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An Approach To The Delineation Of Banking Markets

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An Approach To The Delineation Of Banking Markets

Abstract
The accurate delineation of banking markets is a necessary prerequisite to an analysis of the competitive environment in banking, the operational and allocation efficiency of our banking system, and policy prescriptions for structural change in the banking industry. While delineation constitutes a crucial foundation for analyses of competition, it appears that in practice current delineation techniques at best may be inconsistent, and at worst completely devoid of economic rationale...

Disciplines
Corporate Finance | Economic History | Finance | Finance and Financial Management

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AN APPROACH
TO THE
DELINEATION OF BANKING MARKETS

Stephen A. Mathis
Duane G. Harris
Michael Boehlje

No. 14

August, 1975
AN APPROACH TO THE DELINEATION OF BANKING MARKETS

The accurate delineation of banking markets is a necessary prerequisite to an analysis of the competitive environment in banking, the operational and allocational efficiency of our banking system, and policy prescriptions for structural change in the banking industry. While delineation constitutes a crucial foundation for analyses of competition, it appears that in practice current delineation techniques at best may be inconsistent, and at worst completely devoid of economic rationale.

The purpose of this paper is to present a delineation procedure that can be used to systematically and consistently identify banking markets. Section I discusses the concept of a banking market and reviews prior work in the delineation area. Section II presents the theoretical development of the delineation procedure, while Section III offers a statistical adaptation of the procedure to the banking industry. Section IV gives an empirical example of the technique. Finally, Section V presents a summary and some conclusions of the study.
Delineation Techniques

A number of approaches have been used to delineate various types of economic areas. However, none are very appropriate for market delineation in the banking industry.

Trade Area Techniques One set of delineation methods is designed to outline trade areas. These methods can be classified in two categories—empirical and theoretical.

Empirical techniques include "customer spotting" and "license plate analysis." Customer spotting involves a series of customer interviews at the place of business. These interviews obtain information on the address of the customer to relate business location to customer location. In license plate analysis, license plate numbers of customer cars in the relevant businesses' parking lot are recorded to determine the extent of the trade area (Markin, 1971, pp. 195-196).

The foremost theoretical technique for trade area delineation is the gravitational approach as developed by Reilly (1931) and modified by Converse and Huegy (1952, pp. 388-394). In the gravitational approach the trade area maintained by a firm is a function of the distance from its customers and the size of the town in which it is located. The approach has been modified in some instances to use driving time in place of distance and firm size instead of town population. Another theoretical approach, developed under the so-called "economic law of market areas", identifies the boundary line between two geographically competing areas for like goods as a
The delineation is based on freight and price differences (Hyson and Hyson, 1950, pp. 319-327).

Because these techniques are designed to identify trade areas, they offer little direct help in the task of market delineation. However, they can be of indirect benefit (as will be shown later) in the delineation process and in the overall evaluation of the allocation of banking services.

Political and Ad Hoc Boundaries Because of the difficulty encountered in developing a systematic and consistent approach to market delineation, many studies have used city, county, or SMSA boundaries to define market areas (e.g. Kaufman, 1966). Justification for the use of these political or population areas is usually based on data availability. But political or population boundaries may be quite unrealistic as criteria to delineate market areas. Cities and SMSA's include only urban areas. While counties do include both urban and rural areas, they usually are a result of political decisions made years ago. Furthermore, the concept of a market is virtually ignored. Thus, political and ad hoc boundaries are not appropriate to define banking markets.

Cross-Elasticity Methods The most theoretically appealing delineation technique is based upon cross elasticities. As indicated in the definition of a banking market, one should be able to distinguish banking markets on the basis of differences in the size of cross elasticities between banks.
Specifically cross elasticity is defined as

\[
E_{ij} = \frac{\partial q_j}{\partial p_i} \cdot \frac{p_i}{q_i}
\]

where

- \( E_{ij} \) = the cross price elasticity between bank \( i \) and bank \( j \);
- \( \partial q_j \) = the change in bank \( j \)'s level of service;
- \( \partial p_i \) = the change in bank \( i \)'s price;
- \( p_i \) = the original price maintained by bank \( i \);
- \( q_j \) = the original level of service maintained by bank \( j \).

Theoretically, when \( E_{ij} \) approaches zero, there exists an isolated seller. If \( E_{ij} \) is greater than zero, then a non-isolated seller exists.

The distinction between isolated and non-isolated sellers is contingent upon the existence of interdependent price and output policies between the banks. In the case of an isolated seller, \( E_{ij} \) approaches zero, and no interdependence exists. But this could indicate the presence of either pure competition or isolated monopoly. The bank ignores its rivals, either because there are none as in the case of monopoly, or because the market is so atomistic that one firm has no bearing on the price and output of others in the industry as is the case with pure competition.

Because of the restrictions on entry in the banking industry, it is reasonable to assume that few cases of pure competition exist. Thus, a case of \( E_{ij} \) approaching zero likely reflects the existence of an isolated monopoly or two banks in separate markets. Accordingly,
where $E_{ij}$ is greater than zero, a situation of non-isolation or oligopoly likely exists. The banks are in the same market.

Although cross elasticities are theoretically appealing for market delineation purposes, they are difficult to measure empirically. *Ceteris paribus* demand functions for both banks must be estimated. In addition, elasticities are a static concept—they are not dimensioned over time. Measurement of the interdependence of two banks involves both the magnitude of a reaction and the timing of it.

Thus, a desirable technique for market delineation would be one that incorporates the theoretical appeal of the cross-elasticity approach, avoids the arbitrariness of the ad hoc approaches, offers the empirical applicability of the trade area techniques, and recognizes the dynamics of competitor reactions. The next section presents an approach that attempts to satisfy these criteria.
II. Theoretical Basis for a Delineation Procedure

The conceptual underpinnings for the following delineation procedure are based, as is the cross elasticity approach, on the interdependence among bank pricing functions. Assume that two banks are profit maximizers operating either in an oligopoly setting in the same market, or in separate markets. If the two banks are in the same market, the demand for the services of one bank is dependent upon the price of those same services offered by the second bank. Specifically,

\[ q_i = Q_i(p_i, p_j), \]

where the variables are defined as in equation 1. \(^1\) If the cost function of bank i is defined as a function of the level of its service

\[ c_i = C_i(q_i), \]

the profit expression for bank i, \( \Pi_i \), can be written as

\[ \Pi_i = p_i q_i - c_i \]

or

\[ \Pi_i = p_i Q_i(p_i, p_j) - C_i[q_i(p_i, p_j)] \]

If price is regarded as the bank's decision variable, first order conditions for profit maximization require that

\[ \frac{\partial \Pi_i}{\partial p_i} = p_i \frac{\partial Q_i}{\partial p_i} + Q_i(p_i, p_j) - \frac{dC_i}{dq_i} \cdot \frac{\partial Q_i}{\partial p_i} = 0 \]

\(^2\)
This equation represents the amount of change in bank $i$'s profits resulting from a change in the price of its services.

The crucial measure of interdependence, however, is the existence of a price response by bank $i$ to price changes by bank $j$. To isolate and determine this potential price response, both $p_i$ and $p_j$ must be allowed to vary. This can be represented by taking the total differential of equation (6) with respect to $p_i$ and $p_j$ and then solving for $dp_i/dp_j$.

\[
\frac{dp_i}{dp_j} = - \left[ \frac{p_i \cdot \frac{\partial^2 Q_i}{\partial p_i \partial p_j} + \frac{\partial Q_i}{\partial p_j} \cdot \frac{dC_i}{dp_i} \cdot \frac{\partial^2 Q_i}{\partial p_i \partial p_j} - \frac{d^2 C_i}{dp_i^2} \left( \frac{\partial Q_i}{\partial p_i} \right)^2 \right]
\]

If the existence of rivalry between the two banks is defined in terms of cross elasticities, two cases can be isolated: (1) the rival case in which $E_{ij} > 0$, and (2) the nonrival case in which $E_{ij} = 0$. Note that the nonrival case implies that $\partial Q_i/\partial p_i = 0$, since it can be assumed that both $p_i$ and $q_i$ will be nonzero. Application of these cross elasticity conditions to (7) results in

\[
\frac{dp_i}{dp_j} > 0
\]

for the rival case, and

\[
\frac{dp_i}{dp_j} = 0
\]
for the nonrival case. If two banks are rivals in the same market, the price response will be nonzero. If two banks are nonrivals or in separate markets, the price response will be equal to zero.

In a comparative static framework, the result in (8) implies that the time period of adjustment of bank i's price to changes in bank j's price will be instantaneous—response time will be zero. In contrast, (9) implies that since bank i and bank j are nonrivals, bank i will never respond to price action by bank j—response time will be infinite. These two extreme response times form the basis for a statistical procedure for market delineation.
III. Statistical Adaptation of the Model

**Observed vs. Theoretical Response Times**

While the above theory implies that the response time of one bank to another will be either zero or infinite, in reality it can be expected that response times will be nonzero but finite. For two rivals, price reactions may not be instantaneous because of information or decision lags. If bank i changes its price, it may be some time before bank j is aware of that change. Or, even if bank j immediately discovers the change in bank i's pricing policy, the decision process may result in a delay before bank j can implement its own price changes. Thus, it is likely that for rivals, the response time will be nonzero.

Likewise, even for two nonrivals it is unlikely that observed response time will be infinite. Bank j bases its pricing decisions on variables other than the price charged or offered by bank i. Even though bank j does not respond to bank i's price, it may alter its price at some future date in response to other changing conditions. Thus, violation of *ceteris paribus* conditions will cause observed responses of nonrivals to be finite.

Because both rivals and nonrivals may exhibit nonzero but finite response times, it is necessary to develop an empirical procedure which can identify significant differences in finite response times. Standard statistical methods offer such a procedure.
Rationale for the Statistical Technique

The basic assumptions of the empirical market delineation procedure are that (1) banks can be classified into two groups—rivals and nonrivals, and (2) the average response time between nonrivals is significantly greater than the average response time between rivals. For example, as shown in Figure 1, let $R$ represent a sample of response times drawn from a response time population of rival banks. Then $\bar{X}_R$, the sample mean, is an estimate of the average response time for rival banks. Now let $U$ represent a sample of response times drawn from two unclassified banks, and $\bar{X}_U$ the average response time of those banks. If $\bar{X}_U$ is significantly greater than $\bar{X}_R$, the two banks can be classified as nonrivals and included in separate markets. If $\bar{X}_U$ is not significantly greater than $\bar{X}_R$, the two banks can be classified as rivals and included in the same market.

Application to the Banking Industry

To apply the empirical procedure to the delineation of banking markets, it is necessary to (1) identify a priori a sample of rival banks, (2) determine the appropriate price variable for measurement of response times, and (3) select an appropriate statistical technique to test the significance of differences in response times.

The a priori sample of rival banks is defined to include banks located in the same town or city. It is presumed that if two banks are located in the same town or city, they must have interdependent pricing functions. Because of their close proximity, actions of one bank will affect the decisions of other banks in the city. Furthermore it is presumed that response times between banks in the
Figure 1: Sample Distributions of Rival Bank and Unclassified Bank Response Times
same city can be pooled over different cities to generate the overall rival sample. This assumption implies that rivals will act similarly regardless of their geographical location.

The best price variable for measurement of response times would involve a well-defined service that is homogeneous across banks. Time deposit rates come the closest to satisfying that criterion. Homogeneity across banks is guaranteed by federal regulations pertaining to characteristics of time deposit accounts. It is possible, of course, that markets defined using time deposit rates may be different than those which would be defined using loan rates or other criteria. It is assumed, however, that for most banks deposit and loan markets will be similar for the majority of potential customers.

Any statistical technique which evaluates the significance of differences in measures of central tendency is a candidate for use in the delineation procedure. However, because there is no information on the form of the underlying distributions of response time, it is most appropriate to use a nonparametric technique.

The nonparametric method used in this study tests for level (or location) differences between two populations and is referred to as the Wilcoxon-Mann-Whitney (WMW) test (Fryer, 1966, pp. 190-193). The WMW test normally is a one-tailed test with the hypothesis

\[ H_0: [F(X_1) = G(X_2)] \text{ versus } H_a: [F(X_1) > G(X_2)] \]

for all points along the X scale of measurement, where F and G are the cumulative distribution functions for \( X_1 \) and \( X_2 \) respectively. The test is based upon the general assumption that, if the magnitude of the size of \( X_1 \)'s
is greater than the magnitude of the size of $X_2$'s, and if one draws random samples $x_1$ and $x_2$ of sizes $n_1$ and $n_2$ from the $X_1$ and $X_2$ populations respectively, the $x_1$'s in the combined array of $x_1$'s and $x_2$'s should tend to outrank the $x_2$'s.

In particular, one forms an ordered array for the combined samples of $x_1$'s and $x_2$'s and computes the variate:

$$U = \frac{n_1 n_2}{2} + \frac{n_1 (n_1 + 1)}{2} - T$$

where $T$ is the sum of the ranks of the $x_1$'s in the combined array.

It can be shown that the variable $U$ has an approximately normal frequency distribution with a true mean of

$$\mu_U = \frac{n_1 n_2}{2}$$

and a true variance of

$$\sigma^2_U = \frac{n_1 n_2 (n_1 + n_2 + 1)}{12}$$

Thus, the sampling variate

$$\chi^2 = \frac{U - (n_1 n_2/2)}{\sqrt{(n_1 n_2)(n_1 + n_2 + 1)/12}}$$

has a $N(0, 1)$ frequency distribution and $H_0$ can be tested with the use of the cumulative standard normal distribution tables.
IV. An Empirical Test

To empirically evaluate the application of the conceptual model to the delineation of bank markets, data on changes in time deposit rates since 1960 are being collected from banks in a functional economic area in Iowa (Fox and Kumar, 1966). The results from seven banks in this area are used in the following illustration. Two of the seven banks are located in a town of 3200 people, and the other five are located in four towns ranging in size from 370 to 2300 people. All of the banks are located within a radius of 15 miles. Data are being collected from the remaining 69 banks in the functional economic area to provide a more complete test of the delineation procedure.

A single page mail survey with personal follow-up is being used to collect date of change data from each bank. The survey instrument is shown in the appendix. Although some banks expressed difficulty in completing the survey, others indicated that the data were readily available from minutes of board of directors' meetings or posting ledgers for active time-deposit accounts. Note that date of change information was requested for passbook, 3, 6, or 9 month certificates of deposit, 1 year certificates, 1-2 1/2 year certificates and 2 1/2-4 year certificates.

Calculation of Response Times

Once the data for the seven banks had been collected, response times for the rival sample were calculated. For this illustration, the rival sample was defined as the response times between banks A and B (Table 1). In determining the rival response times, the
### Table 1: Calculated Response Times for Rival and Unclassified Banks

#### Response Time for Unclassified Banks

<table>
<thead>
<tr>
<th>Response Time for Rival Banks</th>
<th>Primary Test</th>
<th>Secondary Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A to B</td>
<td>C to (A or B)</td>
<td>C to D</td>
</tr>
<tr>
<td>213</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>332</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>1</td>
<td>365</td>
<td>18</td>
</tr>
<tr>
<td>365</td>
<td>365</td>
<td>23</td>
</tr>
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<td>12</td>
<td>365</td>
<td>33</td>
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<tr>
<td>365</td>
<td>365</td>
<td>13</td>
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<td>365</td>
<td>13</td>
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<tr>
<td>365</td>
<td>365</td>
<td>12</td>
</tr>
<tr>
<td>31</td>
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<td>174</td>
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<td>365</td>
<td>365</td>
<td>8</td>
</tr>
<tr>
<td>365</td>
<td>34</td>
<td>365</td>
</tr>
<tr>
<td>192</td>
<td>365</td>
<td>26</td>
</tr>
<tr>
<td>365</td>
<td>185</td>
<td>365</td>
</tr>
<tr>
<td>365</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>365</td>
<td>40</td>
<td>365</td>
</tr>
<tr>
<td>33</td>
<td>194</td>
<td>365</td>
</tr>
</tbody>
</table>
number of days that elapsed from the date of a rate change for the lead bank and a rate change in the same deposit category by the rival was calculated. If this elapsed time exceeded 365 days, the response time was specified as 365 days and any rate change by any bank following this 365 day period was designated as a new lead. Only rate changes within the same deposit category were considered as legitimate responses. Furthermore, any rate change within the same category, even if rates were not equalized, was considered as a response.

Next, response times for unclassified banks—banks in the four surrounding towns—were determined. The response time for an unclassified bank was calculated as the elapsed time in days from the date of change for the lead bank in the rival sample and the date of response by the unclassified bank. Other rules for a legitimate response were the same as for the rival sample.

The response times for the rival and unclassified banks are summarized in Table 1. All seven banks used in this analysis offered the passbook and 1 year deposit instruments. All banks except bank C also offered 3, 6, or 9 month certificates of deposit, so response times in this deposit category were also calculated where appropriate.

The Statistical Test

As indicated earlier, the WMW test is a nonparametric test that utilizes the summation of numerical values of the rankings in an array in the test statistic. The following example will illustrate the
application of the WMW test to the hypothesis that the response times
for bank C to banks A or B are in fact not statistically different
from those in the rival sample.

To implement the WMW test, the response times for the two samples,
x_1 and x_2 (Table 1, columns 2 and 1 respectively), are combined into
a single array as follows:

\[
\begin{align*}
365, & \quad 365, \quad 365, \quad 365, \quad 365, \quad 332, \quad 213, \quad 213, \quad 192, \quad 137, \\
(3.5) & \quad (3.5) \quad (3.5) \quad (3.5) \quad (3.5) \quad (7) \quad (8.5) \quad (8.5) \quad (10) \quad (11) \\
122, & \quad 63, \quad 51, \quad 31, \quad 31, \quad 31, \quad 12, \quad 7, \quad 1, \quad 1, \quad 1, \\
(12) & \quad (13) \quad (14) \quad (16) \quad (16) \quad (16) \quad (18) \quad (19) \quad (21) \quad (21) \quad (21)
\end{align*}
\]

where the top values are the response times and the values in parentheses the respective ranks in the array.\(^5\) The sum of the ranks for
\(x_1\) is calculated as:\(^6\)

\[
T = \sum_{r=1}^{n} R_1^r = 115
\]

where \(R_1^r\) is the rank of the \(r\)th observation in the \(x_1\) array. The \(U\) variate is calculated as indicated by equation (10) as:

\[
U = (10)(12) + \frac{10(10 + 1)}{2} - 115 = 60
\]

Finally, the test statistic, \(\lambda\), is calculated as:

\[
\lambda = \frac{60 - (10)(12)/2}{(10)(12)(10 + 12 + 1)/12} = \frac{0}{230} = 0.0
\]

Using the standard cumulative normal distribution tables and a
10 percent significance level, the critical value for \(\lambda\) is 1.28. Since
the calculated test statistic is less than the critical value, the
null hypothesis that the response times come from the same distribution
cannot be rejected.

Table 2 summarizes the various calculated values used to test the
competitor status of the other banks in the sample. Note that the tests
are classified into two categories—primary test and secondary test.
The primary test essentially determines if there is any significant
difference in the response times of the unclassified bank to the lead
bank in the rival sample and the response times of the rival
sample. The secondary test determines if there is a significant
difference in the response times between two unclassified banks and
the response times of the rival sample. Consistent with the
concepts of market dynamics, the crucial or primary test is the response
to the lead bank in the market. The secondary test is a weaker test
because it allows substantial delays in responses and the development
of chains. The secondary test can be used to provide additional
evidence that two unclassified banks are in the same market, but it
cannot be used to disprove the results of the primary test. The
calculated \( \lambda \) values for both the primary and secondary tests are
summarized in Figure 2.

The statistical results of the primary test indicate that the
response times of banks C and D are not significantly different than
those of the rival sample (A and B). Thus, banks A, B, C, and D
would appear to be in the same market. In contrast, the response times
of banks E, F, and G appear to be significantly different than those
### Table 2: Test Statistics for Illustrative Bank Market Delineation

<table>
<thead>
<tr>
<th></th>
<th>Primary Test</th>
<th>Secondary Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C to (A or B)</td>
<td>D to (A or B)</td>
</tr>
<tr>
<td>T</td>
<td>115</td>
<td>185</td>
</tr>
<tr>
<td>U</td>
<td>60</td>
<td>115</td>
</tr>
<tr>
<td>λ_{cal}</td>
<td>0.0</td>
<td>1.23</td>
</tr>
<tr>
<td>λ_{10}</td>
<td>1.28</td>
<td>1.28</td>
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</tbody>
</table>
of the rival sample. Thus, these banks are not in the same market as A, B, C, and D. The secondary tests support the hypothesis that bank C and bank D are in the same market, and that E, F, and G are in the same market. However, they do not lend support to the hypothesis that banks E, F, and G are in a different market than banks C and D.

To obtain an estimate of the geographic boundaries of the market area, the results of the market area delineation were integrated with delineations of the trade area for each of the five banks. A gravity model using bank deposits was utilized in the trade area delineation. The geographic boundaries of the market were obtained by summing the trade areas for the banks determined to be in the market. The results of this geographic delineation of the market area are shown in Figure 3.
Figure 3: Market and Trade Area Boundaries

--- Market Area Boundary

............. Trade Area Boundary
V. Summary and Conclusions

The accurate delineation of banking markets is an important aspect of issues in banking structure. While several methods have been used to determine geographical boundaries in banking, most are either economically unsound or difficult to implement. This paper presents an approach to the delineation of banking markets that is based on standard oligopoly theory, is statistically adaptable to empirical use, and requires modest amounts of data.

The underlying theory establishes a two class scheme for banks—rivals and nonrivals. Rivals are banks that respond to each other's pricing adjustments and are thus in the same market. Nonrivals are banks that do not respond to each other's pricing adjustments and are thus in separate markets.

The statistical adaptation of the theory is based on the assumption that the response time of a bank to a nonrival's price change will be significantly greater than the response time of a bank to a rival's price change. Date-of-change data on time deposit rates were collected from seven adjacent Iowa banks to test the usefulness of the model. Response times were calculated between all banks and sets of banks. A sample distribution of rival response times was established and a nonparametric statistical test was used to test all other response times against that rival sample. Preliminary results indicate that, indeed, the approach can be a useful aid in the delineation of banking markets.
The delineation procedure, however, is not without shortcomings. To accurately use the procedure, the dates of rate changes for all banks must be obtained. If data is missing or incomplete for one bank, it is impossible to determine in which market that bank belongs.

Furthermore, a market center must be specified to use as the base for the test. If this base is not used, elongated chains of rival banks may be identified. A logical criteria would require the base to be a major trading center with a larger population than surrounding towns and possibly more than one bank. It is possible, however, that the choice of the market center could influence the market delineation. That is, if town X is chosen as the market center, Y may be included in the same market with X, and Z excluded. Alternatively, if Z is chosen as the market center, Y might be included in the same market with Z, and X excluded. Thus, "gray areas" between well defined market areas may arise.

The quantification of long delays or essentially nonresponses also presents difficulties. In the preliminary test of the approach, if a response did not occur within 365 days, the response time was specified as 365 days. A different rule for quantifying long delays may result in different numerical results. Also, only responses within the same deposit category were considered as legitimate responses. If any change within the entire maturity structure were considered as a legitimate response, different results again might be obtained.

Finally, the choice of the time deposit variable as the response measure may result in problems. Although time deposit categories are
homogeneous by law across banks, rates on time deposits are also highly regulated. In recent years, most banks have paid ceiling rates, and many banks have adjusted their rates when changes have been made in the ceiling regulations. These exogenous, artificial ceiling regulations may not only impede competition, but also may confound the measurement of competitive responses and delineation of bank markets.
APPENDIX

Time Deposit Rate Questionaire

Would you please record your passbook interest rate as well as the interest rate on any of the listed certificates of deposit as of January 1, 1960.

RATES PAID

<table>
<thead>
<tr>
<th>Date</th>
<th>Passbook</th>
<th>3, 6 or 9 months</th>
<th>1 year</th>
<th>1-2½ years</th>
<th>2½-4 years</th>
</tr>
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<tbody>
<tr>
<td>1/1/60</td>
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Please list below by year, month, and day, the effective dates of change in any of these interest rates since January 1, 1960. Also, please list the corresponding new interest rates in the respective blanks. This information should be readily available from such sources as minutes of board of director's meetings or posting ledgers for active time-deposit accounts.

NEW RATES

<table>
<thead>
<tr>
<th>Date of Change</th>
<th>Passbook</th>
<th>3, 6, or 9 months</th>
<th>1 year</th>
<th>1-2½ years</th>
<th>2½-4 years</th>
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Have you made a change from quarterly to daily compounding on passbook savings accounts? If so, please list the effective date of that change.

Return to: Department of Economics
Iowa State University
Ames, Iowa 50010

Name
Bank
FOOTNOTES

1. This is a model similar to that outlined by Henderson and Quandt (1971, pp. 231-232). The model considers a bank as a producer of a set of differentiated services in an oligopolistic market. The bank thus faces its own distinct demand curve. This framework is considered appropriate for banking markets because of individual banks' ability to differentiate their services via customer relationships, tied sales, etc.

2. It is assumed that second-order conditions for a profit maximum are satisfied.

3. For the rival case, \( \frac{dp_i}{dp_j} \) could be either positive or negative depending upon the sign of the numerator in equation (7). The crucial distinction, however, is that in the rival case, bank i will respond, in some manner, to price changes by bank j. In the nonrival case, bank i will not respond.

4. This identification of the a priori sample of rival banks is considered appropriate for rural banking markets. For large metropolitan areas, the rival sample may have to be defined otherwise.

5. If identical values occur in the combined response time array, the rank for each value is determined as the midpoint of the rankings for the subset of identical values.

6. The ranks for the \( x_1 \) observations are underlined in the array.
7. In calculating response times of (E or F) to (A or B), total days were measured from the lead date by one bank in a two-bank set to the first response by a bank in the other two-bank set.
REFERENCES


