks and because of the emphasis bank examiners place on loss experience as an index of the quality of management. This high degree of risk aversion is, therefore, an extremely influential element in the pricing and asset decisions of banks.

Like other firms, a bank begins with an endowment of equity. It purchases raw materials and utilizes a production function to convert these raw materials into products which it sells. Given this description, a major difference between a bank and most other enterprises is the fact that bank decisions in the factor and product markets are circumscribed by regulatory prohibitions.

The most important regulatory constraint on the pricing strategy of banks is the prohibition of interest payments on demand deposits. Deposits are a basic raw material in their production function; hence, banks must develop strategies to compete for these deposits, usually by lowering the price of services rendered to compensate the customer for the value of deposits. Since business customers purchase a wide range of bank products and need deposits for transactions, they can be enticed to keep deposits balances wherever they are reimbursed most satisfactorily. Thus, the bank and the business customer typically develop a relationship in which bartering is an important component. The prices of individual bank products are influenced

by the deposit balance of the purchaser. But business customers use a variety of products and all prices should not be reduced to take account of the same deposits. Since the typical bank is organized by departments along product lines, a customer pricing algorithm must be developed to provide information to individual departments of the banks on how much to offset its prices on the products it provides.

This implies that the prohibition of interest on demand deposits has forced banks to develop a pricing policy for the total customer package rather than for each of its products independently. However, there are good reasons to believe that a package pricing policy would have developed in the absence of this regulation and would continue if it is abolished. Individual banks sell a wide range of products such as check transfer, loans, trust and pension administration, stock transfer, data processing services, etc., with varying demand elasticities and, hence, varying profit margins on individual business customers. It is reasonable to believe banks would find it desirable to offset the prices of products where the bank faces low demand elasticities in order to entice customers to purchase other products with a higher elasticity of demand.[2] Since the lending arrangement is the major focus for the business customer, the bank takes account of profitable sales of its other products to the customer in determining the loan price or other prices in the package of services provided. This is especially the case where there is a high probability the customer will shift all purchases if he is enticed to switch the source of one of the services. Thus, it is the nature of the customer-bank relationship that forces a customer pricing policy. The bank will continue to serve the customer if it believes him to be profitable over the long run or planning horizon.

The need to accommodate the loan demand of profitable customers, at the request of the customer, imposes opportunity

[2] This is the traditional tied-sale strategy. For a discussion of the economies of the tied-sale, see Meyer L. Burstein, "The Economics of Tie-in Sales," *Review of Economics and Statistics,* February 1960, pp. 68–73.

costs on the bank. In general, the loan offer, which is often an implicit rather than explicit part of the relationship, is made subject to the prime bank rate which will exist when the loan is requested. During periods of easy money, the bank can validate its loan commitments because of the interindustry variation in the seasonal demand for loans by its business customers, or if an unexpectedly large demand develops, it can easily acquire additional funds at reasonable prices relative to the loan rate.

During periods of tight money, interindustry differences in seasonal loan demands break down as higher than usual proportions of customer request loans. In such periods, the marginal cost of acquiring additional funds is relatively high compared to easy money periods and the supply schedule of funds to any individual bank becomes less elastic. The existence of Regulation Q intensifies the potential problem a bank faces in acquiring external funds during tight money periods by making the supply schedule even less elastic than it would otherwise be. Because the prime bank rate is sticky, the spread between loan rates and purchased money costs declines and at times becomes negative. Banks suffer large actual and/or opportunity losses on loans to customers with whom they have profitable long-run relationships. To reduce opportunity losses, the bank can maintain assets which can be easily liquidated to meet the higher loan demand. But, liquidity has a lower opportunity cost during periods of easy money conditions. Thus, the bank must develop a liquidity strategy based on the level of profits versus losses it is willing to accept in easy or tight money periods.

To be profitable, the customer must compensate the bank for the costs entailed in the loan commitment. Banks have exhibited a strong desire to receive this compensation in the form of deposit balances. This is explained by the high degree of risk aversion of bank management due to low capital ratios. The loan commitment to customers who are expected to be profitable over the planning horizon imposes the major risk undertaken by the bank. During periods of tight money, the high cost of funds to meet such commitments could lead to

substantial losses. Compensating deposits are the main source of deposits at an assured price during periods of tight money. They can, therefore, be viewed as a reciprocal insurance premium. On the one hand, they are a payment from the customer to the bank to assure the granting of loan requests; on the other hand, the bank accepts a lower payment in deposits rather than cash fees to lower its risk exposure.

A CUSTOMER PROFITABILITY MODEL

A customer's expected profitability to a bank for a single period of time can be expressed as follows:[3]

$$\pi_i = L_i(R_{iL} - R_A - R_{iR}) - C_{iL} + D_i(1 - rr)R_A - Y_iA + \sum_{j=1}^{N} S_{ij}, \quad (1)$$

where π_i represents the dollars of profit from the ith customer during period t; L_i, the loan balance of the ith customer during period t; R_{iL}, the loan rate for the ith customer's loan during period t; R_A, the bank's cost of acquiring a dollar of lendable funds during period t; R_{iR}, the probability that the ith customer will default on the loan during period t; C_{iL}, the cost of making the ith customer loan, including credit search and handling costs; D_i, the mean deposit balance of the ith customer for period t; rr, the reserve requirement on demand deposits; Y_i, the change in average yield on assets during period t, because of liquidity addition resulting from the loan commitment entailed by the ith customer relationship; A, the total assets of the bank during period t; and S_{ij}, the fees received for providing the jth type of service for the ith customer during period t, minus the costs incurred in providing the service.

The expression $L_i\ (R_{iL} - R_A - R_{iR}) - C_{iL}$ represents the net

[3] The customer profit formulation is presented in this manner because of the estimation requirements of the study. A bank decision framework would call for the development of a linear, chance constrained, or dynamic programming model. The bank maximizes the discounted value of its income stream given its demand schedule, supply schedule, and production. Moreover, it operates subject to a policy decision on the quantity of risk management will accept, which is the probability of liquidity costs, losses on liquidating securities, and opportunity losses due to the need to purchase high cost money to meet loan requests during periods of tight money conditions.

revenue expected from the loan component of the customer relationship. The R_{iL} is the real rate implied by the loan contract. Because of repayment clauses or interest prepayment clauses this may be different from the rate stipulated in the contract.

In principle, the R_A term should not be the marginal cost of funds during the one period t, but should be evaluated after taking into account all alternatives available to the bank through the planning horizon.[4] R_A is also the opportunity cost of funds to the bank. Even if two banks have identical cost of funds schedules, in terms of payments made to external suppliers, they may have different R_A terms because of variations in the opportunities they face in using their available funds. The R_A term is really the shadow price or dual variable of lendable funds when this problem is viewed in a mathematical programming format. Since all banks face identical supply schedules in the securities market, differences in opportunities are functions of the loan markets. Banks in different markets have varying loan demands because of strong or weak savings and loan or mutual savings bank competition for mortgages, variations in the competitive fervor of sales finance and small loan companies for consumer loans, and the intensity of competition from other banks in the business lending sphere. The difference in the R_A term will produce measured differences in the π_i between markets, if market structure is related to the prices businesses are charged for services.

In banking, it is usual to think of the R_{iR} term as the difference between the prime rate and the rate charged. This simplistic view of bank pricing is countered by the concept of a customer

[4] This is the problem that arises in capital budgeting when the firm faces an upward sloping cost of capital. If the entire set of projects available through the planning horizon is not included in the analysis, projects evaluated at an early point in the decision process face a lower cost of capital than those at a later point. Because of this simultaneous solution process, an optimum decision can only be made when all investment alternatives and the cost of funds schedules, through the planning horizon, are viewed concurrently. This problem is also solved by a linear programming solution algorithm; see William J. Baumol and Richard E. Quandt, "Investment and Discount Rates Under Capital Rationing: A Programming Approach," *The Economic Journal*, June 1965, pp. 317–329.

relationship where the price of any product cannot be isolated from the other prices in the package. In this formulation, it is assumed that the sum of R_{iR} payments just compensates the bank for losses experienced. Thus, this sum is subtracted from the net revenue expected from borrowing customers.

The C_{iL} term includes both the direct costs incurred in processing the loan forms and monitoring the loan agreement during the periods in which loans to the ith customer are outstanding and also the costs incurred in monitoring the credit position of the customer when loans are not outstanding. Thus, this term has a positive value for all borrowing customers during all periods.

In any period, therefore, the expression $L_i\ (R_{iL} - R_A - R_{iR}) - C_{iL}$ could have a positive or negative contribution to profits. When loans are outstanding during periods of monetary ease, this component of the relationship almost always produces a positive contribution. A rare exception could occur where the lending component of the relationship is very small relative to deposits maintained or where the customer purchases other profitable products, causing the bank to make loans at unusually low rates. During periods of tight money, a negative value could occur for a large number of customers. During such periods it is not unusual for R_A to be greater than R_{iL}.

The term $D_i\ (1 - rr)R_A$ represents the value received from the customer's deposit balance. Reserves must be subtracted from deposits to determine balances available to the bank. The appropriateness of using only the single parameter, average balance, to denote D_i is open to some question because of the value a bank puts on the certainty of having the deposit when required. It may be desirable to add a penalty term for wide variations within the period. Using R_A as a measure of the value of a dollar of demand deposit balances held by borrowing customers probably understates the true worth of these deposits. They have a high probability of being available during periods of peak needs and are, therefore, more valuable, on the average, than funds derived from more volatile sources.

The term $Y_i A$, which is the change in revenue from the bank's assets not including revenues from the ith customer's loans, accounts for the cost imposed on the bank in the form of a reduced return on assets because of the implicit or explicit commitment to accommodate the loan requests of the customer. During periods when the customer is borrowing the maximum amount the bank will loan, this term will be zero. The size of the sum of $Y_i A$ for the entire bank is determined by the amount of risk the bank management is willing to assume. Banks which have large YA costs will experience small losses due to high costs of purchased funds during periods of high loan demand, when tight money conditions prevail. The large YA cost is due to substantial holdings of short dated securities which provide liquidity but impose a penalty on the current period's revenue. Banks which have small amounts of such liquid assets will experience large losses during periods of peak loan demand. Such banks have invested funds not employed in loans in longer term investments, which cause capital losses during tight money periods, or they have high loan to deposit ratios during periods of easy money conditions and are required to purchase high cost funds or turn away good customers during periods of high loan demand.

The term $\sum_{j=1}^{N} S_{ij}$ represents the sum of fees received by the bank from the charges levied on the nonlending services performed for the ith customer during period t, minus the costs incurred in providing these services. Since deposit balances are often used to compensate the bank for these services, many customers, even large users of such services, will make small or even no payments of fees and the coefficients of the S_j's will often be negative.

It has been stressed that the bank is a long-run profit maximizer. Thus, for any period t, π_i could have a positive or negative coefficient and still the customer could be acceptable. To determine if a customer is expected to be profitable, the computed profits for all periods through the planning horizon must

be discounted at an appropriate rate and summed. The present value of the stream of profits (PV) expected from the ith customer is then:

$$PV_i = \sum_{t=1}^{N} \frac{\pi_{it}}{(1 + K_t)} t, \tag{2}$$

where K is a discount factor which equates the value of money in different periods.

The appropriate discount rate to equate earnings in future periods to a present value is a subject of wide controversy. For our purposes, it is sufficient to note that long-run customer profitability cannot be determined by simply adding income streams across periods. Money has a time value. Income received in early periods can be utilized to earn additional returns. Moreover, funds available in different periods have varying values depending on the relative opportunities available during the period.

If it is assumed that the bank's criterion function is to maximize the value of its discounted long-run profits, equations 1 and 2 fit into a simple decision rule. If the present value of the discounted stream of expected earnings is positive, the customer should be served. If the stream is negative, the customer should be rejected.

If the model of bank pricing behavior developed in equations 1 and 2 describes pricing policies of banks, then it contains implications on how an empirical investigation of the relationship of bank market structure to prices charged must proceed. The model implies that profit maximizing decisions on whether or not to serve a customer are determined by an estimate of over-all customer profitability, which largely depends upon the net revenues from nonloan services the customer is expected to purchase and the expected cyclical distribution of the customer's loan demand and deposit balances. Observed individual prices may be affected by the profitability of other portions of the packages of services purchased by the customer. Potentially high

profit customers are in a strong position to bargain for a reduction in the price of some individual products. If the customer's profitability is marginal, the bank is in a strong position to raise some individual product prices in the package of services performed.

When a package pricing concept is introduced, the question of price differences between markets is transformed into differences in the profitability at which customers will be accepted. But, even this relatively difficult formulation has been shown to inadequately describe the complexity of the problem. The profitability computation extends over a number of periods. A customer's total contribution could produce a loss in some periods and still have a positive expected value over the planning horizon. The experimental design suggested by equations 1 and 2 is not feasible for empirical estimation of market performance. It would be prohibitively expensive to collect data required to estimate customer profitability over an extended time period, for the necessary number of customers, distributed over the necessary range of market concentrations and types of branching restrictions, to determine if market structure affects customer profitability.

Because of the excessive data costs of a multiperiod model, it is necessary to develop a one-period model to estimate the market structure parameters. Equation 1, in isolation, is an example of such a model. It implies that the bank takes into account all of a customer's activities in a single period to determine profitability. In light of the model developed in both equations, which argued that profit maximizing decisions on acceptable customers should be predicated on expectations of a long-term profitable relationship, it is necessary to justify the use of parameters estimated from a one-period model. The usefulness of a one-period model depends upon a demonstration that biases are not introduced. The question of bias must be posed with regard to the purpose of the parameter estimates. One-period estimates would certainly not be reliable for profitability decisions by bank management, but this study is not

involved in guiding individual bank decisions on profitable customer relationships. The customer models are designed to provide estimates of prices charged businesses for services in different bank markets as a starting point for an analysis of market structure effects. The question of bias then reduces to whether or not parameter estimates of the one-period model are related to structure variables differently than the parameters of the *N*-period model.

The parameter values of many of the elements of the customer relationship vector would be expected to change with cyclical phase. This is particularly true of the deposit balance and liquidity cost variables and least true of the estimates of net income derived from other services. But this study is not concerned with determining which customers should be served by a bank. Since all customers for whom we have data have been accepted for a relationship by a bank, for our purposes all that is required is that cyclical changes in the customer characteristic parameters not be influenced by market structure variations. Cyclical influences have a broad effect on the economy and have a differential impact on industries. Industries are to some degree concentrated regionally and bank market structure is also related to region, but there is no strong reason to believe that these relationships will introduce a bias into the empirical estimates. It is extremely unlikely that the industrial distribution of the sample of customers which was chosen in the set of SMSA's with one of the three types of branching restrictions is affected by the business cycle differently than the distribution of customers in the other two sets of SMSA's. It is concluded, therefore, that if banks price their business services to maximize long-run profits, a one-period model, such as equation 1, can be used to estimate the influence of market structure on profitability.

Since our interest is in prices charged rather than in customer profitability, and because some of the variables will be represented by a proxy because data are not available to measure them directly, equation 1 is restructured as follows:

$$R_L = B_1L + B_2D + B_3F + B_4T + B_5L_A + B_6A_A + B_7E + B_8S + \sum_{i=9}^{N} \sum_{j=1}^{M} B_iG_j + U, \quad (3)$$

where R_L, L, D, and S are defined as in equation 1; F is the fluctuation in depositor balances; T, the time in debt in months; L_A, the length of customer arrangement; A_A, the account activity; E, another bank; and G_j, variables depicting the individual bank, market demand, and market structure.

This model is similar to (1) in that it implies that the bank makes decisions based on a single period. The major difference is that the loan rate is assumed to be the major price which the bank uses to determine profitability of the customer. The net revenues received on other products in the package of services, the direct costs and opportunity costs entailed in the customer relationship, and the value of the deposits are assumed to influence the price charged for the loan.

In (3) the cost associated with the loan function and the risk assumed in lending to the customer are imbedded in the loan size variable, L. Other customer characteristics included in the model, such as deposit fluctuation, time in debt, length of customer arrangement, and account activity, are proxies for factors that influence the costs or revenues of the customer relationship that would be captured directly in the measured variables if equations 1 and 2 were estimated. These variables can be expected to influence the terms of the relationship in (1) and are, therefore, included.

The variables included in the G_j terms are proxies for R_A. Since this study was originally motivated by the desire to measure the parameters of the price-structure relationship, special interest is attached to the sign, size, and statistical significance of two of these variables, which will be a measure of concentration of ownership of deposits in the market and a dummy variable to capture the effect of branching restrictions. The YA term in equation 1 is deleted because there is no way to capture the effect of required liquidity for the individual customer.

The significance of equation 3, with loan rate designated as the crucial price of bank services, derives both from the fact that interest on loans is the major source of bank revenue and because loan rates have been used as the dependent variable in all other studies of the effect of market structure on price. Thus, the estimates derived from this model describe an important component of bank prices and can be compared to the findings of other studies.

For the purpose of this study, however, interest rates have a severe shortcoming because observed loan prices fluctuate within a very narrow range. Whatever the explanation for this, it is an observed fact that at the time of the customer survey interest rates on business loans were very rarely above 10 per cent or below the prime rate, which was 5.5 or 5.75 per cent. Moreover, the rates strongly cluster around 6 per cent (see column 2 in Table 1). The narrow range of the distribution of interest rates on business loans is not a manifestation of the particular set of banks and customers surveyed for this study, rather it is a general phenomenon of bank pricing. This same general distribution is found in many surveys of interest rates

TABLE 1. Distribution of Business Loans by Interest Rates
(per cent)

Interest Rate (1)	*Distribution of Number of Business Loans, Customer Sample* (2)	*Interest Rate* (3)	*Distribution of Dollar Amounts of Business Loans, February 1967* (4)	*Distribution of Dollar Amounts of Business Loans, May 1967* (5)
<5.5	4.0	<5.5	2.0	2.1
5.5–5.99	39.0	5.5	3.1	32.1
6.0–6.49	29.3	5.51–6.0	57.1	35.4
6.5–6.99	20.4	6.01–6.49	13.3	11.2
7.0–7.49	3.7	6.5	5.9	5.5
7.5–7.99	2.3	6.51–6.99	7.1	4.8
8.0≤	1.3	7.0	5.0	3.8
		7.0 <	6.5	5.4

SOURCE: Column 2, National Bureau Survey of Bank Customer Profiles; columns 4 and 5, *Federal Quarterly Survey of Interest Rates, Federal Reserve Bulletin*, August 1967, p. 1392.

on loans for business purposes. Some examples are shown in columns 4 and 5 of Table 1. The two parts of Table 1, columns 1 and 2 and columns 3, 4, and 5, are more nearly identical than they at first appear. The customer profile data are unweighted; whereas, the Federal Reserve data are weighted by dollar amounts. Since larger loans have lower rates, the Federal Reserve survey should have a higher proportion than the customer profile in the lower rate brackets.

The narrow range of observed interest rates on business loans, coupled with the strong tendency to cluster around some "normal" rate and its extreme cyclical stickiness, strongly infers that the determination of the loan rate has a large non-systematic component. Discussions with bankers and the literature on bank management give the strong impression that rules of thumb and tradition play an important part in setting loan rates. Thus, there can be substantial movements in the independent variables that are not reflected in the loan rate. This is, of course, a problem of major concern for the empirical portions of this study and will be considerably elaborated in the next chapter.

The implication of equations 1 and 2 that banks are remunerated through three types of payments suggests that models similar to (3) should be formulated with deposit balances and fees designated as the dependent variable. But at this time fees are of relatively minor importance. Thus, only one additional equation will be constructed and estimated.

To measure the relationship of the deposit balance component of the vector of bank prices to market structure, equation 3 is reformulated as follows:

$$D = B_1L + B_2R_L + B_3F + B_4T + B_5L_A + B_6A_A + B_7E + B_8S + \sum_{i=9}^{N} \sum_{j=1}^{M} B_iG_j + U, \quad (4)$$

where all variables are defined as in (3).

This formulation of the model has much to commend it. The deposit balance is one of the most significant components of the

customer-bank relationship. Conversations with bankers suggest that it is very often the crucial bargaining point of the relationship, particularly during periods of strong loan demand. Deposit balances impose a cost upon the business. Even if the balances are voluntarily held and there is increasing evidence that they are largely determined by bank compensation requirements, the business could bargain for additional bank services. Certainly, to the bank, the amount of balances maintained is an important component of the revenue received.

In the following chapter, the parameters of the variables in equations 3 and 4 will be estimated from the customer profile data collected for this study. The basic hypothesis of the study is that the prices of bank services paid by the business customers of banks are determined by components of the package of bank services purchased and the conditions of the banking market in which the customers are served. Thus, taking account of variations in customer profiles with regard to services used and differences in demand in the market, variations in the level of prices are attributed to market structure. The parameter values and the signs of the coefficients of the two structural variables will be analyzed to determine if prices are related to market structure and, if a relationship is established, to determine the quantitative importance of the structural variables on the level of prices businesses pay.