

Michigan Law Review

Volume 66 | Issue 8

1968

Law and Quantitative Multivariate Analysis: An Encounter

Arnold H. Lozowick

Member of the Illinois and District of Columbia Bar

Peter O. Steiner

University of Michigan Law School

Roger Miller

University of Wisconsin

Follow this and additional works at: <https://repository.law.umich.edu/mlr>



Part of the [Antitrust and Trade Regulation Commons](#), and the [Science and Technology Law Commons](#)

Recommended Citation

Arnold H. Lozowick, Peter O. Steiner & Roger Miller, *Law and Quantitative Multivariate Analysis: An Encounter*, 66 MICH. L. REV. 1641 (1968).

Available at: <https://repository.law.umich.edu/mlr/vol66/iss8/2>

This Article is brought to you for free and open access by the Michigan Law Review at University of Michigan Law School Scholarship Repository. It has been accepted for inclusion in Michigan Law Review by an authorized editor of University of Michigan Law School Scholarship Repository. For more information, please contact mlaw.repository@umich.edu.

LAW AND QUANTITATIVE MULTIVARIATE ANALYSIS: AN ENCOUNTER†

Arnold H. Lozowick, Peter O. Steiner,** and Roger Miller****

I. INTRODUCTION

WORDS are the lawyer's stock in tirade. He would rather face a page of fine print than a single algebraic formula. A trial is the collection of oral testimony, a contract aims at expressing a legal undertaking verbally, and that final and highest product of the legal profession, the law review article, is an uninterrupted stream of words.

Words, however, are only one way of finding facts, expressing relationships, or formulating arguments. Numbers may do so as well. For several centuries, scientific disciplines have relied heavily on numerical, or quantitative, approaches to the discovery of truth. In recent decades the social scientists have turned increasingly toward numerical analysis as an essential tool of their trade. The learned journals of the economic profession, for example, often seem to regard words as secondary; the substance of the thought of the contemporary economist emerges in a series of statistical formulae, tables, and other incantations. The same is increasingly true of the political scientist, the sociologist, and the psychologist.

The social scientist has turned to statistical techniques because they permit the investigation of social, economic, and other human relationships not subject to laboratory control with the intellectual rigor and empirical standards of proof hitherto characteristic only of laboratory sciences. One of these techniques, and the subject of this Article, is quantitative multivariate analysis.

The Article attempts to explain the basic approach of quantitative multivariate analysis and to show how it can be applied to the solution of legal problems. We will demonstrate that this tech-

† This Article is based on the work of a team of lawyers, economists, and bankers in the preparation of the defense of a major antitrust case. Mr. Lozowick and Professor Steiner have written this Article and are alone responsible for its contents. Professor Miller organized and supervised the data collection and processing. The authors wish to express their appreciation to Miles G. Seeley, Philip H. Cordes, William R. Lahs, and John E. Allen for their major contributions to the project.

* Member of the Illinois and District of Columbia Bars. B.A. 1951, Yale University; LL.B. 1954, Harvard University.—Ed.

** Professor of Economics and Law, University of Michigan. A.B. 1943, Oberlin College; M.A. 1949, Ph.D. 1950, Harvard University.—Ed.

*** Professor of Economics, University of Wisconsin. B.A. 1949, Princeton University; M.B.A. 1951, University of Pennsylvania; Ph.D. 1958, University of California (Berkeley).—Ed.

nique can grapple with complex factual questions arising in a legal context, and that it can do so in a controlled manner, rather than by the accumulation of a mountain of unrelated facts which can be utilized only by a leap of intuition. This is the key to our argument: It is possible to use numbers and numerical analysis in an ordered search for the truth. In this role numbers serve not merely as the illustrations of a legal argument, but act as important conditions and constraints upon that argument. In deference to the tradition we challenge, this Article consists of many words and few numbers; but the latter are as important as the former.

For many lawyers the word "statistics" evokes a sterile numbers game such as that which characterizes recent Supreme Court antitrust opinions. Many lawyers are disturbed by what they regard as the libertine manner in which the Court selects the statistics it will use and by its arbitrary determination of the numbers which establish the defendant's guilt. With a full awareness of the quagmire we are entering, we will attempt to show that quantitative analysis can assist in the rational solution of a central question of antitrust law: the selection of the relevant market in a merger case. If we are correct in the hypothesis that quantitative analysis can penetrate this morass, it deserves the attention of the legal profession.

This Article chronicles one attempt to blend the sophisticated science of statistics with the mysterious art of the law in an antitrust case. Once again, we hope to provide lawyers with an understanding of a tool which can be used in resolving complex factual questions *wherever* they arise, not merely in an antitrust context. Although the lawyer will not emerge from this encounter as an accomplished statistician or economist, he may be able to talk to his fellow social scientists and to achieve a more fruitful application of social science techniques to the law.

II. THE CONTINENTAL BANK MERGER CASE

On September 1, 1961, the Continental Illinois National Bank and Trust Company of Chicago, the second largest bank in Chicago, merged with the City National Bank and Trust Company, the sixth largest. The surviving bank, Continental, thus became the largest in Chicago. This merger was caught in the first flurry of government actions brought against bank mergers under the antitrust laws—the burst of activity which led to the Supreme Court's *Philadelphia Bank* and *Bank of Lexington* decisions¹ and to the *Manufac-*

1. *United States v. Philadelphia National Bank*, 374 U.S. 321 (1963); *United States v. First National Bank and Trust Co.*, 376 U.S. 686 (1964).

urers Hanover decision in the Southern District of New York.² The Government based its complaint in the *Continental Bank* case on the same statistical approach it employed in those cases—an approach which is either simple or simplistic, depending upon one's point of view.

The gist of the Government's case was its contention that Continental would have an excessive share of the Chicago banking market. This argument was buttressed by an assertion that the concentration of the four largest banks in Chicago was also too high. The complaint alleged that the merged bank's market share would represent 26 per cent of the total deposits of all banks in the city of Chicago and 34 per cent of the total deposits of all banks in the Chicago central business district. It put the corresponding four-bank concentration ratios at 64 per cent and 90 per cent respectively. Especially after the *Philadelphia Bank* case, it was obvious that these figures were in the danger zone and that, if the Government could support them, the merger would be in real trouble.³

There was no doubt about the arithmetical accuracy of the Government's figures. They were based on the balance sheets showing total deposits and loans which the Chicago banks were required to file with bank regulatory agencies. It was possible to show that the Government's selection of the relevant geographic market was somewhat narrow. But so long as the same basis of computation was used, an expansion of the market to include the entire metropolitan area would only have reduced the merged bank's market share to a point between 19 per cent and 22 per cent—figures still well within the danger zone.

This Article will demonstrate how the authors proposed to reduce Continental's market share for a critical segment of banking—loans to businesses—from 27.1 per cent to 9.4 per cent; the four-bank concentration ratio was similarly reduced from 84.7 per cent to 31.6 per cent. These reductions, combined with a similar examination of other segments of the banking business and a historical trend of deconcentration due largely to the successful entry of new banks into the Chicago market, placed the *Continental Bank* case in a category by itself—one which we believed would impress even the United States Supreme Court. Since the Bank Merger Act of

2. *United States v. Manufacturers Hanover Trust Co.*, 240 F. Supp. 867 (S.D.N.Y. 1965).

3. Before the *Philadelphia Bank* case, Continental's lawyers were less concerned with the numbers. They had patiently explained to the economists why the case did not fall under § 7 of the Clayton Act, 15 U.S.C. § 18 (1964), but instead under § 1 of the Sherman Act, 15 U.S.C. § 1 (1964).

1966⁴ gave its retroactive blessing to the Continental Bank merger, no court passed on our presentation.⁵ Although the saga of a successful struggle to defend an antimerger action under section 7 of the Clayton Act must await another day, the defense prepared in the *Continental Bank* case does provide us with a case study in quantitative multivariate analysis.

III. FORMULATING THE PROBLEM

The lawyers for Continental began to prepare their case in traditional fashion: they sat down with their client to be educated in the banking business. Even before the *Philadelphia Bank* case, it was no secret that concentration ratios in an appropriately defined market would be important. What emerged from these discussions was familiar to every banker and to anyone who has worked through the district court's opinion in the *Manufacturers Hanover* case. Even if one accepts the Supreme Court's determination in the *Philadelphia Bank* case that the appropriate "line of commerce" in a bank merger case is commercial banking, this does no more than eliminate nonbanking financial institutions as relevant competitors. There remains the problem of defining the relevant market and developing measures of concentration therein. The principle measures of market structure in the banking industry are bank deposits and loans, which are two types of banking services. These bank services, however, are not rendered in unitary markets but in a multimarket context. Bankers recognize this fact when they speak of "wholesale" and "retail" banking.

"Wholesale" banking, to the banking profession, means the deposit, loan, and related services rendered by banks to large business enterprises whose resources are great, whose needs are large, and whose business activities are usually regional or national in scope. In general, the banks that provide "wholesale" banking services are large ones; competition among large banks for the business of large customers tends to cross local and regional lines. In short, bankers believe that the market for "wholesale" banking services is nationwide.

In "retail" banking, on the other hand, the typical customers are individuals and small businesses. Such customers use banks for personal checking accounts, savings deposits, real estate or auto-

4. 12 U.S.C. § 1828 (Supp. II, 1965-1966).

5. On March 11, 1966, the *Continental Bank* case was dismissed pursuant to § 2(a) of the Bank Merger Act of 1966, 80 Stat. 10: "Any merger . . . which was consummated prior to June 17, 1963 . . . shall be conclusively presumed to have not been in violation of any antitrust laws other than [section 2 of the Sherman Act]."

mobile loans, and small business loans. These small customers cannot go very far to obtain banking services; hence only local banks can effectively compete with one another in providing such services. In other words, the relevant market for "retail" banking services is less than nationwide.

In the *Continental Bank* case, the Antitrust Division of the Department of Justice chose to attack the merger only in the local market, recognizing that the merged bank's share of the national market was insignificant. However, if the bankers' distinction was a valid one, there were good reasons to suppose that Continental's share of the local retail market was in fact much smaller than that shown by the Government's indiscriminating statistics. Large banks have a relatively larger share of the wholesale business than do small banks; small banks have a relatively larger share of the retail business. Therefore, statistics which combine wholesale and retail transactions would overstate a large bank's share of the retail business. Furthermore, Continental's share of the retail market in Chicago was probably smaller than that of banks of equivalent size elsewhere in the country because Illinois law prohibits branch banking.⁶ Continental's inability to establish branches in suburban and neighborhood business areas presumably handicapped its retail business.

Unfortunately, although bankers are convinced that the distinction is valid, their balance sheet data do not distinguish between "wholesale" and "retail" activities; and it was on these balance sheets that the Government had built its case. Even if the markets were fundamentally different, that business fact was useless to the lawyers unless they could separate the markets in the data. Solid criteria were needed to give substance to the distinction. And while the bankers were certain that the markets really were different, they could make neither confident nor precise statements about the characteristics which distinguished them.

In the *Manufacturers Hanover* case, decided well after our project was underway, Judge MacMahon recognized the relevance of the retail-wholesale distinction and proposed a single criterion of differentiation for business loans. On the basis of the evidence presented, he concluded that the crucial factor in determining the nature of a given loan transaction was the size of the loan. He then found that all business loans of more than \$100,000 were made in the national, "wholesale" market, and all smaller loans in the local, "retail" market.⁷

6. ILL. REV. STAT. ch. 16½, § 106 (1963).

7. 240 F. Supp. 867 at 921.

This simple standard, if accepted, would have provided Continental with an even smaller share of the local market than that which resulted from our analysis.⁸ But this standard rested on no firmer a foundation than the strength of Judge MacMahon's intuition. Although his intuition turned out to be good in one case, it could not be relied upon to convince another court. It had no systematic statistical support of any kind; in an adversary proceeding, even a plausible intuitive standard is always vulnerable.

IV. THE ECONOMISTS REFORMULATE THE PROBLEM

At this point Continental's lawyers sought out an academic economist. To their naive dismay he had no magic formula to describe the relevant market and no thermometer to measure the intensity of competition in that market. The economist was unembarrassed, however, since it is obvious that in these respects his profession does not lag behind Congress, the courts, or the Antitrust Division. Still, the trip to academe was not wasted. The economist agreed that market shares are important in antitrust cases when they can be used as proxies for an inherently immeasurable concept—the intensity of competition.⁹ But this will be so only if the "market" is a meaningful one. This requires the identification of the groups of sellers and buyers of a given product whose relations are sufficiently intertwined to give rise to a market in the product. Although no such identification of sellers and buyers would be airtight, not all approximations are equally satisfactory. Although a market is ultimately defined geographically, its definition is not a matter of mere geography. It is a question of fact: which buyers and sellers have access to one another.¹⁰

8. See note 45 *infra*.

9. The economist offered the following theoretical formulation of the problem, amplifying the intuitive approach of the lawyers and bankers. Any "market share" (the fraction of the customers in a market accruing to a particular seller) or "concentration ratio" (the aggregate market shares of the group of largest sellers) is in the first instance merely an arithmetical concept that might or might not be significant in an antitrust case, depending on the substantive standards used in its construction.

With respect to the sales (or purchases) of a given product or service, the general definition of the market share of firm *A* is

$$\text{market share of firm } A = \frac{\text{sales of firm } A \text{ of given product to customer group } X}{\text{all purchases by customer group } X \text{ of given product}}$$

It is clear that the market share of a firm can vary enormously as the definition of "given product" and of "customer group *X*" is changed. To take some extreme examples. Continental Bank's share of business loans to all American borrowers is very low; its share of loans to businesses who are its depositors is very high; its share of "bank savings deposits" is higher than its share of "bank and savings and loan deposits." And so on.

10. For a discussion of the theoretical issues involved in market definition, see Steiner, *Markets and Industries* in 9 INTERNATIONAL ENCYCLOPEDIA OF THE SOCIAL SCIENCES 575 (1968).

At this point the economist proposed an interesting experiment. Assuming that the bankers' distinction between "wholesale" and "retail" banking was a plausible hypothesis, and accepting the lawyers' view that the retail market was the legally relevant market, the economist suggested using observed data about banks and their customers to distinguish between "retail" and "wholesale" customers. Such a distinction, if tenable, could then be applied to Chicago banks and customers, and separate market shares and concentration ratios could be computed for retail banking business. These figures would presumably be better indicators of the effect of the merger on the intensity of competition in the retail market than the Government's balance sheet statistics, which mixed wholesale and retail as well as local and nonlocal customers.

The "experiment" was conducted and is described in detail below. It is worth spelling out our working hypotheses at the start:

1. The retail customer described by the bankers would find it difficult to bank outside of his own locality. He would be, in that sense, "locally limited." If we observed such customers, we would find them banking locally.

2. The wholesale customer would be able to bank either inside or outside of his own locality. Other things being equal, he might find it more convenient to bank locally; but other things would not always be equal. He would be what we call a "non-locally limited" customer. If we observed such customers, we would find some banking locally and others banking far from their own locality.

3. We might therefore sensibly begin our effort to distinguish between the retail and the wholesale customer by looking at those customers who banked locally and those who did not. The former group would include all of the retail customers and some of the wholesale ones; the latter group would be limited to the remaining wholesale customers.

4. We hypothesized that the ability of a customer to conduct his banking business outside his locality would correlate with measurable characteristics of his business, of the bank, and of the transaction.

In fact, our analysis was to concentrate on business loans—a most important segment of the banking business. The first stage would be to identify, if we could, those constellations of characteristics which account for differences between local loans and non-local loans. Identifying such characteristics would be only the first step, since the local-loan category includes some wholesale as well as all retail customers. But by isolating the differences between re-

tail customers and those wholesale customers banking nonlocally, we hoped also to provide the basis for the second stage of the analysis: to distinguish generally between retail (locally limited) and wholesale (non-locally limited) customers.¹¹

V. THE SEARCH FOR DATA

The analysis proposed by the economists (by this time there were two of them—economists, like lawyers, are prone to run in packs) required a substantial quantity of data. We needed information about the locations of bank and borrower and various other characteristics of the bank, of the borrower, and of the loan transaction. We also required a source of information that covered a very large and representative group of transactions.

The importance of a *large* body of data as the basis of the experiment requires some emphasis. In the physical sciences an experiment often consists of a limited number of rigorously controlled laboratory tests. In chemistry, a specific chemical is added to a specific mixture of chemicals and other factors, such as temperature, are held constant. The chemist then notes a specific reaction. Having controlled the factors involved, he has no need to repeat the experiment many times, although some repetition is always desirable to offset errors in measurement. The chemist knows that the added chemical caused the reaction because all other things were unchanged. On the other hand, the social scientist is forced to collect his experimental data from the real world; in our case data describing the normal working of banking markets was required. Such data would necessarily be the product of an *uncontrolled* experiment—other things can and do change from case to case. For this reason the range of factors that might have produced a given result was very large indeed. The social scientist who wants to know whether there is a "real" (or significant) relationship between factor *A* and result *B* must observe a very large number of cases in which factor *A* is present and a very large number of cases in which

11. In order to make this distinction clear, consider three bank customers: a small manufacturing company ("Tiny Manufacturing Co."), Sears, Roebuck & Company, and General Motors. From the point of view of a Chicago bank, these customers would be classified as follows:

	Location of principal office	Customer location relative to Chicago Bank	Customer banking alternatives
Tiny Manufacturing Co.	Chicago	local	locally limited
Sears, Roebuck & Co.	Chicago	local	not locally limited
General Motors	Detroit	nonlocal	not locally limited

it is not present and see whether there is a systematic relationship between factor *A*'s presence or absence and result *B*, even though other things are also changing. In fact, at present there are well-established statistical procedures for identifying a significant relationship if one exists, provided enough cases are examined.

Because the range of factors which might explain any given result in the real world is so broad, a large number of independent observations is required to determine whether a particular factor is influencing a given result. A pattern of correlation takes on increasing significance if it is encountered over and over again despite the fact that other factors are varying in an uncontrolled way. Thus, the fact that a man is shorter than his wife does not establish that men are shorter than women or that short men choose tall wives. However, if a representative sample of ten thousand men and women shows that the men are, on the average, several inches taller than women, we are justified in concluding that this pattern is a significant one and that men do indeed tower over women. (The matrimonial question would require a different set of data.)

Ideally, a lawyer trying to impress a court might have wished to study all loans made in the country. Since this was impossible—as well as unnecessary from the statistical point of view—we settled for a sample of transactions. In order for the results obtained from any such sample to permit valid inferences applicable to the population of loans we were ultimately interested in, our sample would have to be representative of the population. For such purposes a random sample is, paradoxically, ideal. The probability that a random sample will be representative can be predicted with statistical precision, and the probability that sample results closely match those which would be obtained if the entire universe were studied increases as the sample size increases.¹²

With unlimited time and money we could, of course, have set out to collect such data ourselves. But it is always convenient and often possible to use someone else's statistics which have usually been collected for some other purpose. Clients' records, government agencies, private organizations, and universities are all prime data sources. Fortunately, we discovered that in 1955 the Federal Reserve Board had conducted a sweeping survey of the business lending activities of a sample of almost 2,000 of its 6,000 member banks. This survey of over 180,000 separate loan transactions se-

12. It is beyond the scope of this Article to describe the intricacies of survey design and sampling techniques. But these are well-established and thoroughly accepted by statisticians.

lected on a statistical sampling basis accurately reflected the characteristics of more than 1,185,000 business loans totalling more than \$30 billion. In addition to the location of both borrower and bank, the Federal Reserve study contained information about a variety of characteristics of bank, customer, and loan—many of which seemed likely to be relevant to our inquiry.¹³

13. The consent of the Board of Governors of the Federal Reserve System was necessary before we were able to obtain the data from the 1955 survey. To obtain this consent, we made contact with the key economists at the Research Department of the Federal Reserve Board to discuss the possibility of using the 1955 business loan survey data. It was relatively easy to convince these economists that our proposal was based on a carefully conceived, feasible research program which would yield results of general interest to the Board and the banking and academic communities. This was helped by a preliminary analysis of the work already done by the Federal Reserve Board, which showed some significant correlations and suggested the need for further work along the lines we proposed.

There was, however, one stumbling block which is likely to arise in many attempts to use data sources developed by other organizations for their own use. The 1955 business loan survey, though already coded in machine-readable form, contained detailed information permitting the identification of individual banks as well as bank customers. For the Federal Reserve Board to reveal such information would have violated the confidential basis on which it was collected from the banks. Our ability to use the data depended upon our ability to use the data without requiring such disclosure.

Since this problem is likely to arise often, a few words about our solution of it are in order. One expedient involved the suppression of data that identified the lending bank. Instead of identifying each bank by a code number and by its location and size, as the original data did, we reclassified the data to have a new bank identification number assigned that referred to three (or more) banks of the same general size in the same location. In a few cases it was necessary to have banks from different localities in the same group. Where this was necessary, an attempt was made to choose similar localities to group together. Each loan transaction was kept separate in other respects; a computer print-out would show only that one of these banks had made a certain loan, but not which one. The use of *small* groups to avoid disclosure without at the same time losing all of the information about individual entities has been used in other connections—for example, in analyzing confidential data reported by television broadcasting stations to the Federal Communications Commission. If there is to be no identification it is necessary that each group contain a minimum of three reporting entities; in this way even one of the three grouped banks cannot identify the data for one of the other banks with which it is grouped.

A second expedient was to replace precisely coded values of variables by quantitative intervals. For example, all borrowers with total assets of \$1,000,000 to \$5,000,000 would be coded as of the same size class.

Care must be taken in reclassifying data for the purpose of avoiding disclosure not to throw away information that might be important. When a group of banks (as in this case) is created, any differences among the banks in any one group disappear and cannot be focused upon for their explanatory value in the analysis that follows. Thus, any potentially relevant variables must be preserved, particularly in an adversary proceeding. Our grouping of banks assumed that bank size and bank location were relevant. If on the other hand we had supposed that the age of bank was important, a different set of groupings would have been in order. Although it ultimately developed that bank size was not an important variable for our purposes, we could not have assumed this nor would we have been unchallenged had we assumed it.

By grouping banks and adjusting class intervals it was possible to assure the Federal Reserve Board that we had a reclassification scheme in which no bank or borrower would be identified in any individual transaction. With this assurance the Federal Reserve Board gave permission to utilize the data. A computer program was

No secondhand data are ever wholly satisfactory, and this set was no exception. Five principal deficiencies became apparent:

1. The data were for 1955, six years before the merger date. This was potentially a serious weakness, but the basic patterns of bank and customer behavior we were looking for would not be likely to change rapidly.¹⁴ Research disclosed that the 1955 survey was the only suitable source of data for our purposes.¹⁵

2. The data, although a random sample of loans of banks in the Federal Reserve System, did not sample the 50 per cent of the nation's banks which are not members of the Federal Reserve System. Comparable data for nonmember banks was not generally available, although (fortunately) we were able to find such data for the Chicago metropolitan area in the final stages of the study.¹⁶

3. The data referred only to business loans. This meant that we would have to focus on the business-lending aspect of the banking business, but that was, after all, a most important aspect. In the *Philadelphia Bank* case the Antitrust Division relied heavily on testimony about the supposed plight of the small businessman, and the Supreme Court reflected this concern in its opinion.¹⁷

4. The data did not consider business loans of nonbank financial institutions. The economists urged that we supplement these data in order to consider the effect of competition from nonbank financial institutions in defining markets and computing market shares. Plainly, the addition of nonbank competitors might dramatically reduce concentration in the market.¹⁸ After the decision in the *Philadelphia Bank* case, however, it seemed equally plain to the lawyers that the appropriate "line of commerce" in bank merger cases under section 7 of the Clayton Act was commercial banking.¹⁹

developed which took the original data, reclassified it, and produced a new computer tape containing the essential information about each of the 180,000 loan transactions in the 1955 Loan Survey. This tape can not be used to discover confidential information about individual banks or borrowers.

14. Our efforts to update the 1955 data to 1961 are briefly described in note 46 *infra*.

15. The Federal Reserve Board had conducted a similar wide-ranging study of business loans in 1957. However, this study omitted the critical variable of borrower location and it was therefore of no value to us.

16. See note 42 *infra*.

17. 374 U.S. at 369.

18. Refer to the equation contained in note 9 *supra*. Nonbank custom would increase the denominator of the ratio without changing the numerator. It would thus necessarily reduce the market shares of *banks*. By way of contrast, our proposal was to compute concentration ratios based on the elimination of "wholesale" business. This would affect both the denominator and numerator of the ratio and need not necessarily reduce concentration.

19. This question has perhaps been reopened by the Bank Merger Act of 1966, 80 Stat. 7.

The lawyers therefore rejected this academic advice, at least for the purposes of this litigation.

5. The basis of sampling was the individual loan, not the individual borrower. This seemingly minor point became very important at a later stage in our analysis.²⁰

Had this body of data not been available, our subsequent research would have been different but we should still have been able to splice together other smaller bodies of data and make some progress toward defining the relevant market.

VI. IDENTIFICATION OF THE SIGNIFICANT VARIABLES

With the data available we set about our research for an explanation of the differences between local and nonlocal loans. In quantitative analysis the search for objective explanations begins with the identification of systematically related variables. If two variables tend to be systematically related, as are the height and weight of individuals, they are said to be "correlated." The degree of correlation may vary from very low to very high. At one extreme, "zero correlation" means that there is no systematic tendency for a relationship between the variables. At the other extreme, "perfect correlation" implies that all of the variation in one variable can be accounted for by variation in the other.²¹

Our first objective was to determine whether we could account for a substantial part of the difference between local and nonlocal loans on the basis of systematic correlation with other measurable variables. The 1955 business loan survey made this possible because every loan covered by the survey was identifiable as either a local or a nonlocal loan; it was clear if the borrower and the bank were located in the same place or in two different places.²² The survey also contained information about some twenty-five additional char-

20. See pages 1666-68 *infra*.

21. See note 26 *infra*.

22. In the 1955 survey a loan was considered local if the borrower's address was in the same city, county or metropolitan area (whichever was the largest) as that of the bank. For example, a loan made by a bank in Chicago to a customer located anywhere in the Chicago metropolitan area, including the suburbs, was treated as a local loan. We established, as a separate exercise in quantitative analysis, that *this* area was indeed the proper local "retail" market area by an analysis of the geographic distribution of the retail business of the Continental and City National Banks, and also by special surveys of seven other smaller banks in the area, selected in a random manner. The analysis showed that the area served by a bank did not always cover the entire metropolitan area, but the coverage increased as the size of the bank increased. There was so much overlapping of areas served, however, that it was clear that only the metropolitan area as a whole was a satisfactory market definition, rather than some smaller area, as the government contended.

acteristics of each such loan transaction.²³ On the basis of our conversations with bankers, the testimony in previous cases, economic theory, and common sense, we expected to find that some of these characteristics, such as loan size, borrower size, and bank size, would help account for the difference between local and nonlocal loans.

Well-established statistical techniques permit the determination of whether and to what extent each of a series of "independent variables"—in our case factors such as loan size, borrower size, and bank size—helps account for the variation in the "dependent variable"—in our case whether the loan was local or nonlocal. The phrase "significantly correlated" means that a systematic relationship is strong enough to make it highly improbable that it reflects mere chance.

One way to suggest the approach is to look at a simple one-way tabulation of the data. Table 1 shows the relation between size of loan and the location characteristic.²⁴ This table summarizes information covering all of the loans in the 1955 survey, over 180,000 sampled transactions representative of over one million loans. Table 1 clearly shows that, ignoring all other factors, the percentage of loans made locally decreases as the size of loan increases. Although any particular loan might be local or nonlocal for a large number of reasons, the pattern which emerges from this table suggests that *one* of the important reasons has something to do with the loan size.

A similar finding emerged for borrower size, as shown in table 2. Ignoring all other factors, the tendency to borrow nonlocally increases as the size of the borrower increases.

On the other hand, not all of the factors we had chosen exhibited such a clear relationship. As table 3 shows, for example, increasing bank size is not associated with any clear pattern in the location characteristic of the loans.

From these three tables we are not entitled to conclude that

23. A partial listing of these characteristics is as follows:

Bank characteristics: Federal Reserve district, state, city of the lending bank; (from these we also can derive branching status, and city size); size of bank (total deposits); loan ratio.

Borrower characteristics: Legal form of organization, date of organization, business of borrower; city location of borrower; location relative to lending bank; size of borrower (total assets).

Loan characteristics: Original amount of loan; amount outstanding; original maturity of loan; bank participation; call class of loan; repayment method; type of collateral; effective interest rate; date loan made; federal government participation or guarantee.

24. In our analysis we actually looked both at *number of loans* and *dollar balance* of loans. In this exposition we will limit attention to number of loans. This is partly a matter of convenience, but more basically since the loan survey was a sample of *loans*, it is each loan that is an independent observation, not each dollar. In general, the results were similar whether number of loans or dollar amount was used.

TABLE 1
Loan Size and Loan Location

Loan Size ^a	Percentage of Loans Made Locally
Under \$10,000	90.3%
\$10,000-25,000	88.5
\$25,000-50,000	85.9
\$50,000-100,000	81.5
\$100,000-200,000	75.5
\$200,000-500,000	63.7
\$500,000-1 million	57.5
\$1 million-5 million	46.1
\$5 million-10 million	37.5
\$10 million and over	38.9
All Loan Sizes	88.7

a. Here and elsewhere, lower limit inclusive.

TABLE 2
Borrower Size and Loan Location

Borrower Size (Total assets)	Percentage of Loans Made Locally
Under \$50,000	90.5%
\$50,000-250,000	91.2
\$250,000-1 million	86.6
\$1 million-5 million	75.0
\$5 million-25 million	56.1
\$25 million-100 million	38.0
\$100 million and over	33.8
All Borrower Sizes	88.7

TABLE 3
Bank Size and Loan Location

Bank Size (Total deposits)	Percentage of Loans Made Locally
Under \$50 million	91.0%
\$50 million-200 million	85.0
\$200 million-400 million	86.0
\$400 million-1.5 billion	82.0
\$1.5 billion and over	91.0
All Bank Sizes	88.7

loan size and borrower size are important but that bank size is not. It does not suffice to examine separately each of a series of possible independent variables in relation to the dependent variable, location of the loan transaction. It is entirely possible that two separate characteristics, each of which appears to relate systematically to differences in the location characteristic, are really measuring the same thing. Everyone knows that borrowers of large amounts tend to be

larger firms; indeed, a large loan creates a large asset. The apparent relationships in tables 1 and 2 may really be due to only one of these characteristics; there is no way to tell which from those tables. One way to sort out these relationships is to cross-classify by both variables, as is done in table 4. In this table every *row* examines the variation according to borrower size for a given size of loan. A row partakes of the "controlled experiment" in which we examine the effect upon the location characteristic of variation in customer size holding loan size constant. Each *column* holds customer size constant and looks at the effect of loan size. Since each row of table 4 shows a systematic relation between customer size and the location characteristic, we can conclude that customer size plays a role *independent* of loan size. And, since each column shows a systematic relation between loan size and the location characteristic, we conclude that loan size also plays a role *independent* of customer size.

We have made progress, but we are not ready to conclude that both loan size and customer size are important explanatory variables. The reason is that table 4 ignored a variety of other variables. For example, in that table we included all loans—some were single bank loans, some pool loans, some secured, some unsecured, some at higher interest rate than others, and so forth. Perhaps the apparent pattern of table 4 is due to differences in *these* respects; the apparent relationship between loan and customer size may be a spurious one reflecting other "real differences" that just happen to be correlated with loan and customer size. Apparent relationships often disappear when considered with other factors.

These first tentative steps into the mystery of quantitative multivariate analysis have taken us to the very heart of the experimental process we are describing. Since it is impossible to *control* variables in a social or economic context as a physical scientist does in a physics or chemistry experiment, it is necessary to introduce such controls by studying a large number of actual events in all of their complexity. This would be impossible without the techniques of modern statistics and the mechanical assistance of the computer. With the computer, it is simply a matter of gathering the data, designing the computer program to process the data, and feeding it all into the computer. Out pops the result: an acre of tables or mathematical formulae. (Patience: you are paying your experts to teach you how to reduce the tables to reasoned verbal arguments.)

In principle, the computer is used to classify the basic information so that the interrelationships between the various indepen-

TABLE 4
Loan Size, Borrower Size, and Loan Location
(Percentage of Loans Made Locally)

Loan Size	Borrower Size (Total Assets)							All borrower sizes**
	Under \$50,000	\$50,000-250,000	\$250,000-1 million	\$1 million-5 million	\$5 million-25 million	\$25 million-100 million	\$100 million and over	
Under \$10,000	90.6%	91.6%	86.3%	82.7%	71.5%	74.4%	48.5%	90.3%
\$10,000-25,000	89.3	90.7	87.2	73.3	59.9	50.7	41.2	88.5
\$25,000-50,000	83.6	89.7	88.0	76.4	59.4	24.7	43.5	85.9
\$50,000-100,000	91.0	87.7	86.5	75.9	48.2	41.1	24.5	81.5
\$100,000-200,000	79.8	89.2	84.5	72.7	52.9	27.0	29.1	75.5
\$200,000-500,000	50.3	81.3	81.2	71.4	52.3	38.2	26.0	63.7
\$500,000-1 million	25.0	57.5	74.5	71.2	60.3	35.7	29.0	57.5
\$1 million-5 million	*	59.3	43.4	62.4	56.5	40.1	33.5	46.1
\$5 million-10 million	—	—	*	*	48.6	37.3	35.0	37.5
\$10 million and over	—	—	—	—	40.9	29.6	45.6	38.9
All loan sizes	90.5	91.2	86.6	75.0	56.1	38.0	33.8	88.7

* Six or fewer loans in cell.

** Includes borrowers of unknown size.

— No loans in cell.

dent variables and the dependent variables are fully revealed. There are two basic ways to do this. One way is the *cross-classification*: a table or a series of tables in which each variable under study is introduced and related to each other variable. Table 4 is an example of a two-way cross-classification. In preparing a cross-classification, the computer pigeonholes each transaction in an appropriate "cell" described by the particular values of each of the variables under consideration. It then prints out each cell in a prespecified pattern, adding up and perhaps performing calculations upon the observations in each cell. Thus, in table 4, the upper left hand cell represents loans of under \$10,000 to borrowers with assets of less than \$50,000. The computer has stuffed the cell with all such loans and then computed the percentage of such loans which were made to local customers. The result is 90.6 per cent.

The only technological limit to cross-classification is the memory capacity of the computer. There is, however, a limit to the process, even for the expert, because the addition of every new variable multiplies the number of cells by the number of possible values of the new variable. A simple example will make this clear. Suppose we visualize nine categories of loan size, nine of customer size, five of bank size, and ten categories of type of loan. There are 81 (9×9) distinct combinations of loan size and customer size. Each of these eighty-one cells can contain loans by each of five bank sizes; thus there are 405 distinct loan-customer-bank size classes. But each of these cells can contain ten different types of loan. To distinguish among them while still maintaining all of the previous distinctions requires 4,050 distinct cells. It would take a very large body of experimental data to "fill" a cross-classification with 4,050 cells to such an extent that significant patterns would be apparent. The great virtue of the Federal Reserve Board's 1955 business loan survey was in its 180,000 sampled transactions which represented over one million loans; the large number of observations permitted extensive cross-classification. In this respect, our most serious restraint was the inability of the mind to interpret what spewed out of the computer. Our largest cross-classification contained over 200 pages of computer printout; each page contained ninety-nine cells; six independent variables were cross-classified.

The 1955 business loan survey contained over twenty-five variables of potential interest to us. No single cross-classification could realistically examine this number of variables.²⁵ Fortunately, the

25. Consider the approximate number of cells. Suppose each variable had only 5 values. This means 5^{25} cells—an astronomical number of the order of a billion billion.

social scientist, aided and abetted by the mathematical statistician, has other tools for dealing with problems of this complexity. The most important is *regression analysis*, which examines simultaneously a large number of independent variables using computer-assisted mathematical techniques. Given a properly constituted body of observations, regression analysis can give estimates of the effect of changes in each independent variable on changes in the dependent variable, holding all other independent variables constant. It can also reveal the likelihood that these observed relationships in the data are the result of chance or reflect actual relationships in the universe from which the data was collected. Furthermore, regression analysis will show how much of the variation in the dependent variable is accounted for by variations in the independent variables studied or, conversely, how much of the variation in the dependent variable is the result of chance, measurement errors, or the influence of other variables not included in the analysis. Here we enter an area which borders on the occult.²⁶ Suffice it to say that, in the

Even our enormous sample of 180,000 loans would appear as flecks of dust in a mountain of zeros in any cross-classification containing so many cells.

26. We cannot give the uninitiated a short course in statistics here. But we can at least illuminate the vocabulary by a somewhat oversimplified illustration. The following are the hypothetical results of a regression analysis in which an attempt was made to relate variation in a dependent variable (Y) to three independent variables (X_1 , X_2 , X_3):

Hypothesized Relationship:	$Y = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \epsilon$
Relationship to be estimated:	$Y' = a_1 X_1 + a_2 X_2 + a_3 X_3$
Computed Relationship:	$Y' = .20X_1 + .04X_2 - .13X_3$
Coefficient of Determination:	$R^2 = .61$

Significance of Regression Coefficients

Coefficient	Standard error	t ratio	Significantly different from zero at 5% level
a_1	.05	$\frac{.20}{.05} = 4.0$	yes
a_2	.002	$\frac{.04}{.002} = 20.0$	yes
a_3	.09	$\frac{-.13}{.09} = 1.4$	no

The measures a_1 , a_2 and a_3 are called *regression coefficients*; they are estimates of α_1 , α_2 and α_3 . Each regression coefficient tells how much the dependent variable (Y) changes on average for each unit change in the particular independent variable, holding the other independent variables constant. For example, the fact that $a_1 = +.20$ means that for a 10 unit increase in the value of X_1 , it is predicted that Y will increase by 2 units on the average, assuming no change in X_2 or X_3 .

Continental Bank case, the consulting economists used regression analysis to examine a large number of variables and to eliminate a number of variables which were found to be unimportant.²⁷

In the *Continental Bank* case we deliberately chose cross-classification instead of regression as the primary technique of multivariate analysis for two reasons. First, the lawyers were convinced that a courtroom presentation based on a regression analysis would strain the limits of judicial tolerance. Second, in some areas, cross-classifications were more revealing of significant relationships than was regression analysis.²⁸ But cross-classification was used only on the variables that regression analysis suggested might prove significant.

The absolute size of the regression coefficients is not necessarily an indication of their importance, for two reasons. The first is that the importance of a coefficient depends on the units in which the X's and Y are measured as well as the range of their variation. For example, using the hypothetical formula given above, suppose that X_1 can vary only from 0 to 2, that X_2 can vary from 100 to 1000, and that Y is normally a number with a value like 50. The predicted variation in Y resulting from the maximum variation in X_1 would be .4 ($2 \times .2 = .4$). This is a relatively unimportant variation where Y is normally in the range of 50. On the other hand, a maximum variation in X_2 would be 900 and the predicted effect on Y from such a variation would be 36 ($900 \times .04 = 36$). This is a relatively important variation.

The second reason that the absolute size of the regression coefficient does not indicate their importance is that these figures are averages. Their reliability depends on how much variation there is around the average, looking at the individual cases. The *standard error* of the regression coefficient gives a measure of that variability. Roughly two-thirds of the individual observations will lie within \pm one standard error of the mean of a normally distributed variable and 95% will lie within \pm two standard errors. For example, the value of a_1 (.20) is more than twice its standard error (.05). Hence there is less than a 5% chance that the true value of the coefficient (X_1) is equal to zero, and the value of a_1 is the result of sampling variation. Using this widely accepted 5% test in our example, both a_1 and a_2 are "significantly" different from zero in the sense that it is highly improbable that they reflect sampling variation from an α_1 or α_2 equal to zero. On the other hand, a_3 has a value less than twice its standard error and there is more than a 5% chance that it comes from an $\alpha_3 = 0$.

Finally, the *coefficient of determination* R^2 shows how much of the variation in Y is accounted for by the estimated relationship with X_1 , X_2 and X_3 . In our example 61% is accounted for. The "unexplained" 39% is presumably due to chance, to errors in measurement, and most important to the potentially enormous list of other variables that also influence Y. All of these are embodied in the ϵ ("*epsilon*" or "error") term in the hypothesized relationship.

27. For example, interest rate was eliminated as an important variable. Although the regression coefficient of the interest rate variable was significantly different from zero, even if this variable could vary over its complete range, holding other variables constant, its estimated effect would only account for a change of 2% in the proportion of loans that are nonlocal. The potential contribution of the interest rate is even less than this because of its high degree of correlation with loan and borrower sizes and other variables. For *given* values of the other variables its variation would be restricted and its independent variation would account for a considerably smaller change in the proportion of nonlocal loans.

28. This was true, for example, of the effect of secured as contrasted with non-secured loans, where the effect was limited to one type of loan. See note 32 *infra* and accompanying text.

The relatively small list of six variables of demonstrated significance in explaining variation in the location characteristic of the loan produced the 200-page cross-classification mentioned above. It was designed to reveal the nature of the relationships in a way that was amenable to understanding by the lawyers and to presentation to a court. These six important variables were loan size, borrower size, participation status of the loan, secured status of the loan, size of the borrower's city, and the nature of the branch banking laws in the borrower's state.

VII. THE SIGNIFICANCE OF THE SIGNIFICANT VARIABLES

The identification of "significant" variables is a matter of applying well-known and professionally accepted statistical techniques. This aspect of the total experimental process is dependent upon sophisticated mathematical analysis as well as upon the use of computers. Although the lawyer is likely to be left far behind the experts in this area, his expertise and understanding of the realities of the case are essential when it comes to the *interpretation* of the significant characteristics.

Thus far, our study had revealed only the significant differences between local and nonlocal loans. Our real interest lay in the identification of locally limited as opposed to non-locally limited loans. The local loan category included some wholesale customers who could have borrowed nonlocally had they wished. We needed to distinguish between variables causally related to the necessity of borrowing locally and variables that reflected mere convenience in banking locally. Since we wished ultimately to develop a standard of local limitation for application to the Chicago metropolitan area, we were interested only in factors that could be operative there in identifying wholesale and retail bank customers. With these goals in mind, we settled to the task of deciding why the significant variables were significant.²⁹

A. Loan Size

As table I indicates, the percentage of loans made locally shows a clear and steady decline as the size of loan increases. Nonlocal loans, in other words, tend typically to be larger than local loans. It is not hard to find causal factors that link loan size to local lim-

29. All of the following statements about the "facts" are based upon the full multivariate analysis. They are, in other words, the net of the effect of the other variables included in the analysis.

itation. The larger the loan, the more attractive it becomes to bankers. Moreover, a large loan justifies the bank expenditures required to establish the credit position of the borrower. Widely dispersed banks are willing and able to consider such loans and to make a good fraction of them. Conversely, the small borrower often finds that the costs of getting information about himself to banks in areas where he is not known makes such banks either totally unwilling to deal with him or willing to do so only at prohibitive interest rates. Loan size, we concluded, was a measure of ability to borrow nonlocally.

B. *Borrower Size*

Table 2 demonstrates that the percentage of loans made nonlocally shows a marked tendency to increase as borrower size increases. The distinction is particularly pronounced between borrowers with assets over and under \$1 million. Again, causal links with ability to borrow nonlocally are easy to find. Large companies tend to have well-established national credit ratings, widely dispersed business activities, standing contacts with banks in many parts of the country, and a need for a large variety of banking services (including large deposit accounts and corporate trust department services). All of these factors make the large borrower an attractive customer for many banks. We concluded that borrower size was a significant indicator of whether or not a loan was locally limited. As noted above,³⁰ these two factors have independent significance; table 4 shows that an increase in the size of the loan or in the size of the borrower results in an increase in the proportion of nonlocal loans, even though the other factor is held constant. In other words, large loans to small borrowers and small loans to large borrowers both tend to show a greater proportion of nonlocal loans than small loans to small borrowers.

C. *Participation Status of Loan*

This variable distinguishes between types of loans on the basis of the number of banks involved: single-bank loans; "overline participation loans," in which one bank—the "originating bank"—shares with another bank a loan which the originating bank does not wish (or is not legally permitted) to make alone; and "pool loans," in which the customer negotiates with a group of two or more banks to meet its borrowing requirements. The statistical

30. See page 1655 *supra*.

analysis showed that almost 90 per cent of all single-bank loans were local in character, while only 45 per cent of all pool loans were local. Overline loans, like single-bank loans, were predominantly local when viewed as loans of the originating bank (85 per cent local), but for the nonoriginating bank were even less localized than pool loans (only 37 per cent local).

A pool loan by definition is one in which a borrower chooses to deal with a group of two or more banks. A borrower with sufficient sophistication to undertake this sort of arrangement will tend to exploit the competitive advantages of negotiating with a large number of banks, some of which are likely to be outside of his local area; hence the large proportion of nonlocal pool loans. We were prepared to regard the difference between pool loans and single bank loans as reflective of ability to borrow nonlocally.³¹

Overline loans presented a different problem. Ordinarily, in an overline loan only the originating bank deals with the borrower; the other bank participates in the loan at the request of the originating bank. The borrower may not even be aware that the second bank is involved. The economists initially suggested that overline loans be divided into two groups; those loans made by the originating bank would be lumped with single bank loans, those loans made by the nonoriginating bank would be considered with pool loans. On the basis of the statistical findings, this classification seemed reasonable since the two types of overline loans appeared to share the statistical characteristics of the single bank and pool loans, respectively. Upon consideration of the banking realities of the situation, however, we realized that this solution was erroneous. Since our analysis was focusing on the borrower's behavior in relation to his bank or banks, it was irrelevant that banks chose to place overlines with nonlocal banks. Thus, the low level of local loans in the category "overlines originating at another bank" revealed nothing about customer-bank relationships. The customer's ability to deal with banks in various localities could be measured only by looking at the bank with which he dealt—the originating bank. Hence, for the purpose of identifying local limitation, only the experience of the originating bank was significant.

D. Secured Status

In this case our hunches were not confirmed by the figures. We had been reasonably sure before the data were processed that

³¹. Again this effect is in addition to the effect of other variables such as loan size or borrower size.

whether or not a loan was secured would prove to be significant. We suspected that secured loans would tend to be less local than unsecured loans because collateral would make a borrower more attractive to distant lenders. We were quite wrong. There was a significant relationship, but it was complex. For overline participation and pool loans, the existence of collateral had no significant effect. For single-bank loans, the cross-classification showed that both where the borrower was small (assets under \$1 million) and where the loan was small (under \$25,000) secured loans were significantly *more* local than unsecured loans. A partial explanation of this finding may be that if a relatively small business borrower needs collateral to obtain a loan, this suggests a weakness in his credit rating which frightens off nonlocal banks. If this is so, "secured status" is serving as a proxy for a variable not included in the analysis: "credit rating." Assuming that this was the case, we concluded that in the case of single-bank loans the presence or absence of collateral would have to be taken into account in determining local limitation.³²

E. *Size of Borrower's City*

Table 5 reveals that, in addition to the other significant variables, the larger the borrower's city, the smaller the percentage of loans

TABLE 5
Size of the Borrower's City and Loan Location

Size of Borrower's City (population)	Percentage of Loans Made Locally
Cities of 8 million and over	97.0%
Cities of 2 million to 8 million	96.3
Cities of less than 2 million	93.6
Unclassified Cities and other areas	84.1
All City Sizes	88.7

made nonlocally. All other things being equal, a borrower in New York is more likely to borrow at home than a borrower in Philadelphia or Kalamazoo. At first glance this may seem surprising; one might expect the New York borrower to be more sophisticated financially, and one would hardly expect his credit with nonlocal banks to be adversely affected by the size of his city.

³². Use of a variable for only part of the data may sound peculiar, but it is not. Perhaps an illustration from far afield will help to clarify the problem. Studies of labor force participation show that age and sex are highly important variables in explaining whether or not a person is in the labor force. The number and age of the individual's children is very important for women, but of no importance for men, for obvious reasons. A careful analysis of the problem will include this variable for women, but not for men.

In fact, we concluded that this factor does not reflect inability to borrow nonlocally, but rather indicates less need to do so. We reasoned that non-locally limited customers would borrow locally only if local banks had adequate resources. Accordingly, other things being equal, borrowers in large cities would be more likely than those in small cities to deal with local banks simply because the banking resources of a large city are greater than those of a smaller city. In interpreting the data in order to identify ability to borrow nonlocally, the city-size relationship complicates rather than simplifies. It emphasizes that some local loans are indeed made to non-locally limited borrowers. This factor had to be accommodated in our subsequent analysis.

F. *Branch Banking Situation at Borrower's Location*

Borrowers in states where the banking laws permit operation of branch banks tend to secure a significantly larger percentage of their loans within their local area than do borrowers in unit-banking jurisdictions which permit a bank to have only one business office.³³ The explanation of this finding also appears to reflect available banking resources and not local limitation. In general, the resources of the banking system are more widely available to borrowers in branch banking states than in unit-banking states. The widespread branches of a large bank can readily draw on the resources of the home office. The Bank of America—although headquartered in San Francisco—is in the same community as the borrower in Sacramento; but the First National Bank of Chicago is a nonlocal bank to the borrower in Peoria.

G. *Summary*

We concluded that four of the six independent variables significantly related to loan location would be directly useful in developing a standard of local limitation: loan size, borrower size, participation status of loan, and secured status of loan. We felt that the remaining two variables, borrower's city size and borrower location in a branch-

33. The one-variable classification on the basis of branch as compared to unit-banking states (similar to tables 1, 2, 3 and 5) showed only a small difference in the percentage of local loans when number of loans was taken as a measure (customers in branch banking states: 89.9% local loans; customers in unit-banking states: 85.4% local loans). The difference was more marked when dollar amounts rather than number of loans was considered (branching: 69.5%; unit: 51.9%). Furthermore, this pattern persisted through the multivariate tables, justifying its inclusion as a significant variable.

or unit-banking state, did not reflect the ability of a borrower to borrow outside his own locality but rather indicated his need to do so.

VIII. DEVELOPMENT OF THE STANDARD OF LOCAL LIMITATION

The problem remaining was to distinguish between the local "retail" customer and the local "wholesale" customer who presumably could borrow nonlocally. The economists suggested that those local borrowers who shared the distinguishing characteristics of the nonlocal borrower be classified as non-locally limited. For example, since nonlocal loans tended to predominate among very large loans, we would treat very large local loans as not locally limited. Since nonlocal loans tended to predominate among loans to very large borrowers, we would treat local loans to very large borrowers as not locally limited. We would attempt to define and adopt a quantitative standard for drawing a line between locally limited and non-locally limited customers based upon the constellation of characteristics that were associated with those borrowers who had demonstrated by their actual loan behavior that they were not locally limited.

The economists designed the second stage of the analysis to build upon the foundations laid by the first. The prior steps had included all of the loans in the 1955 loan survey in order to have the widest possible range of data from which to determine the basic patterns. For the second stage, we restricted the sample to loans made to borrowers in unit-banking states, since we had concluded that the loan location characteristic with respect to borrowers in branch banking states was influenced by the reduced need of such borrowers to look elsewhere for loans and since the *Continental Bank* case required us to define the locally limited market in Illinois, a unit-banking state. On the other hand, it was impossible to make a similar allowance for the effect of the size of the borrower's city without unduly restricting the body of experimental data; Chicago was alone in its population size class (two to eight million) in unit-banking states.

The next step was to divide the loans to borrowers in unit-banking states into five categories corresponding to their participation and secured status. Separate consideration was to be given to (1) single-bank secured loans, (2) single-bank unsecured loans, (3) overline loans (originating bank), (4) overline loans (nonoriginating bank), and (5) pool loans. For each of these five types of loan we set up a table classifying transactions by loan size and borrower size. Each such table constitutes a part of the cross-classification on the four variables (loan size, borrower size, participation status, secured

status) we had identified as both relevant for distinguishing local from nonlocal loans and reflective of ability to borrow nonlocally.

One of these five tables is table 6. Each cell in table 6 contains information about single-bank unsecured loans of a specified size to borrowers of a specified size. The number in the cell shows the percentage of all such loans which were made to local borrowers. As expected, this table shows in almost every row and column a decreasing proportion of local loans as loan size and borrower size increase.³⁴ In general, local loans predominate in the upper left hand part of the table and nonlocal loans predominate in the lower right hand part. Our problem was to find a boundary—running approximately from lower left to upper right—that divided the table into locally limited and non-locally limited characteristics.

In deciding where to draw this boundary line, we began with the proposition that the higher the percentage of nonlocal loans in any cell, the greater the likelihood that other borrowers of the same size borrowing the same amount would be able to borrow nonlocally. The question then was how large a percentage of loans in a specific cell must be made nonlocally to permit the inference that all other loans with the same characteristics might also have been made nonlocally. Nothing in our statistics to this point answered this question. Clearly, as long as any wholesale customers chose to deal with local banks in whole or in part, some non-locally limited loans would be local loans.

After further consideration, we were led to an estimated boundary figure of 25 per cent nonlocal loans as the level which would entitle us to classify all loans in a cell as non-locally limited loans. Looking at table 6, this means that cells with a local loan percentage of 75 per cent or more were considered as locally limited. In our selection of this standard, great emphasis was given to two considerations which may cause non-locally limited loans to appear as local loans in the table. The first of these factors we have met before: many borrowers who are not locally limited will conduct much of their borrowing activity locally simply because loan banks have sufficient resources for the borrowers' needs and offer loans on competitive terms. This is particularly true of large city borrowers, who are included in this table and play an important part in the over-all sample. The second consideration arises from the fact that the data

34. The patterns are not as completely systematic as those shown in table 4 because, as a result of breaking down the data into such detail, the number of transactions reflected in many cells is relatively small, and hence the fluctuations due to chance and individual circumstances are greater.

TABLE 6
Standard of Local Limitation
Single Bank Unsecured Loans to Borrowers in Unit Banking States
(Percentage of Loans Made Locally)

Loan Size	Borrower Size (Total Assets)							
	Under \$50,000	\$50,000-250,000	\$250,000-1 million	\$1 million-5 million	\$5 million-25 million	\$25 million-100 million	\$100 million and over	Unknown
Under \$10,000	94.1%	93.7%	88.4%	86.6%	62.2%	100.0%	63.4%	3.8%
\$10,000-25,000	93.3	91.8	84.2	77.4	70.0	—	19.6	52.6
\$25,000-50,000	73.9	88.6	87.6	72.0	42.7	26.8	29.2	100.0
\$50,000-100,000	100.0	88.7	86.7	66.7	37.0	11.4	1.9	—
\$100,000-200,000	*	95.1	79.8	68.5	43.4	7.3	7.1	*
\$200,000-500,000	—	*	72.4	63.6	40.5	30.7	19.0	*
\$500,000-1 million	—	—	58.0	63.0	43.1	22.7	4.9	—
\$1 million-5 million	—	*	—	45.7	45.0	25.4	14.8	—
\$5 million-10 million	—	—	—	—	*	*	3.9	—
\$10 million and over	—	—	—	—	*	*	9.7	—

The solid line divides locally limited loans (above line) from non-locally limited loans (below line). The broken line corresponds to the standard of local limitation utilized in the *Manufacturers Hanover* case.

* Six or fewer loans in the cell.

— No loans in the cell.

in the 1955 business loan survey concern individual loan transactions, not individual customers. The significance of this is easily demonstrated. Suppose one borrower had three outstanding loans of equal size, two from banks in his own city and one from a distant bank. He has demonstrated by his behavior that he is not locally limited. But in the survey his activities would be recorded as three separate loans, all in the same cell, with a "local percentage" of 67, even though he is demonstrably able to borrow nonlocally.

There is yet another consideration which suggests that the 25 per cent nonlocal loan standard was a reasonable and conservative one. The 1955 survey showed that only 11 per cent of all loans were made nonlocally. The standard we had adopted, therefore, required an incidence of nonlocal loans over twice as high as that which would be expected in an "average" selection of loans. There was, of course, nothing sacred about the 25 per cent standard; we might have used 20 per cent or 30 per cent instead.³⁵ But our judgment, based on the banking data and what we knew about banking practices, told us that the correct percentage lay somewhere within that range. Subsequently we utilized a completely different set of data to validate this approximation.

With this decision made, drawing the boundary shown by the solid line on table 6 was a routine matter.³⁶ A similar boundary was drawn on the tabulations for single-bank secured loans, for overline loans by originating banks, and for pool loans. Of course, the location of the boundary line differed in each case, and the fraction of loans classified as locally limited changed because of the effect of secured status and loan type on local limitation. Overline loans by nonoriginating banks, which were predominately nonlocal in character, were classified according to the boundary developed for over-

35. For the reader bothered by the use of a standard based on a minority of the transactions in a given cell, an example chosen from a quite different area might be helpful. Suppose one wanted to estimate the ages at which women usually bear children. Suppose further that the available data to answer this question consisted of a large sample of women giving the age of each and whether she had a child during the previous year. Since in a large group of women only a small percentage have children in any year, any age group in which a higher than average number of women had children during the year would be an obvious candidate for inclusion in the usual child-bearing age group. Yet the second percentage figure might still be far less than 50%. On the other hand, if the data covered only women who actually bore children in a given year, and the ages of these women, an entirely different statistical test would be used, based on the distribution of child-bearing ages. Similarly, in our case, the base statistic, the percentage of nonlocal loans in the group of all loans, was very low and hence the minority of cases which we used in our standard was quite reasonable, since the standard was substantially above the average for nonlocal loans.

36. Largely but not wholly routine because it was necessary to pay attention to the number of loans in any cell and the problem of sampling variability where the number of loans was small.

line loans made by originating banks. As discussed above, we had concluded that for overline loans the borrower's relationship with the originating bank was controlling.³⁷ These tables revealed the same general pattern shown in table 6. They defined, tabularly, a criterion for classifying loans as locally limited or non-locally limited.

The line we drew between locally limited and non-locally limited loans was to some extent arbitrary, although not capricious. But as an arbitrary line it had everything to recommend it over Judge MacMahon's inspired but unsupported hunch in the *Manufacturers Hanover* case.³⁸ Our standard rested on a solid foundation of empirical investigation and analysis. Moreover, though our statistical study did not determine precisely *where* the line should be drawn, it did establish that *some* line should be drawn. That is, the systematic correlation between the independent variables and the location characteristic were persuasive that there were in fact two different banking markets, each with identifiable characteristics. As a result, our standard of local limitation, far more complex than Judge MacMahon's, is also far more difficult for a court to ignore. While no standard can be totally objective, it was possible in our procedure to identify the specific points in the analysis at which judgment was exercised. If a judge once starts down the path marked out by our analysis, he can avoid its thrust only by the independent exercise of his judgment in drawing the line at some different place.

IX. VALIDATION OF THE CRITERIA OF LOCAL LIMITATION

Because judgment did play a role, and because a good lawyer does not take unnecessary chances, we sought some independent ways to validate the analysis.³⁹ Our principal attempt to validate the proposed standard was by a further study. The value of the 1955 business loan survey lay in its extraordinarily wide scope and in the fact that it included many important loan characteristics. However, it could reveal only where loans were in fact made, not where they might have been made. To measure local limitation directly re-

37. See page 1662 *supra*.

38. See pages 1645-46.

39. One such validation was to show that the standard was a very conservative one in terms of the number of borrowers classified as non-locally limited. The class of locally limited loans according to our standard included 93.8% of all of loans to borrowers in unit-banking states; less than 7% were placed in the "wholesale," non-locally limited market. A similar pattern was observed when we looked at the general structure of the economy. Using Internal Revenue Service data classifying active corporations by asset size, we found that in 1961-1962 only 1.6% had assets of over \$5 million and only 5.7% had assets of over \$1 million. In large part, the non-locally limited borrowers were in the over \$1 million class size.

quired more information than the 1955 loan survey could provide. However, we could and did study in more detail a random selection of a group of customers of the two banks involved in the merger. This enabled us to remedy the defect in the 1955 survey, which surveyed loan transactions rather than customers. Looking directly at bank customers, we were able to determine the geographic extent of the customer's own business operations, his affiliations with larger business organizations, and the extent of his banking connections. The customer with extensive connections or with dispersed plants or offices might be directly classified as not locally limited. On the basis of this survey an alternative classification of the customers was made. In about 80 per cent of the cases, the results of the two classifications were the same, and in the remaining 20 per cent the discrepancies went both ways—some customers whom our statistically derived standard had classified as locally limited were classified as not locally limited by the customer survey; in some cases the reverse was true. This was, the lawyers were assured, a good record of prediction of individual cases by a technique designed to predict aggregate or average behavior.⁴⁰

X. APPLICATION OF THE STANDARD OF LOCAL LIMITATION TO THE CHICAGO METROPOLITAN AREA BANKING MARKET

Now we were close to the payoff. The branch of our analysis we have described had developed a reasonable and, we believed, wholly defensible standard of local limitation. A second major branch had attempted to establish that the relevant area of the "retail market" was the entire Chicago Metropolitan Area and not any smaller subdivision thereof. This hypothesis also rested upon a quantitative analysis of the location of the Continental Bank's retail customers and of the customers served by other banks throughout the area

40. There are a number of subtle and sophisticated statistical issues involved here which we need not go into in this Article. Let us merely mention a few reasons why an individual account might be an exception to an average relationship. A customer who, statistically, had all the earmarks of a locally limited customer might prove to have dispersed banking connections because his father was a well-known tycoon, or because he had moved recently from another large city. A very large customer who statistically would appear as not locally limited might in fact be limited because the kind of business he conducted was specialized in by local banks, or because he had had some recent shaky financial experiences that local (but not distant) banks were in a position to condone. The vast list of unmeasured influences on human behavior makes 100% prediction of individual behavior impossible, but does not prevent accurate prediction of group behavior. Life insurance is the classic example. While never venturing to predict when an individual will die, insurance companies predict accurately how many of a class will die each year.

which was based on a stratified random sample of seven banks in the area.⁴¹

The final step in analyzing the 1955 loan survey data was to apply the standard of local limitation to the Chicago area business loan market by computing market shares for Continental and City National, as well as for a group of other large banks.⁴² While we now had what the lawyers believed to be the correct concept of the locally limited market,⁴³ it seemed advantageous for courtroom presentation to present three different sets of market-share computations for 1955.

First, we wanted a set of market shares based solely on the total loans of all Chicago area banks to all of their business customers within and without the area. This is the approach to bank market shares taken by the Government in attacking bank mergers. It is quite simple and thoroughly misleading.

Market shares based on loans to all Chicago area borrowers by all banks within the Chicago area and outside it were also required. These computations do not depend on the concept of local limitation; they simply include all borrowers with Chicago area addresses in the Chicago market. To move from raw concentration ratios to these figures, it is necessary to eliminate loans by Chicago area banks to non-Chicago customers and add loans to Chicago customers by banks elsewhere. These figures are an improvement over the Government's since loans made to customers outside the Chicago area must certainly be irrelevant to competition and concentration in the local Chicago market. The trouble is that these figures include all the loans to those Chicago wholesale customers who could borrow anywhere they wished.

Finally, we wanted to present a computation of market shares and concentration ratios based on loans to customers locally limited to the Chicago area. These concentration ratios involve the use of the standard of local limitation which our analysis had developed. The following tables show the results of the computations.

41. See note 22 *supra*. Our survey covered the loans of a number of smaller banks in the Chicago area which were primarily in the retail banking business, as well as the two larger banks involved in the merger. On the basis of these surveys, we were prepared to argue, therefore, that the entire area was a web of interlocking markets with no rational dividing lines smaller than the area as a whole.

42. We were fortunately able to correct one of the deficiencies in the 1955 survey, the absence of data covering loans of banks which were not members of the Federal Reserve System. The Federal Reserve Bank of Chicago had, in 1955, conducted a parallel survey of all banks in the Federal Reserve District, member and nonmember, and the bank made these data available to us.

43. The economists never wavered in criticizing the lawyers' exclusion of nonbank competition. See pages 1651-52 *supra*.

TABLE 7
*Market Shares and Concentration Ratios Based Upon
Number of Loans—1955*

	All Loans by CMA* Banks	All Loans to CMA Borrowers	All Loans to CMA Locally Limited Borrowers
Continental Bank	6.3%	4.0%	3.3%
City National Bank	1.9	1.4	3.3
Continental Bank, After Merger	8.2	5.4	4.5
Four Largest CMA* Banks	19.0	12.7	9.7
Four Largest CMA* Banks, After Merger	20.9	14.1	10.9

* Chicago metropolitan area.

TABLE 8
*Market Shares and Concentration Ratios Based Upon
Dollar Volume of Loans—1955*

	All Loans by CMA* Banks	All Loans to CMA Borrowers	All Loans to CMA Locally Limited Borrowers
Continental Bank	24.4%	11.1%	6.5%
City National Bank	2.7	2.5	2.9
Continental Bank, After Merger	27.1	13.6	9.4
Four Largest CMA Banks	82.0	42.2	28.7
Four Largest CMA Banks, After Merger	84.7	44.7	31.6

* Chicago metropolitan area.

The reduction in market shares and concentration ratios by virtue of what we believe to be proper market definition was dramatic; in view of prevailing economic and legal standards, a court might well accept it as a difference in kind instead of degree.⁴⁴ If the Government should choose number of loans as the relevant measure, market shares (which are in any case relatively low) are cut almost in half. If, as was more likely, the Government's focus was on dollar volume, the market share of the merged bank would drop from 27.1 per cent to 9.4 per cent and the four-bank market share would drop from 84.7 per cent to 31.6 per cent.⁴⁵ Notice, inciden-

44. It is important to note that there is nothing in our procedure which inherently reduces market shares and concentration ratios. In any market some banks will have more than an average share of locally limited business and some less. Only for the former does reduction operate. For example, in table 8, City National Bank's market share is increased under our procedure.

45. The results of our analysis were less favorable to the Continental Bank than the application of the \$100,000 standard adopted by Judge MacMahon in the *Manufacturers-Hanover* case. Using the latter standard, Continental's post-merger share of

tally, that the simple identification of borrowers' location (as shown in the middle columns of tables 7 and 8, which neglect our criteria of local limitation) cut dollar volume market shares in half. We had every reason to believe that if a similar analysis were possible in 1961, when the merger took place, an equally impressive reduction would have appeared.⁴⁶

These large quantitative reductions in concentration ratios have a profound qualitative significance. An industry in which the four largest firms control more than 80 per cent of the dollar volume of business is likely to be dominated by these firms; on the other hand, an industry in which the four largest firms control only 30 per cent of the dollar volume necessarily has a large number of sellers. In the latter situation, rivalry among firms is likely to be intense and buyers will have a wide choice of alternatives.

The utility of our analysis of local limitation did not end with the reduction of the merged bank's market share to below 10 per cent and the lowering of the four-bank concentration ratio to slightly over 30 per cent. The analysis also revealed that the character of the local banking market was not at all what surface appearances suggested.

Using the 1955 figures, for example, Chicago area banks made about 23,000 business loans totaling \$2.4 billion. The average loan balance was over \$100,000. While only 3,000 of these loans were to borrowers located outside the Chicago area, these nonlocal loans accounted for fully one half (\$1.2 billion) of the dollar balances. Another 1,500 loans by Chicago banks to Chicago-located borrowers were excluded from the local market by the application of the standard of local limitation. The remaining locally limited loans involved only \$307 million of loan balances. The average size of these locally limited loans was less than \$20,000. Thus, although the elimination of non-locally limited loans resulted in only a small reduction in the number of loans, it achieved a dramatic reduction in the over-

the number of loans would be 4.2%, of dollar amounts, 7.3%. This loss of advantage was more than compensated for, in our view, by the gain in our confidence in the ability to defend our standard.

46. There were a number of techniques we used to justify using the 1955 data for a case which arose in 1961. One was the special survey of customers of the merged banks, in which we chose 1961 customers as the subject of the study. See note 40 *supra* and accompanying text. Another way to show that the structural features of banking markets had not changed significantly in the intervening years. Thus, we showed that the size distribution of business entities had not significantly altered over the period and that the loan portfolios of large banks showed a stable size distribution of loans. Each of these demonstrations required special statistical studies on the use of existing studies.

all dollar volume of the local business loan market and the average loan size in that market.

The significance of this finding can be fully appreciated only in the light of the broader economic argument made on behalf of Continental. The substance of that argument was that the Chicago area banking market had been characterized by the entry and successful growth of many new banks in the two decades preceding the merger. Our finding that the true local—or “retail”—business loan market was small in both over-all size and size of individual transactions meshed perfectly with the growth of the number of bank competitors in the market. If the average *local* market loan is approximately \$20,000, it is clear that even the smallest bank could make such loans. Therefore, the large downtown banks with their immense resources have no preclusive competitive advantages in this local, retail market.

XI. PRESENTATION OF THE RESULTS

Of course, even if all of this reads well in a law review, the important question is whether courts can be persuaded to accept such a statistical analysis. This question in fact breaks down into two quite different ones: the question of admissibility and that of intelligibility.

The problem of admissibility need not detain us. Lawyers and judges in the “big case” have certainly accustomed themselves to processing vast quantities of statistical material. Quantitative analysis would not significantly add to this task. Indeed, if the legal profession seriously absorbed modern sampling and other statistical techniques, the gathering of data for a complicated economic case would be simplified. If opposing lawyers can satisfy themselves and the court as to the validity of the parties’ data selection and processing, there should be no difficulty in getting the information revealed by the data into the record.

The question of intelligibility is a more formidable one. Obviously, if we had presented our 200-page computer printout cross-classification of the six relevant variables to the court in the *Continental Bank* case, we would have done the court and our case a disservice. Quantitative analysis is a powerful tool, but we did not expect the court to try to trace every step we had taken.

Indeed, the lawyers’ basic courtroom strategy was not to start with quantitative analysis at all. We were prepared to produce a series of ordinary witnesses, bankers and bank customers, who would testify about their own banking experiences. The court would

thereby be introduced to the "locally limited" and "non-locally limited" customer in the flesh. Banks would describe the loans they actually made to customers in their locality and to those located elsewhere. In this manner we would present "retail" and "wholesale" banking in qualitative rather than quantitative terms.

We planned to hold back our quantitative analysis until the court understood our theory of the case and its key terminology. The presentation of the analysis would then be the task of the economist, testifying as an expert witness. We expected him to describe the process of data collection and statistical manipulation. This testimony would cover the scope and objectivity of the underlying data, as well as the statistical techniques and computer processing we had used in preparing the data for analysis. Finally, the economist would explain the reasoning process presented in this Article, using our tables and charts for illustration and clarification. It would then be open to opposing counsel to demonstrate analytic errors and alternative explanatory hypotheses.

XII. A SUMMARY AND A PROSPECT

Our case study has described the essential features of quantitative multivariate analysis as applied to a legal problem. The goal of quantitative analysis is to discover and present an ordered analysis of a complex factual situation. It is the counterpart in the social sciences of the controlled experiment in the natural sciences. As noted above, it is an essential characteristic of quantitative analysis that it lays bare the analytic process and does not leave vital questions to "intuitive" resolution. In this way it should be possible to deepen the fact-finding process which is at the heart of every trial.

The essence of the process is the identification and evaluation of the various factors which influence social phenomena. Using quantitative analysis, the social scientist can reach insights about which factors cause a given result and which do not. To do so, he uses data collected from the workings of society as it exists. Although no two events are similar in all respects, the social scientist can determine significant factors by observing the patterns which emerge from a large number of events. For the lawyer, therefore, quantitative analysis will be of use where a question of causation can best be answered by indirect evidence. In our case, we developed objective standards to identify bank borrowers who were locally limited by discovering the factors which caused loans to be made locally rather than nonlocally.

Other examples of questions which might be approached in this manner come readily to mind. In an elegant exercise in the application of statistical theory to a legal problem, Michael O. Finkelstein has demonstrated that a quantitative test can be used to prove whether or not discriminatory techniques were used in the selection of juries.⁴⁷ Alfred F. Conard has shown how quantitative analyses of automobile personal injury litigations wholly changes the lawyer's view of the nature of the problem.⁴⁸ Quantitative techniques could be used, for example, to determine whether a particular type of automobile was properly designed; the examination of a large enough sample of accidents involving various types of automobiles may reveal whether or not a particular type is more accident-prone than others. If such a pattern did exist, and if other factors were investigated and rejected as the cause of the pattern, this would show that it is the particular type of automobile that is at fault. If no such pattern emerged, the opposite would seem to be proved, that is, that the particular automobile design was no worse than others.

The necessity of accumulating a large body of experimental data makes quantitative analysis an expensive game. So does the use of sophisticated computers, not to mention the cost of sophisticated experts. Clients may boggle at the cost of preparing a "big case," but they are usually so concerned with winning it that they will sign the necessary checks.

Quantitative analysis is not merely a mechanical or statistical process, although a statistical technique and the manipulation of large bodies of data are among its necessary elements. The exercise of intelligence in the formulation of the problem and in the interpretation of the statistical results is also necessary. It is in these areas that the lawyer must contribute to the analysis. His understanding of the legal context of the problem and of the nuances of the factual situation must be brought to bear if the results are to be useful.

Our principal concern thus far has been the use of quantitative analysis in the resolution of complicated factual questions, concentrating on its use in litigation of the "big case." For the practicing lawyer, this is likely to be its most important immediate application. However, the legal profession is concerned in the long run with improving the law as well as applying it. Quantitative analysis

47. Finkelstein, *The Application of Statistical Decision Theory to the Jury Discrimination Cases*, 80 HARV. L. REV. 338 (1966).

48. Conard, *The Quantitative Analysis of Justice*, 20 J. LEGAL ED. 1 (1967).

has an important role to play in this process: it can assist in evaluating the effects, and the effectiveness, of our legal system.

For example, it is obvious that the antitrust laws are based at least in part on economic theories which assume that certain types of market structures or behavioral rules will yield desirable economic performance in the real world. The antitrust laws are presumably designed to foster a competitive system and thus to achieve an efficient use of resources. In the *Continental Bank* case, quantitative analysis was used to describe, we believe with considerable sophistication, the structure of banking markets in the American economy. However, economists have already begun to use these techniques to investigate the more fundamental question of the relationship between particular kinds of market structures and the performance of markets.⁴⁹ This research has, thus far, been largely inconclusive. Attempts have been made, for example, to relate bank concentration ratios in various cities to the level of interest rates paid on savings deposits or charged on bank loans in such cities. Thus far the economists have been content to measure concentration ratios by the raw balance sheet figures which our studies in the *Continental Bank* case show to be potentially misleading. Hopefully, some of this research will be repeated using the insights gained from our work.

In time, if such quantitative research into the operation of economic markets is refined and expanded, it may be possible to develop rules of market behavior and standards of market structure which will in fact lead to important improvements in economic performance. Furthermore, the very process of achieving such knowledge would necessarily entail a refinement of concepts such as "market," "concentration," or "trend." Hopefully, these refinements could be administered with some objectivity and an even hand; at present, we suffer an almost random application of confusing—even though often overly precise—standards.

This is only one example of a part of our legal structure which could be refined by the use of quantitative analysis. There are many others. In many areas, the research lawyer or the law professor will want to enlist the cooperation of other social scientists—the economist, the sociologist, and the political scientist—as well as that of

49. See, e.g., Edwards, *The Banking Competition Controversy*, 3 NAT'L BANKING REV. 1 (1965); Edwards, *Concentration in Banking and Its Effect on Business Loan Rates*, 46 REV. OF ECONOMICS AND STATISTICS 294 (1964); Flechsig, *The Effect of Concentration on Bank Loan Rates*, 20 J. OF FINANCE 298 (1965).

the statistical analyst. However, the lawyer, if he makes the effort necessary to understand the techniques, will find that he can bring his own special legal insights to bear on the solution of these problems.