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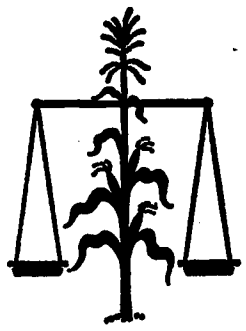
The report contains a series of papers that have been presented during the past decade by lawyers and economists at workshops sponsored by the North Central Land Economics Research Committee. The papers describe the bringing together of legal and economic research methods in order to solve rural problems. The first paper is entitled "Legal-Economic Research in Theory and Practice" and states that interdisciplinary research is essential for a broader view of a problem. "The Legal Researcher's Methods" is the second presentation, giving a detailed analysis of how a lawyer uses the classic law library, the non-legal library, and other methods to accomplish his research. The third paper deals with the research methods the economist uses and is entitled "Acquisitions of Primary and Secondary Data in Economics." The fourth presentation is "Research Methods Adaptable to Legal-Economic Inquiry" which concludes that linear programing and simulation are valid tools for this type of research. The fifth paper is called "Organization for Legal-Economic and Related Research," treating the problem of organizing across disciplinary lines and the difficulties encountered. The sixth and last paper is a summary of the workshops and re-emphasises and critiques the major points of each individual paper. (RH)

# *Methods for Legal-Economic Research into Rural Problems*

Edited by N. William Hines
and Marshall Harris

- Legal-Economic Research in Theory and Practice
- The Legal Researcher's Methods
- Acquisition of Primary and Secondary Data in Economics
- Research Methods Adaptable to Legal-Economic Inquiry: Linear Programming and Simulation
- Measurement and Inference in Legal-Economic Research
- Organization for Legal-Economic and Related Research
- Summary of Workshop





*Agricultural Law Center*
COLLEGE OF LAW
THE UNIVERSITY OF IOWA
IOWA CITY, IOWA

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# PREFACE

The North Central Land Economics Research Committee during the past decade has sponsored a series of workshops, seminars, and symposia on legal-economic research. The first papers devoted entirely to legal-economic research, entitled Economic-Legal Approach to Agricultural Problems, were presented at one of the sessions of the summer meeting of the American Farm Economic Association, Michigan State University, in 1955. The second in this series of discussions was a seminar on Legal-Economic Research held at the University of Illinois in the summer of 1958. The third series of papers involving legal-economic research was presented at a seminar held at the Farm Foundation, fall of 1960; the seminar was concerned with Family Farm Corporations. The fourth formal presentation on legal-economic research, sponsored by the North Central Committee, was made at Purdue University at the meeting of the American Farm Economic Association, summer of 1964, on the general subject of Legal-Economic Aspects of Emerging Agricultural Problems. The fifth series of papers and comments are reported herein, being the formal presentations upon which was based this Workshop on Methods for Legal-Economic Research on Rural Problems. In addition, the North Central Land Economics Research Committee, through its Legal Aspects Subcommittee, has sponsored many informal discussions on legal-economic research, by providing the necessary leadership, facilities, and financial support.

The Workshop reported herein was organized and carried out under the auspices of the Legal Aspects Subcommittee. This report is published by the Agricultural Law Center, College of Law, The University of Iowa, as part of its service to researchers interested in the analysis and solution of critical problems associated with rapidly developing technology and economic and social change. The authors alone are responsible for the content of their papers.

Membership of the Committee and Subcommittee and Participants in the Workshop were as follows:

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# FOREWORD

During the past decade cooperative research involving the disciplines of law and economics has been expanding rapidly in the Midwest. This interdisciplinary research has been sponsored largely by agricultural economists in the universities and U.S. Department of Agriculture and lawyers in the law schools, although several participants have been trained in both law and economics. As the research began to spread from state to state, to become more complex, and to encompass a wide range of topics, a felt need arose for frequent and serious consultations on relevant methodology and methods. Numerous informal consultations of diverse purposes and coverage were arranged. At least four formal discussional meetings were held at which papers on selected subjects were read, discussed in detail, and later published. These consultations and discussions provide a firm foundation for the instant Workshop. Its immediate forerunner, however, was an informal discussion held a year earlier at which time it was agreed that a Workshop of several days duration should be held.

This Workshop was concerned principally with research methods, that is, the manner in which technical details are treated. For example, the system worked out by lawyers for determining what is the law on particular points or the ways in which techniques are used by economists in gathering and analyzing empirical evidence on particular relationships are research methods. The world of methodology, however, was not untouched, for several writers found it desirable to present the philosophical and logical foundations that undergird and support, as well as guide in the selection of their research methods. Methodology is thus concerned with the philosophy and logic of how to proceed, while methods deal with tools and techniques of accomplishing a specific purpose.

The Workshop program provided for six half-day sessions for examination of specific subjects and one half-day session for summary and evaluation. An assigned subject-matter area was opened up by a formal presentation and a prepared discussion. The discussants had the papers in time to put their remarks in written form and the six papers were distributed to participants prior to their presentation. Open discussion by all participants was made operationally feasible by limiting participation to eighteen researchers, including almost an equal division between lawyers and economists.

The first paper brings into focus relevant ideas about legal-economic research and gleans from the past those experiences that may be of value in guiding future interdisciplinary research. The second and third papers present respectively the legal researcher's methods in determining what is

the law and the economist's methods in acquiring primary and secondary data in economic analysis. The fourth and fifth papers deal with research methods that are adapted to legal-economic research—one with linear programming and simulation and the other with regression, correlation, classification, measurement, probability, and nonparametric statistical measures. The sixth paper is concerned with the logistics of organizing for interdisciplinary research. The last paper brings the entire Workshop into focus and ends with some general remarks about future legal-economic research. In short, first the general setting and substance of legal-economic research are established; then a generalized picture of the methods of each discipline is presented; this is followed by a discussion of a few selected methods applicable to legal-economic research; the necessity of adequate organizational structures is noted; and lastly the Workshop is evaluated.

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J. H. Beuscher



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Clayton Yeutter

# LEGAL-ECONOMIC RESEARCH in THEORY and PRACTICE

Marshall Harris* and N. William Hines**

## INTRODUCTION

As society's problems become more diverse and complicated, new and improved approaches for seeking solutions to those problems must be developed. Nowhere are the development of new methods of approach and the refinement of existing methods more important than in the basic research work that is the backbone of reliable decision making. One common fault much in need of reform is the tendency of researchers to classify particular problems in terms of the traditional research interests of the various science and humanities disciplines. Having donned their blinders, they then conceptualize the research required within the confines of the chosen discipline's narrow borders.

Such an approach is wholly inadequate as applied to most of today's serious problems. It is inane, for example, to classify water pollution control as a sanitary engineering problem, or to assign research in rural poverty to economists alone, or to assert that local government reorganization is a matter singularly legal in its character. To be sure, these disciplines have taken a keen interest in some important elements of the problems suggested, but the most distinguishing characteristic of these and many other issues now challenging our society is their multifacetness. Most of today's pressing problems cross disciplinary lines in their causes and possible solutions; it is, therefore, imperative that research in these areas reflect the interdisciplinary nature of the problem.

Interdisciplinary research is the subject of this Workshop. More particularly, this Workshop is concerned with the research methods of two disciplines, law and economics, and the applicability of those methods to interdisciplinary research into problems of the rural community. The focus on these two disciplines is not prompted by any belief that research in law or economics, or the combination of the two, offers any panacea for rural problems; nor does the emphasis on rural problems stem from any conviction that such problems are peculiarly susceptible to interdisciplinary treatment. Both the disciplinary focus and the subject-matter emphasis are explained by the fact that the organization sponsoring the Workshop is the Legal Aspects Subcommittee of the North Central Land Economics Research Committee, a group which specializes in rural affairs.

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Combining and coordinating legal and economic research addressed to regional rural problems by no means exhausts the possibilities for interdisciplinary research, but it is surely a start in the right direction.

## HISTORICAL BACKGROUND

Interdisciplinary research is an innovation for neither law nor economics. Some excellent work has been produced in projects teaming law researchers with other social scientists, particularly sociologists, psychologists, and psychiatrists.[1] Similarly, notable results have been achieved in combining economists in a common research effort with scholars from other disciplines.[2] Only limited success, however, has been experienced in crossing law and economic research in fields other than rural affairs.[3] Researchers in the North Central Region have long played leadership roles in developing interdisciplinary legal-economic research into agricultural problems, and the resulting activity and production in this region have outstripped such work in the rest of the country.[4]

It is difficult to trace the origins of interest in legal-economic research in the region. In general terms, it might be said that the interest in legal-economic research in the region started with the first realization that agriculture was moving from a customary economy to a contractual one.[5] Research projects concerned with farm leasing arrangements carried on in the late 1930's stimulated an interest among several agricultural economists in the relationships between economic decisions and the legal milieu in which they must be made.[6] As early as 1940 one agricultural college in the region created a spot in its faculty for a law-trained researcher.[7]

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[1] Brown, Legal Research: The Resource Base and Traditional Approaches, 7 Amer. Behavioral Scientist 3 (1963); Kramer, Some Observations on Law and Interdisciplinary Research, 1959 Duke L.J. 563; Schwartz, Field Experimentation in Sociolegal Research, 13 J. of Leg. Educ. 401 (1961).

[2] Bertrand, and Corty, Rural Land Tenure in the United States: A Socio-Economic Approach to Problems, Programs, and Trends (1962); The Social and Economic Significance of Land Tenure in the Southwestern States, (Hoffsomer, ed. 1950).

[3] C. F. Schulz, Introduction of the Trained Economist to the Estate Planning Process, 45 Geo. L. J. 568 (1957).

[4] See Ellis, Collaboration Between Law and Agriculture, 7 J. Legal Ed. 65 (1954).

[5] For an early statement of this thesis see, Harris, Legal Aspects of Land Tenure, 23 J. Farm Econ. 173 (1941).

[6] See Hannah & Ackerman, Legal Aspects of Farm Tenancy in Illinois, Illinois Agri. Exp. Sta. Bull. 465, April, 1940; Harris, Cotton & Schickele, Farm Tenure in Iowa: Some Legal Aspects of Landlord Tenant Relationships, Iowa Agri. Exp. Sta. Bull. 371, April 1938. Lawyers and economists, by the middle 1930's, were working together informally, and sometimes with political scientists, on various aspects of the New Deal's "land program;" for example, the model or standard state soil conservation district law promulgated by the USDA was the result of interdisciplinary work, so was the Report of the President's Committee on Farm Tenancy.

[7] H. W. Hannah joined the staff of the University of Illinois in 1940.

Gradually other inroads were made.[8] The record shows that generally the agricultural schools became interested in cooperative research marrying law and economics well in advance of law schools in the region.

The first important manifestation of law school interest in cooperative research between law researchers and agricultural economists occurred at Wisconsin in the later 1940's as a part of Professor Jacob H. Beuscher's "law-in-action" program. Beuscher's interests were and are much broader than legal-economic research, but his concern with the "living law" led him to become the first law school researcher to embrace the idea of cooperative research and education programs with agricultural economists. Beuscher's trainees were the most prolific legal-economic researchers of the late 40's and early 50's.[9]

Early in the 1950's the first cooperative research between a law school researcher and an economist located in different universities was commenced. This cooperation between John C. O'Byrne at The University of Iowa and John F. Timmons at Iowa State University was highly productive[10] and ultimately led, in 1953, to the establishment of the Agricultural Law Center at Iowa City. In 1954, the United States Department of Agriculture manifested its interest in interdisciplinary research within the region by assigning Marshall Harris to research work in the Agricultural Law Center, where he has remained for the last twelve years.

Since 1954, the legal-economic research activity has increased substantially within the region and has spread into other parts of the nation as well. The volume of work is amply demonstrated by a bibliography of regional legal-economic publications prepared in 1964 which shows over 260 entries.[11] In 1955, the extent of this interest was formally recognized by the, then, North Central Land Tenure Research Committee when it created a special Subcommittee on Legal Aspects. The original membership of the Subcommitee included legal representatives from only Iowa, Illinois, and Wisconsin. Economists from Minnesota, Iowa, and South Dakota composed the balance of the membership. The current Subcommittee membership includes nine lawyers from seven states and several economists. Cooperative research is now in progress in North Dakota, South Dakota, Nebraska, Kansas, Iowa, Wisconsin, Illinois, and Kentucky. Some

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[8] Lawyers Ellis and Solberg joined the USDA economists working on legal-economic problems and other lawyers worked for brief periods with the USDA research staff.

[9] See, *e.g.*, Beuscher & Young, Your Property—Plan its Transfer, Wis. Agr. Ext. Cir. 407 (rev. 1953); Coates, Present and Proposed Legal Control of Water Resources in Wisconsin, 1953 Wis. L. Rev. 256; Ward & Beuscher, The Inheritance Process in Wisconsin, 1950 Wis. L. Rev. 293; Wrozesek, Contracts—The Canner-Grower Contracts in Wisconsin, 1948 Wis. L. Rev. 413.

[10] See, *e.g.*, Timmons & O'Byrne, Transferring Farm Property Within Families in Iowa, Iowa Agr. Exp. Sta. Bull. 394, 1953.

[11] Ellis and Dolson, Bibliography of North Central States Research (1964).

experience has been had with such research in the last decade in most of the remaining North Central states. Currently several of the agricultural colleges in the region are diligently seeking to add legally trained researchers to their staffs.

Another development of the last decade deserving note is the emergence of the first legal-economic researchers in whose professional training law and economics have been merged. The introduction of these individuals, who hold both a law degree and a graduate degree in economics, may signal the beginning of a new era in the growth of legal-economic research within the region.

## CURRENT STATUS

The reference to a new era serves to remind us that having traced briefly the history of the legal-economic research and generally determining where we have been, the time has arrived to ask the question: Where are we now? The preceding discussion describes the progress of the recent past in terms of publications, people, and places. Viewed in those terms, the picture looks exceedingly bright. But it may be that the phenomenal growth in activity during the last decade has not been accompanied by a comparable development in legal-economic research methods. Many people in many places may be working productively on many projects and yet may not, in any real sense, be improving the methods of legal-economic research. It is submitted that in great measure this is precisely what has been happening, and that it is time to step back and take a critical look at our work.

Within the region the tendency in the past has been to include under the umbrella of legal-economic research all inquiries into legal problems related to agriculture, and we have done this in the above brief historical sketch. Little or no distinction has been made between research in agricultural law alone and research involving law and economics jointly, between basic research and applied research, or even between research and educational programs. This monolithic approach probably has had a beneficial effect because it permitted the greatest number of people to pursue their own interests and still retain some sense of community with others who were working in the same general subject-matter areas. All of this activity did and does have considerable merit and serves worthwhile purposes. Still, when the array of activity that today poses as legal-economic research is measured by the standards developed over time in the several workshops, seminars, and conferences on the subject, it begins to appear that, to borrow from the political jargon of the times, we have been slow to arrive at the mainstream of legal-economic research.

Is legal-economic research a concept with some core of meaning that is commonly agreed upon, or is it merely a blanket description of law-related

agricultural activities? We would urge that an effort be made to distinguish between the central core of legal-economic research and the peripheral activities that surround it, that our current situation should not be measured in gross production figures of all research on agricultural law, but rather in the progress that has been made in recognizing and overcoming difficulties as to methods in legal-economic research. Judged by this standard, our progress to the moment may take on a quite different shading.

*Legal-Economic Research Defined*

To evaluate progress in the area, it first is necessary to settle on a generally acceptable definition of what is meant by legal-economic research. If our concepts of legal-economic research are as varied as the work done in its name, agreement on a working definition is long overdue. Let us suggest that the legal-economic research discussed herein is basic and applied research accomplished by the use of recognized methods of both law and economics, and designed to integrate the learning and analytical techniques of the two disciplines in the study of those rural problems that overflow disciplinary lines in their causes, effects, and possible solutions.[12] Educational and extension activity may play important roles in disseminating the results of legal-economic research, but they are secondary to its central theme. It should be clear that independent research by lawyers into rural legal problems is no more legal-economic research than is similar independent research by economists into the economic problems of agriculture. The key element in legal-economic research is its interdisciplinary character. In pointing toward progress in the future, the distinction must be made between 1) research in law related to rural society accomplishable by legally trained minds using legal research methods and

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[12] Considerable difficulty is encountered in describing research with adjectives that have similar meaning to both legal and economic researchers. What is basic research to the lawyer may be applied research to the economist. What the lawyer would call applied research, the economist might think of as closer to the preparation of educational materials. This is not to imply that economic research is superior or inferior to legal research; it is just that the same descriptive terms have different connotations.

To explain this in greater detail, an economist distinguishes between basic and applied research on the basis of whether the research is for the purpose of formulating new theories, discovering new principles, and developing new research procedures or whether it involves the application and utilization of known theories, principles, and research techniques to unresearched problems. A legal researcher would agree in the classification of the former endeavor, but would also categorize the latter as basic research if the problem was significant and the research exhaustive. To the legally trained, applied research might refer either to background materials collected to support a legislative proposal, or to the activity carried on by a practitioner in preparing a case for argument.

The kind of legal or economic search required to prepare classroom materials or to publish a bulletin explaining the legal or economic aspects of a certain activity to laymen might be labeled as applied research by some lawyers and a few economists, however, for purposes of this paper we chose to call this the production of educational materials.

2) legal-economic research involving the research methods of both law and economics. The more completely the work is characterized by the uniting of the methods of the two disciplines, the more nearly the research approaches the ideal.

To apply the above definition in evaluating the work to date, it must be realized that the goal of hybridization is reached in short steps. In viewing the research undertaken to date, three stages of development emerge.

COOPERATION may be considered the first stage. It has resulted in the layering of law and economics, or cohabitation of the results of legal and economic research between the covers of the same publication, without the attainment of any true hybridization. This was a characteristic exhibited by most of the early cooperative research publications, and it is still the dominant level of working together. The observed picture is a layer of economics and a layer of law, each researched separately, each written separately, each reported separately, but both assembled in the same publication. This degree of cooperation, however, represents substantial progress, and anyone who mentions it with disdain is not well informed on how interdisciplinary progress may be achieved. It shows progress in two ways: First, it offers to the reader, whatever his training and experience, viewpoints of the two disciplines on the same subject, at the same time, and in the same place. But, more importantly, it facilitates the economist's intellectual growth in asking the most meaningful legal questions, and it enhances the lawyer's appreciation and understanding of the economist's analytical approach to current problems. This means that the biological mutualism between law and economics mentioned by Professor Beuscher[13] can be observed and evaluated more meaningfully than if the reporting were in separate journals, on the shelves of separate colleges, and in separate buildings. This mutualism, that is, the interdependence as the condition of individual welfare or the beneficial association of the two disciplines, appears in clearer perspective than the biological, for the association has not transgressed the most elementary elements of cohabitation!

COORDINATION may be spoken of as the second stage of legal-economic research. Some of the research of the past decade progressed to this stage. The two disciplines were not only given equal rank, but they were brought into common action on an identical problem using smoothly functioning analytical tools. Much of the layering disappeared; that which

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[13] See Beuscher, Making Land Laws Serve Economic Ends, 37 J. Farm Ec. 1143 (1955).

remained was less thick and less impervious.[14] Before a researcher can discover the relationship between two things, a relatively clear understanding of the exact status of each thing is absolutely essential. The economist must retain the responsibility for stating as precisely as possible what the economic situation is, while the lawyer does the research necessary to present what the law is. The coordination is directed toward discovery of the relationship between the two—law and economics. The coordination emerges when the two scholars decide what the substance and content is of the problematic situation on which the research will focus. It comes into full bloom when the analytical tools and techniques are agreed upon to determine the connection between specific aspects of law and economics—when the empirical evidence is marshalled to show the relationship between specific law and economic well-being in real life, at the grass roots operating level. By such research, relationships between the legal and the economic systems can be discovered. A clearer understanding of the two-way impact between law and economics is being established by coordinated legal-economic research, particularly in terms of the specific situations under observation.

INTEGRATION may be spoken of as the third stage of legal-economic research. When this stage is reached, the layering characteristic of reported results has completely disappeared, and coordination of the research has become so complete that the two disciplines operate essentially as one on major aspects of the research. The duality of law and economics has largely disappeared, at least as to final product; the two disciplines are joined together to produce one whole, entire, unified product. Perhaps one could say that a separate discipline has emerged, that a new field of study (which is one of the definitions of a discipline) has been established. However, the methods of each discipline are not diluted. In determining what is the law and the economic situation, the best methods of each discipline are used. But in establishing the inter-relationships or associations between law and economics, the methods of the two disciplines may be joined or new methods may be evolved; perhaps the methods of each discipline may be improved by the process. The integration might result in something akin to "political economy," harking back to an early heritage.

But many economists and lawyers may say that this is pushing the matter too far and that we cannot afford the luxury of integration of legal and economic research, feeling that specialization has proved its superior

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[14] As an example of this stage of development we cite, with no small degree of timorousness, Harris & Hines, Installment Land Contracts in Iowa, Agric. Law Center Mono. No. 5 (1965).

value. The worth of specialization, however, is not brought into question necessarily. Integration of research and teaching of law and economics may well proceed effectively without in any way compromising the pristine purity of either discipline.

Research merely to determine what the law is regarding some economic activity in agriculture may involve only legal research. It is where the problem is one of determining the impact of law upon economic performance, and of economic activity upon the law, that the methods of the two disciplines must be joined.

Perhaps integration is sure to happen if scholars are permitted to be trained, as at present, in both disciplines. Perhaps this is the only means by which integration can be accomplished.[15] On the other hand, perhaps integration of legal and economic research may be most effective when it is organized and carried out by researchers separately trained in the two disciplines.

*Objectives and Purposes*

One of the difficulties in evaluating our progress to date is the lack of agreement on the objectives to be served by legal-economic research. If some consensus could be reached as to the varying purposes to be achieved or the objectives to be reached by legal-economic research, perhaps greater progress could be made toward the ends sought. If so, an effort to articulate such objectives would seem in order. The following are posed for consideration, looking toward a general agreement as to what we are trying to accomplish through legal-economic research at both the macro and micro levels.

As to basic legal-economic research, the objectives should be—

To develop underlying theory, to discover fundamental principles, and to establish interrelatedness between legal-institutional milieu in which agricultural activities take place and the economic well-being of those engaged in agricultural production, and to propose realistic alternative means of remedial action for improving the legal-institution milieu and associated economic arrangements under which agricultural production and income distribution take place.

As to applied legal-economic research, the objectives should be—

To present to all decision-making groups the law and economic facts under which agricultural production takes place and to furnish such decision makers ways and means of improving their decision-making process, specifically as to legal-institutional arrangements that fit their economic needs, by establishing relationships between specific legal arrangements and economic performance under them.

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[15] As an example of an integrated work, see Yeutter, A Legal-Economic Critique of Nebraska Watercourse Law, 44 Neb. L. Rev. 11 (1965).

As to both basic and applied research, an objective in addition to those listed above would be—

> To develop, by thoughtful planning and successful experimentation, the tools, procedures, and working relations that will expedite accomplishment of the above objectives for basic and applied legal-economic research, that is, to improve the methods and techniques involved in legal-economic research.

The major objective of most basic legal-economic research is to establish the relations that exist between or among various legal-economic phenomena in real life. More specifically, what are the relations between law and economics? How does law affect economic performance? How does the ever-changing economic situation require changes in the law?

Another important objective is the formulation of new theory and the discovery of new principles relating to those phases of law and economics that are interrelated. In many situations, the adaptation of old theory and principles for interdisciplinary use may be all that is necessary. Perhaps the development of theory and the discovery of principles will represent the most valuable contribution of legal-economic research.

An integral part, or perhaps in some cases a natural by-product, of basic research is an increase in insight regarding how legal-institutional arrangements might be used more effectively and also how relevant law might be improved. In addition, the research might be designed specifically to produce alternative means from which might be projected better laws and institutional arrangements to meet emerging agricultural requirements. These objectives of basic research are largely complementary and supplementary; the accomplishment of one contributes to the attainment of the other. The research might suggest adjustments in the economic as well as the legal system.

The objectives of applied research designed to reveal to decision makers only an expository statement of what is the legal or economic situation are different from research to establish relationships between law and economics. Such research may have the purpose of endeavoring to improve decision-making under existing legal-economic situations by enlarging the knowledge of the decision makers. At one level this might mean informing those who formulate legal policy of the current state of legal and economic affairs in a certain area. At another level the purpose might be to present the relevant legal and economic facts to farm people who must make legal-economic decisions in their day-to-day activity. Whatever the purposes of such research, it should be recognized as only different from, and not inferior to, basic research.[16]

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[16] A dividing line between basic and applied research acceptable to all scholars has not been established. It could be argued, for example, that discovery of the relation-

The importance of development of applicable research methods, whether for basic or applied research, cannot be overstressed. Methods are particularly crucial in all research, for the results of research can be no more reliable than the methods employed. But methods become doubly important when two disciplines are trying to integrate their research. The integration of research depends heavily but not entirely on the integration of methods. The integration of methods depends on much discussion among those trained in the two disciplines in formulating research plans and on many experiments in testing the plans projected. Failures may be as essential to progress as successes. Unfortunately, researchers seem disinclined to present failures to their colleagues. It would seem that they prefer to let their fellow researchers make the same mistakes.

*Unresolved Problems*

Once legal-economic research is viewed as a continuum along which we are proceeding toward the goal of a more completely integrated research method, the next question to be faced is: What obstacles must be overcome to permit more rapid realization of this goal? We would suggest that almost all of the difficulties currently confronting legal-economic research fall naturally into one of two categories: 1) a less than optimum intellectual climate for interdisciplinary research and 2) a failure to construct a framework of methods that adequately accommodates and exploits the contributions of the two disciplines. Stated another way, the two hurdles that have the most debilitating effect on the development of legal-economic research are those that prevent the bringing of researchers together on favorable terms in an atmosphere conducive to productive collaboration and those that impede the development of joint research techniques taking full advantage of each discipline's research talents.

## THE INTELLECTUAL CLIMATE

Quite obviously this Workshop is purposed primarily toward wrestling with problems of methods; still, recognition of the problems associated with creating an environment favorable for interdisciplinary research should not be completely neglected. Method problems become relevant only when researchers from the two disciplines come together in a spirit of cooperation. The portion of the Workshop program devoted to administrative organization may be expected to reflect the concern for appropriate working conditions, but without treading too heavily on their domain, a few preliminary observations will be advanced.

One of the great impediments to fulfillment of the promise of legal-

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ship of law and economics is exclusively applied research. Whether specific objectives demand basic or applied research, or both, is relatively unimportant to the presentation.

economic research is the provincialism that seems to afflict professional researchers of both disciplines. One way in which this provincialism manifests itself is in the esteem accorded efforts at interdisciplinary research by the respective disciplines. Academic intolerance is such that a presumption of inferiority seems to be rather automatically assigned to the research requiring association with members of another discipline. Practitioners of interdisciplinary research may find that they are regarded by purists within their own disciplines as intellectual outlaws or "collaborators" in the least approving meaning of that term.

Respectability is perhaps the concept that best captures the essence of this reaction against interdisciplinary research. It is not that members of the separate disciplines regard association with another discipline as evil or even unwise, so much as they feel it is less respectable than the ordinary, time-honored research of their own disciplines. The mental picture of two established disciplines, law and economics, each covertly deprecating the quality of the research endeavors of the other, may appear facetious when envisioned in the abstract, but deep down in all of us is that little suspicion that no other discipline's research is quite so important as our own.

Provincialism rears its head in somewhat different forms in the two disciplines, so that it is difficult to fix the blame for the general lack of enthusiasm toward interdisciplinary research. The more than occasional insistence by members of both disciplines that the function of the other discipline is to justify, facilitate, or implement, as the case may be, the execution of their marvelous legal or economic schemes, has no doubt put many a potential collaborator to flight. Also, the pernicious tendency of both disciplines to employ technical vernacular to explain everyday phenomenon has jilted a fair number of interdisciplinary suitors. On balance, however, a case can be made for the proposition that representing a discipline, economists have been less provincial in their attitude toward legal-economic cooperation than have legal researchers. If this is true, perhaps the explanation is simply that the legal profession has had many more centuries to turn itself inward.

An even more troublesome symptom of this provincialism is the notion held by all too many lawyers and economists that there is some magical property in their discipline's mental regimen that develops an analytical mind in the product of its training, the qualities of which cannot be fully appreciated by trainees of other disciplines, let alone equaled by them. In essence, this is a way of rationalizing the belief that the other discipline's work is less meritorious on the ground that their intellectual processes are inferior. Isn't it a kindness to quickly pick the relevant information from their meager brains and send them on their way? Unreasonable though it

may appear, this attitude may frequently explain the tendency to favor interdisciplinary cooperation over collaboration or integration.

Still another closely related problem of respectability that should be recognized in connection with the type of research proposed herein centers in the attitude that research concerning agriculture and other rural affairs is for some reason a second-rate endeavor. It is difficult to pinpoint the source of this bias or to assess its strength in any meaningful terms, but it is harder still to deny that it exists. This attitude may be primarily a midwestern phenomenon, but frankly we doubt that it is. One can only speculate at its underlying causes. A good guess might be that it reflects the subconscious rejection of, or ambivalence toward, its heritage by a nation only a generation or two removed from a primarily agrarian culture. Having only recently made the leap to urbanization and industrialization, academicians in the new order are still somewhat embarrassed by the traces of the barnyard that cling to their city shoes, and therefore look on the profession of an interest in agriculture as somewhat demeaning to the professor.

## METHODS PROBLEMS FACING INTERDISCIPLINARY RESEARCHERS

The problems with methods that face legal and economic researchers as they seek to work together in the integration of a particular legal-economic research project may be divided into the following eight categories for purposes of discussion:

1. Stating the problematic situation.
2. Determining the objectives or purposes.
3. Formulating hypotheses, propositions, and ideas to be tested.
4. Selecting the research methods.
5. Determining the evidence needed.
6. Examining the evidence, handling the data.
7. Formulating the conclusions, interpreting the facts.
8. Reporting the results.

Two things should be made clear at the onset: 1) The thought processes in formulating and prosecuting a research project cannot be divided, except for convenience, into eight or any other number of topics, and 2) neither can the researchers' minds complete all of the conceptualizations necessary on one category before working on some of the others. Thus, researchers will find that the bounds of each of these categories will be transgressed frequently. The process of project formulation, however, may well proceed from one category to the next, knowing that it will be necessary to back track frequently. For example, in determining the objectives, additional insight into the problematic situation may require a refinement, expansion, or merely a clearer statement of the problem. Or,

even when the researchers are preparing a report on the results, they may find it necessary to return to the evidence to determine how particular facts should be interpreted on a matter that fertile imaginations overlooked in the original formulation. Even some new evidence may be needed on a particularly crucial issue. The researcher should not be frustrated by the going-back-and-forth process. It is essential to effective research formulation and completion.

Usually the selection of a problem deserving of research poses little difficulty. However, not all research problems merit interdisciplinary attention, therefore, some consideration should be given to the question of whether the proposed area justifies the research planned. Several points are worthy of serious consideration. First, the problematic situation should be clearly definable so its perimeters are readily discernible. It should be easily isolated from other problems. Research is much less difficult and the results are much more likely to be of value if the contours of the problem are clear. Second, the research should be designed to propose or point toward solutions that will lead to purposeful action. Third, research that focuses on the most acute, timely, or strategic issues is to be preferred. Fourth, the results of the research should be as widely applicable as possible. Other things being equal, preference should be given to the study that will affect the largest number of people, either directly or indirectly. A fifth item to consider is the difficulty in carrying out the particular research. These questions are of importance: Is the evidence easy or hard to assemble? To process? Are the necessary research methods and techniques familiar to available personnel?

The reaction of the economist and the lawyer may not coincide on all of these matters. Some give and take are sure to be necessary. Adjustments to suit the needs of both parties may often be made without detracting substantially from the over-all value of the study. The important thing is to assure that the selected project reasonably lends itself to an interdisciplinary approach and that the researchers are firmly committed to so approaching it.

*Stating the Problematic Situation*

At least a blurred picture of the problem will have emerged during the selection process. A clear conception of the problem needs to be made as soon as possible to guide in succeeding phases of the research. Unless specific aspects of the larger problem area are isolated and clearly stated, the research is likely to wander all over a general subject matter area. The researchers should cut through to the heart of the problem so that attention can be focused on its most influential elements.

The process of visualizing and stating the problem is largely one of conceptualization. It demands imagination, inventiveness, and an analytical

mind. The more clearly the problem can be conceived and the more precise the hypotheses can be stated, the less irrelevant evidence will be gathered, and so on. The natural urge should be resisted to "get going" on the study, to get to the library, the court house, or the interviews. The secret to successful research is not greater physical maneuvering but full utilization of the researcher's intellectual processes.

Before trying to visualize and state the problem, both the lawyer and economist should seek out and study all available information on the problem. Time is well spent by researchers in learning what others have produced in the particular and closely related areas. Each researcher is primarily responsible for probing the knowledge in his respective fields, but each should endeavor to become familiar generally with the major areas of knowledge in the other discipline that relate to the problem under study.

Several matters command attention in formulating a statement of the research problem. First, the subject matter or problem upon which the research will center should be visualized and stated in terms of the theory and principles of both disciplines. Integration of the disciplines may present some difficulty here. How can economic and legal theory be used jointly in describing the problem? Are different problems involved where the approach is positive than where it is normative? Second, all aspects of the problem should be developed in detail. Each part should be isolated and dissected for detailed description. Later difficulties are most likely to be avoided if time is taken at this early stage to identify and visualize all of the various aspects of the problematic situation. Third, to the extent that adjustments in the law or legally drafted arrangements will be required to improve the situation, the problem situation statement should encompass alternative lines of remedial action. The visualized remedies may be difficult to state with the same degree of accuracy as the initial description of the problem, but forcing the imagination to look into remedies will help clarify the problem statement and will furnish the background for the testing of remedies during the research process. After all, the remedies should be grounded in facts even as the relationships are determined by examination of fact situations. As a fourth point, it would be well to set down toward the end of the statement of the problem, probably in outline form, the present status of knowledge of the legal and economic aspects of the problem as discovered in the preliminary investigation suggested earlier. This would give each member of the team, insofar as reasonably possible, a common base from which to work. In the same manner, the assumptions and presuppositions of the researchers might well be spelled out in some detail. Those things taken as granted or as already proved and those things required as an antecedent, whether

in theory, logic, or fact, should be clearly stated so they will cease to bother the researchers and will help guide in the selection of the evidence needed.

*Determining the Objectives or Purposes*

A lawyer and an economist may have different objectives or purposes in mind in researching the same problem area. If so, the purposes of each should be exposed. If there is some conflict between the different objectives, an effort should be made to reconcile them. Care should be taken in harmonizing the objectives of the two parties, to the extent needed, to keep the study focused on the original problem and to develop a singleness of purpose insofar as possible.

Even where the purposes of the researchers are similar, discussion of objectives may bring the two minds closer together before they undertake the difficult task of formulating the hypotheses to be tested. It may also help to keep the search on the original track as it progresses. Development of a statement of objectives provides an opportunity to review the results of thinking up to that place.

At this juncture, each researcher will need to look backward toward the problematic situation and forward toward the evidence and how it will be handled. Each researcher should be able to visualize all aspects of the study—legal and economic—although each specialist will see more clearly and more completely what is involved in his own discipline than of the discipline of his colleague.

The final statement of objectives should reveal clearly 1) whether an effort will be made to establish relations among relevant variables; 2) whether alternative lines of remedial action will be sought to make the law more effective in attaining economic objectives; 3) whether and to what extent the research will be designed to discover what the law is; 4) whether it is intended to propose ways and means of meeting particular economic situations; and 5) at what interdisciplinary level the research is being undertaken—whether the two parties plan to *cooperate* in researching on the same topic, or to *coordinate* their research by interchanging ideas and making their individual efforts contribute to the same ends, or whether their research calls for *integration* through the development of a unified approach to a commonly conceived problem.

*Formulating Hypotheses to be Tested*

At this stage in planning the research, the process becomes more difficult. From the viewpoint of the researchers, a hypothesis is a summary statement of a proposition or principle to guide the research. Researchers from both disciplines are familiar with the use of hypotheses in discovering the significant facts or applicable law in a problem situation under inquiry. The formulation of hypotheses requires the best possible thinking when

the endeavor is to establish relationships among legal-economic variables and to outline alternative actions to improve the law. In this setting, hypotheses become tentative statements of relationships believed to exist among the legal and economic variables. They may also furnish guidance in testing, insofar as it is possible to test, various lines of remedial action.

In any case, the hypotheses should guide the researchers in selecting the evidence needed from among the vast quantity of evidence available. To serve this role most effectively, the hypotheses as stated should fit into a sound theoretical framework.

The evidence may prove that the hypotheses are exact statements of relationships that do exist, or that the statements are grossly in error—that a new statement of relationships must be formulated, or that minor adjustments only are needed to make the hypotheses, as stated, comport with real life. The researchers are not trying to prove that their hypotheses are correct. Rather, they are using hypotheses as tools to facilitate the discovery of facts, principles, or relationships that exist in the real world.

*Selecting the Research Methods*

This Workshop is concerned principally with methods—the application of specific research methods or techniques to the solution of specific problems. A method, paraphrasing Webster, is a systematic (not a haphazard) procedure, technique, or mode of inquiry employed by or proper to a particular discipline. It is a way, technique, or process of doing something. It is concerned with analytical procedures for reaching the stated objectives. It deals with the techniques of scientific inquiry. The method must be determined before the evidence needed to test the hypotheses can be outlined.

The basic question confronting legal-economic researchers is what research methods are most applicable to the wide range of legal-economic problems. This question, of course, must await the presentation of the papers that will parade before us the respective methods of the two disciplines. The question to which this paper is addressed at this time is: What difficulties will legal-economic researchers encounter in determining which methods are applicable to particular research undertakings?

If a method is the procedure for scientific inquiry, proper to a particular discipline, then are not legal and economic researchers confronted with two or more methods—those related to the discipline of law and those to economics? Subsequent papers of this Workshop will deal with some of the legal researcher's methods and with selected methods of the economic researcher. There is no inclination to encroach upon the domain of these papers.

If a lawyer is trying to discover what is the law that governs a particular situation in agriculture, presumably he would use the proper legal re-

search method. Likewise, if an economist is trying to discover what the economic situation is, he would employ the proper method of economics.

The focus of this Workshop is on neither legal nor economic research methods *per se*. We leave such matters up to the research leaders of each discipline. We are concerned here with methods applicable to legal-economic research. To put the matter another way, we are concerned with only those methods of law and of economics (and perhaps methods uncommon to either discipline) that are applicable to integrated research on problems that exhibit both legal and economic characteristics. To the extent that the methods of the two disciplines prove usable, they should be adopted. But we may well find in pondering the problems that new methods must be fashioned or that legal-economic methods may be joined or integrated in such a way that new or hybrid methods may emerge.

The basic question is: How do the lawyer and economist work together in outlining the methods to be used in joint legal-economic research? The more highly skilled each party is in his own discipline, the greater faith he may have in the methods of his discipline, and possibly the less tolerance with the methods of the other discipline. However, a greater appreciation of the value of others' methods must be cultivated if the two disciplines are to be joined in a concerted attack on a particular legal-economic problem.

There is no magic wand to accomplish the purpose—no royal road to interdisciplinary research. The first ingredient is an open, fertile mind, in which such attitudes as tolerance, respect, and patience toward the researcher from another discipline are essential. The second requisite is adequate knowledge of the methods of the other discipline. This may be acquired most rapidly by studying about the methods employed by the other discipline and by exhaustive conversation with one's colleagues across the campus.

In final analysis, if we are intellectually willing to follow the process to wherever it may lead, we are likely to end up with a set of new methods or recognizable hybrids with distinctive characteristics. The crystal ball at the moment would seem to favor the latter, but we should leave the matter in the laps of the gods.

*Determining the Evidence Needed*

The tendency may be to gather all of the evidence that fertile minds conjure up, and then to sift through it using only that which appears valuable. This is the easy approach to evidence gathering; it requires a minimum amount of thinking. A better procedure would be to weigh each item of proposed evidence carefully to determine its potential usefulness. If several hypotheses have been formulated, outline the evidence needed on each, no more and no less. It is better to engage in long thought-

ful discussions than to start off half prepared as to the evidence needed. Ask the dual question: Is all of the evidence as outlined really needed, and is all needed evidence included? What purpose is to be served by each bit of evidence? The study can be no better than the evidence upon which it is based.

In thinking through the evidence needed, the researchers should be concerned also with the availability of the evidence and the means by which it will be obtained. Some evidence is easy to assemble from public records. Other evidence can be obtained only from private records, which may or may not be available to the researchers. Still other evidence may have to be gathered by personal interviews with numerous respondents. The cost of getting the evidence may be of major concern to most researchers.

Here are some questions to consider: What are the relationships between the status of the law and economic performance that the study is designed to establish? If a statistical analysis is needed, what method of sampling, what statistical techniques, and so on, appear appropriate? Is a pilot study needed? Is the case method applicable? What are the differences in methods if only a little is known about the situation in contrast to a situation about which much is known? What situations demand a study in depth as contrasted with a more generalized or over-all study?

In gathering evidence, the meaning of each term, unit, measure, and concept should be made clear and kept constant. Many items have a way of taking on new meaning as the research progresses. This is not to be deplored, in every case. But it should be known when it happens. The best safeguard is to spell out in detail all definitions or concepts and to adjust them if the situations demand such. But each definition or concept should be adhered to rigidly and slavishly. Everyone working on the study should be conscious of the need to apply consistent interpretations.

In every highly coordinated legal-economic study, full knowledge of what is the law will be needed. The basic methods used to obtain this information will be those of the lawyer, depending largely on the law library as the major source. The economist may assist in determining what relationships are of interest and perhaps in establishing priorities, for he may have observed some legal relationships in the particular situation or he may have some questions about emerging relationships that have escaped the lawyer's observation. The two researchers may even want to take a trip to a typical scene of the difficulty to make empirical observations and to discuss the research with informed parties.

The economist, likewise, will need to present what the economic situation is, depending on the necessary methods of economics to discover the relevant facts. Here the lawyer may assist in determining what economic

facts are needed, for he may have questions as to the economic situation that have been overlooked by the economist.

To the extent that this process encompasses all the evidence needed, the methods of law and economics can be used separately. Coordination of the processes of the two disciplines in determining what evidence should be gathered is all that is required.

Integrated interdisciplinary research contemplates more than independent evidence gathering. A good experimental start to integrated legal-economic studies would involve more than a coordinated determination of the evidence needed, each party gathering the evidence assigned to him, and a joint interpretation of the meaning of the evidence. The methods used would be those of the two disciplines, combined into an effective analytical tool. There might emerge a legal-economic method of handling (manipulating) the evidence. Cooperation in determining methods and evidence, and coordination in gathering and handling the evidence, may be necessary first steps in developing fully integrated studies, but a goal would be to attain complete integration wherever appropriate.

Many legal-economic studies will involve so many different kinds of evidence that a pilot study may prove valuable. Such a study should involve experience in evidence gathering in the form suggested. A small quantity of evidence should be put through the proposed analytical process. These questions should be of concern: Are the data sheets or questionnaire forms properly constructed? Will the questions be asked so as to get the information desired? In the proper order? Of the right people? How accurate will be the facts or evidence? Is additional evidence needed? Is the evidence, in the form in which it will be obtained, adaptable to the analytical process decided upon? Will the evidence help to reveal accurately existing factual or legal patterns or legal-economic relationships? Will the evidence furnish a sound basis for the kinds of interpretations and conclusions called for in the study? If the lawyer and the economist participate in the pilot study in about the same way that they will serve in the final study, the problems of working together may be largely solved.

*Examining the Evidence*

After the evidence has been assembled, the first task is to determine its accuracy. Each item should be edited, whether statistical or narrative, as soon as possible for completeness, consistency, and accuracy. Some of the editing may be done by others, but the principal researchers should do enough editing to lay out specific directions to the persons responsible for the editing. Everyone involved in editing may need to work together closely in planning the editing process.

Some of the evidence may need to be translated into more usable form.

For example, narrative statements may need to be classified and prepared for statistical manipulation. Statistical data may need to be readied for the particular statistical process to which it will be subjected. Subsequent papers will shed additional light on how to handle evidence.

With the evidence before the researcher, and while it is being checked, edited, and made ready for analysis, the researchers should be concerned again with research methods, particularly the analytical processes. Are the proposed methods and processes adaptable to the evidence as it appears in final form? Are adjustments in the analytical processes needed? If so, they should be made before the computer starts to run or other processing of the evidence is undertaken. Each part of the total process should be examined to see that it and the assembled evidence are compatible. For example, is the statistical process too refined for the evidence? A trained statistician may be needed to relate the statistical processes to the assembled evidence. Classification of the evidence may require the best judgment of both legal and economic minds to arrive at the best possible classification for showing relationships. For example, economists have traditionally classified tenants by the kind of rent paid. Does this classification make sense to the lawyer for the purposes at hand? Poor classification and ill-adapted statistical devices may cover up rather than reveal true relationships.

Review the analytical processes to be certain that they meet acceptable statistical and analytical standards. The analysis should be in terms of the problem statements. If not, the problems should be restated to conform to the real life situation revealed in gathering and examining the evidence. In addition, the analysis should be in terms of the hypotheses; or, if additional insight indicates that the hypotheses are poorly stated, they should be revised so that the evidence will be used to test the best possible statement of the hypotheses. Perhaps an important hypothesis has been overlooked; if so, it should be added. But do not use the same data to test hypotheses that was used to formulate them.

*Formulating Conclusions*

The relationship between the evidence and the conclusions should be made explicit. The researchers should not depend upon conviction, instinct, or intuition for important conclusions. Conclusions and interpretations as to relationships between law and economics should flow logically from the evidence. Personal judgment unsupported by evidence should be so labeled.

The two parties will use different procedures in testing the results of the evidence. The economist may turn to statistical tests on certain statistical data, but he should also use logic, theory, and depend on related insights, in the same fashion as the legal researcher. The thought processes

may not prove to be as much unalike as imagined. The preponderance-of-evidence idea of the lawyer and statistical measures of probability of the economist may well be complementary rather than conflicting.

In addition to the traditional testing of the evidence, the parties should make an informal test in many studies. Going back to the real world, do the conclusions and interpretations of relationship correlate with actual observed conditions? Do they appear to be well grounded in logic and theory, in light of experience? What are the reactions of well-qualified people involved in real life situations to the generalizations drawn from the study?

*Presenting the Results*

Before the researchers finalize plans for the study, they should agree upon, at least tentatively, the audiences to which the findings will be reported. These questions should be considered: Will a report be made for the legal profession exclusively? For economists only? Or, will the results be presented in one report to both groups? Will a report be prepared for lay consumption also? Or, will separate reports be made to all three groups?

The lawyer naturally thinks of his colleagues in the legal profession. The economist will think of his colleagues, too, and both may think of laymen. The lawyer will be comfortable in reporting to his colleagues, but he may encounter real problems when writing the first time for lay consumption. The economist likewise is more at ease in writing for economists, but he may have some experience in writing for lay people.

Part of the problem of reporting may arise out of the desire to make one report serve both lawyers and economists. Do not fall into this trap, if indeed it is a trap. Also, do not sell your colleagues short. Lawyers may be interested in and capable of assimilating much more economic knowledge than either economic or legal researchers might imagine. The same principle may hold for economists. The basic report is on legal-economic research. It may be addressed to the lawyer-economist audience.

After the basic report is prepared, the researchers may feel that their task is completed. And it may well be, depending upon one's viewpoint. It is doubtful that maximum use of the research will result if the findings are not made available to major interested groups. The researcher need not do this job himself, but he should feel some responsibility for seeing that his findings are used as widely as possible.

## COMMENTS

James Munro*

A principal assumption of the authors appears to be that a combined approach, or a hybrid approach, to legal-economic research would be

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preferable to an effort by each person singly. This assumption is apparently based on the idea that any person identified with a given profession or "discipline" is self-centered and sealed off from other areas of research or knowledge. The assumption proves too much or too little. Too much in that it implies that problems (presumably in the area of agriculture) are susceptible of ready solution through the combined efforts of economists and lawyers. Is it not possible that many problems need the help of neither? Too little in that it seems to be based on the inadequacy of each working on his own, or perhaps each operating separately but with the use of information obtained from the other.

Is it possible that the emphasis placed on repetition of such terms as "interdisciplinary" could itself inhibit the very result desired, namely, an integrated team effort? It is submitted that the extent to which either law or economics will stand on its own feet as a dominant research factor depends on the situation. Law may play a minor role, perhaps merely pointing out, for example, the incidents of joint tenancy; or it may have a creative function, for example, in working out estate plans involving one of several possible solutions.

Much is said of "methods." Is the term defined anywhere? For example, the paper asserts that unless proper methods are used, research is of no avail. For example, "[T]he results (can be) . . . no more reliable than the methods employed."

I think that the paper makes the major assumption that the more highly skilled the practitioner, the greater faith he will have in his own methods, and possibly the less tolerant he will be of the methods of the other.

I suggest that the contrary may well be true—that the lawyer, as he becomes more skilled, becomes less parochial and more protean in his adaptation. As such, he should welcome the other technician, but only to the extent that his counterpart, so to speak, also has broken the sound barrier of intellectual self-containment.

Harris and Hines generally suggest that, rather than pin down any particular or specific operating procedure, the matter of joint efforts be worked out on an *ad hoc* basis, not with respect to the limitations of the various disciplines, but solely with reference to the contours of the problem itself. Moreover, the attempt to merge one's professional identity with that of another may not only be futile, but may well deprive the project of the valuable contributions which each may make acting on his own and in his own field. In many, perhaps not all instances, it may be that the best results will flow from maximizing, not minimizing, the expertise of the individual worker.

# THE LEGAL RESEARCHER'S METHODS

William F. Dolson* and Marlin M. Volz**

The primary purpose of this paper is to present to our economist friends a blow by blow description of legal research. The paper attempts to give the economists a basic understanding and knowledge of the sources of the law. Lawyers, nonetheless, may find it valuable as a general brush-up on legal research.

The first part of this paper is designed to give the reader general background information concerning: (1) The emanation of law, and (2) where the law can be found. The second part involves the use of a illustrative problem to demonstrate the processes of classic library legal research. The last part attempts to bring the reader up to date on the latest methods of legal research, including the use of electronic data retrieval and non-library research.

Legal research means different things to different people. Practicing attorneys are primarily interested in what the law is, whereas, the legal scholar is not only interested in determining what is the law, but what the law is about to be and what the law ought to be. However, the starting point of legal research for both groups is usually the same—the law library. One obvious advantage that the legal scholar has here is that the ordinary practitioner's law library is modest compared to law libraries usually available to legal scholars (Harvard Law School Library contained one million plus volumes in 1964).

Before proceeding with a discussion of the emanation of law, we would first like to answer briefly the question: What is law? Through the ages law has been defined many different ways. One definition, which probably meets with the approval of most modern writers, is: "Law, in the sense in which courts and lawyers use the term, consists of those precepts of general application for the regulation of human conduct which are enforced by the state, the organized political body."[1] The two main sources from which the law emanates are (1) constitutions and legislative enactments, and (2) decisions of courts. A relatively new source has been administrative rules and regulations. These sources will be examined more thoroughly in connection with the discussion of law books to follow.

## CLASSIFICATION OF LAW BOOKS

Law books are classified as primary authority, secondary authority, and

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[1] BROWN, PERSONAL PROPERTY 1 (2nd ed. 1955).

books of index. The economist should be cautioned at this juncture that the meaning of these terms in law does not necessarily correspond to their meaning in economic research.

*Primary Authority*

Primary authority in law is defined as that which is most persuasive to the courts. Primary authority is found in statutory materials and judicial decisions. The term statutory materials, as used here, has a broader meaning than its common usage–legislative enactments. It denotes all primary authority other than court decisions (that is, constitutions, treaties, codes, ordinances, court rules, and administrative rules and regulations of federal, state, and local governments). A statement considered as primary authority usually emanates from one of the three branches of government (executive, legislative, or judicial).

The executive branch promulgates rules and regulations which have the persuasiveness of primary authority. For example, pure food and drug regulations of the U.S. Department of Agriculture, rules of the state department of taxation, and regulations requiring school fire drills constitute primary authority on the federal, state, and local levels, respectively.

The legislative branch of government enacts laws. These laws on the federal and state level are called statutes, while on the local level they are called ordinances.

The judicial branch of government comprises the federal and state judiciary. The function of the courts is to render judgments and decisions with respect to controversies between litigants.

A constitution, whether on the federal or state level, is the supreme law of the jurisdiction and is the measure of the limit and scope of any legislative act or judicial decree. The Federal Constitution may be found, among other places, in the United States Code Annotated. This is a particularly valuable source inasmuch as it presents the Constitution, replete with excellent historical data and exhaustive annotations. There are publications containing the state constitutions as well. A good example is Vernon's Annotated Missouri Statutes which contain the Missouri Constitution. Here again, the exhaustive annotations make this source very valuable.

A treaty partakes of the nature of a contract or compact based upon valid consideration in the form of mutual promises. The treaty-making power extends to all proper subjects of negotiation between governments of the different nations and, so far as the United States is concerned, is unlimited and subject only to constitutional restraints. Until 1950 these were published in the United States Statutes at Large (Volume 1-64). Since then they have been published in the United States Treaties and

other International Agreements Series. Also, there are numerous other sources for treaties and related materials.

Legislation is a definitive expression of governmental policy and is that source of law which looks to the future and changes existing conditions by making a new rule applicable thereafter to all or some part of those subject to its power. Legislative enactments are found in two types of books: Publications containing session laws and those containing codes. The sequence of publication of legislation usually involves several steps.

First, the enactments of each session of the Legislature are published at the close of the legislative session and are variously termed in different jurisdictions as Session Laws, Laws, General Laws, or Public Acts. For example, the United States Statutes at Large contain the enactments of each session of Congress, while the Missouri Session Laws contain the enactments of each session of the Missouri Legislature.

Secondly, legislation will be found later in revised statutes or codes. That is, the session laws are periodically rearranged by grouping together all laws relating to a particular topic. Nothing is added or changed in such a process. The legislative enactments are merely brought together in orderly sequence. The laws relating to schools, for example, are usually placed under the topic "Schools and School Districts."

An index is then prepared to aid in the search for a particular enactment. The United States Code is an example of a compilation of federal statutory material. It is an official publication, that is, one published under the sanction of the governmental unit. In contrast, the United States Code Annotated is an unofficial publication of the federal statutory material, that is, published by a private publisher. As is the case of the Federal Constitution, the historical notes and annotations make the Code Annotated extremely valuable in research.

The state statutes also are published officially. The Missouri Revised Statutes of 1949, together with their Supplement, is an example; whereas Vernon's Annotated Missouri Statutes is an example of an unofficial publication of the state statutes. As in the case of the federal statutory material, this publication contains valuable historical notes and case data.

The statutory material also includes municipal charters, codes, and ordinances. These contain the rules and regulations by which a municipality is governed. For example, the charter and ordinances of Kansas City are available in two large volumes. As far as the inhabitants thereof (and others) may be regulated by them, they are considered primary authority.

Statutory materials also consist of court rules. These rules pertain to the practice and procedure of the particular court adopting them and facilitate the administration of justice. If they do not exceed the limits of the au-

thority of the court to make them, they have the effect of legislative enactments. They are subservient, however, and in the case of a conflict, the legislative enactment prevails. The rules of the Supreme Court of Missouri are published by the Clerk of the Court, and may be found in both the official and unofficial publications of the Missouri statutes.

Administrative rules and regulations (executive orders, rules promulgated by the heads of agencies, and decisions of administrative agencies) also are considered statutory materials. The Federal Register (published under the authority of the Federal Register Act of July 26, 1935) and the Code of Federal Regulations (a compilation of the materials contained in the Federal Register) are two notable sources for rules and regulations on the federal level. In the various states, there are sources for administrative rules and regulations. In Kentucky these are published in the Kentucky Administrative Regulations Service.

Primary authority also consists of decisions by the judicial branch of the government. The purpose of the judiciary is to decide litigation, to formulate rules of law not covered by statutory materials, and to apply and interpret existing materials. This exposition and interpretation of the law becomes binding upon property and persons within the court's jurisdiction. Usually, only court decisions reported for general use are persuasive as primary authority.

In the trial or lower courts, decisions are often oral and not normally published. Appellate court decisions, on the other hand, are usually written and accompanied by an opinion.

The United States Consititution and the Congress have created a federal system of courts, consisting of the Supreme Court, the Eleven Courts of Appeal, the District Courts and a number of special courts. The Federal Cases contain the decisions of the lower federal courts from 1789-1880. Decisions of United States Courts of Appeal are published in the Federal Reporter, First and Second Series. United States District Court opinions are found in the Federal Supplement. The Federal Rules Decisions Reporter now reports the District Court opinions involving the Federal Rules of Civil Procedure since 1939 and the Federal Rules of Criminal Procedure since 1946.

Decisions of the United States Supreme Court are contained in three different sets of books: The United States Reports, the Supreme Court Reporter, and the Lawyer's Edition of the Supreme Court Reports. The latter work, in addition to reporting all of the decisions of the United States Supreme Court, annotates many such decisions on a selective basis. These annotations discuss the points of law involved in the reported cases and give references to other cases and materials which are related.

There are also state courts established under the constitutional and

legislative authority of the state, which have jurisdiction in all cases arising under the laws of the various states. The decisions of the highest state courts are published in two places: the States Reports (for example, the Missouri Reports), and the National Reporter System (published by the West Publishing Company).

The National Reporter System was commenced in 1879, thus duplicating the official reports, at least from the time the system began. One of its unique features is the key number system which will be explained later. It contains the decisions of all state appellate courts and divides them into seven reporter areas: the Atlantic Reporter, the Northeastern Reporter, the Northwestern Reporter, the Pacific Reporter, the Southeastern Reporter, the Southern Reporter, and the Southwestern Reporter. A recent addition is the California Reporter. It includes the cases decided by the Supreme Court, District Courts of Appeal and the Appellate Department Superior Court.

The New York Supplement originally contained all of the lower appellate court decisions of the state of New York. It has since been expanded to include the decisions of the New York Court of Appeals.

The above mentioned units, plus the Federal Reporter, the Federal Supplement, the Federal Rules Decisions Reporter, and the Supreme Court Reporter, comprise what is known as the National Reporter System. Advance sheets are also published for each of these units for immediate reference to recent decisions, prior to the publication of bound volumes.

Court decisions also may be found in the annotated reports. These reports contain cases which are unique either from the viewpoint of the facts involved or because of the highly controversial rule of law in issue. Only a small number of the decided cases are reported under this selective process. However, the valuable annotation which appears at the end of each reported case more than justifies the existence of the annotated reports. The American Law Reports is the current annotated publication of a general nature. Wage and Hour Cases, Labor Cases, and Negligence Compensation Cases Annotated are examples of the numerous special reports which collect decisions in particular areas of the law.

*Secondary Authority*

Law books also contain secondary authority. Unlike primary authority, secondary authority is neither controlling nor persuasive to the courts. However, in the absence of primary authority, secondary authority may be drawn upon by courts in deciding cases of first impression.

Encyclopedias, textbooks, treatises, and legal periodicals comprise books of secondary authority. An encyclopedia has two purposes. One, it is a commentary in that it treats the law narratively. Secondly, it is a book of index; that is, it gives reference by footnote to primary authority

(either statutes or court decisions) from which the narrative statement is obtained.

There are two types of encyclopedias, unrestricted and restricted. An unrestricted encyclopedia gives reference to all court decisions. The Cyclopedia of Law and Procedure was the first major publication of this type. However, it was replaced by Corpus Juris, which in turn was followed by Corpus Juris Secundum. Corpus Juris Secundum represents a complete rewriting of the text of Corpus Juris and, to this extent, does replace Corpus Juris. However, Corpus Juris Secundum only cites recent cases and it may be necessary to refer by footnote to Corpus Juris for earlier cases on the subject.

A restricted encyclopedia gives reference only to the leading or more important cases, more specifically, the select cases of the annotated reports. Ruling Case Law was the first of the restricted encyclopedias. It has been replaced by American Jurisprudence. One of the significant features of American Jurisprudence is that it cites the leading cases and by footnote reference incorporates the annotated series. Thus, more exhaustive discussion than is practical to include within the bound of the encyclopedia can be readily obtained, for example, in the American Law Reports.

Textbooks and treatises are narrative treatments of the law. Generally, they treat one particular area of law; for example, the *Law of Waters and Water Rights* by Henry Farnham. This three-volume work is characterized by extended discussion of legal principles. It also contains extensive footnotes for the court decisions which support these principles. The *American Law of Property*, another example, is a comprehensive eight-volume treatise on property law. Highly regarded textbooks on other law subjects include Prosser on *Torts* and Corbin on *Contracts*. In addition, the American Law Institute has published numerous volumes on various subjects of the law, known as "Restatements of the Law," of which the *Restatement of the Law of Torts* is an example. Not all textbooks concentrate on one particular area of law. For example, Beuscher's *Law and the Farmer* covers many law topics, as does Clark's *Summary of American Law*.

The law journals published by the law schools and the State Bar Associations often contain articles of interest. Professor Bolmeier's article on a "Board of Education's Right to Regulate Married Students,"[2] in the University of Louisville's *Journal of Family Law*, is an example of an article dealing with a narrow issue in a specialized law journal.

*Books of Index*

In addition to primary and secondary authorities, law books consist of books of index which include the digest and all other types of publica-

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[2] 1 FAMILY L. J. 172 (1961).

tions containing secondary authority (for example, encyclopedias, textbooks, treatises, legal periodicals, and annotated reports). However, the digests and the encyclopedias are perhaps the more popular books of index.

Digests contain short summaries of court decisions under alphabetically arranged topic headings. Each topic is divided into key numbers, so that once the proper key number is located it may be used in going from one digest set to another. The American Digest abstracts state and federal cases and is composed of the Century Digest, covering the years prior to 1896, and six decennial editions each covering a period of ten years (the First, Second, Third, Fourth, Fifth, and Sixth Decennials). The General Digest, third series, covers the years since 1956, pending publication of the Seventh Decennial. In addition to the American Digest System, the Federal Digest annotates all federal decisions. State digests (for example, the Missouri Digest) cover the decisions of the various state courts.

Publications containing secondary authority also serve as books of index. For example, after having located a narrative statement of law which answers the problem and is supported by statutory or case authority by means of a footnote reference, one can readily locate the authority from which the statement was obtained.

## TECHNIQUES FOR USE OF LAW BOOKS

The nature, classification, and relative persuasive value of law books having been considered, this section will examine the fundamental techniques of using these sources. The discussion is cast in the academic atmosphere of a traditional legal scholar, rather than the office of a typical lawyer in a county seat town. It is assumed that most readers, particularly the economists, will be more familiar with research in the academic setting.

A general outline of how to use law books effectively would look something like the one found in Price and Bitner, *Effective Legal Research*:[3]

1. *Analysis of the Problem.* Separation into aspects involved, including parties, procedure, and substantive issues.

2. *Preliminary Review of the Subject Matter.* Where needed for orientation, through treatises, encyclopedias, *Restatements*, and the like.

3. *Search of Statutes and Administrative Regulations Involved.*
   a. Federal statutes.
   b. Home-state statutes.
   c. Other-state statutes: collections and indexes across state lines; persuasiveness of cases construing.
   d. Administrative regulations implementing statutes.
   e. Finding legislative intent where helpful.

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[3] PRICE & BITNER, EFFECTIVE LEGAL RESEARCH 315 (1953).

4. *Search for Cases in Point.*
   a. Reading cases and orders cited by annotated statutes, treatises, etc.
   b. Finding additional cases through digests.
      i. Through Key-Numbers in *Reporter* cases read.
      ii. Tables of cases approach.
      iii. Analytical or topical approach.
      iv. Fact approach.
      v. Words and phrases approach.
   c. Search of the Annotated Reports System. (If desired this may precede "b," above.)
   d. As cited in administrative rulings.

5. *Search of Encyclopedias and Treatises.* To refresh the memory, to supply additional cases, and for subject matter analysis.

6. *Search of Legal Periodicals.* For a more detailed analysis of theoretical and controversial points, and for discussion of individual cases.

7. *Search of Loose-Leaf Services.* To coordinate all material in tax and regulatory fields.

8. *Search of Miscellaneous Material.* Study of A.L.I. *Restatements*, form books, government publications, etc.

9. *Completing the Search.* Making certain that the latest editions and supplements have been consulted, including the digest portions of National Reporter System advance sheets covering later cases than the General Digest.

10. *Appraising the Authorities Found.* Checking the subsequent interpretations and application of cases and statutes.

The above outline should be thought of as being a flexible guide, rather than a rigid requirement. Some attorneys, for example, begin their research with a review of legal periodicals. Others go immediately to a loose-leaf service. The real value of such an outline is that it shows what a truly exhaustive search would entail. However, to illustrate legal research, an attempt will be made to follow the outline, and references will be made to it as each method of approach is discussed.

The first step in the lawyer's analysis of the problem is to ascertain the essential facts from his client's presentation. The legal scholar, however, is not furnished with a ready made problem; and therefore, he must formulate the problem to be researched. For the purpose of this paper it will be assumed that our legal scholar is writing a treatise on water rights in Wisconsin, and that part of this study will deal with the use of diffused surface water.

The decision to study the law of diffused surface water was prompted in part by the recent increase in the construction of farm ponds, which are usually filled through the impoundment of diffused surface water. One

basic problem, connected with construction of farm ponds, is contained in the following hypothetical situation:

During the last two years, A has suffered poor corn crops because of dry weather, although there were a few days when it rained hard. Unfortunately, A was unable to use this rain water because it quickly ran off into a natural depression. The depression carried the water across the land of a lower neighbor B. A constructed an earthen dam across the depression to collect the run-off and now has a farm pond covering five acres, which he uses to irrigate his crops. The farm pond impounds all the water that formerly flowed through the depression to B's land. B claims that he was making beneficial use of this water before the impoundment and that he will suffer injury until the normal flow in the depression is re-established. B brought an injunction suit against A to enjoin him from obstructing the natural flow of water in the depression. B also sued for damages incurred since the construction of the impoundment.

The first step in the analysis of the problem is to determine the essential fact words. Those fact words which are usually deemed essential are: (1) The parties or persons, (2) the subject matter or property involved, (3) the cause of action (what happened), and (4) the object of the action or remedy sought.

The parties may be important because they may belong to a class governed by special rules (for example, infants or insane persons); they may engage in certain activities, occupations, or professions (for example, innkeepers or brokers); or there may be a special relationship between them (for example, guardian and ward or landlord and tenant). In our particular problem the parties, A and B, are *adjoining landowners.*

The subject matter or property involved comprise the essential things and places involved in the problem (for example, a will, a sidewalk, or a school bus). The subject matter in our problem is real *property* or more specifically *water,* and still more specifically, what *class* of water.

The cause of action is a description of what happened. It may be an act of commission (assault or embezzlement) or omission (negligence or failure of consideration for a contract). In either case, the act involved is the wrong upon which the plaintiff is basing his claim. The cause of action in the present problem is based on the following: The *impoundment* on A's land across a depression (which extends from his into B's land) completely obstructs the *natural flow or drainage* of water, and as a result B no longer is able to *appropriate* water out of the depression for his farming operation.

The object or remedy sought in a civil case may be damages, specific performance, injunction, or a declaration of rights. Conviction is the object of a criminal action. B in our problem seeks both *injunctive relief* and *damages.*

In an ordinary lawsuit other points of controversy are considered along

with the above fact words. They may be disputed points of law or procedure arising out of the case other than the cause of action, such as damages or jurisdiction. Unlike the practicing attorney, the legal scholar can ignore these considerations where they are not germane to the object of his research. This is true in the present problematic situation.

The next step after analyzing the problem is to identify the legal issue or issues. Legal issues are arrived at through a process of deciding what points of law are involved and then formulating questions for each point. The researcher draws primarily on his formal legal education and subsequent experience in framing the legal issues. In some cases, however, a preliminary review of the subject matter is required before the issues can be intelligently formulated. Encyclopedias and treatises are often used for this purpose.

The process of framing the legal issues includes the use of the fact words developed above—those in italics. Words should be selected with the anticipation that they will be used when the questions are framed. Each legal issue should involve only one point, and should be completely and concisely stated with the thought in mind that it will be turned over to someone else to do the searching. This does not mean that the issue as framed becomes final. Ascertainment of relevant facts is a continuing process and, as new legal insights are gained through research, readjustment of the original appraisal of the facts and a consequential restatement of the issues may be necessary.

On the basis of the analysis outlined and the observation of the rules mentioned above, the researcher determines that the issues are: (1) Is the water which flows through the natural depression located on the land of A and B part of a natural watercourse or is it diffused surface water? (2) If it is diffused surface water: Does upper landowner A have the absolute right to build a dam and impound all the diffused surface water flowing in the natural depression, if such action cuts off all the flow to the lower land of B to his injury? (3) If the water is a part of a natural watercourse: Does A as a riparian owner have the right to divert all water in the watercourse to his land, when such action cuts off the flow to lower riparian B to his injury?

*Preliminary Review of the Subject Matter*

The next step, a preliminary review, may have been required earlier, when the researcher analyzed the problem, if he was unfamiliar with the subject matter. In either case, he may want to review the subject matter area before continuing with his search. Here treatises, encyclopedias, *Restatements*, and so forth are used.

Before proceeding with a discussion of the preliminary review, it should be pointed out first that there are four basic methods of approach in legal

research: (1) The analytical or law chart approach, (2) the descriptive word index or fact approach, (3) the table of cases approach, and (4) the words and phrases approach.

The analytical approach is a more scholarly, and relatively speaking is less mechanical. It involves the use of a table of contents or law chart. This is the approach that will be used relative to the preliminary review of the subject matter. Significant books of index and search books divide the law into 400 topics. The topics make up the seven basic divisions of law: persons, property, contracts, torts, crimes, remedies, and government. Law book publishers, such as West Publishing Company, have prepared a law chart comprised of these grand divisions and topics. By using this method the researcher selects the most appropriate grand division (an illustration of the law chart is found in the beginning of the first volume of the index to the encyclopedia *Corpus Juris Secundum*).

After surveying the grand divisions, "property" seems to be the obvious choice for the issues involved in our problem. This division is then consulted to determine what topics embrace our problem. The topic "Waters" is certainly applicable and the topics "Drains" and "Adjoining Landowners" are possibilities. "Waters" is a logical choice in that the issues revolve around the use of water. The upper landowner is interfering with the natural drainage; and, therefore, "Drainage" or "Drains" would appear to be a likely topic. The relationship of the parties is that of adjoining property owners, and the topic "Adjoining Landowners" has possibilities, although it is more general than the others. The normal procedure of a legal researcher would be to search for authorities under all of these topics, but for the purpose of this paper, the presentation will be limited to "Waters."

An examination of the table of contents ("Analysis" and "Sub-Analysis") for the topic "Waters" in *Corpus Juris Secundum* determines where the search should start.[4] Section 112, "What are surface waters?" seems to offer the best starting place in view of the first issue which raised the questions of how legally to classify the water involved. This section is read for background purposes. Other sections under "Waters" also are read in order to obtain general background information with respect to all issues. We will assume, for the purposes of this presentation, that the background reading clearly shows the water involved to be diffused surface water. Actually, the questions of whether waters are diffused or part of a natural watercourse is a close one. Consequently, a researcher may decide to expand his research to cover both possibilities.

Footnotes cited as authority for statements in the text are ignored at

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[4] The topic "Waters" is found in volumes 93 and 94 of CORPUS JURIS SECUNDUM.

this point, unless a footnote cites a case so unmistakenly in point that an immediate follow-up is justified. It is necessary also to refer to the supplement or to the pocket part at the end of the volume for recent statements and court decisions. In our case we would search the supplements for volumes 93 and 94.

*Search of Statutes and Administrative Regulations*

After obtaining an orientation of the subject matter, the researcher proceeds with the task of finding all the information which relates to the issues. In some instances, the researcher will have specific pieces of information which bear on the issues, such as a statement in a treatise or pertinent statute. In this case we will assume that the researcher is aware of recent enactments of legislation on the subject of water rights in his and other jurisdictions. Therefore, the next step will be a search of statutes and administrative regulations involved. This is step three in the above cited outline.

It has been decided that this is a matter of state jurisdiction and that federal statutes would not be applicable. We then move to the appropriate home-state statutes (3. b.), in this case the Wisconsin statutes. The table of contents, in the statutes, does not follow the law chart. Its arrangement is according to chapters. The Revisor of Statutes cautions, "The chapter method is not safe unless you know the book well. . . ." An approach more adaptable to our search of the statutes is the descriptive word index method of approach.

The descriptive word index (or fact) method of approach, sometimes referred to as the subject-index method, involves an examination of the facts and issues to determine what are the outstanding words or phrases, commonly called "catchwords." The editors of the various books of index have compiled descriptive word indexes where "catchwords" are listed in alphabetical order. When the word is located in the index, reference is made to a particular volume and page, section number or key number, wherein the matter is treated.

The subject-index to the two-volume *Wisconsin Statutes* is found at the end of the second volume. The index is made up of (1) heads (boldface capitals), (2) subheads (boldface indented), (3) entries (plain roman), (4) subentries (plain roman indented), and (5) cross references (italics). Reference is made to articles and sections of the *Wisconsin Constitution* and to sections and chapters of the statutes.

For convenience sake, the issue in our problem is narrowed down to the second issue: "Does upper landowner A have the absolute right to build a dam and impound all the diffused surface water flowing in the natural depression, if such action cuts off the flow to the lower land of B to his injury?" The catchword "diffused surface water" is an obvious choice.

However, it is not listed as a head, nor is the catchword "surface water" listed. This is not unusual as only 2,500 words are listed as heads. If a head is not found to correspond to the original catchwords, it is necessary to think of other possible heads under which the subject is indexed. One possibility is "waters."

The catchword "Waters" is found to be a head. Since there are no subheads under "Waters," all the entries are checked. The entries, as heads, are in alphabetical order. The word "diffused surface water" is not an entry; the entry listing "surface waters" is not relevant.

Reaching a blind alley with these catchwords, the researcher thinks of other appropriate ones. The catchword "Dams" is an entry listed under the head "Waters: Dams on non-navigable, 31.31." Sometimes a section is broader than its entry description, so section 31.31 is read for content. It is deemed inapplicable.

The catchword "Dams" is itself a head. Under it is found the entry: "Jurisdiction of Commission, 31.33." The pertinent part of the Wisconsin statute provides "all dams heretofore or hereafter erected or constructed on streams not navigable in fact for any purpose whatsoever shall be subject to and regulated and controlled by the provisions, so far as applicable, of sections 31.02, 31.03, 31.12, 31.18, 31.19, 31.20, 31.22, 31.25, 31.26 and 31.28 of the statutes." (These sections provide that any plan for dam construction must be approved by the P.S.C.) This appears to be a real find.

The researcher next checks section 31.33 in the *Wisconsin Annotations*. The *Wisconsin Annotations* include interpretative court decisions, notes, attorney general opinions, and the legislative history for each section in the Wisconsin Statutes. The last edition of the *Wisconsin Annotations* was printed in 1960. The *Wisconsin Annotations* do not have a supplement; however, annotations to the statutes after 1960 can be found following the sections affected in the statute volume.

There is also available an unofficial supplement to the *Wisconsin Annotations,* called *Mason's Annotations,* published by a private company. In recent years West Publishing Company has come out with *Wisconsin Statutes Annotated.* Unlike the *Wisconsin Statutes,* this is not an official compilation of the laws. However, this has the advantage of having the statutes and annotations in one work.

The one case annotated under section 31.33 in the *Wisconsin Annotations* of 1960 is not in point. However, the legislative history reveals that this section, when originally adopted, pertained to mills and mill dams on non-navigable streams. This information, plus the language of the statute itself leads the researcher to conclude that section 31.33 is limited to natural watercourses and not applicable to dams which impound diffused surface water. So this is not a real find after all.

No applicable Wisconsin statutes have been found; and, therefore, the points covered in 3.d (administrative regulations implementing statutes), and 3.e (finding legislative intent) of the Price-Bitner outline will be bypassed. This takes the researcher to a search for cases in point.

*Search for Cases in Point*

In searching for cases in point the researcher, for illustrative purposes, will generally continue to follow the above-mentioned outline. However, it should be stressed that this outline, or any outline, should be thought of as a flexible guide. For example, the search could start with a search of the *Annotated Reports System* before the digest system.

Since the search yielded no cases cited by the *Wisconsin Annotations* (4.a.), the researcher continues his search for cases through the digests (4.b.). It is possible to employ five different methods of approach for this purpose.

The four most basic methods of approach have been outlined above, with respect to the discussion of the preliminary search. The fifth involves finding cases through key numbers in *Reporter* cases read.

The method of approach which will be first employed by the researcher depends (as will be brought out in the discussion) on the information at hand. In our case, the researcher begins with the *analytical or topical approach* (4.b.iii.). The reader will recall that this was the method used with respect to the search for preliminary material in *Corpus Juris Secundum.*

To illustrate the analytical or topical method of approach to the digest system, the *American Digest System* is consulted. Here the object is to find a digest paragraph, headnote, or syllabus which purports to be a condensed statement of what courts have decided on various points of law.

The search is commenced with the most recent bound decennial—the *Sixth Decennial Digest.* A list of digest topics is found at the beginning of each volume of the digest. This list contains the topic "Waters and Water Courses." This topic is found in volume 31. The "analysis" of the topic is similar to that found in *Corpus Juris Secundum.* The researcher finds "Surface Waters" and under it the most appropriate key number, 117 "Rights to Surface Waters." Turning to key number 117, he fails to find any Wisconsin case in point. However, a digest note for a Texas Civil Appeals case is found, and it seems appropriate to our issue. It states: "Surface waters belong to the landowner" and cites the case.[5] This case is read in full to determine the exact rule adopted and whether the court's statement of the law was made in reference to facts similar to those in our problem.

Once the key number (117) is ascertained, it is then checked in all the

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[5] Pecos County Water Control & Improvement Dist. v. Williams, 271 S.W.2d 503 (Texas Civ. App. 1954).

digests, from the *Fifth Decennial* back to *Century Edition* (Sec. 127 in this particular volume); then the search is brought forward through the latest *General Digest Volume.* The search reveals no Wisconsin cases. However, in volume 31 of the *Fourth Decennial,* two digest notes are found for a South Dakota case, *Terry v. Heppner.*[6] The second note states: "Landowner is entitled to use surface water as he pleases so long as it continues in fact to come to his premises." Neither the South Dakota nor Texas Appeals case is precedent in our jurisdiction; however, they do indicate what the general rule is with respect to our issue. *Terry v. Heppner* looms particularly important because its facts are analogous to those in our problem.

Another approach in using the digest system is the descriptive-word index method or *fact approach* (4.b.iv.). This method was previously mentioned with respect to our search of the *Wisconsin Statutes* and involves the use of catchwords. The researcher selects the "catchwords" by determining what words in the issue as stated appear to have the most legal significance. In our case, the appropriate catchword selected is "surface waters." The search for the word "surface waters" begins in Volume 52 of the *Descriptive-Word Index* (P-Z) to the *Fifth Decennial* edition of the *American Digest System.* Here the search begins with the fifth instead of the sixth decennial, but it makes little difference where the researcher starts as long as all the decennial digests and general digests are completely checked. After finding the catchword "surface waters" (on page 1185), the researcher looks under this heading for appropriate sub-titles and finds "Appropriation of Waters 130." All court decisions relating to this entry will be found in the digest system under key number 130 of the topic "Waters." Another appropriate sub-title found is "Rights to Surface Water, Waters 117." However, this key number has already been examined through the analytical approach.

The next step is to consult the *Century Digest,* all five remaining decennial digests, and the *General Digest* for the topic "Waters 130." Again the search reveals no Wisconsin case in point. Most cases digested under this key number are found to deal with appropriative rights in the western states. However, it is interesting to note that the South Dakota case *Terry v. Heppner* was found under this key number.

Two other methods of approach to find cases through the digests are *key numbers* in *Reporter* cases read (4.b.i.) and the *table of cases* (4.b.ii.). To illustrate the use of these approaches, let us assume that the researcher re-examines *Corpus Juris Secundum* (having read it the first time for preliminary review) and takes note of the cases cited as authority for the text. One appropriate statement is found in Volume 93, section 113: "Riparian rights do not attach to surface waters,[16] and the lower proprietor has no

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[6] 59 S.D. 317, 239 N.W. 759 (1931).

right to have surface waters flow to his land from upper or higher land.[17]" No Wisconsin cases are cited in footnotes 16 and 17, but the South Dakota case *Terry v. Heppner* is cited in both footnotes. It is significant that this case is cited as authority for the general rule, particularly because the facts of the case are analogous to those in our problem.

The table of cases approach is used where a relevant case is known, and the researcher wishes to find additional cases covering the same point. Relative to our problem, *Terry v. Heppner* has been found to be pertinent. Using the table of cases approach, *Terry v. Heppner* is found in the table of cases in volume 34 of the *Fourth Decennial Digest.* This digest contains all cases cited during a ten-year period (1926-36). The same is true for the other digests. References following the cases are to digest topics and key numbers (e.g., *Terry v. Heppner*, 59 S.D. 317, 239 N.W. 759-Waters 116-117, 130). This method has turned up an additional key number, key number 116. It is consulted in all the *American Digests* for Wisconsin cases in point, but none is found.

The key number method of approach involves going to a known case such as *Terry v. Heppner,* in the Northwestern Reporter and examining its headnotes for the case. Five headnotes summarize various legal points in the case and refer to the appropriate topics and key numbers in the *American Digest.* This method of search turns up the same topic and key numbers found by the use of other methods: "Water and Watercourses, key numbers 116 and 117" plus a new one, 118, which proves to be too general for our purposes.

A fifth method of approach in finding cases in the digest system is the *words and phrases approach* (4.b.v.). This may be a good starting point especially where a particular word has taken on notable importance. It involves a search for cases in which the court has defined the word. This is accomplished by use of a table of words and phrases. There is a table of words and phrases for each advance sheet, *Reporter* bound volume, and *Reporter Digest* (except the *American Digest System*).

One of the issues in our case is whether the water involved was diffused surface water or part of a natural watercourse. The answer to this question involves the definition of "surface water" and "watercourse." The tables of words and phrases in advance sheets, bound volumes of *Reporters,* and *Reporter Digests* only cite the cases where a definition of a particular word can be found. They do not define the words. For example, the word "watercourse" is listed in the "Table of Words and Phrases" in Volume 22 of the *Kentucky Digest.* Here two Kentucky cases, *Morgan v. Morgan*[7] and *Withers v. Berea College,*[8] are cited without including the definition given to the term in the respective decisions.

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[7] 205 Ky. 545, 548, 266 S.W. 35, 36 (1924).
[8] 349 S.W.2d 357, 358 (Ky. 1961).

The words and phrases method of approach is best used in conjunction with West's separate work "Words and Phrases." This law dictionary, which is not part of the digest system, aims to cover words judicially defined in the *American Digest System*. Common words as well as legal terms are defined in this work. The word "surface water" is listed in "Words and Phrases." One of the definitions given for this term is from the Indiana Court of Appeals: "'Surface water' in its ordinary sense means water collected on the surface of the ground. *Ramsey v. Ketcham.*"[9] Definitions from other jurisdictions follow.

In addition to the basic methods of approach presented above the *Annotated Reports System* provides still another avenue to find cases in point. The methods of approach mentioned above may be used to find cases through the *Annotated Reports System* approach (4.c.). Cases also can be found in the *Annotated Law Reports* by use of the *American Jurisprudence.*

Volume 56 of *American Jurisprudence* contains a comprehensive section on "Waters." The following statement is found in section 6: "Watercourses, as herein considered, are to be distinguished from natural channels or drainways for the drainage of surface water,[18]. . . ." In addition to referring to cases, footnote 18 refers to an annotation in the *American Law Reports.*[10] This annotation is entitled, "What constitutes natural drainway or watercourse for flow of surface water." It reviews all court decisions dealing with the question of what constitutes a natural drainway for the flow of surface water. Included in this review is a Wisconsin decision, *Hoyt v. City of Hudson.*[11] The digest note for the case is read to determine whether the case is in point. The digest notes are valuable for they go into the subject in much greater detail than the usual digest note.

*Search of Encyclopedias and Treatises*

There are no administrative rulings connected with our problem (4.d.) so we move on to the next step in our outline, a search of encyclopedias and treatises. The use of this material at this point is to refresh the memory, supply additional cases, and further analyze the subject matter.

One treatise, which is a classic in its field, is the three-volume work of Farnham on *Water and Water Rights.* It was published back in 1904. Other relevant treatises are Gould on *Waters;* Kenney, *Irrigation and Water Rights;* and the English treatise, Coulson and Forbes, *The Laws of Waters and Land Damage.*

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[9] 73 Ind. App. 200, 204, 127 N.E. 204, 205 (1920).

[10] Annot., 81 A.L.R. 262 (1932). More recent court decisions and annotations on this general subject may be found by referring to the supplements of the AMERICAN LAW REPORTS under the heading 81 A.L.R. 262-274.

[11] 27 Wis. 656, 9 Am. Rep. 473 (1871).

*Search of Legal Periodicals*

We next search for articles, comments, or notes in legal periodicals. One of the main functions of legal periodicals is to give a more detailed analysis of theoretical and controversial points, in addition to a discussion of individual cases. The various indexes to legal periodicals or law journals (published by law schools and law associations) are examined. Again materials on water law are indexed under the topic "Water and Watercourses."

A search of legal periodicals for the years 1940-43 in Volume 6 of the *Index to Legal Periodicals* reveals an article in the *Minnesota Law Review* entitled, "Interference with Surface Waters," by S. V. Kinyon and R. C. McClure.[12] This article proves to be highly valuable, not only for the text, but for the cases cited.

*Search of Miscellaneous Materials*

Since there are no loose-leaf services specifically covering water resources law, we move on to a search of miscellaneous material. A government publication which proves to be helpful in researching our questions is Hutchins, *Selected Problems in the Law of Water Rights in the West.*[13] The value of this book is that it examines specific water problems in depth.

*Completing the Search and Appraising the Authorities Found*

The last step in the legal library research process is (1) to check the latest editions and supplements, including the digest portion of the *National Reporter System* advance sheets (this covers cases too recent to be included in the *General Digest*), and (2) to examine the subsequent history and treatment of the cases or statutes. The latter task has been greatly simplified by the publication of *Shepard's Citations.* It offers a method to determine the result of cases on appeal, together with all subsequent cases which have applied, interpreted, or otherwise cited the case involved. The same is true with respect to the legislative investigation. There are *Shepard's Citations* covering: (1) The decisions and statutes on a federal level (for example, *Shepard's United States Citations*), (2) the cases reported in the *National Reporter System* (for example, *Shepard's Southwestern Reporter Citations*), and (3) the various state reports and statutory materials (for example, *Shepard's Missouri Reporter and Statutory Citations*).

To illustrate the use of *Shepard's Citations,* assume that a researcher finds the case of *Joseph Triner Corporation v. McNeil,* reported in volume 2 of the *Northeastern Reporter,* Second Series, at page 929. It involves the constitutionality of the Illinois Fair Trade Act. (This particular case is

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[12] 24 MINN. L. REV. 891 (1940).
[13] *USDA Misc. Publication No. 418* (1940).

used instead of a water case because it lends itself ideally to a discussion of the procedure in using *Shepard's Citation.*) The researcher first consults the 1945 bound volume of *Shepard's Northeastern Report Citations.* The next step is to locate the volume number in which the case is reported in the *Northeastern Reports* in the Shepard unit. The Shepard's volume is checked chronologically. The researcher can locate the volume number of the report in which the case is reported in the upper right-hand corner of the page. The heavy-face type numbers within the page are examined to locate the initial page number of the report in which the case is reported. The researcher will find it in the third column of citations. By the use of symbols, the key to which appears in the front of each volume, the history and treatment of the case is obtained.

After locating the page reference (in the third column of citations), the researcher is first referred to cross references to the state reports and *American Law Reports.* This is indicated by the use of parentheses around the citations. He finds the *Triner* case is reported officially in Volume 363 of the *Illinois Supreme Court Reports* at page 559 and also appears in Volume 104 of the *American Law Reports* at page 1435. The next three citations preceded by the letter "a" indicate that the case was affirmed by the United States Supreme Court and may be found in the three different cited sources (the *United States Reports,* the *Lawyer's Edition of the Supreme Court Reports,* and the *Supreme Court Reporter*). The next citation, preceded by the letter "s" denotes a previous action in the same case. The citations which follow give the judicial interpretation of every case. For example, it is noted that the letter "f" precedes three of the citations together with small superior numbers in advance of the citing page number. This means that the principles of law brought out in paragraphs 5 and 9 of the syllabi in the *Triner* case have been followed in the cited cases. Thus, the citations dealing with a point of law in any paragraph of the syllabus may be referred to directly. The letter "n" which follows the particular citation means that the *Triner* case has been cited in notes of the *American Law Reports.* Further citations give references to all of the units of the *National Reporter System,* with the state of the citing case indicated, wherein the *Triner* case has been considered. Additional citations are made to articles in law reviews citing the *Triner* case (*Harvard Law Review, Boston University Law Review,* and *Massachusetts Law Quarterly*). Thus, a complete citation history and treatment can be obtained by the use of

*Shepard's Citations*

The use of *Shepard's Citations* in connection with statutory materials is similar. The purpose of this division is to note every instance in which the constitution, legislation, or other statutory material has been cited, applied,

or construed and also every instance wherein these have been affected by subsequent changes. The symbols used in connection with this division are somewhat different. Here again, the key is easily obtained by consulting the front of the volume which is used.

If the researcher were interested in the history of a provision of the federal constitution, statutes, court rules, or departmental reports, he would consult *Shepard's United States Citations. Shepard's Federal Reporter Citations* would be consulted for matters pertaining to patents, trademarks, and rule of the lower federal courts. A state publication, such as *Shepard's Missouri Citations*, is used if a researcher is interested in the state constitution, legislation, laws, or city ordinances.

If there is more than one volume in the Shepard unit, each volume and the Cumulative Supplement must be consulted since the case was decided, for a complete history. Up to the minute citations of its history may be obtained by writing the publishers. With the use of *Shepard's Citations* the traditional search for legal authority in law books ends.

## ELECTRONIC DATA RETRIEVAL

Perhaps the newest and most important development in the area of legal research has been electronic data retrieval by the use of computers. One of the pioneers in this area is the Health Law Center at the University of Pittsburgh.

As indicated earlier, researching a problem under the classical method of legal research involves the use of the indices of the various sources. The result obtained depends upon the skill of the researcher to look in the right places within the index and the person who compiled the index to put the various items under appropriate headings. A search employing electronic data retrieval is set up on an entirely different basis. The computer searches each case, statute, and so forth, for certain key words which normally appear in that type of case or statute. As one can see, this type of search depends more upon the skill of the analyst who chooses the words and modifiers to be used.

Setting up the system first involves the storing of the statutes, cases, ordinances, and so forth, on magnetic tape, which forms the memory of the computer. This is done by an instrument known as a Flexowriter which is similar to a typewriter. While the worker types out the material on the machine, it makes a typewritten copy and punches a copy on a paper tape, which later is used to put the information on magnetic tape for use by the computer.

For simplicity, the search involved here will consider the cases handed down by the Supreme Court of Pennsylvania. The question the computer

has been asked is "What is the law of diffused surface water in Pennsylvania?"

The search analyst selects four basic groups of words for the purposes of this search. Each group contains a different set of modifiers for the key words "water" and "waters." The selection is based on past experience and the use of a thesaurus especially compiled for this type of research. The thesaurus contains words most often used by the courts and legislatures, along with their many synonyms and modifiers.

The analyst must then tell the computer what relation the words and their modifiers must have. For example, in Group No. 1, the analyst requests any document which contains the key words "water" or "waters," modified by any of the words listed below it, if the modifying word is within five words before or after the key words. In Group No. 2 the analyst has told the machine he wants the modifying words to be within the same sentence as the key words. The computer is then set to search the vocabulary tape. It is a magnetic tape made up of all the words used in the documents from which it was made (in this case the Supreme Court Reports of Pennsylvania). The machine can be told to start the search at the letter "W" (water).

The computer now begins its search for the key words. Upon locating them, it stores their "addresses" (or location on the tape) in its memory. Once this is completed, an output command is given to the machine specifying the coverage of the material desired. The machine can be asked for: (1) The full text of the statutes, (2) the descriptive title, (3) the section numbers, or (4) under a new method known as KWIC (key word in context)—only three lines of the statute which contain the key words (to give one the gist of the statute). The same output commands can be made when requesting cases. With respect to our problem, the headnotes of each of the cases found were requested.

The end product of the computer search is the output sheet. At the top left corner is the citation of the case, followed by its name. Printed below are the headnotes of that case. The words in the right margin are those words which were used in the search. These words are useful in determining which of the many cases shall be read and analyzed.

In addition to the Pennsylvania Supreme Court Reports, the Health Law Center has taped the Internal Revenue Code, the ordinances of the city of Pittsburgh, and recent legislation of the fifty states. With respect to our problem involving the law of diffused surface water the computer found: 518 cases decided by the Pennsylvania Supreme Court, 8 sections under the Internal Revenue Code, 106 titles under the Pittsburgh Ordinances, and 110 recent titles under the most recent legislative enactments of the fifty state legislatures.

Now the search has been completed, and the various materials found can be delivered to the researcher for his inspection and analysis. As always, it is up to him to determine the cases to be used and how to use them. However, the computer has saved him many hours of laborious work in the law library. It cannot be stressed enough that a computer is unable to think. It can only do certain mechanical functions which its operator tells it to do, but the potential of this area of legal research is almost unlimited.

## FIELD STUDIES AND NON-LEGAL MATERIALS

Classical law library research, as outlined above, continues to be the primary method by which lawyers research day-to-day legal problems, although computer research has gained some inroads. Most practicing lawyers usually end their search when the classical law-in-the-books search is completed. However, some researchers use it as a jumping-off place. Those in the latter category usually are undertaking a more scholarly approach toward the legal problem involved. Legal research in depth most likely will involve the use of extensive field research or of non-legal materials, or both.

The use of non-legal materials involves the use of materials falling in the following categories: (1) General reference collections (general reference works, periodicals, and government documents), (2) book collections, (3) dissertations and theses, and (4) monographs and pamphlets. The use of non-legal materials will no doubt be covered in some detail during the course of the workshop.[14] On this assumption we will move on to a brief discussion of field research.

Field research has been an integral part of the Law-in-Action program, which has been developed over the years at the University of Wisconsin Law School under the guidance of Professors J. H. Beuscher and Willard Hurst. This type of research, of course, is not limited to Wisconsin. The Agricultural Law Center at The University of Iowa, for example, has employed this type of research in connection with studies relating to land tenure.[15]

An example of such Law-in-Action study consisted of a field study (during the summer 1955) of the operation of the installment land contract in Wisconsin. It was undertaken in an attempt to shed light on how, where, and why this device was being used in the purchase of farms in Wisconsin. Recorded land contracts for the sale of farms were examined over a

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[14] See chapter 12 on *Non-Legal Materials* by Leon Lebowitz in HOW TO FIND THE LAW (West, 1957).

[15] See HARRIS & HINES, INSTALLMENT LAND CONTRACTS IN IOWA, Agric. Law Center Mono. No. 5 (1965).

four-year period in four counties. This information was supplemented by interview data. Buyers, sellers, practicing lawyers, bankers, and representatives of government and private loan agencies were included in the interview survey. Information obtained from the field research was later reported in a law review article.[16]

Field research has also played an important part in a recent water law study at the University of Wisconsin.[17] The study includes a report of the roles played by state agencies and local units of government with respect to laws and rules that relate to the use and disposition of water. In connection with this study, selected lower court cases involving water rights were digested and included in the Report.[18]

An analysis of the Public Service Commission's administration of Wisconsin's irrigation permit law was also included. It was based on a detailed survey of applications for irrigation permits and hearing records for the period 1949-1960. An earlier version of the findings was published in the *Wisconsin Law Review*.[19]

The report's analysis of the role of local government in the allocation of water involved field research consisting of interviews with city attorneys, superintendents of water departments, city clerks, representatives of industries which consume large quantities of water, clerks of circuit courts, and others. A version of this analysis was also published in the *Wisconsin Law Review*.[20]

To illustrate the use of the above described tools of field research and non-legal materials, we again refer to the legal problem involving the use of diffused surface water. Non-legal materials appropriate in researching the problem might include newspapers, periodicals, and government publications; books, theses, pamphlets on the subject; general and special encyclopedias; and general, special, and miscellaneous fact books and dictionaries.[21]

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[16] See Dolson and Zile, *Buying Farms on Installment Land Contracts*, 1960 Wis. L. Rev. 384.

[17] The Shaping of Wisconsin's Private and Public Rights in Water by Wisconsin State Administrative Agencies and Local Units of Government, Together with a Description of Local Court Cases. (A phase report under Part III, Contract 12-14-100-1010 (43) between the University of Wisconsin and the U.S. Department of Agriculture for a Study of Legal and Economic Aspects of Water Rights in Minnesota, Wisconsin, Indiana, and Ohio.)

[18] See Report, *supra* note 17, at 189.

[19] See Comment, *Wisconsin's Water Diversion Law: A Study of Administrative Case Law*, 1959 Wis. L. Rev. 279; *Report, supra* note 17, at 36.

[20] See Comment, *Role of Local Government in Water Law*, 1959 Wis. L. Rev. 117; *Report, supra* note 17, at 148.

[21] See Table of Newspaper Articles Cited and Table of Other Materials Cited in Dolson, A New Look at the Law of Diffused Surface Water in Wisconsin 341 (unpublished thesis on file at the University of Wisconsin Law School).

A list of people whom the researcher might interview would comprise persons who would be knowledgeable in the field of water use in practice as well as theory. In Wisconsin this list would include the State Geologist, a Soil Conservation Service supervisor, a project supervisor for the U.S. Department of Agriculture, Soil and Water Conservation Research Branch, the chief engineer for the Public Service Commission, the attorney for the Public Service Commission, and the State drainage engineer.[22]

A questionnaire could be used with certain groups interested in the area of study, namely, owners of farm ponds, lawyers and lenders of money, soil conservation organizations, government agencies connected with water resources, and many other groups. A survey could be made of the largest water users (farmers, industry, and so forth) to determine how many of them are making use of diffused surface water, if any at all. A questionnaire for use with owners of farm ponds, for example, might cover such questions as:

1. When you purchased the property was the farm pond, etc., one of your main considerations? Minor? None at all? Was it reflected in the purchase price?
2. Did you completely understand your legal rights and duties in relation to the water on the land? Partially? None at all?
3. If you knew of all or some of the legal aspects of the water, how did you gain such knowledge: (a) Lawyer, (b) common knowledge, (c) explained at closing the transaction, or (d) other?
4. Did you anticipate any problems which would arise by your or others use of the water and, if so, what did you do in anticipation of these problems?
5. Do you make a conscious effort to collect surface water (rain, melted snow, and so on) on your property by methods other than the farm pond? If so, what methods do you use? For what purposes do you collect this water?
6. Have you had any conflicts connected with the use of the surface water in the pond? Adjoining landowners? Others? If so, what type of conflicts?
7. How were conflicts involving areas covered by the previous question resolved, if they have arisen or if they should arise: (a) Between the parties themselves, (b) law suit, (c) disinterested third party, or (d) other?
8. Do you have any legally binding agreement, contract, deed for easement, and so forth, with any adjoining landowner relative to the surface water on your land?

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[22] See Table of Interviews cited in Dolson, *supra* note 21, at 340.

9. Have you ever applied to any governmental agency for a permit or assistance in relation to the surface water on your property, that is, construction of farm pond, irrigation, and so forth. If so, to whom?
10. Do you use any of the water on your land for other than ordinary household uses, that is, for watering stock, irrigation, commercial sale of it, and so on?

## CONCLUDING REMARKS

This paper has not been intended to be an exhaustive exposition of the various methods of approach in researching a legal problem. Rather, it has been intended to briefly describe to economists the three basic legal research approaches (classic law library, non-legal library, and field research), and a new one—electronic data retrieval. The original presentation of the paper included the showing of color slides to demonstrate each point. With respect to the law library approach it illustrated the types of materials found in the law library, how they are classified, what their nature is and the techniques of finding legal authorities in such materials.

## COMMENTS

Loyd K. Fischer*

Although Mr. Dolson's paper is entitled "The Legal Researcher's Methods," most of the presentation is devoted to a detailed exposition of the "methods" of research of the practicing attorney, not those of the legal researcher. "Method," as used by Dolson, refers not to the philosophy or frame of reference of research, which is the concern of methodology, but instead it rightly refers to the sources of information and the mechanics or techniques of finding the desired information. Such a presentation makes an important contribution to the Workshop in that it reveals the typical lawyer's conception of research.

Problems of communications between lawyers and economists concerning research, however, do not arise from differences in their methods of gathering information. An economist's search of literature is not markedly different in method, or even in purpose, from the lawyer's search of the legal library.

To many lawyers, perhaps most of them, the classical search of the law library *is* legal research; but to a research economist engaged in empirical analysis, the search of literature constitutes only a preliminary step in the conceptualization of an inquiry. By careful perusal of relevant literature, and exploitation of other readily available information, the economist acquires a better understanding of the problematic situation. By this means

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he hopes to gain insight into the scope of the problem and the variables which bear on it.

The economist will proceed with data collection after he has (1) acquired a thorough familiarity with relevant information which is readily accessible, (2) prepared a precise statement of the problem for which a solution is sought, and (3) formulated a set of hypotheses, which are capable of empirical testing, concerning the causes and consequences of the stated problem and possible solutions to it. Only after these preliminary steps have been taken is an economics researcher in a position to make rational decisions as to what information is needed for his analysis.

This comment is not intended to question the appropriateness of the classical search of the law library as a method of research for the practicing attorney preparing a case. In the first place, the economist is rarely able to separate his inquiry into such neatly defined steps as is implied in the preceding paragraph. Nor does the lawyer proceed with his search of legal sources without considerable thought as to the nature of the problem confronting him. He quite obviously does not select materials at random but instead proceeds with his search on the basis of considered judgment as to what might be relevant and significant and what most likely would be irrelevant or inconsequential. As with the economist, his knowledge of the nature and scope of the problem improves as his inquiry proceeds. Furthermore, the lawyer and the economist can readily utilize both legal and non-legal materials in their search of the literature.

Whether a legal researcher consciously follows the sequential steps in research presented above may be of little consequence in library research. The lawyer who has never heard of these steps and the economist whose training in research methods stressed them may proceed in much the same manner and be almost equally effective. However, research involving surveys or field studies is much less forgiving. The researcher who goes to the field without the best possible understanding of the problem at hand will likely come back from the field with information which is both irrelevant and inconsequential. Furthermore, he will also likely fail to acquire information which is essential for his analysis.

Near the close of his presentation Mr. Dolson deals briefly with (1) field research and (2) use of non-legal materials in legal research. His differentiation of these "methods of approach" from the classical law library research is not completely clear. "Non-legal materials" seem to be properly presented merely as alternative sources of information which may supplement that found in the law library. Such a differentiation would hardly constitute a different "method" of research, but such is Mr. Dolson's classification.

Somewhat more attention is devoted to "field research," including a cou-



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ple of examples. Although the presentation dsitinguishes field research from law library research, it does so only in the same way as "non-legal materials" are differentiated. In other words, one could infer from the presentation that only the source of information has changed. However, the points made in the paper with respect to (1) the purpose of the field studies, (2) the selection of people to be interviewed, and (3) the nature and content of the questions to be asked indicate a fundamental change in the frame of reference from that of the law library research.

This part of Mr. Dolson's presentation is dealing with the functioning of the legal researcher, not the practicing attorney. The person who devised the questions clearly had in mind a problem judged to be of considerable consequence. He also had formulated, either consciously or unconsciously, some hypotheses concerning the nature, scope, causes, and consequences of the problematic situation. The questionnaire was designed to derive the information required for testing preformulated hypotheses. It is this necessary chronological sequence of steps which differentiates Dolson's "field" researcher from his "library" researcher.

The citations given concerning the field studies presented as examples indicate that Mr. Dolson has been involved in these inquiries which were conducted using research methods apparently conforming to that described in this comment. This fact makes all the more surprising the final statement in the paper. Mr. Dolson concluded in his original presentation, "With the information gathered by the field survey and the legal and non-legal library research, the legal researcher now is adequately equipped to attack the legal problem involved." The researcher, particularly if he is making a field survey, who has not begun to "attack" the problem until he has gathered the information on which the analysis is to be based, is not likely to find a satisfactory solution to that problem.

# ACQUISITION OF PRIMARY AND SECONDARY DATA IN ECONOMICS

Roger W. Strohbehn*

Data collection often is considered a prosaic activity in research, yet the successes or shortcomings of a research project are influenced heavily by the selection of data most relevant to the study. Furthermore, a large amount of a researcher's time is devoted to obtaining primary and secondary data for answering the specific questions under study. Therefore, a discussion of data collection methods of economic researchers appears to be important in developing procedures for legal-economic research.

This paper is comprised of four parts:

(1) A brief discussion of aspects of the methodological framework used in economic research;
(2) A discussion of the features and sources of primary and secondary data;
(3) A review of questionnaire construction and sampling procedures for statistical inference; and
(4) Two illustrations of the survey method of collecting primary data.

## ECONOMIC INQUIRY

Data gathering methods of economists can be viewed with fuller understanding if we first outline the economist's approach to inquiry into an economic problem. For our present purpose we do not need to be particularly concerned with whether the research problem is to determine what exists or to determine what should exist. Rather, we need to specify how economists approach a problem so that comparisons can be made between the conventional methods of gathering economic and legal data or evidence.

A research economist is concerned primarily with trying to explain or predict economic behavior of individuals, firms, or governments. By economic behavior, we mean that behavior related to the wealth getting and wealth consuming activities of men. Problems for inquiry into economic behavior are recognized by observing that individuals are experiencing difficulty in achieving their economic objectives or that the behavior of individuals differ with existing theoretical explanations. The analysis may take the form of trying to explain observed behavior, to illustrate the effect

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W. B. Back and James Hedrick contributed to the development of this paper. The errors and shortcomings of the paper, of course, are the sole responsibility of the author.

of certain economic stimuli in the behavior of individuals, or to predict the economic consequences of the actions of individuals.

Economists that adhere to the Dewey philosophy of "normative" research establish a set of diagnostic hypotheses through reasoning and observation that identify the strategic elements in a "real world" problem situation. These hypotheses guide the inquiry in the collection of relevant facts, which in turn are used for the formation of remedial hypotheses that specify the tentative lines of action that will enable individuals to achieve their ends-in-view (immediate goals).

Economists that follow the "positive" or predictive philosophy of research relate the observed economic behavior to existing theory and when it fails to provide an explanation of the behavior or provides inaccurate predictions, then new or modified theories are devised in an attempt to specify the relevant variables and their relationships. This is done through the construction of simplifying models that seek to isolate the significant variables in explaining or predicting some economic phenomenon from the myriad of forces impinging on the individual, firm, or government in real life. When the relevant variables of a certain economic behavior are known the purpose of the analyses is to estimate the coefficients of the relationship among the variables or to quantify the model.

Regardless of whether a normative or positive approach is used, the economist seeks to obtain and examine all the available background information about the problem area. As mentioned in the paper by Harris and Hines, this aspect of the research undertaking is common to both economists and lawyers. A library search is one part of this process and the economist will search through selected books, bulletins, reports, journal articles of similar research and historical articles related to the selected problem situation. The search should start in the bibliographies that classify materials that are likely to be relevant to the selected problem. As the various reference materials are studied they provide still more references to reports and other published material that do not get included in bibliographies as well as additional references to allied topics that have been investigated by researchers in other specialty areas of economics or by researchers in other disciplines. During the library search the researcher should become familiar with the body of knowledge related to the problem situation.

In addition to the library research the economist discusses his research problem with other economists, sociologists, lawyers, engineers, business leaders, and any other persons able to provide insights into the different facets and magnitude of the problem. If the research is of a pioneering nature, in an area where little or no previous research has been done, the economist may make informal observations among people that are experi-

encing the problem. These observations may be made through conversations with selected individuals and by visual observation of the physical effects generated by the problem.

Throughout this entire phase of the research task, the economist is seeking to isolate the specific aspects of the larger problem so that attention can be devoted to the most crucial elements of the problem. In this phase the specific objectives of the research project are developed to guide the research and prevent it from wandering aimlessly from interest to interest in the problem area.

After the objectives have been clearly stated the next step is to bring together the relevant thories that bear on the specific aspects of the problem situation selected for study. The theory serves to collect the things we know about the phenomenon and provides a frame of reference for research on the phenomenon by setting out the definitions, postulates and assumptions about the phenomenon.

The relevant theories will have been identified in the body of knowledge that was examined in the library phase of the research. Or, if the previously stated theories do not appear to provide an accurate or adequate explanation of the economic phenomena under study a new or modified theory will need to be constructed. The later task requires a fertile mind that is capable of taking existing concepts and information and weaving a logical, consistent theory to explain the existing situation and identify the instrumental variables that individuals (society) can adjust to achieve a desired goal or end.

From the constructed theory the research economist derives hypotheses about the problem situation which serve as guides during the research.[1] Hypotheses are simply tentative statements of relationships among the variables or elements of the problem situation but stated in such a way they are capable of being tested, that is, being confirmed or refuted by applying the hypotheses to a real world situation. This is what the economist refers to as *research*—the confirmation or refutation of hypotheses to discover principles, relationships or facts that exist in the real world.

The hypotheses guide the researcher in selecting the evidence or data needed to test the hypotheses. Thus, rather than collecting "all the facts" about a problem situation and then trying to analyze it to see what it "means," hypotheses are used to indicate what information or data is needed to provide an answer to specific questions. By following this procedure an efficient use of research time and funds is achieved by carefully constructing the hypotheses and collecting the information that is necessary to test them and obtain the information in a form that is

[1] Null hypotheses of statistics are still another type of hypotheses which are used for the purpose of establishing the accuracy of the factual information collected.

amenable to analysis. In addition, by specifying the hypotheses in advance of the data gathering phase, we are ensuring ourselves that we will obtain the necessary information for the analysis rather than relying on the chance that the relevant information to test a hypothesis will be available after we have first gathered "all the facts."

Development of hypotheses requires the researcher to not only look back to the theory and background information, but also look forward to the kinds of information that are available or that can be obtained and also to the method of analysis that is most suitable to the problem at hand. Needless to say, this kind of research methodology requires a certain amount of simultaneousness of the research phases or at least some feedback and revision of work in the various phases as the research project progresses.

In short, the research economist seeks to be objective in his research through the application of the "scientific method" to the problem situation and to accept either positive or negative results as verification or repudiation of the suggested theory.[2] By way of contrast, the prevailing view of legal research among lawyers is to objectively analyze and evaluate the problem situation (a specific case) in an adversary context, relying primarily on existing statutes, codes and previous court decisions. In other words, examine both sides of the issues to more adequately prepare oneself to argue a given side of the issue.[3]

It is at this point that we reach the main topic of this paper, data collection, because data from the real world are necessary either to develop hypotheses about economic behavior or to test hypotheses that have been derived from another source of data or information.[4] In the case of legal-economic research data collection may take the form of gathering evidence (data) to measure the effectiveness of existing institutions, including laws or to support arguments for or against a proposed law.

Because the economist relies on developing and testing his theory and hypotheses based on information from existing situations, a sample of data is sought to represent the whole population referred to in the theory. From this representative sample, inferences may be drawn about the behavior of the population for rejecting or confirming the hypothesis. In the case of the development of remedial hypotheses, the factual accuracy of the estimates

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[2] For a complete discussion of the scientfic method, see Cohen & Nagel, AN INTRODUCTION TO LOGIC AND SCIENTIFIC METHOD (1934).

[3] As indicated in Chapter I, the type of law research that is envisioned as a component part of legal-economic research is *jurisprudence* research. This entails research in the creation of laws to achieve desired social ends, as opposed to legal research that is designed to seek justice in a specific case through the application of existing law.

[4] Guides to the actual conduct of research operations, including problem formulation and data gathering, can be found in Ferber & Verdoorn, RESEARCH METHODS IN ECONOMICS AND BUSINESS, chs. 2, 5 (1962).

derived from the data are being tested; while in the case of theoretical hypotheses, the hypothesis itself is being tested. By drawing the sample according to statistical procedures we can measure the reliability of any estimate such as an arithmetic mean, obtained from the sample as representing the true estimate (parameter) of the whole population. With this information we can decide whether to reject or not reject a hypothesis on the basis of the likelihood that we would be rejecting a true hypothesis or not rejecting a false one if the sample estimate is erroneous.

## KINDS AND SOURCES OF DATA

An economist has two basic sources of information available to him. He can seek data directly from the observational unit—*primary data.* Or, he can rely on data obtained from sources other than the unit of observation—*secondary data.*[5] Both primary and secondary data have appropriate places in research programs.

Secondary data are useful to the economic researcher especially in the problem definition phase and for the development of theoretical relationships among variables generating behavior of a specified group of individuals or some other economic phenomena. When the problem being studied is approached at the group or macro level, as opposed to the individual firm or micro level, secondary data are used because aggregate information is needed for many well defined groups and can be obtained from available historical series, such as employment and production by industrial groups. Frequently in macro-economic studies, such as inter-industry input-output analysis, the data requirements are so immense that the researcher must rely on secondary data.

Secondary data usually are collected for general unspecified use or are the by-product of public programs, and frequently are presented as aggregate information pertaining to certain classifications of individuals or entities participating in programs. This gives secondary data an advantage of frequently being readily available at low cost. The presentation of aggregate information often means that the entire group or population under study is represented, which eliminates the need for probability statements about their accuracy. One of the major advantages of secondary data is that the data frequently are available to cover a series of years and hence provide reliable information of trends in economic behavior over time.

Sources of both quantitative and nonquantitative secondary data include professional journals published by the various professional associations and institutions; bulletins, monographs and pamphlets published by State Ex-

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[5] It should be noted that primary and secondary refer to *sources* of the data, and not to the acceptability of the data by implying that primary data is preferred over secondary as being more authoritative.

periment Stations and governmental agencies; and analytical and historical books with an economic orientation. Sources of secondary statistical data, in addition to the above, are numerous. All sources may be divided into two groups—published and unpublished.

A partial listing of published sources includes *The Censuses of Agriculture, Population, Manufacturers, and Governments;* Statistical reports published by various public agencies such as *The Farm Income Situation, Farm Costs and Returns, Farm Real Estate Market Developments, Survey of Current Business, Monthly Labor Review, Statistical Abstract of the United States,* plus statistical reports issued by various agencies in each of the States.

More information is available in various public agencies than is published. It is usually on a less aggregated basis than the published data. Finding and gaining access to unpublished sources may be difficult but a wealth of information may be obtained if suitable cooperative arrangements are worked out. At the Federal level sources of unpublished data include Agricultural Stabilization and Conservation Service, Statistical Research Service, Economic Research Service, Soil Conservation Service, Forest Service, Bureau of Labor Statistics, Office of Business Economics, Bureau of the Census and the Information Service of any Federal agency. With the advent of large capacity automatic data processing equipment, many agencies are developing "Data Banks" that will permit researchers to gain quick access to unpublished data. At the State level some examples of sources of unpublished secondary information include the Department of Agriculture, Department of Commerce and Industry, Department of Labor, and Office of Vital Statistics. At the county level information may be obtained from the County Clerk, Superintendent of Schools, County Assessor, and County Planner. These Federal, State, and County sources of unpublished secondary data are only indicative of the kinds of offices that possess data. The thorough researcher must ferret out the sources of information by pursuing all likely contacts and leads.

Primary data frequently are sought because they provide a maximum of flexibility in approach to research questions. Use of primary data permits a researcher to specify exactly what population he wishes to study and to seek information according to certain criteria or set of definitions most meaningful to the particular hypothesis being tested. Many research questions are directed to problems answerable only from detailed information about individual observational units.

Primary data may be obtained from a wide variety of sources. In general, however, these sources can be grouped under the headings of internal records, public records of individuals or transactions among individuals, and specially designed surveys.

Internal records include such items as account books recording the business activities of the firm, income tax reports, and other records of quantities of resources used and output achieved. Such records contain a wealth of information; however, gaining access to them requires the cooperation of individuals. Also, care must be exercised to insure consistency of information obtained for all observations.

Individual public records are a second source of primary information. Real estate records in county clerks' offices and in county assessors' offices provide a limited amount of economic data, but they do provide a means of identifying a specific group of individuals or observational units from which a sample may be drawn for a detailed survey. Records of individual farms in the county offices of the Agricultural Stabilization and Conservation Service are useful in providing physical data of land use and crop yields.

A survey is useful to obtain primary data because of the flexibility it affords in obtaining information relevant to the problem under investigation. Current information can be obtained from a particular designated group according to the unique definitions and criteria of the study. Surveys, however, tend to be expensive and time consuming. They generally are used to provide supplemental information or data that otherwise are unavailable. Surveys can be divided into two groups—enumerative questionnaires and motivational or attitudinal interviews—according to the type of information that is to be obtained and the different formulation of the questionnaire and/or interview techniques that are required. For the enumerative questionnaire the respondent is expected to know or have access to the desired information and direct questions may be used; whereas, in the attitudinal interview the respondent may not be fully aware of the reasons behind his actions or behavior and a series of "unstructured" questions or problem situations are presented to the respondent to obtain his ideas and reaction about the problem being studied.

Surveys with enumerative questionnaires are used when the information can be obtained by direct simple questions such as information about input-output data of firms, expenditure and income of individuals, information of a descriptive nature about the observational unit, or short-term expectations of consumption of specified items by consumers or of production plans by producers. A variety of methods can be used to obtain this type of information. The choice of method depends upon the complexity of the questionnaire, location of the observational units, and budgetary considerations. Face-to-face interviews, telephone interviews, and mail questionnaires usually are considered in order of decreasing preference, but this order also indicates an order of decreasing cost per observation.

Motivational or attitudinal research seeks to determine the underlying

relations or reasons behind the observed behavioral pattern, and usually requires a face-to-face interview. The reason for seeking information about the motivations leading to a particular action by individuals is not the discovery of the motivation itself, but rather to determine at what level an appropriate remedy could be applied. Attempts to adapt motivational or attitudinal research in economics is relatively new and the tools used to obtain the information have been borrowed from the pioneers in this area —psychologists and sociologists. Two examples of this type of survey in agricultural economics were reported by C. B. Baker and G. D. Irwin, and by E. M. Rogers and G. H. Beale.[6] These tools include such methods as psychological projective techniques, depth interviews, and scaling techniques and may provide valuable information in the hands of skilled researchers. The methods of motivational or attitudinal research may be particularly suited to legal-economic research where the problem under study is influenced by factors not fully recognized by the respondent or not easily measured.

## QUESTIONNAIRE CONSTRUCTION AND SAMPLING PROCEDURES

### *Questionnaires*

Whether the survey is oriented toward obtaining enumerative or attitudinal type of information, care must be exercised in the construction of the questionnaire to obtain correct and accurate information. Designing a questionnaire to obtain unbiased answers is as much an art as a skill—both are needed. The questions should be worded and grouped to conform to the respondent's frame of reference rather than being phrased and assembled in groups that are most meaningful to the researcher. Biased answers are likely to be obtained if this principle of questionnaire construction is violated or perhaps the respondent will refuse to answer the question because he does not understand it. Questions must also be phrased so that they are unambiguous and easily understood. This will help ensure that the questions are interpreted in the same manner by all respondents.

Every questionnaire should be pretested before conducting the actual survey to determine whether the questions are properly understood. The pretest is performed by asking the questions of a small number of individuals that have the same characteristics or are experiencing the same situation as the sample-survey group that will be interviewed. Questions that

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[6] Baker and Irwin, *Effects of Borrowing From Commercial Lenders on Farm Organization*, Bulletin 671, University of Illinois Agricultural Experiment Station; Rogers and Beale, *Projective Techniques: Potential Tools for Agricultural Economists*, 41 J. FARM ECON., No. 3 (1959).

are misunderstood during the pretest should be reworded in light of the experience of the interviewers and the project supervisor. During the pretest it may also be discovered that a different order of asking the questions may make it easier for the respondent to recall the information. After the questionnaire has been revised it is then ready to take to the field for the actual survey.

If the survey is to be conducted on an interview basis, as opposed to a mail survey, care must also be exercised to ensure that the answers provided by the respondents are their own genuine answers. The answers should not be biased by reflecting what the respondent thinks the interviewer "wants" to hear and neither should the interviewer allow his own biases to become known to the respondent so that they influence the respondent's answers.

While the questionnaire is being constructed the researcher should be considering how the information collected during the survey is to be processed and assembled for the analysis. If the answer to a question is amenable to machine processing because it is a quantitative answer or multiple choice among alternative answers, the questionnaire can be precoded. Precoding simply means that a designated space is reserved on the questionnaire for the number of digits in each answer that corresponds to a specific location on an electronic data card for tabulation and analysis. Thus, an editor can edit a questionnaire and record the answers in the designated code spaces so that a key punch operator can transfer the information from the questionnaire to punch cards. This eliminates the need for transcribing the answers to tabulation sheets prior to key punching and reduces the chance of errors creeping into the data in the processing stage. While the editor is editing the questionnaire he should verify internal consistency of answers within the questionnaire, eliminate errors and omissions (if possible), and ensure comparability between questionnaires.

*Sampling*

The sheer mass of primary data available as evidence pertaining to a certain question requires that only a sample of the data be drawn to represent the entire population. Thus, the problem in sampling becomes one of choosing a sample that will yield information with a high degree of accuracy or will permit inferences to be drawn from the sample data that are valid for the whole population from which the sample was drawn. In this process, the researcher must specify the population for which the inferences are to be valid, and the sample size and sample design that will yield such inferences with the desired accuracy at the lowest cost.

Identification of the relevant population depends on two criteria: (1) Specification of the individuals or observational units affected by the stimu-

lus or environment under study, and (2) the geographical area to be represented by the sample. The nature and focus of the study generally will indicate definitions and criteria to use in specifying the particular group of individuals to be included in the population. For example, if a study was being made to determine the legal and economic effects upon individuals buying farm land under a land installment contract during a certain period, say between 1955 and 1965, we would need to identify those individuals who had used this transfer device during that decade. The relevant population thus becomes buyers of farm land who used a land installment contract to buy land during 1955-65. The criteria for eligibility in the sample would be that the individual was in the process of buying farm land during 1955-65 and used an installment contract as the transfer device. If the study was more comprehensive and designed as a comparative study of alternative methods of acquiring ownership of land, then individuals acquiring land by all methods would be included in the relevant population. Regardless of the problem being studied, the individuals that are to be the reference group of the research and the source of information must be carefully defined. This will help avoid confusion and misunderstanding during the operation of the survey when uncertainties arise about the inclusion of unusual observational units. In addition to the subject matter criterion, the geographic area to be represented must also be clearly specified. Budget limitations and political boundaries are often among the guiding factors in determining the area from which the sample will be drawn.

The selection of a sample to minimize sampling bias has received considerable attention by statisticians and has become a field of specialty in statistics. A large variety of different types of sampling procedures have been developed to accommodate the needs of the researcher according to his particular problem and the nature of the observational units in the population. For present purposes we do not need to know the characteristics or advantages of the various types of samples; however, it may be useful to simply list the types of sampling procedures available. These are: (a) simple random, (b) systematic, (c) multistage random, (d) stratified, (e) cluster, (f) stratified cluster and (g) judgment.[7] Consultation with a "sampling" statistician, during the planning phase for the collection of primary data is desirable in all studies and essential in many of them.

The decision about the size of sample to use depends in part on the sample design selected, the degree of accuracy desired in the estimates, and the cost of collecting the data. Quite obviously these considerations

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[7] A concise presentation of the features of each of these samples can be found in Ackoff, THE DESIGN OF SOCIAL RESEARCH (1953).

are interdependent and must be considered simultaneously within the amount of funds available for this purpose.

## ILLUSTRATIONS

The first illustration of the data collection methods used in a legal-economic research project is taken from the preliminary investigation of the use of land trusts that Professor N. G. P. Krausz of the University of Illinois and the author conducted in the spring of 1964. This does not represent a good example to illustrate the methods of data collection discussed above; however, it does represent an interdisciplinary effort on a legal-economic problem.

Use of a land trust as a form of business organization to facilitate the intergenerational transfer of rights in real estate is relatively new and its application in agricultural situations is quite limited. Background information about land trusts was obtained through informal discussions with attorneys who had advised clients to use a land trust arrangement and with an attorney of the Chicago Title and Trust Company, where land trusts apparently originated. In addition, a library search was made to obtain references about the legal provisions and requirements of a land trust. The library research included (1) a review of the forms of joint business organizations, i.e., corporations, partnerships, and business trusts, and (2) an examination of monographs and law review articles on the features of land trust arrangements.

Because of the newness of this device in agriculture, a preliminary investigation was needed to obtain descriptive information of the type of situations in which land trusts have been used. Information was desired about (1) the legal and economic reasons for selecting a land trust in preference to some other business form, (2) physical characteristics of the farm business, (3) participation in management decisions and the distribution of income among the beneficiaries of the trust, and (4) some of the legal provisions of the trust. The questionnaire that was devised to obtain this information is presented in the appendix.

The lack of any published information about the actual use of land trusts combined with the preliminary nature of this study prompted us to seek descriptive information covering a range of situations in which land trusts were being used. With this limited objective, we decided to conduct a small survey among a known group of land trust users in three widely separated counties. Because of the exploratory intent of the survey, a judgment sample was selected to obtain information about 10 to 12 situations in which land trust had been applied. Personal interviews were used to obtain the information from land trust users. Information was obtained actually from five land trust situations in two counties. A discus-

sion was held with attorneys in the third county which revealed land trusts were being used as a method of holding rights in agricultural land, but they were not being used as a form of business organization. For this reason no interviews were held with land trust users in that county.

The exploratory nature of this study made it unnecessary to attempt to draw inferences from the sample information to indicate either the extent to which land trusts were being used, or for a comparative analysis among land trust users in the effect of using a land trust on the operation of the farm business. Therefore, no attempts were made to use statistical sampling procedures to obtain the data; and consequently, no statistical tests were applied to the data.

A second example of the primary data collection methods of the economist is the rural land ownership survey that was conducted in seven Southeast states in 1960. This study represents a more typical problem of data collection than the previous study; however, it was not an interdisciplinary effort on a legal-economic problem. Information about methods of land acquisition, plans for land transfer and various financial arrangements was obtained, so perhaps the lawyers in our group may view this study as one providing descriptive information about some of the areas of their interest.

Detailed information about the ownership of land was unavailable in any secondary statistical series. Therefore, a survey of rural land owners was needed to obtain information about (1) the characteristics of rural land owners in the Southeast; (2) the kinds of rural land owned; (3) the acquisition and transfer of land ownership; and (4) changes in land use. The large amount of nonfarm land in the Southeast region meant that a survey of *farm* land owners, as had been done in the Midwest and the Great Plains, would not provide a complete indication of the patterns of *rural* land ownership. Many important holdings of commercial forest land would be omitted and changes in land use where whole tracts of land had shifted out of farm use would not be detected in a survey limited only to farm land owners. A mail survey was unsuitable for this study because of the lack of a convenient list of land owners and because of the likely low response to the type of questions to be asked on a "do-it-yourself" mail questionnaire. The high cost of a personal interview survey made it necessary to select a small sample of the total owners.

Estimates were desired to permit comparisons among the four subregions within the Southeast region—Coastal Plain, Piedmont, Mountain and Tennessee Plain. A list of all land owners was not available; therefore, an area-cluster sample was drawn to select geographic area segments in which the prospective owners for the interviews would be identified. All land owners holding an ownership interest in any land within a segment were considered to be in the sample. Budget limitations indicated that a

sample of approximately 600 to 700 segments could be drawn from each of the four subregions (strata), which would permit useful cross-classifications to be made of the data. Selection of 100 sample counties was done by first listing the states in alphabetical order within each of the four subregions, then listing the counties in contiguous sequence within economic areas, and from this array selecting counties at a systematic interval from a random starting point. This procedure provided stratification by major subregion, by State within the subregion, by economic area within the State and a limited stratification within economic area.

Within the 100 selected counties, 604 area segments were selected at a systematical interval with a random start from an array of all such units in the "open country" portion of the U.S. Department of Agriculture Master Sample materials that define or indicate sample segments in all counties of the United States.

A questionnaire was developed to obtain the information by personal interview. A pretest of the questionnaire was made by asking the proposed questions of about 25 owners of rural land in two counties in North Carolina. Appropriate changes were then made in the wording of questions that were not clearly understood by the respondents. To facilitate the processing of the information to punch cards, the questionnaires were precoded. This enabled a key punch operator to punch the information directly from the questionnaires after they had been edited to verify internal consistency of the information obtained on an individual questionnaire, eliminate errors and omissions, and ensure comparability between questionnaires.

Information about the sampling rate was used to obtain the expansion factors that were applied to the data collected from the sample land owners. Expanding the sample data enabled statistical estimates to be made about the number of rural land owners in the Southeast region with specified characteristics and the number of acres and land value associated with various groupings of owners.

## SUMMARY

The preceding discussion may be summarized as follows: An economist approaches his research through the construction of logical theories, pertinent hypotheses, and effective models to isolate the relevant variables pertaining to some particular economic phenomenon for the purpose of contributing knowledge that will help alleviate the problem situation or predict economic behavior. Data from the real world must be assembled to test the validity of the hypotheses. In order to achieve wider applicability of the findings, data are desired that refer to an entire population affected by the problem situation. When the cost of obtaining information about the

entire population is prohibitive, a sample of data is drawn according to statistical procedures to permit statistical inferences to be extended to the whole population from the sample observations. Depending on the objectives, methods and budget limitations, either primary and/or secondary data will be assembled to test the theory or to show the consequences of some economic stimulus. Primary data provide great flexibility in obtaining the exact information desired; however, they also are the most costly to collect. Primary data are obtained from internal records, individual public records, and by surveys of individuals. Secondary data frequently are sought because they provide time series data and are relatively inexpensive to obtain. The main disadvantage of secondary data is that the researcher must accept the definitions used by the collecting agency and subclassification of the data into new or more refined categories usually is impossible. The wide variety of sources of secondary data that are available on many subjects lessens this disadvantage.

## APPENDIX

### LAND TRUST INTERVIEW QUESTIONS

Name ..... Address .....

.....

Section I.

Please answer the following questions pertaining to the organization of the land trust.

1. When was the land trust established? .....
2. How long did you own legal title to the land now in trust, before placing it in the land trust? .....
3. What was the source of the idea to use a land trust for your situation?

   .....
4. Were other alternative devices or methods considered to solve the problems encountered in your situation? (If "Yes", specify the alternatives) Yes..... No.....

   .....
5. Why was the land trust chosen in preference to the other alternatives?

   .....

   .....
6. Who is responsible for the management decisions of the property in the land trust?

   .....
7. Who is the trustee for your land trust? .....
8. What duties are assumed by the trustee under the land trust agreement?

   .....

   .....
9. What compensation is received by the trustee? .....
10. Have certificates of interest been issued by the trustee to the beneficiaries? Yes..... No.....

    If "Yes":

    a. How many certificates have been issued? .....
    b. What is the valuation of these certificates? .....
    c. To whom were the certificates issued? .....

d. Have any of the certificates been transferred? Yes.... No....
If "Yes", to whom; and by gift or sale? .....

11. Does the land trust agreement contain provisions to retain the certificates within the family, if desired? Yes.... No....
12. What costs were involved in establishing the land trust? (initial fee, and annual fee) .....
13. Has the land trust required the payment of any additional taxes?
Yes.... No.... If "Yes", explain. .....
14. Has the land trust required the keeping of any additional records? Yes.... No....
15. When does the land trust end? .....
16. Is the land trust agreement working out satisfactorily? Yes.... No....
17. What suggestions do you have for the improvement of your land trust?
.....
.....

Section II.

Indicate the extent to which the following considerations were factors in deciding to utilize a land trust agreement by checking the appropriate blank.

A. Farm management considerations:
   1. To reduce the possibility of the farmland unit being divided into units of uneconomic size.
      Strong.... Moderate.... Slight.... Not a factor....
   2. To provide for the transfer of the farm business between generations as a going concern by keeping capital intact and gradually transferring management responsibilities to assure continuous experienced management of the farm over time.
      Strong.... Moderate.... Slight.... Not a factor....
   3. To provide a source of capital to the farm business through either loans from nonparticipating beneficiaries or through contributions of capital and management by participation beneficiaries?
      Strong.... Moderate.... Slight.... Not a factor....
   4. Other .....

B. Legal-economic considerations:
   1. To facilitate transfer of property to succeeding generations before death to minimize gift and inheritance taxes.
      Strong.... Moderate.... Slight.... Not a factor....
   2. To limit the liability of resource owners (beneficiaries).
      Strong.... Moderate.... Slight.... Not a factor....
   3. To provide a wider distribution of earnings to take advantage of lower tax brackets.
      Strong.... Moderate.... Slight.... Not a factor....
   4. To provide a method for a fair distribution of property among heirs.
      Strong.... Moderate.... Slight.... Not a factor....
   5. Other .....

Section III.

Please answer the following questions to provide information about some of the operational characteristics and management features of the farm.

1. How many total acres are in this land trust? ..... acres.
2. How many separate farm operating units are farming these land trust acres?
   .....

3. For each farm, indicate how many acres are held in the land trust, owned by the operator, and rented from others.

| | *Land trust* | *Operator owned* | *Rented from others* |
|---|---|---|---|
| Farm 1 | ..... | ..... | ..... |
| Farm 2 | ..... | ..... | ..... |
| Farm 3 | ..... | ..... | ..... |

4. How many of the land trust acres are tillable cropland, permanent pasture, and timber land?

| | *Tillable cropland* | *Permanent pasture* | *Timber land* |
|---|---|---|---|
| Farm 1 | ..... | ..... | ..... |
| Farm 2 | ..... | ..... | ..... |
| Farm 3 | ..... | ..... | ..... |

5. What product supplies the major portion of the farm income?

| | *Grain* | *Hogs* | *Beef cattle* | *Dairy* | *Other* (specify) |
|---|---|---|---|---|---|
| Farm 1 | ..... | ..... | ..... | ..... | ..... |
| Farm 2 | ..... | ..... | ..... | ..... | ..... |
| Farm 3 | ..... | ..... | ..... | ..... | ..... |

6. What was the amount of gross sales from each farm last year? (Product sales minus livestock and feed purchases.)
   Farm 1 $..... Farm 2 $..... Farm 3 $.....
7. How many man-months of labor are used per year on each farm?
   Farm 1 ..... Farm 2 ..... Farm 3 .....
8. Are the major farm management decisions made by: (a) single operator, (b) partnership, (c) board of managers, or (d) other (specify)?
   Farm 1 ..... Farm 2 ..... Farm 3 .....
9. Is the income received by the beneficiaries from the trust a portion of the *rent* from the land in trust or a portion of the *profits* of the farm business?
   Rent..... Profit.....

Section IV.

Please fill in the blanks for each member of the family and other beneficiaries concerning their age, occupation, residence (both state and whether living on or off land in trust), and extent of participation in the farm business (*direct*—participate in major management decisions, *indirect*—participate as a landlord or shareholder).

| | *Age* | *Occupation* | *Residence* | | *Participation in farm business* |
|---|---|---|---|---|---|
| Husband | .... | ..... | ..... | ..... | ..... |
| Wife | .... | ..... | ..... | ..... | ..... |
| Son 1 | .... | ..... | ..... | ..... | ..... |
| Son 2 | .... | ..... | ..... | ..... | ..... |
| Son 3 | .... | ..... | ..... | ..... | ..... |
| Daughter 1 | .... | ..... | ..... | ..... | ..... |
| Daughter 2 | .... | ..... | ..... | ..... | ..... |
| Daughter 3 | .... | ..... | ..... | ..... | ..... |
| Others (specify) | | | | | |
| ..... | .... | ..... | ..... | ..... | ..... |
| ..... | .... | ..... | ..... | ..... | ..... |

# COMMENTS

James P. White*

In the past several decades various law schools in the United States have become increasingly concerned with activities and concurrent legal problems resulting from their particularized environmental location. Consequently, law schools located in areas of industrial development frequently accord specialized consideration to legal problems resulting from this industrialization while law schools in the western states have undertaken research in mining law, oil and gas law, and water rights. Law schools in urban areas have been increasingly occupied with various legal-economic-sociological aspects of urbanization. Thus also have law schools in agricultural areas become occupied with problems of agricultural law. In recent years there have been increasing efforts of cooperative legal-economic research between law schools and departments of agricultural economics.[1] This interdisciplinary research has been particularly active in the North Central states and has been given added impetus in this region by the activities of the North Central Land Tenure Research Committee (NCR-6) and its Legal Aspects Subcommittee.

However, while legal economic interdisciplinary research has been increasing, the basic problems of methods and methodology inherent in this joint research remain. "Intradisciplinary specializations in law and economics have resulted in somewhat different approaches to inquiry. Lawyers are more accustomed to library research; economists deal more with empirical data. Lawyers are inclined to use ordinal evaluations while economists tend to cardinal measurement with numerous statistical application. Lawyers tend to look to precedents for their intellectual bearings; economists tend to use normative approaches. While these distinctions may be stated here in an exaggerated form, they constitute differences of degree, at least, between approaches of economists and lawyers."[2]

The paper on which I am commenting is entitled, "Acquisition of Primary and Secondary Data in Economics." The assigned task which this paper and its author attempt to fill is that of explaining to a group of lawyers and economists, in joint meeting assembled, the mechanics and use of data collecting as part of the economist's research function. This paper is primarily directed at those lawyers who work in conjunction with economists in the area referred to as "agricultural law."[3] The paper is most suc-

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[1] See Ellis, *Collaboration Between Law and Agriculture*, 7 J. LEGAL ED. 65 (1954).

[2] Timmons, *Methodological Problems in Legal-Economic Research* in LEGAL-ECONOMIC RESEARCH, Agric. Law Center Mono. No. 1, at 37 (1959).

[3] It has been suggested that the purpose of research in agricultural law is " . . .

cessful in accomplishing the task assigned. I think that all persons trained in the law who anticipate interdisciplinary research in matters relating to law and agriculture should have this document at hand and should read, study, and peruse it before undertaking their particularized research project.

The paper is composed of four parts. They are:

(a) a discussion of some methodological ideas used in economic research;
(b) a discussion of the features and sources of primary and secondary data;
(c) a review of sampling procedures for statistical inference; and
(d) illustrations of the survey method of collecting primary data.

The first section of the paper discusses the ideas which economists use in approaching inquiry into economic problems. I would suggest that an economist engaged in research does not differ from a lawyer engaged in research as greatly as it might appear. However, while the lawyer is attempting to predict the behavior of individuals, the economist is attempting to predict economic behavior (wealth getting and wealth consuming). The paper discusses both the Dewey philosophy of research ("establish a set of diagnostic hypotheses through reasoning and observation that identify the strategic elements in a 'real world' problem situation") and the Positive philosophy of research ("relate observed economic behavior to existing theory and when it fails to provide an explanation of the behavior or provides inaccurate predictions, then new or modified theories are devised in an attempt to specify the relevant variables and their relationships."). The use of data and hence data collecting is necessary because data must be used to test theory and hypotheses. Legal-economic research measures existing laws or institutions or weighs the advantages or disadvantages of a proposed law.

Dr. Strobehn states that ". . . the type of law research that is envisioned as a component part of legal-economic research is *jurisprudence* research. This entails research in the creation of laws to achieve desired social ends, as opposed to legal research that is designed to seek justice in a specific case through the application of existing law."[4] I would suggest that ideal legal-economic research is not purely jurisprudential in nature, a philosophical analysis of legal concepts and theories,[5] but it is also an effort to utilize the methods of science in the field of law. Thus I would suggest

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(1) to determine weaknesses and strengths in our legal institutions in achieving economic objectives of agriculture, (2) to develop the legal means for attaining economic objectives in agriculture, and (3) to present results of these analyses in understandable forms . . ." from "Economics and Land Law Project," College of Law, State University of Iowa and Agricultural Experiment Station, Iowa State College (1954).

[4] See footnote 3 of Strohbehn's paper.

[5] See COHEN & COHEN, READINGS IN JURISPRUDENCE AND LEGAL PHILOSOPHY (1951) and FRIEDMAN, LAW IN A CHANGING SOCIETY (1959).

that legal-economic research is not only jurisprudential research but is increasingly jurimetric research.[6] Legal-economic research should become increasingly compatible with investigation of the pattern and breadth of all experience which is relevant to the law.

The types of data or authority used by one conducting legal-economic research are classified like those used in legal research as primary and secondary in nature. Primary data consists of such items as individual records, public records, and specially created surveys. Secondary data consists of general observational data such as general population statistics. Unlike the relative ranking of primary and secondary authority in legal research, wherein secondary authority is far less authoritative or persuasive, the ranking of primary and secondary data does not indicate an order of persuasiveness, but rather refers to whether the data is derived directly from the observational unit or from other sources. Both primary and secondary economic data are of first importance in their authoritativeness and persuasiveness.

The paper contains excellent examples of the survey method of collecting primary data and makes this particular method intelligible to the non-economic ear. These examples serve to amplify and clarify the discussion of data collecting.

It has been observed that "Foremost among the prerequisites for legal-economic research is the removal of terminological disciplinary barriers to cooperative research. If one mind had the capacity and length of life to become thoroughly competent in the content and method of both law and economics, these barriers would be removed automatically."[7] This paper is a progressive step in abolition of these barriers and a welcome addition to the literature of legal-economic research in agricultural law.

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[6] See Loevinger, *Jurimetrics: The Methodology of Legal Inquiry*, 28 LAW & CONTEM. PROB. 5 (1963).

[7] Timmons, *supra* note 2, at 31.

# RESEARCH METHODS ADAPTABLE TO LEGAL-ECONOMIC INQUIRY: LINEAR PROGRAMMING AND SIMULATION

Neil E. Harl*

Notwithstanding earnest blandishments for cooperation or integration or merger of their disciplines[1] and ebullience over the prospects of mutual intellectual gain,[2] lawyers and economists are finding themselves propelled inexorably down well-marked and well-worn disciplinary paths juxtaposed by the inherently interrelated nature of the subject matter of law and economics. Forays into the neighboring discipline have reportedly been discouraged by active disapprobation of provincial invasion, by the centripetal process of acceptability of research efforts,[3] and by unfamiliarity with the patois and modus operandi of the neighboring discipline. Of these factors, the latter appears particularly amenable to objective inquiry and susceptible to remedial efforts. This workshop, focusing on "Applying Legal-Economic Research Methods to Regional Agricultural Problems," is itself recognition of the tractability of that part of the problem. If research is viewed as a means and as a procedure for solving problems and adding incrementally to the store of knowledge at the growing points of disciplines, the methodology of inquiry may provide a common ground and intellectual bond for those individuals venturing beyond disciplinary bounds.

This paper examines preliminarily some obstacles and pitfalls lying in the incompletely charted area between law and economics and then turns to a review of a model encompassing two research methods or techniques, linear programming and simulation, that have been used in social science research and that appear to have application in legal-economic inquiry.

## COMMUNICATION AND METHODOLOGY OF LEGAL-ECONOMIC RESEARCH

Even the most casual observer of research activities in law and economics would scarcely doubt that both contemporary research methods and meth-

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[1] *E.g.*, Timmons, *Integration of Law and Economics in Analyzing Agricultural Land Use Problems*, 37 J. FARM ECON. 1126 (1955); LEGAL-ECONOMIC RESEARCH, Agric. Law Center Mono. No. 1 (1959).

[2] See Harris, *Legal-Economic Interdisciplinary Research*, 10 J. LEGAL ED. 452 (1958).

[3] The propensity for researchers to limit their efforts to disciplinary confines appears to be "linked with the tendency of the ablest social scientists to want to address problems basic to their particular science, rather than those of mere application." Stone, *Roscoe Pound and Sociological Jurisprudence*, 78 HARV. L. REV. 1578, 1582 (1965).

odology[4] in the two disciplines are marked with clearly distinguishable features. Practicing lawyers, law teachers, and jurisprudents of the various schools of thought, especially the analytical and historical, traditionally have looked upon research as primarily a search through published materials, an appropriate appeal to logic, and a synthesis from the materials derived therefrom. While the configuration of the research product may be somewhat different for different schools of jurisprudential thought, the methodology and methods for research have drawn few dissenters. Economists, on the other hand, while far from presenting a united front on methodology of research, have exhibited a marked propensity for theory, empiricism, and measurement. Although the search through published materials is a necessary touchstone for research in economics, it consumes relatively less of the researcher's time than in law.[5]

It appears reasonable to hypothesize that differences in methodological approach between law and economics are related to differences in the nature of science as viewed and applied by the disciplines. While economics is generally considered a social science, a split of authority exists as to whether law or jurisprudence can in fact be similarly classified.[6] Whether law is a science is, of course, essentially a matter of definition of "science."[7] If a science is viewed as a body of systematic disciplinary knowledge,[8] or the principles developed by scholars to explain the body of disciplinary

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[4] Methodology, as used herein, is defined as a branch of philosophy or logic dealing with principles of procedure. Research methods are those specific tools or techniques such as linear programming, regression, analysis of variance, game theory or simulation, employed pursuant to a particular methodological plan or procedure.

[5] One key difference in the role of published materials in law and economics is their authoritativeness and relevance to decision-making action. Cases, statutes, regulations, and constitutional provisions represent what the law is as of a particular time and place. Economics, as a discipline, is not favored by decision-making groups comparable to judges and legislatures to determine if economic theory and empiricism is "right" or "wrong" as tested against some normative scale. Research results in economics can be most readily criticized not because of departures from what is or is not valid economic dogma, but on grounds of errors in logic, assumptions, methodology, or interpretation of results.

[6] *Compare* CAIRNS, LAW AND THE SOCIAL SCIENCES (1935) (anthropology, economics, sociology, political science, and psychology referred to as social sciences), *with* 25 ENCYCLOPEDIA AMERICANA 186f (1958) (history, geography, political science, economics, sociology, anthropology, criminology, jurisprudence, and philosophy included as social sciences).

[7] As viewed by one legal writer, "philosophy is an attempt to generalize on the basis of speculation; science is an attempt to specify on the basis of investigation. There has not yet been any such thing as 'scientific' legal theory. The basic philosophy and methodology of the law today is the same as in the days of Hammurabi, Justinian and Aquinas." Loevinger, *Jurimetrics, The Next Step Forward*, 33 MINN. L. REV. 455, 475 (1949).

[8] See BERMAN, THE NATURE AND FUNCTIONS OF LAW 10 (1958).

knowledge,[9] then law could arguably be considered a science. However, if a science is defined as a method for verifying and rejecting hypotheses about human behavior,[10] or as a method for seeking systematically to apply the spirit and techniques of scientific method to man in his relation to others, the law would be a doubtful tenant in the mansion of the sciences.[11]

Science is not, however, noted for unanimity of agreement as to its scope and nature. By one view, sometimes called the mathematical approach to science and methodology, the essence of science is measurement or exactitude, and research on what is not measureable is something other than science. Thus, quantifiable or measureable data relating to scarcity, or the satisfaction of human wants, may be the subject of scientific inquiry. By another view, the essence of science is not measurement, but the making of interpretations or generalizations about data and their relationships, some of which are open to measurement and some are not. According to this approach, some generalizations and interpretations are useful even though the data cannot be mathematically formulated or subjected to precise metric calculation. Adherents to this school of thought would generally agree that what is stated mathematically may also be stated in nonsymbolic language. But they would also point out that there may be useful generalizations articulable in nonsymbolic language which cannot be formulated or expressed mathematically.

It is perhaps deceptively easy to succumb to the temptation to hold that the differences in views toward science and methodology may be rationalized on the grounds of acceptability of mathematical (or statistical) methods in the respective disciplines or to schools of thought within a discipline. But if mathematics is merely a language which, under some conditions may be more convenient and lend more precision than the prevailing spoken or written dialect in dealing with research problems, it is doubted whether so much can be attributed to the role of mathematics. As long as the product of legal research is based upon prior law, intro-

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[9] *Id.* at 16.

[10] See Wunderlich, *Semantic Problems of Interdisciplinary Research in Optimizing Institutions for Economic Growth*, p. 126, AGRICULTURAL POLICY INSTITUTE, North Carolina State University, and Southern Land Economics Research Committee (1964).

[11] The incipient science of jurimetrics represents an attempt to apply modern scientific method to legal problems. *E.g.*, *Symposium—Jurimetrics*, 28 LAW & CONTEMP. PROB. 1 (1963). Current activity under the rubric of jurimetrics, however, appears to be concentrated heavily on automatic data retrieval based upon a classificatory scheme of case law and statutes, which is essentially doing a manual search extremely rapidly and extremely well. If "jurimetrics" is defined to mean the science of law measurement, automatic data retrieval would seem to be on the periphery of jurimetrics. It is noted that the term jurimetrics was christened, "the scientific investigation of legal problems," by its alleged creator. See Loevinger, *supra* note 7, at 483.

spection, and logical consistency, the written and spoken word are feasible media for research and communication.[12] However, if new law or the products of legal research were to be based upon findings of social performance and efficacy, or were to be related to the task of describing and summarizing empirical reality, then mathematics could conceivably be substantially more convenient and precise in some instances. Just as a stenographer taking dictation finds that shorthand is a more efficient method of recordation than old English script, a social science analyst involved in legal-economic research may find that translation of relationships into the symbolism of mathematics is advantageous.[13] It is submitted, then, that the differences in methodological approach between law and economics are essentially based upon differences in the philosophy of determinants of research results. The relationship of law to the various social sciences, including economics, and the identity of and weight attached to the various independent variables in the law-making function may have considerable bearing, not only upon the broad proposition of interdisciplinary research, but also upon the more narrow matter of choice of methodology.[14] Perhaps the most crucial question relates to the identity of forces or elements contributing to the molding of new law. Traditionally, through the doctrine of *stare decisis*, the variable representing prior law in the law-making function has loomed large and assumed major proportions. Thus, the configuration of new, emerging law is heavily influenced by prior law. The needs of the social order for certainty, stability, and uniformity justify the inclusion of prior law as a factor influencing new law; however, if the roots of law extend to areas of knowledge and human experience examined by the social sciences, then legal change should be influenced by the research results of the social sciences. By this view, the law

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[12] However, written and spoken word may not be the most efficient language for research and communication even here. The use of the electronic digital computer in automatic data retrieval for legal research is receiving attention on several fronts and holds considerable promise for reducing time and expense of legal research and improving the accuracy thereof. See generally Note, *Jurimetrics: The Electronic Digital Computer and Its Application in Legal Research*, 50 IOWA L. REV. 1114 (1965). See note 11 *supra*.

[13] The symbol-manipulating capacities of electronic digital computers have revolutionized data analysis in the social sciences as in many other fields. One beneficent aspect of computerized research is the necessity for appraising the logical implications of verbal propositions. Moreover, translation of verbal propositions into programming language requires precision in identifying variables and their relationships, thus revealing ambiguities and implicit assumptions in the verbal formulation.

[14] See Harl, *Modifying Institutional-Legal Relations Among Private Parties to Facilitate Adjustments in Agriculture*, 46 J. FARM ECON. 953, 956-59 (1964); Harl, *The Role of Law in Achieving Policy Goals for Agricultural and Industrial Organization*, Proceedings of a Seminar on Federal, State, and Local Laws Affecting Marketing, North Central Regional Marketing Research Committee (NCR-20) Number 5, North Dakota Agricultural Experiment Station Bull. 455 (1965).

as a dependent variable is flexible and amenable to change. And by this view, legal research or research designed to affect the law *in futuro* is carried well beyond the search for legal precedent. The law is shaped by economic considerations and by sociological, political, and other aspects, with the weighting of each variable in the law-making function determined by the duly constituted decision-making body—judges, legislatures, government agencies having rule-making power, and the electorate. The shift from heavy reliance on precedent to partial dependence on the social sciences whose findings are deemed relevant for a particular legal issue under study brings an additional dimension to legal research. The methodology and methods of research utilized by the social sciences may be helpful as the emphasis shifts to inclusion of other variables than prior law in the law-making functions. More than a decade ago one legal scholar observed, "as in Jhering's juristic heaven, new facts and ideas can gain admission to the house of the law today only by smashing their heads through the solid walls. Jurimetrics promises to cut windows in the house of the law so that those inside can see out, and to cut doors, so that those outside can get in."[15]

## ECONOMIC PERFORMANCE OF THE LEGAL FORM OF FIRM ORGANIZATION[16]

In a private enterprise economy, the firm, as an autonomous administrative unit transforming inputs into outputs pursuant to some entrepreneurial objective function and consistent with a technical production function, occupies a central role both in law and in economics. From the legal standpoint, the firm as an institution represents, embodies, and participates in specific relationships of an interindividual, interfirm, firm-individual, and intrafirm nature. In effect, the law provides a relatively highly developed, finite, structural framework for the conduct of economic activity by firms. The interest of economics in the firm is primarily that associated with the dual role of resource allocation and income distribution. Although the economic theory of the firm, as part of the wider theory of value in the theoretical investigation of price determination and resource allocation, is an important part of economic theory, the attention of economic theoreticians and empiricists has concentrated heavily upon an assumed abstraction of the firm as an entity resembling somewhat the sole proprietorship form of organization.[17] The economic effects of the legal

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[15] Loevinger, *supra* note 7, at 490.

[16] This section of the paper and the one following draws heavily upon material and ideas in Harl, Identification and Measurement of Selected Legal-Economic Effects of the Corporate Form of Business Organization Upon a Small, Closely-Held Firm (1965), unpublished dissertation in Iowa State University Library.

[17] *E.g.*, HICKS, VALUE AND CAPITAL (2d ed. 1946); Marschak, *Theory of An Efficient Several-Person Firm*, 50 AM. ECON. REV. 541 (proceedings issue, 1960).

form of organization upon the firm have received relatively little attention in the literature,[18] notwithstanding that the choice of form of organization may affect resource allocation and income distribution[19] and impinge upon the accomplishment of objectives of the firm and the individual owners and members of the firm. If the legal form of organization does in fact affect economic activity of the firm, an opportunity may exist for developing a theory of business organization optimality based upon attainment of the objectives of a firm or a firm's decision makers.

Assuming that the firm operates within perfectly competitive product and factor markets, the received economic theory holds that the firm's objective is to maximize net revenue or profit[20] given a set of prices and a technologically determined production function guiding activities of the firm.[21] Net revenue maximization is accomplished by determining the optimal mix of inputs and outputs, *i.e.*, the static equilibrium position. These assumptions have been relaxed as economists have considered the departure from the purely competitive environment in factor and product markets and have analyzed the firm under various forms and degrees of less than perfectly competitive behavior.[22] These extensions retain the basic analytic framework and decision-making processes postulated for the firm under perfect competition while extending the theory to different market situations. And economic inquiry has considered various effects of relaxing the assumptions of perfect knowledge and certainty in the classical theory of the firm.[23] Recent investigation has contributed to a "behavioral

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[18] Some attention has been given, although relatively slight, to problems of the firm associated with the form of organization. See, *e.g.*, SIMON, ADMINISTRATIVE BEHAVIOR (2d ed. 1958); Cyert & March, *Organizational Structure and Pricing Behavior in An Oligopolistic Market*, 45 AM. ECON. REV. 129 (1955). Investigations involving contractual acquisition of factors of production through leasing arrangements involving landlord-tenant relationships come perhaps the closest to consideration of the form of business organization from a legal as well as an economic standpoint. See *e.g.*, De Benedictis & Timmons, *Identification and Measurement of Inefficiencies in Leasing Systems*, Iowa State University Agricultural & Home Economics Experiment Station, Research Bull. No. 490 (1961).

[19] See, *e.g.*, Harl, *Public Policy Aspects of Farm Incorporation*, 20 BUS. LAW. 933 (1965).

[20] Profit, $\pi$, is defined as the difference between the firm's total revenue and total cost, C. Total revenue of a firm operating in a perfectly competitive market is given by the number of units of product sold, q, multiplied by the fixed unit price, p, received. Thus,

$$\pi = pq - C$$

and profit equals net revenue.

[21] See, *e.g.*, HENDERSON & QUANDT, MICROECONOMIC THEORY—A MATHEMATICAL APPROACH 43 (1958). See Shubik, *Objective Functions and Models of Corporate Optimization*, 75 Q. J. ECON. 345, 347 (1961).

[22] *E.g.*, CHAMBERLIN, THE THEORY OF MONOPOLISTIC COMPETITION (8th ed. 1962).

[23] *E.g.*, HEADY, ECONOMICS OF AGRICULTURAL PRODUCTION AND RESOURCE USE PT. III (1952).

theory of the firm" on the way business firms make economic decisions.[24] Economic theoreticians have considered substitutes for profit maximization as the single firm objective[25] and have questioned the assumption of maximization of profits.[26] Although it is perhaps beyond the pale of argument that maximization of profit is a part of nearly every firm's objective function, it may indeed be a gross oversimplification of motives of entrepreneurs to acquiesce in the assumption that profit maximization constitutes the entire objective function.[27] It has been argued that the primary objective of the firm may be long-run security of profit or survival,[28] maximization of sales subject to a minimum profit constraint,[29] or attainment of "satisfactory" profits.[30] It has been urged that entrepreneurial motives are not limited to maximization of profit, but include diverse personal motives (*e.g.*, security, power, and prestige) as well.[31] It has been suggested that if the utile were a better behaved measure, the introduction of subjective utility might provide a suitable substitute for profit maximization.[32]

In a closely held firm, the objective function may be a question of fact, ascertained with appropriate empirical technique. The firm's objective function may be a product of the interaction of the parties' objective functions,[33] although the objectives of the owners or other decision makers with respect to the firm may not be fully included in the set of firm objectives. Therefore, not only may the firm have an objective function of multiple elements, but the objectives of the individuals associated with the firm in an ownership or decision-making role may also add additional dimensions to the matrix of elements.

The organization of firms constitutes a major part of legal literature. The writings appearing in legal journals under the rubric of the various components of the broad field of business organization[34] and the reported

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[24] *E.g.*, CYERT & MARCH, A BEHAVIORAL THEORY OF THE FIRM (1963).

[25] See, *e.g.*, Rothschild, *Price Theory and Oligopoly*, 57 ECON. J. 299 (1947).

[26] *E.g.*, Simon, *A Behavioral Model of Rational Choice*, 69 Q.J. ECON. 99 (1955).

[27] See Cole, *An Approach to the Study of Entrepreneurship*, ENTERPRISE AND SECULAR CHANGE 188 (Lane & Riemersma eds. 1953).

[28] Rothschild, *supra* note 25.

[29] BAUMOL, BUSINESS BEHAVIOR, VALUE AND GROWTH 49 (1959).

[30] See, *e.g.*, Margolis, *The Analysis of the Firm: Rationalism, Conventionalism, and Behaviorism*, 31 J. BUSINESS 187 (1958).

[31] See KATONA, PSYCHOLOGICAL ANALYSIS OF ECONOMIC BEHAVIOR (1st ed. 1951).

[32] See Cyert & March, *op. cit. supra* note 24, at 9. An entrepreneur or member of a firm, as a decision maker, is also a member of a household which has as its assumed objective the maximization of utility. Therefore, the profit maximizing objective may be modified somewhat if the objectives of profit maximization for the firm and utility maximization for the entrepreneur as a consumer are not in consonance.

[33] *Cf.* Papandreou, *Some Basic Problems in the Theory of the Firm*, 2 A SURVEY OF CONTEMPORARY ECONOMICS 183 (Haley ed. 1952).

[34] The economic firm concept has no exact counterpart in legal literature, although

judicial decisions assure a plenitude of information on alternative forms of organization. Much of the legal research and writing on firm organization is readily classifiable by traditional form of organization. Thus, material may be found under the subheadings of corporations,[35] partnerships,[36] agency,[37] and trusts.[38] Legal material may also be located under subject matter headings that transcend firm organizational lines, for example, materials on taxation[39] and bankruptcy.[40]

The efficacy of the legal forms of doing business could conceivably be subjected to testing on the basis of the extent to which attainment of the firm's objectives is thereby impeded. However, reference to attainment of desired firm objectives is hardly meaningful, pragmatically, unless objectives of firm owners with respect to their personal estates are considered along with the form of firm organization. Thus, it would seem not unrealistic to hypothesize that the totality of objectives of a closely-held firm might include (1) maximization of returns to fixed factors of production, (2) maximization of firm net profits, (3) minimization of the income tax bill for the firm, (4) minimization of the income tax bill for the shareholders, (5) minimization of the income tax bill of the firm and shareholders, (6) minimization of estate settlement costs and taxes for senior owners, (7) maximization of the firm's net worth over time, and (8) maximization of the net worth of the firm's owners over time.[41] It is likely that additional objectives could be posited, almost without limit, as empirical observation is extended. In each particular instance, relevant questions are (1) what elements combine to make up the firm's objective function, and (2) what weights are attached to each element in the function? It would seem feasible to consider the effects of the form of firm organization from the standpoint of the various elements in the objective function.

## A MODEL FOR TESTING ALTERNATIVE FORMS OF FIRM ORGANIZATION

In a research study conducted jointly by the Economic Research Service, U.S. Department of Agriculture, and the Department of Economics and

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the unincorporated sole proprietorship, the general partnership, and the small, closely-held corporation without subsidiaries approximate the economic "firm" in scope and functional meaning. The large corporation with subsidiaries or with ownership or management linkage to another legal entity may depart substantially from the concept of the economic firm.

[35] See, *e.g.*, O'NEAL, CLOSE CORPORATIONS: LAW AND PRACTICE (1958).

[36] *E.g.*, ROWLEY, LAW OF PARTNERSHIPS (2d ed. 1960).

[37] *E.g.*, MECHEM, LAW OF AGENCY (4th ed. 1952).

[38] *E.g.*, SCOTT, TRUSTS (2d ed. 1956).

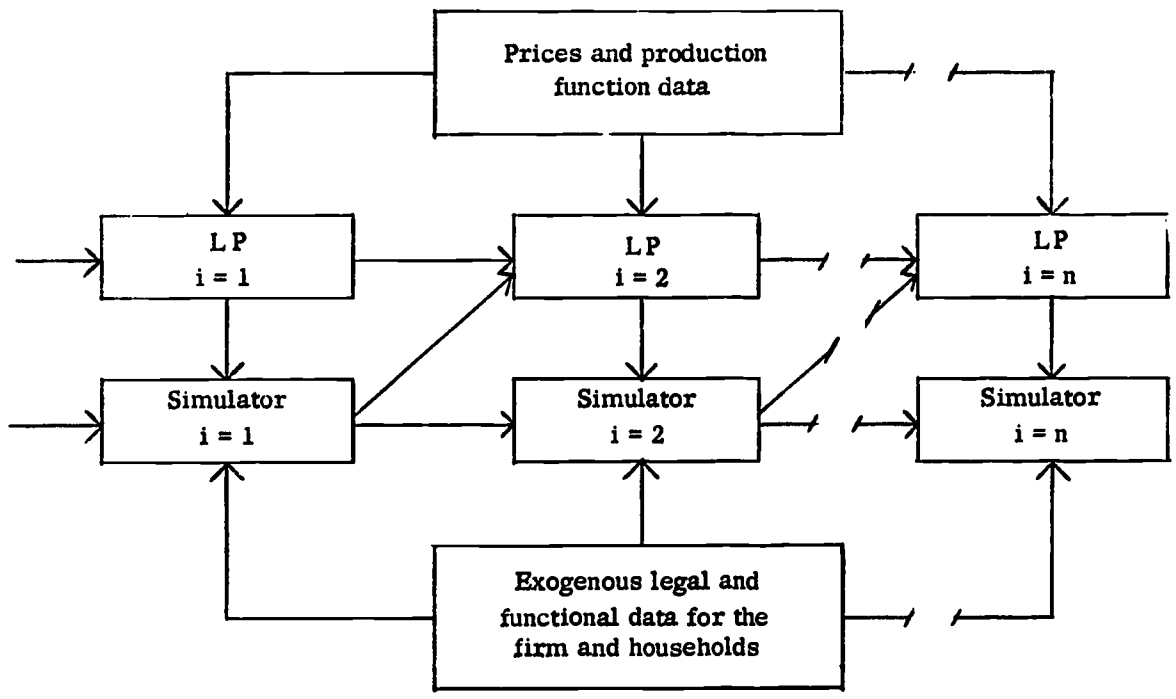
[39] *E.g.*, O'BYRNE, FARM INCOME TAX MANUAL (rev. ed. 1964).

[40] *E.g.*, COLLIER, BANKRUPTCY (14th ed. 1962).

[41] The stated objectives were used in operation of the model described in the follow-

Sociology, Iowa State University, a model was constructed utilizing both linear programming and simulation techniques to measure the economic effects of the legal form of firm organization. The deterministic model is recursive, involving n years of firm activity. The model first generates, for each year, an optimum production plan based upon *ex ante* price and yield expectations.[42] The *ex post* solution[43] is then obtained and the relevant portions of the solution are transmitted to the simulation portion of the model for specified computations as shown in block diagram form in Figure 1. Necessary accounting and inventory data are transmitted directly to the next year's linear programming matrix. The simulator, reflecting with

Figure 1.




ing part of this paper to test the economic effects of the corporate form of organization for firms. For all runs, the linear programming segment of the model maximized net returns to fixed factors in the conventional fashion. The entire model was operated in tests of attainment of each of the eight stated objectives.

[42] *Ex ante* prices and yields were derived using various expectation models. One model used, a weighted trend of n prior years, was of the following form with $\beta$ as the coefficient providing the weight for any i-th year's price:

$$\beta = \frac{(n+1) - X_i}{(n/2)\quad(n+1)}$$

Thus, for a five year weighted trend, the formula for the price of a commodity for any year is:

$$Y = .3333\,X_1 + .2667\,X_2 + .2000\,X_3 + .1333\,X_4 + .0667\,X_5.$$

[43] The *ex post* solution is based upon actual prices and yields experienced in the years under study.

substantial fidelity the legal form of business organization and the legal framework for the households of the firm's owners and decision makers, provides data for the next year's linear programming matrix and the next year's simulation. The process is repeated as a "run" for each of the n years under study. Various "runs" can be made under different assumptions relative to the legal structure of the firm or household, the decision-making model, or the technical production function.

In the following sections, the research methods included in the model are examined. Attention is then directed to construction of the simulation portion of the model.

*Linear Programming*

As a flexible and powerful tool for research, linear programming has received extensive use both in static analysis of the firm and in dynamic firm investigations.[44]

Linear programming is a method for calculating the "best" plan for achieving stated objectives in a situation in which resources are limited. Linear programming problems may be concerned with either minimizing or maximizing an objective function. Thus, given a specified set of prices and amounts of various ingredients and a set of limitations on fat, fiber, and protein content, linear programming may be used to calculate the "least cost" formulation for animal feed containing a certain chemical analysis. Similarly, given a certain number of acres of land, hours of labor, and dollars of capital; given prices for these inputs and for outputs in the form of crops and livestock; and given rates of transformation of inputs into outputs, linear programming can be used to specify the precise level of farm activities or enterprises to maximize profit.

The theory of linear programming rests upon several basic assumptions, one of which is that the number of processes is finite. The term "process" refers to a way of doing things; for a firm, it may mean a method of converting resources into a product. For example, transformation of corn, hay, labor, and other specified inputs into beef through medium quality steers could be a process; transformation of the same inputs except through fancy quality steer calves would be a different process. In Figure 2, the sixty-two different activities included in the ISU-USDA model are listed from left to right across the top of the figure.

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[44] See, *e.g.*, Arroyo, *Dynamic Programming Models for Identification and Measurement of Inefficiencies in Leasing Arrangements*, Unpublished Ph.D. Dissertation, Iowa State University Library (1961); De Benedictis & Timmons, *Identification and Measurement of Inefficiencies in Leasing Systems*, Iowa State Univ. Agric. and Home Econ. Experiment Station, Research Bull. 490, at 39-72 (1961). Linear programming was allegedly developed in 1947 as a technique for planning activities of the United States Air Force. See DORFMAN, SAMUELSON & SOLOW, LINEAR PROGRAMMING ANALYSIS 3 (1958).

Just as the processes must be limited to a finite number, the resource restrictions must also be confined to a fixed number; and it is necessary to the linear programming problem that at least one resource be limiting. Thus, Figure 2 contains a total of 58 entries in the restriction column along the left margin of the figure. However, rows 1 and 60 are price rows and not restrictions, and rows 44 through 57 are for accounting purposes rather than for directly limiting production.

In linear programming, any process may be used to any positive extent so long as sufficient resources are available; indivisibilities in production are ignored. For example, a computed linear programming solution may specify production of thirty-seven and one-tenth litters of hogs. Quite obviously, such figures must be rounded off to the nearest unit.

A further assumption of linear programming is that each process is characterized by constant proportions between inputs and outputs and that these ratios are independent of the extent to which the process is used. Thus, if one litter of hogs can be produced to market weight on twenty hours of labor, eighty bushels of corn, and 300 pounds of protein supplement, it is assumed that fifty litters could be produced with 1,000 hours of labor, 4,000 bushels of corn, and 15,000 pounds of protein supplement. Activities are, therefore, linear in the sense that the quantity of a particular input required for a specific activity is dependent upon and is a linear function of the level of the activity. If this is not realistic under the circumstances for all ranges of output, then different ranges of output or segments of the production function may be considered as different processes and represented by different activities.

Linear programming theory also assumes that the output of two processes produced simultaneously is always the sum of the output of the two separate activities. Thus, complementary or other interaction between processes is not specifically identified except to the extent that a process can be defined to include such interrelationship. In general, linear programming methods are based upon the assumption that resource supplies, input-output coefficients, and prices are known with certainty.

The mathematical equations for the static linear programming model may be summarized as follows:

Net revenue (R) is a linear function of process levels:

$$R = p_1q_1 + p_2q_2 + \ldots + p_nq_n \qquad (1)$$

where the p's are the net price[45] per unit of output and the q's are the quantities of output produced. For example, for a firm producing corn, oats, and hogs the equation might be phrased as—

[45] Typically, net prices are computed by calculating the gross or market price per unit of activity and subtracting therefrom the variable costs.

Net revenue = (net price per bu. of corn) (bushels of corn produced) +
(net price per bu. of oats) (bushels of oats produced) +
(net price per pound for hogs) (pounds of hogs produced)

The linear program may be directed to select process levels such that R is a maximum. However, the process levels are limited by the quantities of inputs or resources available. The amounts of inputs used in production cannot exceed specified levels—

$$\begin{aligned} a_{11}\,q_1 + a_{12}\,q_2 + \ldots + a_{1n}\,q_n &\leqq x_1 \\ a_{21}\,q_1 + a_{22}\,q_2 + \ldots + a_{2n}\,q_n &\leqq x_2 \end{aligned} \qquad (2)$$

where each "a" is the quantity of an input required to produce one unit of a particular output, represented by the q's. The X's are amounts of the inputs available—such as acres of land or hours of labor. Thus, if a firm had 160 acres of land ($X_1$) available, and it produced corn, oats, and hogs, the equation might be formulated as:

(one acre) (number of acres of corn produced) + (one acre) (number of acres of oats produced) + (0 acres) (number of litters of hogs produced) $\leqq$ 160

A solution could specify that some land should lie idle; but a solution could not commit more than 160 acres to production.

A further linear programming equation specifies that process levels must be nonnegative:

$$q_j \geq 0 \qquad (3)$$

Although mathematically feasible, a negative process level is economically meaningless if production is unidirectional. One cannot very well produce corn, labor, and protein supplement from hogs, for example.

To increase the effectiveness and precision of linear programming in the ISU-USDA study, various modifications were made in the conventional linear programming matrix.[46] Decision making, conventionally on a calendar year basis, was based on a fiscal year to make the decision period correspond more closely with the production period for the various activities and to minimize the number of activities extending into two or more decision-making periods.[47] Since capital flows are deemed particularly important in assessing the economic effects of alternative organizational forms, the capital-using and capital-supplying activities were constructed for substantially more finite manipulation of capital flow than for many linear programming models. As shown in Figure 2, capital use was placed

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[46] See Harl, Identification and Measurement of Selected Legal-Economic Effects of the Corporate Form of Business Organization Upon a Small, Closely-Held Firm, 202-213 (1965), unpublished dissertation in Iowa State University Library.

[47] A November 1-October 31 fiscal year was used in the ISU-USDA study. Thus, it is assumed that decisions are made on November 1 for the following twelve-month period. Only hog activities were found to span decision-making periods based on a November 1-October 31 fiscal year.

on a basis of two-month subperiods, with each two-month subperiod eligible to borrow additional debt capital from shareholders, the deferred compensation fund, or outside credit sources. Activities may use capital from appropriate subperiods and also add to capital supply in particular subperiods upon sale of output. Thus, in the course of a year, capital can be subjected to multiple use.

Inasmuch as the allocation of resources among activities or processes, both in a linear programming framework and in the real world, is done on an *ex ante* basis in accordance with an expectation model or models of the decision makers, *ex ante* prices and yields are used in the ISU-USDA study in determining the optimum production plans. However, the coupling of simulation, a device for approximating reality, with linear programming raises substantial questions as to the advisability of using production plans based upon *ex ante* considerations for the simulation phase of the study. In theory, it would seem that introduction of *ex post* production plans into the simulator would be more in consonance with reality and with the nature of the research tool. Therefore, the *ex ante* production plans (based upon prices and yields in $R_{01}$ of Figure 2) are transformed into *ex post* production plans (based upon prices and yields in $R_{60}$ of Figure 2) within the linear programming matrix.

Investment activities (additional machinery and buildings) are included in the linear programming matrix, but with suitable simplification and modification in accordance with the capabilities of the analytic framework. The investment activities are based upon an annual service cost to the firm; however, once an investment is made in additional facilities, the quantitative level of acquisition is carried over to succeeding years wherein an annual service charge is exacted.

To provide a realistic assessment of crop production alternatives during the n years covered by the study, the linear programming model represented in Figure 2 includes not only product prices in the open market and rotation activities without direct governmental control, but also production alternatives within the framework of commodity support programs, acreage control, cropland diversion, and other relevant governmental programs.

*Simulation*

Simulation has become an important research tool for analysis and decision making in the physical and behavioral sciences. It has been used to solve waiting line problems, inventory problems with uncertainties of demand and delivery time, maintenance operations, scheduling of airplane traffic, urban traffic patterns and flows, and numerous other problems requiring an associative link with reality.[48] Simulation is well suited for ex-

[48] See, *e.g.*, BIERMAN, FOURAKER & JAEDICKE, QUANTITATIVE ANALYSIS FOR BUSINESS

plaining and predicting the performance of an operational system.[49] With simulation models, the effects of alternative policies can be ascertained directly by experimentation without disturbing the existing system.

In solving a simulation model, the objective is to determine, deductively and with generality, the implicit relationships among endogenous[50] variables and the initial conditions, parameters, and time paths of exogenous[51] variables.[52]

Simulation has the advantage of admitting more complexity and realism than is possible in most analytically solved models. Simulation models may encompass such features as discontinuities, nonlinearities, time-delays, and irreversibilities. A further advantage of simulation is that it makes possible frequent changes of almost unlimited magnitude in the model or the data input.

The principal disadvantages of simulation stem from the usual complexity of the models and the necessity for a multiplicity of models because of their specificity with respect to a particular problematic situation. An additional disadvantage of present simulation techniques is the paucity of workable tests of significance. Tests are needed to indicate when the time paths generated by a simulation model agree sufficiently with observed or specified time paths to suggest other than mere coincidence.[53] Using the so-called "arithmetic effects" (that is, the differences in output resulting from a model run, from a series of independent alterations in the basic simulation model) may be disappointing in that interaction effects may be masked and little generality of results produced. The latter objection can be met to some extent and a modest degree of generality achieved by testing the effects of a model change in relation to all other changes made. The former objection can be met in part similarly by formulating sufficient runs to isolate the effects of changes in the model. An additional disadvantage of simulation is that, unlike linear programming or some other

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DECISIONS 189-92 (1961); COMPUTER APPLICATIONS IN THE BEHAVIORAL SCIENCES ch. 23 (Borko ed. 1962); BUFFA, MODELS FOR PRODUCTION AND OPERATIONS MANAGEMENT ch. 18 (1963).

[49] See Jackson, *Simulation as Experimental Mathematics*, Symposium on SIMULATION MODELS: METHODOLOGY AND APPLICATIONS IN THE BEHAVIORAL SCIENCES 245 (Hoggatt & Balderston eds. 1963).

[50] Endogenous variables are generated within and determined by the system, and may act upon other variables in the system.

[51] Exogenous variables are determined independently of the system under study and are regarded as acting upon the system with unidirectional causality flowing from exogenous variables to the system.

[52] See Orcutt, *Simulation of Economic Systems*, 50 AM. ECON. REV. 893 (1960).

[53] See Cohen, *Simulation of the Firm*, 50 AM. ECON. REV. 534, 540 (proceedings issue, 1960).

analytic tools,[54] simulation offers no formal procedure for selecting the recursive "runs" such that the solutions will converge to an optimum with a given amount of computing or a given number of runs. Optimal solutions are obtained by iteration of the simulation model through a heuristic process. The conditions for each run are obtained by interpretations of prior runs. A related problem with simulation techniques is that an observed "optimum" may be in fact a local optimum, and only the knowledge and alertness of the researcher may forestall a misinterpretion of research results.

Most simulation studies of firms reported in the literature involve relatively large firms, numerous decision makers at various levels, some elasticity of demand for products, a market environment in which the firm is a price setter, and avoidance of consideration of the legal framework. In the ISU-USDA study, the simulation technique is utilized to represent a small firm with few decision makers, perfectly elastic demand for the firm's products, a market environment in which the firm is a price taker, and full consideration of the legal framework. Inasmuch as the law provides the major parameters for the model and is known and can be completely specified with considerable certainty, the need for sampling, fitting of functions, or consideration of stochastic elements is generally obviated in the present formulation.

*Construction of simulation portion of model*

The purpose of the simulator in the ISU-USDA model is to represent, with substantial fidelity, the legal form of organization within which the firm operates. Alternatively, the simulator could represent the corporation, general or limited partnership, trust, sole proprietorship, or other variants of the traditional forms of business organization. In this study, the simulator represents the corporate form.

The notation used for variables is $x_{ij}^{k}$ where i = years 1 – n, j = shareholders 1 – m, and k = identification of the variable, 1 – p. The study covered ten years of firm operation[55] and assumed four shareholders for the firm. The model could easily be expanded to cover a longer time span and a greater number of shareholders, with the principal restraint on the size of j being increasing computational complexity as j increases.

As shown in Figure 1, the simulator receives information from three basic sources: (1) selected data from the linear programming matrix, (2) specified variable levels from the prior year's simulation, and (3) values of

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[54] With analytic tools such as linear programming, optimal closed solutions can be obtained to a formulated problem. Analytic tools are characterized by optimality and calculability.

[55] The study covered the period 1953 through 1962 for the firm subjected to analysis.

exogenous variables from magnetic tape in accordance with a predetermined combination or pattern. These data, and the endogenous variables and structural framework of the simulator, provide the necessary elements for simulation of the legal form of business organization.

The linear programming matrix for the i-th year provides specified information to the simulator via the main computing program. The simulator receives $x_i^1$, *ex post* return to fixed factors; and levels of hog activities, $P_{13}$, $P_{14}$, $P_{15}$, $P_{48}$, and $P_{49}$, which are referred to in the simulator as $x_i^{190}$ to $x_i^{194}$ respectively.[56]

To maintain inter-year linkage, specified information is transmitted from the i-th year's simulator to the simulator of the following year. The variables whose values pass from one simulator to the next under the regular method of income tax formulation are:

1. $x_{(i-1)j}^{92}$—current cumulative total of debt capital investments in the corporation by the j-th shareholder.
2. $x_{(i-1)j}^{93}$—current deferred compensation fund value for the j-th shareholder.
3. $x_{(i-1)}^{94}$—corporate federal income tax paid.
4. $x_{(i-1)}^{95}$—corporate state income tax paid.
5. $x_{(i-1)j}^{97}$—taxable income received from the sale of corporate stock by the j-th shareholder.
6. $x_{(i-1)j}^{98}$—nontaxable return of capital from debt investments in the corporation by the j-th shareholder.
7. $x_{(i-1)j}^{99}$—debt investments of the j-th shareholder outside the firm generated by the model.
8. $x_{(i-1)}^{100}$—cumulative value of corporate earnings and profits before deducting dividends declared.
9. $x_{(i-1)j}^{109}$—nontaxable return of capital to the j-th shareholder from sale of corporate stock.
10. $x_{(i-1)j}^{116}$—federal income tax paid by the j-th shareholder.
11. $x_{(i-1)j}^{139}$—current aggregate income tax basis of corporate stock held by the j-th shareholder.
12. $x_{(i-1)j}^{177}$—amount of property other than corporate stock available for distribution to the j-th shareholder from the estate of the shareholder with greatest probability of death upon final settlement of the estate.

The simulator also receives data from sources exogenous to the linear programming matrix and the simulator. Among these data are the variables

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[56] Levels of hog activities are needed in the simulator to determine long-term capital gains taxation. Gains attributable to sows held for breeding purposes and held for twelve months or longer are eligible for net long-term capital gains treatment. Int. Rev. Code of 1954, § 1231 (hereinafter cited as I.R.C.).

| Resource used or activity produced | | R 0 | Rotation I (A) (GP) $P_1$ | Rotation I (B) (GP) $P_2$ | Rotation II (A) (GP) $P_3$ | Rotation II (B) (GP) $P_4$ | Rotation I (A) (NGP) $P_5$ | Rotation I (B) (NGP) $P_6$ | Acreage Retirement I $P_7$ | Acreage Retirement II $P_8$ | Rotation I(A) (GP)' $P_9$ | Rotation I(B) (GP)' $P_{10}$ | Rotation I(B) (NGP)' $P_{11}$ | Rotation I(B) (NGP)' $P_{12}$ | Hogs I $P_{13}$ | Hogs II $P_{14}$ | Hogs III $P_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ex post net price | | 01 | $a_{01,1}$ | $a_{01,2}$ | $a_{01,3}$ | $a_{01,4}$ | $a_{01,5}$ | $a_{01,6}$ | $a_{01,7}$ | $a_{01,8}$ | $a_{01,9}$ | $a_{01,10}$ | $a_{01,11}$ | $a_{01,12}$ | $a_{01,13}$ | $a_{01,14}$ | $a_{01,15}$ |
| Labor Supply | F | 02 | $a_{02,1}$ | $a_{02,2}$ | $a_{02,3}$ | $a_{02,4}$ | $a_{02,5}$ | $a_{02,6}$ | | | $a_{02,9}$ | $a_{02,10}$ | $a_{02,11}$ | $a_{02,12}$ | $a_{02,13}$ | $a_{02,14}$ | $a_{02,15}$ |
| | A | 03 | | | | | | | | | | | | | $a_{03,13}$ | $a_{03,14}$ | $a_{03,15}$ |
| | B | 04 | $a_{04,1}$ | $a_{04,2}$ | $a_{04,3}$ | $a_{04,4}$ | $a_{04,5}$ | $a_{04,6}$ | | | $a_{04,9}$ | $a_{04,10}$ | $a_{04,11}$ | $a_{04,12}$ | $a_{04,13}$ | $a_{04,14}$ | $a_{04,15}$ |
| | C | 05 | $a_{05,1}$ | $a_{05,2}$ | $a_{05,3}$ | $a_{05,4}$ | $a_{05,5}$ | $a_{05,6}$ | | | $a_{05,9}$ | $a_{05,10}$ | $a_{05,11}$ | $a_{05,12}$ | $a_{05,13}$ | $a_{05,14}$ | $a_{05,15}$ |
| | D | 06 | $a_{06,1}$ | $a_{06,2}$ | $a_{06,3}$ | $a_{06,4}$ | $a_{06,5}$ | $a_{06,6}$ | $a_{06,7}$ | $a_{06,8}$ | $a_{06,9}$ | $a_{06,10}$ | $a_{06,11}$ | $a_{06,12}$ | $a_{06,13}$ | $a_{06,14}$ | $a_{06,15}$ |
| | E | 07 | $a_{07,1}$ | $a_{07,2}$ | $a_{07,3}$ | $a_{07,4}$ | $a_{07,5}$ | $a_{07,6}$ | | | $a_{07,9}$ | $a_{07,10}$ | $a_{07,11}$ | $a_{07,12}$ | $a_{07,13}$ | $a_{07,14}$ | $a_{07,15}$ |
| Capital supply year n | | 08 | | | | | | | | | | | | | | | |
| Capital supply | F | 09 | $a_{09,1}$ | $a_{09,2}$ | $a_{09,3}$ | $a_{09,4}$ | $a_{09,5}$ | $a_{09,6}$ | | | $a_{09,9}$ | $a_{09,10}$ | $a_{09,11}$ | $a_{09,12}$ | $a_{09,13}$ | $a_{09,14}$ | $a_{09,15}$ |
| | A | 10 | | | | | | | | | | | | | $a_{10,13}$ | $a_{10,14}$ | $a_{10,15}$ |
| | B | 11 | $a_{11,1}$ | $a_{11,2}$ | $a_{11,3}$ | $a_{11,4}$ | $a_{11,5}$ | $a_{11,6}$ | | | $a_{11,9}$ | $a_{11,10}$ | $a_{11,11}$ | $a_{11,12}$ | $a_{11,13}$ | $a_{11,14}$ | $a_{11,15}$ |
| | C | 12 | $a_{12,1}$ | $a_{12,2}$ | $a_{12,3}$ | $a_{12,4}$ | $a_{12,5}$ | $a_{12,6}$ | $-a_{12,7}$ | $-a_{12,8}$ | $a_{12,9}$ | $a_{12,10}$ | $a_{12,11}$ | $a_{12,12}$ | $-a_{12,13}$ | $-a_{12,14}$ | $a_{12,15}$ |
| | D | 13 | $-a_{13,1}$ | $-a_{13,2}$ | $-a_{13,3}$ | $-a_{13,4}$ | $-a_{13,5}$ | $-a_{13,6}$ | $-a_{13,7}$ | $-a_{13,8}$ | $-a_{13,9}$ | $-a_{13,10}$ | $-a_{13,11}$ | $-a_{13,12}$ | $a_{13,13}$ | $-a_{13,14}$ | $-a_{13,15}$ |
| | E | 14 | $-a_{14,1}$ | $-a_{14,2}$ | $-a_{14,3}$ | $-a_{14,4}$ | $-a_{14,5}$ | $-a_{14,6}$ | | | $-a_{14,9}$ | $-a_{14,10}$ | $-a_{14,11}$ | $-a_{14,12}$ | $-a_{14,13}$ | $-a_{14,14}$ | $-a_{14,15}$ |
| Capital supply year n + 1 | | 15 | | | | | | | | | | | | | | | |
| Corn equiv. supply | | 16 | $-a_{16,1}$ | $-a_{16,2}$ | $-a_{16,3}$ | $-a_{16,4}$ | $-a_{16,5}$ | $-a_{16,6}$ | | | $-a_{16,9}$ | $-a_{16,10}$ | $-a_{16,11}$ | $-a_{16,12}$ | $a_{16,13}$ | $a_{16,14}$ | $a_{16,15}$ |
| Silage supply | | 17 | | | | | | | | | | | | | | | |
| Hay I equiv. supply | | 18 | $-a_{18,1}$ | $-a_{18,2}$ | $-a_{18,3}$ | $-a_{18,4}$ | $-a_{18,5}$ | $-a_{18,6}$ | | | $-a_{18,9}$ | $-a_{18,10}$ | $-a_{18,11}$ | $-a_{18,12}$ | | | |
| Hay II equiv. supply | | 19 | $-a_{19,1}$ | $-a_{19,2}$ | $-a_{19,3}$ | $-a_{19,4}$ | $-a_{19,5}$ | $-a_{19,6}$ | | | $-a_{19,9}$ | $-a_{19,10}$ | $-a_{19,11}$ | $-a_{19,12}$ | $a_{19,13}$ | $a_{19,14}$ | $a_{19,15}$ |
| Hay storage | | 20 | $a_{20,1}$ | $a_{20,2}$ | $a_{20,3}$ | $a_{20,4}$ | $a_{20,5}$ | $a_{20,6}$ | | | $a_{20,9}$ | $a_{20,10}$ | $a_{20,11}$ | $a_{20,12}$ | | | |
| Growing space housing | F | 21 | | | | | | | | | | | | | $a_{21,13}$ | $a_{21,14}$ | $a_{21,15}$ |
| | A | 22 | | | | | | | | | | | | | $a_{22,13}$ | $a_{22,14}$ | $a_{22,15}$ |
| | B | 23 | | | | | | | | | | | | | $a_{23,13}$ | $a_{23,14}$ | $a_{23,15}$ |
| | C | 24 | | | | | | | | | | | | | $a_{24,13}$ | $a_{24,14}$ | $a_{24,15}$ |
| | D | 25 | | | | | | | | | | | | | $a_{25,13}$ | $a_{25,14}$ | $a_{25,15}$ |
| | E | 26 | | | | | | | | | | | | | $a_{26,13}$ | $a_{26,14}$ | $a_{26,15}$ |
| Farrowing space | F | 27 | | | | | | | | | | | | | | $a_{27,14}$ | |
| | A | 28 | | | | | | | | | | | | | $a_{28,13}$ | $a_{28,14}$ | |
| | B | 29 | | | | | | | | | | | | | $a_{29,13}$ | $a_{29,14}$ | $a_{29,15}$ |
| | C | 30 | | | | | | | | | | | | | | $a_{30,14}$ | |
| | D | 31 | | | | | | | | | | | | | $a_{31,13}$ | $a_{31,14}$ | |
| | E | 32 | | | | | | | | | | | | | $a_{32,13}$ | $a_{32,14}$ | $a_{32,15}$ |
| Land owned | | 33 | $a_{33,1}$ | $a_{33,2}$ | $a_{33,3}$ | $a_{33,4}$ | $a_{33,5}$ | $a_{33,6}$ | $a_{33,7}$ | | | | | | | | |
| Land rented | | 34 | | | | | | | | $a_{34,8}$ | $a_{34,9}$ | $a_{34,10}$ | $a_{34,11}$ | $a_{34,12}$ | | | |
| Machinery I capacity | | 35 | $a_{35,1}$ | $a_{35,2}$ | $a_{35,3}$ | $a_{35,4}$ | $a_{35,5}$ | $a_{35,6}$ | | | $a_{35,9}$ | $a_{35,10}$ | $a_{35,11}$ | $a_{35,12}$ | | | |
| Machinery II capacity | | 36 | $a_{36,1}$ | $a_{36,2}$ | $a_{36,3}$ | $a_{36,4}$ | $a_{36,5}$ | $a_{36,6}$ | | | $a_{36,9}$ | $a_{36,10}$ | $a_{36,11}$ | $a_{36,12}$ | | | |
| Silo capacity | | 37 | | | | | | | | | | | | | | | |
| Hog management | | 38 | | | | | | | | | | | | | $a_{38,13}$ | $a_{38,14}$ | $a_{38,15}$ |
| Government programs-O | | 39 | $a_{39,1}$ | $a_{39,2}$ | $a_{39,3}$ | $a_{39,4}$ | | | | | | | | | | | |
| Government programs-R | | 40 | | | | | | | | | $a_{40,9}$ | $a_{40,10}$ | | | | | |
| Capital borrow limit | | 41 | | | | | | | | | | | | | | | |
| Labor hire limit | | 42 | | | | | | | | | | | | | | | |
| Land acquire limit | | 43 | | | | | | | | | | | | | | | |
| Land retirement I | | 44 | $-a_{44,1}$ | $-a_{44,2}$ | $-a_{44,3}$ | $-a_{44,4}$ | | | $a_{44,7}$ | | | | | | | | |
| Land retirement II | | 45 | | | | | | | | $a_{45,8}$ | $-a_{45,9}$ | $-a_{45,10}$ | | | | | |
| Capital borrowed I | | 46 | | | | | | | | | | | | | | | |
| Capital borrowed II | | 47 | | | | | | | | | | | | | | | |
| Capital borrowed III | | 48 | | | | | | | | | | | | | | | |
| Capital borrowed IV | | 49 | | | | | | | | | | | | | | | |
| Capital borrowed V | | 50 | | | | | | | | | | | | | | | |
| Hog interyear transfer I | | 51 | | | | | | | | | | | | | | | |
| Hog interyear transfer II | | 52 | | | | | | | | | | | | | | | |
| Hog interyear transfer III | | 53 | | | | | | | | | | | | | | | |
| Machinery I transfer | | 54 | | | | | | | | | | | | | | | |
| Machinery II transfer | | 55 | | | | | | | | | | | | | | | |
| Farrowing space transfer | | 56 | | | | | | | | | | | | | | | |
| Growing space housing | | 57 | | | | | | | | | | | | | | | |
| Ex ante net price | | 60 | $a_{60,1}$ | $a_{60,2}$ | $a_{60,3}$ | $a_{60,4}$ | $a_{60,5}$ | $a_{60,6}$ | $a_{60,7}$ | $a_{60,8}$ | $a_{60,9}$ | $a_{60,10}$ | $a_{60,11}$ | $a_{60,12}$ | $a_{60,13}$ | $a_{60,14}$ | $a_{60,15}$ |

[Figure 2. LINEAR PROGRA

| Hogs I | Hogs II | Hogs III | Silage conversion | Cattle I | Cattle II | Cattle III | Cattle IV | Continuous soybeans(O) | Continuous soybeans(R) | Capital transfer | Capital transfer II | Capital transfer III | Capital transfer IV | Capital transfer V | Capital transfer VI | Capital borrow I | Capital borrow II | Capi borro |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_{13}$ | $P_{14}$ | $P_{15}$ | $P_{16}$ | $P_{17}$ | $P_{18}$ | $P_{19}$ | $P_{20}$ | $P_{21}$ | $P_{22}$ | $P_{23}$ | $P_{24}$ | $P_{25}$ | $P_{26}$ | $P_{27}$ | $P_{28}$ | $P_{29}$ | $P_{30}$ | $P_{3}$ |
| $a_{01,13}$ | $a_{01,14}$ | $a_{01,15}$ | $-a_{01,16}$ | $a_{01,17}$ | $a_{01,18}$ | $a_{01,19}$ | $a_{01,20}$ | $a_{01,21}$ | $a_{01,22}$ | $a_{01,23}$ | $a_{01,24}$ | $a_{01,25}$ | $a_{01,26}$ | $a_{01,27}$ | $a_{01,28}$ | $-a_{01,29}$ | $-a_{01,30}$ | $-a_{01,}$ |
| $a_{02,13}$ | $a_{02,14}$ | $a_{02,15}$ | | $a_{02,17}$ | $a_{02,18}$ | $a_{02,19}$ | $a_{02,20}$ | | | | | | | | | | | |
| $a_{03,13}$ | $a_{03,14}$ | $a_{03,15}$ | | $a_{03,17}$ | $a_{03,18}$ | $a_{03,19}$ | $a_{03,20}$ | | | | | | | | | | | |
| $a_{04,13}$ | $a_{04,14}$ | $a_{04,15}$ | | $a_{04,17}$ | $a_{04.18}$ | $a_{04,19}$ | $a_{04,20}$ | $a_{04,21}$ | $a_{04,22}$ | | | | | | | | | |
| $a_{05,13}$ | $a_{05,14}$ | $a_{05,15}$ | | $a_{05,17}$ | $a_{05,18}$ | $a_{05,19}$ | $a_{05,20}$ | $a_{05,21}$ | $a_{05,22}$ | | | | | | | | | |
| $a_{06,13}$ | $a_{06,14}$ | $a_{06,15}$ | | $a_{06,17}$ | $a_{06,18}$ | | | $a_{06,21}$ | $a_{06,22}$ | | | | | | | | | |
| $a_{07,13}$ | $a_{07,14}$ | $a_{07,15}$ | $a_{07,16}$ | $a_{07,17}$ | $a_{07,18}$ | | | $a_{07,21}$ | $a_{07,22}$ | | | | | | | | | |
| | | | | | | | | | | $a_{08,23}$ | | | | | | $a_{08,29}$ | $-a_{08,30}$ | $-a_{08,}$ |
| $a_{09,13}$ | $a_{09,14}$ | $a_{09,15}$ | | $a_{09,17}$ | $a_{09,18}$ | $a_{09,19}$ | $a_{09,20}$ | | | $-a_{09,23}$ | $a_{09,24}$ | | | | | | | |
| $a_{10,13}$ | $a_{10,14}$ | $a_{10,15}$ | | $a_{10,17}$ | $a_{10,18}$ | $a_{10,19}$ | $a_{10,20}$ | | | | $-a_{10,24}$ | $a_{10,25}$ | | | | | | |
| $a_{11,13}$ | $a_{11,14}$ | $a_{11,15}$ | | $a_{11,17}$ | $a_{11,18}$ | $a_{11,19}$ | $a_{11,20}$ | $a_{11,21}$ | $a_{11,22}$ | | | $-a_{11,25}$ | $a_{11,26}$ | | | | | |
| $-a_{12,13}$ | $-a_{12,14}$ | $a_{12,15}$ | | $a_{12,17}$ | $a_{12,18}$ | $-a_{12,19}$ | $-a_{12,20}$ | $a_{12,21}$ | $a_{12,22}$ | | | | $-a_{12,26}$ | $a_{12,27}$ | | | | |
| $a_{13,13}$ | $-a_{13,14}$ | $-a_{13,15}$ | | $a_{13,17}$ | $a_{13,18}$ | | | $a_{13,21}$ | $a_{13,22}$ | | | | | $-a_{13,27}$ | $a_{13,28}$ | | | |
| $-a_{14,13}$ | $-a_{14,14}$ | $-a_{14,15}$ | $a_{14,16}$ | $-a_{14,17}$ | $-a_{14,18}$ | | | $a_{14,21}$ | $-a_{14,22}$ | | | | | | $-a_{14,28}$ | | | |
| | | | | | | | | | | | | | | | | $a_{15,29}$ | $a_{15,30}$ | $a_{15,}$ |
| $a_{16,13}$ | $a_{16,14}$ | $a_{16,15}$ | | $a_{16,17}$ | $a_{16,18}$ | $a_{16,19}$ | $a_{16,20}$ | | | | | | | | | | | |
| | | | $-a_{17,16}$ | $a_{17,17}$ | $a_{17,18}$ | $a_{17,19}$ | $a_{17,20}$ | | | | | | | | | | | |
| | | | | $a_{18,17}$ | $a_{18,18}$ | $a_{18,19}$ | $a_{18,20}$ | | | | | | | | | | | |
| $a_{19,13}$ | $a_{19,14}$ | $a_{19,15}$ | | | | | | | | | | | | | | | | |
| $a_{21,13}$ | $a_{21,14}$ | $a_{21,15}$ | | $a_{21,17}$ | $a_{21,18}$ | $a_{21,19}$ | $a_{21,20}$ | | | | | | | | | | | |
| $a_{22,13}$ | $a_{22,14}$ | $a_{22,15}$ | | $a_{22,17}$ | $a_{22,18}$ | $a_{22,19}$ | $a_{22,20}$ | | | | | | | | | | | |
| $a_{23,13}$ | $a_{23,14}$ | $a_{23,15}$ | | $a_{23,17}$ | $a_{23,18}$ | $a_{23,19}$ | $a_{23,20}$ | | | | | | | | | | | |
| $a_{24,13}$ | $a_{24,14}$ | $a_{24,15}$ | | $a_{24,17}$ | $a_{24,18}$ | $a_{24,19}$ | $a_{24,20}$ | | | | | | | | | | | |
| $a_{25,13}$ | $a_{25,14}$ | $a_{25,15}$ | | $a_{25,17}$ | $a_{25,18}$ | | | | | | | | | | | | | |
| $a_{26,13}$ | $a_{26,14}$ | $a_{26,15}$ | | $a_{26,17}$ | $a_{26,18}$ | | | | | | | | | | | | | |
| | $a_{27,14}$ | | | | | | | | | | | | | | | | | |
| $a_{28,13}$ | $a_{28,14}$ | | | | | | | | | | | | | | | | | |
| $a_{29,13}$ | $a_{29,14}$ | $a_{29,15}$ | | | | | | | | | | | | | | | | |
| | $a_{30,14}$ | | | | | | | | | | | | | | | | | |
| $a_{31,13}$ | $a_{31,14}$ | | | | | | | | | | | | | | | | | |
| $a_{32,13}$ | $a_{32,14}$ | $a_{32,15}$ | | | | | | | | | | | | | | | | |
| | | | | | | | | $a_{33,21}$ | | | | | | | | | | |
| | | | | | | | | | $a_{34,22}$ | | | | | | | | | |
| | | | | | | | | $a_{35,21}$ | $a_{35,22}$ | | | | | | | | | |
| | | | | | | | | $a_{36,21}$ | $a_{36,22}$ | | | | | | | | | |
| | | | $a_{37,16}$ | | | | | | | | | | | | | | | |
| $a_{38,13}$ | $a_{38,14}$ | $a_{38,15}$ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | $a_{41,29}$ | $a_{41,30}$ | $a_{41}$ |
| | | | | | | | | $-a_{44,21}$ | | | | | | | | | | |
| | | | | | | | | | $-a_{45,22}$ | | | | | | | | | |
| | | | | | | | | | | | | | | | | $a_{46,29}$ | | |
| | | | | | | | | | | | | | | | | | $a_{47,30}$ | |
| | | | | | | | | | | | | | | | | | | $a_{4}$ |

## 2. LINEAR PROGRAMMING MATRIX FOR ISU-USDA MODEL]

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $a_{60,13}$ | $a_{60,14}$ | $a_{60,15}$ | $-a_{60,16}$ | $a_{60,17}$ | $a_{60,18}$ | $a_{60,19}$ | $a_{60,20}$ | $a_{60,21}$ | $a_{60,22}$ | $a_{60,23}$ | $a_{60,24}$ | $a_{60,25}$ | $a_{60,26}$ | $a_{60,27}$ | $a_{60,28}$ | $-a_{60,29}$ | $-a_{60,30}$ | $-a_{60}$ |

| Cattle II | Cattle III | Cattle IV | Continuous soybeans(O) | Continuous soybeans(R) | Capital transfer | Capital transfer II | Capital transfer III | Capital transfer IV | Capital transfer V | Capital transfer VI | Capital borrow I | Capital borrow II | Capital borrow III | Capital borrow VI | R O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_{18}$ | $P_{19}$ | $P_{20}$ | $P_{21}$ | $P_{22}$ | $P_{23}$ | $P_{24}$ | $P_{25}$ | $P_{26}$ | $P_{27}$ | $P_{28}$ | $P_{29}$ | $P_{30}$ | $P_{31}$ | $P_{32}$ | |
| $a_{01,18}$ | $a_{01,19}$ | $a_{01,20}$ | $a_{01,21}$ | $a_{01,22}$ | $a_{01,23}$ | $a_{01,24}$ | $a_{01,25}$ | $a_{01,26}$ | $a_{01,27}$ | $a_{01,28}$ | $-a_{01,29}$ | $-a_{01,30}$ | $-a_{01,31}$ | $-a_{01,32}$ | Ex post net price |
| $a_{02,18}$ | $a_{02,19}$ | $a_{02,20}$ | | | | | | | | | | | | | Labor supply |
| $a_{03,18}$ | $a_{03,19}$ | $a_{03,20}$ | | | | | | | | | | | | | |
| $a_{04,18}$ | $a_{04,19}$ | $a_{04,20}$ | $a_{04,21}$ | $a_{04,22}$ | | | | | | | | | | | |
| $a_{05,18}$ | $a_{05,19}$ | $a_{05,20}$ | $a_{05,21}$ | $a_{05,22}$ | | | | | | | | | | | |
| $a_{06,18}$ | | | $a_{06,21}$ | $a_{06,22}$ | | | | | | | | | | | |
| $a_{07,18}$ | | | $a_{07,21}$ | $a_{07,22}$ | | | | | | | | | | | |
| | | | | | $a_{08,23}$ | | | | | | $a_{08,29}$ | $-a_{08,30}$ | $-a_{08,31}$ | $-a_{08,32}$ | Capital supply year n |
| $a_{09,18}$ | $a_{09,19}$ | $a_{09,20}$ | | | $-a_{09,23}$ | $a_{09,24}$ | | | | | | | | | Capital supply |
| $a_{10,18}$ | $a_{10,19}$ | $a_{10,20}$ | | | | $-a_{10,24}$ | $a_{10,25}$ | | | | | | | | |
| $a_{11,18}$ | $a_{11,19}$ | $a_{11,20}$ | $a_{11,21}$ | $a_{11,22}$ | | | $-a_{11,25}$ | $a_{11,26}$ | | | | | | | |
| $a_{12,18}$ | $-a_{12,19}$ | $-a_{12,20}$ | $a_{12,21}$ | $a_{12,22}$ | | | | $-a_{12,26}$ | $a_{12,27}$ | | | | | | |
| $a_{13,18}$ | | | $a_{13,21}$ | $a_{13,22}$ | | | | | $-a_{13,27}$ | $a_{13,28}$ | | | | | |
| $-a_{14,18}$ | | | $a_{14,21}$ | $-a_{14,22}$ | | | | | | $-a_{14,28}$ | | | | | |
| | | | | | | | | | | | $a_{15,29}$ | $a_{15,30}$ | $a_{15,31}$ | $a_{15,32}$ | Capital supply year n + 1 |
| $a_{16,18}$ | $a_{16,19}$ | $a_{16,20}$ | | | | | | | | | | | | | Corn equiv. supply |
| $a_{17,18}$ | $a_{17,19}$ | $a_{17,20}$ | | | | | | | | | | | | | Silage supply |
| $a_{18,18}$ | $a_{18,19}$ | $a_{18,20}$ | | | | | | | | | | | | | Hay I equiv. supply |
| | | | | | | | | | | | | | | | Hay II equiv. supply |
| | | | | | | | | | | | | | | | Hay storage |
| $a_{21,18}$ | $a_{21,19}$ | $a_{21,20}$ | | | | | | | | | | | | | Growing space housing |
| $a_{22,18}$ | $a_{22,19}$ | $a_{22,20}$ | | | | | | | | | | | | | |
| $a_{23,18}$ | $a_{23,19}$ | $a_{23,20}$ | | | | | | | | | | | | | |
| $a_{24,18}$ | $a_{24,19}$ | $a_{24,20}$ | | | | | | | | | | | | | |
| $a_{25,18}$ | | | | | | | | | | | | | | | |
| $a_{26,18}$ | | | | | | | | | | | | | | | Farrowing space |
| | | | $a_{33,21}$ | | | | | | | | | | | | Land owned |
| | | | | $a_{34,22}$ | | | | | | | | | | | Land rented |
| | | | $a_{35,21}$ | $a_{35,22}$ | | | | | | | | | | | Machinery I capacity |
| | | | $a_{36,21}$ | $a_{36,22}$ | | | | | | | | | | | Machinery II capacity |
| | | | | | | | | | | | | | | | Silo capacity |
| | | | | | | | | | | | | | | | Hog management |
| | | | | | | | | | | | | | | | Government programs-O |
| | | | | | | | | | | | | | | | Government programs-R |
| | | | | | | | | | | | $a_{41,29}$ | $a_{41,30}$ | $a_{41,31}$ | $a_{41,32}$ | Capital borrow limit |
| | | | | | | | | | | | | | | | Labor hire limit |
| | | | | | | | | | | | | | | | Land acquire limit |
| | | | $-a_{44,21}$ | | | | | | | | | | | | Land retirement I |
| | | | | $-a_{45,22}$ | | | | | | | | | | | Land retirement II |
| | | | | | | | | | | | $a_{46,29}$ | | | | Capital borrowed I |
| | | | | | | | | | | | | $a_{47,30}$ | | | Capital borrowed II |
| | | | | | | | | | | | | | $a_{48,31}$ | | Capital borrowed III |
| | | | | | | | | | | | | | | $a_{49,32}$ | Capital borrowed IV |
| | | | | | | | | | | | | | | | Capital borrowed V |
| | | | | | | | | | | | | | | | Hog interyear transfer I |
| | | | | | | | | | | | | | | | Hog interyear transfer II |
| | | | | | | | | | | | | | | | Hog interyear transfer III |
| | | | | | | | | | | | | | | | Machinery I transfer |
| | | | | | | | | | | | | | | | Machinery II transfer |
| | | | | | | | | | | | | | | | Farrowing space transfer |
| | | | | | | | | | | | | | | | Growing space housing |
| 17 $a_{60,18}$ | $a_{60,19}$ | $a_{60,20}$ | $a_{60,21}$ | $a_{60,22}$ | $a_{60,23}$ | $a_{60,24}$ | $a_{60,25}$ | $a_{60,26}$ | $a_{60,27}$ | $a_{60,28}$ | $-a_{60,29}$ | $-a_{60,30}$ | $-a_{60,31}$ | $-a_{60,32}$ | Ex ante net price |

TRIX FOR ISU-USDA MODEL]

| Resource used or activity produced | | R O | Capital borrow V $P_{33}$ | Capital sell $P_{34}$ | Capital transfer VII $P_{35}$ | Labor hire full time $P_{36}$ | Labor hire part time $P_{37}$ | Land acquisitions I $P_{38}$ | Land acquisition II $P_{39}$ | Additional cap. machinery I $P_{40}$ | Additional cap. machinery II $P_{41}$ | Feed substitution I $P_{42}$ | Feed substitution II $P_{43}$ | Corn buy $P_{44}$ | Additional hay storage $P_{45}$ | A farr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ex post net price | | 01 | -a 01,33 | a 01,34 | a 01,35 | -a 01,36 | -a 01,37 | -a 01,38 | | -a 01,40 | -a 01,41 | -a 01,42 | -a 01,43 | -a 01,44 | -a 01,45 | -a |
| Labor supply | F | 02 | | | | -a 02,36 | | | | | | | | | | |
| | A | 03 | | | | -a 03,36 | | | | | | | | | | |
| | B | 04 | | | | -a 04,36 | | | | | | | | | | |
| | C | 05 | | | | -a 05,36 | -a 05,37 | | | | | | | | | |
| | D | 06 | | | | -a 06,36 | -a 06,37 | | | | | | | | | |
| | E | 07 | | | | -a 07,36 | | | | | | | | | | |
| Capital supply year n | | 08 | -a 08,33 | a 08,34 | | | | | | | | | | | | |
| Capital supply | F | 09 | | | | a 09,36 | | | | | | | | | | |
| | A | 10 | | | | a 10,36 | | | | | | | | | a 10,45 | a |
| | B | 11 | | | | a 11,36 | | | | a 11,40 | | a 11,42 | a 11,43 | a 11,44 | | |
| | C | 12 | | | | a 12,36 | a 12,37 | | | | a 12,41 | | | | | |
| | D | 13 | | | | a 13,36 | a 13,37 | | | | | | | | | |
| | E | 14 | | | a 14,35 | a 14,36 | | a 14,38 | | | | | | | | |
| Capital supply year n + 1 | | 15 | a 15,33 | -a 15,34 | -a 15,35 | | | | | | | | | | | |
| Corn equiv. supply | | 16 | | | | | | | | | | | | -a 16,44 | | |
| Silage supply | | 17 | | | | | | | | | | -a 17,42 | -a 17,43 | | | |
| Hay I equiv. supply | | 18 | | | | | | | | | | a 18,42 | | | | |
| Hay II equiv. supply | | 19 | | | | | | | | | | | a 19,43 | | | |
| Hay storage | | 20 | | | | | | | | | | | | | -a 20,45 | |
| Growing space housing | F | 21 | | | | | | | | | | | | | | |
| | A | 22 | | | | | | | | | | | | | | |
| | B | 23 | | | | | | | | | | | | | | |
| | C | 24 | | | | | | | | | | | | | | |
| | D | 25 | | | | | | | | | | | | | | |
| | E | 26 | | | | | | | | | | | | | | |
| Farrowing space | F | 27 | | | | | | | | | | | | | | -a |
| | A | 28 | | | | | | | | | | | | | | -a |
| | B | 29 | | | | | | | | | | | | | | -a |
| | C | 30 | | | | | | | | | | | | | | -a |
| | D | 31 | | | | | | | | | | | | | | -a |
| | E | 32 | | | | | | | | | | | | | | -a |
| Land owned | | 33 | | | | | | -a 33,38 | | | | | | | | |
| Land rented | | 34 | | | | | | | -a 34,39 | | | | | | | |
| Machinery I capacity | | 35 | | | | | | | | -a 35,40 | | | | | | |
| Machinery II capacity | | 36 | | | | | | | | | -a 36,41 | | | | | |
| Silo capacity | | 37 | | | | | | | | | | | | | | |
| Hog management | | 38 | | | | | | | | | | | | | | |
| Government programs-O | | 39 | | | | | | -a 39,38 | | | | | | | | |
| Government programs-R | | 40 | | | | | | | -a 40,39 | | | | | | | |
| Capital borrow limit | | 41 | a 41,33 | | | | | | | | | | | | | |
| Labor hire limit | | 42 | | | | a 42,36 | a 42,37 | | | | | | | | | |
| Land acquire limit | | 43 | | | | | | a 43,38 | a 43,39 | | | | | | | |
| Land retirement I | | 44 | | | | | | | | | | | | | | |
| Land retirement II | | 45 | | | | | | | | | | | | | | |
| Capital borrowed I | | 46 | | | | | | | | | | | | | | |
| Capital borrowed II | | 47 | | | | | | | | | | | | | | |
| Capital borrowed III | | 48 | | | | | | | | | | | | | | |
| Capital borrowed IV | | 49 | | | | | | | | | | | | | | |
| Capital borrowed V | | 50 | a 50,33 | | | | | | | | | | | | | |
| Hog interyear transfer I | | 51 | | | | | | | | | | | | | | |
| Hog interyear transfer II | | 52 | | | | | | | | | | | | | | |
| Hog interyear transfer III | | 53 | | | | | | | | | | | | | | |
| Machinery I transfer | | 54 | | | | | | | | | | | | | | |
| Machinery II transfer | | 55 | | | | | | | | | | | | | | |
| Farrowing space transfer | | 56 | | | | | | | | | | | | | | |
| Growing space housing | | 57 | | | | | | | | | | | | | | |
| Ex ante net price | | 60 | -a 60,33 | a 60,34 | a 60,35 | -a 60,36 | -a 60,37 | -a 60,38 | | -a 60,40 | -a 60,41 | -a 60,42 | -a 60,43 | -a 60,44 | -a 60,45 | -a |

| d ion II | Corn buy $P_{44}$ | Additional hay storage $P_{45}$ | Additional farrowing space $P_{46}$ | Additional growing space $P_{47}$ | Continuation hogs I $P_{48}$ | Continuation hogs II $P_{49}$ | Continuation hogs III $P_{50}$ | Capital borrow VI $P_{51}$ | Capital borrow VII $P_{52}$ | Capital borrow VIII $P_{53}$ | Capital borrow IX $P_{54}$ | Capital borrow X $P_{55}$ | Capital borrow XI $P_{56}$ | Hay I buy $P_{57}$ | Hay II buy $P_{58}$ | Transfer machinery I $P_{59}$ | Transfer machinery II $P_{60}$ | Tr farrowi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | -a 01,44 | -a 01,45 | -a 01,46 | -a 01,47 | a 01,48 | a 01,49 | a 01,50 | -a 01,51 | -a 01,52 | -a 01,53 | a 01,54 | -a 01,55 | -a 01,56 | -a 01,57 | -a 01,58 | -a 01,59 | -a 01,60 | -a 0 |
| | | | | | a 02,48 | a 02,49 | a 02,50 | | | | | | | | | | | |
| | | | | | a 03,48 | a 03,49 | a 03,50 | | | | | | | | | | | |
| | | | | | a 04,48 | a 04,49 | | | | | | | | | | | | |
| | | | | | a 09,48 | a 09,49 | a 09,50 | -a 09,51 | | | | | | | | | | |
| | | a 10,45 | a 10,46 | a 10,47 | a 10,48 | -a 10,49 | -a 10,50 | | -a 10,52 | | | | | a 10,57 | a 10,58 | | | a 1 |
| 3 | a 11,44 | | | | -a 11,48 | -a 11,49 | | | | -a 11,53 | | | | | | a 11,59 | | |
| | | | | | | | | | | | -a 12,54 | | | | | | a 12,60 | |
| | | | | | | | | | | | | -a 13,55 | | | | | | |
| | | | | | | | | | | | | | -a 14,56 | | | | | |
| | | | | | | | | a 15,51 | a 15,52 | a 15,53 | a 15,54 | a 15,55 | a 15,56 | | | | | |
| | -a 16,44 | | | | a 16,48 | a 16,49 | a 16,50 | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | -a 18,57 | | | | |
| 3 | | | | | a 19,48 | a 19,49 | a 19,50 | | | | | | | | -a 19,58 | | | |
| | | -a 20,45 | | | | | | | | | | | | | | | | |
| | | | | -a 21,47 | a 21,48 | a 21,49 | a 21,50 | | | | | | | | | | | |
| | | | | -a 22,47 | a 22,48 | a 22,49 | a 22,50 | | | | | | | | | | | |
| | | | | -a 23,47 | a 23,48 | a 23,49 | | | | | | | | | | | | |
| | | | | -a 24,47 | | | | | | | | | | | | | | |
| | | | | -a 25,47 | | | | | | | | | | | | | | |
| | | | -a 27,46 | | | | | | | | | | | | | | | -a 2 |
| | | | -a 28,46 | | | | | | | | | | | | | | | -a 2 |
| | | | -a 29,46 | | | | | | | | | | | | | | | -a 2 |
| | | | -a 30,46 | | | | | | | | | | | | | | | -a 3 |
| | | | -a 31,46 | | | | | | | | | | | | | | | -a 3 |
| | | | -a 32,46 | | | | | | | | | | | | | | | -a 3 |
| | | | | | | | | | | | | | | | | -a 35,59 | | |
| | | | | | | | | | | | | | | | | | -a 36,60 | |
| | | | | | | | | a 41,51 | a 41,52 | a 41,53 | a 41,54 | a 41,55 | a 41,56 | | | | | |
| | | | | | a 51,48 | | | | | | | | | | | | | |
| | | | | | | a 52,49 | | | | | | | | | | | | |
| | | | | | | | a 53,50 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | a 54,59 | | |
| | | | | | | | | | | | | | | | | | a 55,60 | |
| 43 | -a 60,44 | -a 60,45 | -a 60,46 | -a 60,47 | a 60,48 | a 60,49 | a 60,50 | -a 60,51 | -a 60,52 | -a 60,53 | -a 60,54 | -a 60,55 | -a 60,56 | -a 60,57 | -a 60,58 | -a 60,59 | -a 60,60 | -a |

| onal space 7 | Continuation hogs I $P_{48}$ | Continuation hogs II $P_{49}$ | Continuation hogs III $P_{50}$ | Capital borrow VI $P_{51}$ | Capital borrow VII $P_{52}$ | Capital borrow VIII $P_{53}$ | Capital borrow IX $P_{54}$ | Capital borrow X $P_{55}$ | Capital borrow XI $P_{56}$ | Hay I buy $P_{57}$ | Hay II buy $P_{58}$ | Transfer machinery I $P_{59}$ | Transfer machinery II $P_{60}$ | Transfer farrowing space $P_{61}$ | Transfer growing space $P_{62}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | $^{a}$ 01,48 | $^{a}$ 01,49 | $^{a}$ 01,50 | $^{-a}$ 01,51 | $^{-a}$ 01,52 | $^{-a}$ 01,53 | $^{-a}$ 01,54 | $^{-a}$ 01,55 | $^{-a}$ 01,56 | $^{-a}$ 01,57 | $^{-a}$ 01,58 | $^{-a}$ 01,59 | $^{-a}$ 01,60 | $^{-a}$ 01,61 | $^{-a}$ 01,62 | Ex post net price |
| | $^{a}$ 02,48 | $^{a}$ 02,49 | $^{a}$ 02,50 | | | | | | | | | | | | | Labor supply |
| | $^{a}$ 03,48 | $^{a}$ 03,49 | $^{a}$ 03,50 | | | | | | | | | | | | | |
| | $^{a}$ 04,48 | $^{a}$ 04,49 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | Capital supply year n |
| | $^{a}$ 09,48 | $^{a}$ 09,49 | $^{a}$ 09,50 | $^{-a}$ 09,51 | | | | | | | | | | | | Capital supply |
| 47 | $^{a}$ 10,48 | $^{-a}$ 10,49 | $^{-a}$ 10,50 | | $^{-a}$ 10,52 | | | | | $^{a}$ 10,57 | $^{a}$ 10,58 | | | $^{a}$ 10,61 | $^{a}$ 10,62 | |
| | $^{-a}$ 11,48 | $^{-a}$ 11,49 | | | | $^{-a}$ 11,53 | | | | | | $^{a}$ 11,59 | | | | |
| | | | | | | | $^{-a}$ 12,54 | | | | | | $^{a}$ 12,60 | | | |
| | | | | | | | | $^{-a}$ 13,55 | | | | | | | | |
| | | | | | | | | | $^{-a}$ 14,56 | | | | | | | |
| | | | | $^{a}$ 15,51 | $^{a}$ 15,52 | $^{a}$ 15,53 | $^{a}$ 15,54 | $^{a}$ 15,55 | $^{a}$ 15,56 | | | | | | | Capital supply year n + 1 |
| | $^{a}$ 16,48 | $^{a}$ 16,49 | $^{a}$ 16,50 | | | | | | | | | | | | | Corn equiv. supply |
| | | | | | | | | | | | | | | | | Silage supply |
| | | | | | | | | | | $^{-a}$ 18,57 | | | | | | Hay I equiv. supply |
| | $^{a}$ 19,48 | $^{a}$ 19,49 | $^{a}$ 19,50 | | | | | | | | $^{-a}$ 19,58 | | | | | Hay II equiv. supply |
| | | | | | | | | | | | | | | | | Hay storage |
| 47 | $^{a}$ 21,48 | $^{a}$ 21,49 | $^{a}$ 21,50 | | | | | | | | | | | | $^{-a}$ 21,62 | Growing space housing |
| 47 | $^{a}$ 22,48 | $^{a}$ 22,49 | $^{a}$ 22,50 | | | | | | | | | | | | $^{-a}$ 22,62 | |
| 47 | $^{a}$ 23,48 | $^{a}$ 23,49 | | | | | | | | | | | | | $^{-a}$ 23,62 | |
| 47 | | | | | | | | | | | | | | | $^{-a}$ 24,62 | |
| 47 | | | | | | | | | | | | | | | $^{-a}$ 25,62 | |
| | | | | | | | | | | | | | | | $^{-a}$ 26,62 | |
| | | | | | | | | | | | | | | $^{-a}$ 27,61 | | Farrowing space |
| | | | | | | | | | | | | | | $^{-a}$ 28,61 | | |
| | | | | | | | | | | | | | | $^{-a}$ 29,61 | | |
| | | | | | | | | | | | | | | $^{-a}$ 30,61 | | |
| | | | | | | | | | | | | | | $^{-a}$ 31,61 | | |
| | | | | | | | | | | | | | | $^{-a}$ 32,61 | | |
| | | | | | | | | | | | | | | | | Land owned |
| | | | | | | | | | | | | | | | | Land rented |
| | | | | | | | | | | | | $^{-a}$ 35,59 | | | | Machinery I capacity |
| | | | | | | | | | | | | | $^{-a}$ 36,60 | | | Machinery II capacity |
| | | | | | | | | | | | | | | | | Silo capacity |
| | | | | | | | | | | | | | | | | Hog management |
| | | | | | | | | | | | | | | | | Government programs-O |
| | | | | | | | | | | | | | | | | Government programs-R |
| | | | | $^{a}$ 41,51 | $^{a}$ 41,52 | $^{a}$ 41,53 | $^{a}$ 41,54 | $^{a}$ 41,55 | $^{a}$ 41,56 | | | | | | | Capital borrow limit |
| | | | | | | | | | | | | | | | | Labor hire limit |
| | | | | | | | | | | | | | | | | Land acquire limit |
| | | | | | | | | | | | | | | | | Land retirement I |
| | | | | | | | | | | | | | | | | Land retirement II |
| | | | | | | | | | | | | | | | | Capital borrowed I |
| | | | | | | | | | | | | | | | | Capital borrowed II |
| | | | | | | | | | | | | | | | | Capital borrowed III |
| | | | | | | | | | | | | | | | | Capital borrowed IV |
| | | | | | | | | | | | | | | | | Capital borrowed V |
| | $^{a}$ 51,48 | | | | | | | | | | | | | | | Hog interyear transfer I |
| | | $^{a}$ 52,49 | | | | | | | | | | | | | | Hog interyear transfer II |
| | | | $^{a}$ 53,50 | | | | | | | | | | | | | Hog interyear transfer III |
| | | | | | | | | | | | | $^{a}$ 54,59 | | | | Machinery I transfer |
| | | | | | | | | | | | | | $^{a}$ 55,60 | | | Machinery II transfer |
| | | | | | | | | | | | | | | $^{a}$ 56,61 | | Farrowing space transfer |
| | | | | | | | | | | | | | | | $^{a}$ 57,62 | Growing space housing |
| ),47 | $^{a}$ 60,48 | $^{a}$ 60,49 | $^{a}$ 60,50 | $^{-a}$ 60,51 | $^{-a}$ 60,52 | $^{-a}$ 60,53 | $^{-a}$ 60,54 | $^{-a}$ 60,55 | $^{-a}$ 60,56 | $^{-a}$ 60,57 | $^{-a}$ 60,58 | $^{-a}$ 60,59 | $^{-a}$ 60,60 | $^{-a}$ 60,61 | $^{-a}$ 60,62 | Ex ante net price |

entered at different levels for each computer solution or run of the model. The exogenous variables are:

1. $x_i^4$ —real property taxes. It is assumed that taxes on real property acquired in the course of the program are included in the cost thereof. As a simplifying assumption, real property taxes are considered as paid during the first quarter of the year after accrual.
2. $x_i^5$ —personal property taxes. Like real property taxes, it is assumed that personal property taxes are paid during the first quarter of the year after accrual. It is further assumed that personal property taxes on property purchased in the course of the program are included in the cost thereof.
3. $x_i^6$ —insurance against loss of property by insurable means, and insurance indemnifying the firm against tort liability.
4. $x_i^7$ —employee fringe benefits of a fixed cost nature, *e.g.*, health and accident plans and group term life insurance.
5. $x_i^8$ —corporation annual fees imposed by the state.
6. $x_i^9$ —debt financing charge for obligations secured by real property, including payments of principal and interest. Later calculations separate the interest and principal increments.
7. $x_i^{11}$ —new corporate investment eligible for extra first year 20 per cent depreciation deduction.
8. $x_i^{12}$ —depreciable property eligible for the double declining balance method of depreciation.
9. $x_i^{13}$ —amortizable incorporation expenditures.
10. $x_i^{14}$ —depreciation allowable on depreciable property under methods other than the double declining balance method.
11. $x_{ij}^{17}$ —annual compensation paid to the j-th shareholder.
12. $x_{ij}^{19}$ —annual rental paid for property leased to the corporation by the j-th shareholder.
13. $x_{ij}^{40}$ —the fraction of outstanding stock owned by the j-th shareholder.[57]
14. $x_{ij}^{41}$ —consumption of the j-th shareholder for the i-th year, exogenously determined.[58]
15. $x_{ij}^{47}$ —exemptions from federal income tax available to the j-th shareholder.
16. $x_{ij}^{56}$ —exemptions from state income tax available to the j-th shareholder.

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[57] In this study, most computations involving transactions concerning corporate stock are based upon fractional or decimal amounts of the aggregate and not upon numbers of shares.

[58] Consumption is treated as endogenously determined in some runs, in which case $x_{ij}^{32}$ becomes the consumption variable and $x_{ij}^{41}$ is set equal to zero.

17. $x_{ij}^{69}$ —amount of corporate stock made available for purchase by the j-th shareholder.
18. $x_i^{78}$ —amount of dividends declared by the corporation in the i-th year.[59]
19. $x_i^{79}$ —cumulative amount of dividends declared by the corporation.
20. $x_i^{81}$ —a predetermined constant based upon original aggregate stock value plus changes in value of inventory property other than that attributable to reinvestment of earnings.[60]
21. $x_i^{82}$ =1/Z where Z equals the number of shares of corporate stock issued and outstanding.
22. $x_{ij}^{83}$ —original aggregate tax basis of corporate stock held by the j-th disinvesting shareholder.
23. $x_i^{90}$ —principal amount paid on debt capital secured by real property in the i-th year.
24. $x_{ij}^{96}$ —outside income of the j-th shareholder not affected by the model.
25. $x_i^{105}$ —number of shares of corporate stock issued and outstanding.[61]
26. $x_i^{106}$ —amount of corporate stock made available by shareholder number one for purchase by other shareholders in the i-th year.
$x_{i1}^{106} = x_{i2}^{69} + x_{i3}^{69}\, x_{i4}^{69}$
27. $x_i^{117}$ —cumulative amount of principal paid on debt capital secured by real property.
28. $x_i^{119}$ —interest rates at level *a*. This is the approximate rate of interest actually paid for debt capital for production purposes in the i-th year.
29. $x_i^{120}$ —interest rates at level $\beta$. This rate is one-half of 1 per cent less than rate *a*.
30. $x_i^{121}$ —state corporation income tax rates.
31. $x_i^{122}$ —state individual income tax rate on the first 1,000 dollars of taxable income.
32. $x_i^{123}$ —federal corporate income tax rates at the lowest marginal rate.
33. $x_i^{124}$ —federal individual income tax rates at the lowest marginal increment of taxable income for husband and wife filing jointly.
34. $x_i^{125}$ —federal individual income tax rates on the next to lowest marginal increment of taxable income for husband and wife filing jointly.

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[59] Dividend declarations are endogenously determined in some computer runs.

[60] $x_i^{81}$ is net of debt secured by real property, and non real estate debt is assumed herein to be repaid each year before simulation computations commence. Therefore, $x_i^{81}$ is a net amount.

[61] It is assumed herein that the corporation has outstanding only one class of stock. Modifications in the model for multiple classes of stock could be made at the cost of additional computational complexity.

35. $x_i^{126}$ —federal individual income tax rates on the third from lowest marginal increment of taxable income for husband and wife filing jointly.
36. $x_i^{127}$ —federal individual income tax rate on the fourth from lowest marginal increment of taxable income for husband and wife filing jointly.
37. $x_{ij}^{128}$—average propensity of the j-th shareholder to consume out of current income.
38. $x_{ij}^{130}$—fraction of stock transmitted by inter vivos gift to the j-th shareholder.
39. $x_{ij}^{145}$—value of noncorporate investments of the j-th shareholder not affected by the model.
40. $x_{ij}^{146}$—amount of life insurance proceeds includible in the estate of the insured j-th shareholder for federal estate tax purposes.
41. $x_{ij}^{161}$—proportion of the j-th shareholder's property passing to the surviving spouse upon death.
42. $x_{ij}^{162}$—number of children of the j-th shareholder sharing in the nonspouse portion of j-th shareholder's property.
43. $x_{ij}^{169}$—proportion of corporate stock passing to the j-th shareholder by inheritance upon death of shareholder number one.
44. $x_{ij}^{170}$—value of property owned by the spouse of the j-th shareholder and not included in the j-th shareholder's estate.
45. $x_{ij}^{171}$—proportion of the j-th shareholder's corporate stock owned by the wife thereof.
46. $x_{ij}^{172}$—miscellaneous assets of the j-th shareholder includible in his gross estate.
47. $x_{ij}^{173}$—debts deductible from the gross estate of the j-th shareholder at death.
48. $x_{ij}^{174}$—capital available to the j-th shareholder from outside sources for investment.
49. $x_{ij}^{175}$—amount of the j-th shareholder's adjusted gross estate qualifying for the marital deduction.
50. $x_{ij}^{180}$—amounts of property receivable by the surviving spouse of the j-th shareholder as surviving joint tenant, not including amounts previously attributable to the surviving spouse by virtue of prior ownership.
51. $x_i^{181}$ —rate of individual federal income tax on the next to the lowest increment of taxable income under the Revenue Act of 1964, for husband and wife filing jointly.
52. $x_i^{182}$ —rate of individual federal income tax on the third from lowest marginal increment of taxable income under the Revenue Act of 1964, for husband and wife filing jointly.

53. $x_i^{183}$ —rate of individual federal income tax on the fourth from lowest marginal increment of taxable income under the Revenue Act of 1964, for husband and wife filing jointly.
54. $x_i^{184}$ —rate of corporate federal income tax on the second increment of income.
55. $x_{ij}^{185}$—coefficient for computing estate settlement costs to allow for surety bond costs for appropriate j.
56. $x_i^{186}$ —*ex post* price per pound of smooth sows for activity $P_{13}$.
57. $x_i^{187}$ —*ex post* price per pound of smooth sows for activity $P_{14}$.
58. $x_i^{188}$ —*ex post* price per pound of smooth sows for activity $P_{15}$.
59. $x_i^{189}$ —*ex post* price per pound of smooth sows for activities $P_{53}$ and $P_{54}$.
60. $x_{ij}^{195}$—insurance proceeds not includible in gross estate of the j-th shareholder but payable to surviving spouse.
61. $x_{ij}^{196}$—value of real estate owned by the j-th shareholder net of debt obligations thereon.

The computational structure of the simulator is divided into three divisions. Division I relates to computations applicable to both the regular and Subchapter S methods of corporate income taxation. Division II involves the computations relevant to the regular method only; Division III refers to computations unique to corporations taxed under Subchapter S of the Internal Revenue Code. Because of limitations of space, only the principal equations of Divisions I and II are included herein.[62]

*Division I.* Similarity existing between regular and Subchapter S corporations warrants joint use of a portion of the simulator. That segment of the simulation structure is given in the following formulations:

Compute allowable total depreciation for the firm, $x_i^{10}$

$$x_i^{10} = .20\, x_{i(i=6-10)}^{11} + .20\, x_{i(i=2-10)}^{12} + x_i^{13} + x_i^{14} \qquad (4)$$

Subject to $.20\, x_i^{11} \leq 2{,}000$

Compute total fixed costs for the firm, $x_i^3$

$$x_i^3 = \sum_{k=4}^{10} x_i^k \qquad (5)$$

Compute net profit of the firm,[63] $x_i^2$

$$x_i^2 = x_i^1 - x_i^3 - (x_i^{119})(10{,}000) \qquad (6)$$

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[62] For Division III of the model, see Harl, Identification and Measurement of Selected Legal-Economic Effects of the Corporate Form of Business Organization Upon a Small Closely-Held Firm 249-66 (1965), unpublished dissertation, Iowa State University Library.

[63] It is assumed that the firm has, on the average, $10,000 of uninvested capital for current transactions. The linear programming computations assume complete investment of all funds. Therefore, the interest on the assumed amount of idle funds is deducted from firm income.

Compute social security tax paid by the corporation,[64] $x_{ij}^{16}$

$$x_{ij}^{16} = 0 \quad \text{for } i = 1, 2 \tag{7a}$$

$$x_{ij}^{16} = .04x_{ij}^{17} \quad \text{for } i = 3, 4 \quad x_{ij}^{17} \leq 4200 \tag{7b}$$

$$x_{ij}^{16} = .045x_{ij}^{17} \quad \text{for } i = 5, 6 \quad x_{ij}^{17} \leq 4200 \tag{7c}$$

$$x_{ij}^{16} = .05x_{ij}^{17} \quad \text{for } i = 7 \quad x_{ij}^{17} \leq 4800 \tag{7d}$$

$$x_{ij}^{16} = .06x_{ij}^{17} \quad \text{for } i = 8, 9 \quad x_{ij}^{17} \leq 4800 \tag{7e}$$

$$x_{ij}^{16} = .0625x_{ij}^{17} \quad \text{for } i = 10 \quad x_{ij}^{17} \leq 4800 \tag{7f}$$

Obtain the current cumulative total of debt capital investment in the corporation by the j-th shareholder,[65] $x_{ij}^{21}$

$$x_{ij}^{21} = x_{(i-1)j}^{92} \tag{8}$$

Compute the interest payable to the j-th shareholder on debt capital invested in the corporation during the prior year,[66] $x_{ij}^{18}$

$$x_{ij}^{18} = (x_1^{119})(x_{ij}^{21}) \tag{9}$$

Compute the current deferred compensation fund deduction for the j-th employee-shareholder,[67] $x_{ij}^{20}$

$$x_{ij}^{20} = .15\, x_{ij}^{17} \tag{10}$$

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[64] It is assumed that the entire amount of social security tax, both the employees' and employer's share, is paid by the corporation and deducted from corporate gross income. Social security taxes paid by a corporation are deductible for income tax purposes as costs of doing business, whereas such taxes are not deductible by employees or self-employed taxpayers. I.R.C. §§ 162(a), 164(b), 3502. If a corporation pays an employee's share of social security tax, without deducting it from the employee's compensation, that amount is also deductible by the corporation but it constitutes additional compensation to the employee. Mim. 5319, 1942-1 Cum. Bull. 60; I.T. 3154, 1938-1 Cum. Bull. 113. For inclusion of the employees' share in their gross income, see formulation of $x_{ij}^{35}$.

[65] The simulator is constructed such that debt capital invested in the corporation by shareholders as creditors may either be repaid annually on the last day of the firm's fiscal year or the debt capital investment may be permitted to accumulate from year to year without necessarily having a repayment on the last day of the fiscal year. The use of the model in this study assumes annual repayment of debt capital, with $x_{ij}^{21}$, therefore, reflecting only the prior year's debt capital investment in the firm.

[66] The variable $x_{ij}^{21}$ may be negative for any j due to consumption by the shareholder's family in excess of spendable income. The corporation is not required herein to reflect loans to the shareholders in such case, inasmuch as it is assumed that the corporation is not operating under exogenous capital rationing and could borrow money at $x_1^{119}$ rate of interest for lending to shareholders, with the interest received just offsetting the interest paid. Such interest paid by the shareholders is not deductible for income tax purposes because of the assumption *infra* that each shareholder claims the standard deduction and does not itemize deductions for income tax purposes. A negative $x_{ij}^{18}$ is set equal to zero for purposes of later computations.

[67] It is assumed that a contribution of 15 per cent of compensation to employee-shareholders is paid to the deferred compensation fund by the corporation. See I.R.C. § 404(a)(3)(A). The simplifying assumption is made that computations relating to participation in the plan by nonshareholding employees are parallel to but independent of calculations herein.

Compute corporate taxable income,[68] $x_i^{15}$

$$x_i^{15} = x_i^2 - \left[ \sum_{j=1}^{m} x_{ij}^{16} + \sum_{j=1}^{m} x_{ij}^{17} + \sum_{j=1}^{m} x_{ij}^{19} + \sum_{j=1}^{m} x_{ij}^{20} \right] + x_i^{90} \quad (11)$$

Compute deferred compensation fund value for each shareholder-employee as of the i-th year,[69] $x_{ij}^{22}$

$$x_{ij}^{22} = \left(x_{(i-1)j}^{93}\right)\left(1. + x_i^{119}\right) + x_{ij}^{20} \quad (12)$$

Compute total deferred compensation fund value as of the i-th year, $x_i^{23}$

$$x_i^{23} = \sum_{j=1}^{m} x_{ij}^{22} \quad (13)$$

Compute the amount of total deferred compensation plan funds available for lending to the corporation,[70] $x_i^{24}$

$$x_i^{24} = .5\, x_i^{23} \quad (14)$$

Compute corporate net long-term capital gains income,[71] $x_i^{30}$

$$x_i^{30} = (400)[(x_i^{190})(x_i^{186}) + (2x_i^{191})(x_i^{187}) + (x_i^{192})(x_i^{188}) + (x_i^{193})(x_i^{189}) + (x_i^{194})(x_i^{189})] \quad (15)$$

*Division II.* The corporate legal framework under the regular method of income taxation is portrayed in this division of the simulator.

Obtain the amount of state corporation income tax paid in year i–1, $x_i^{29}$

$$x_i^{29} = x_{(i-1)}^{95} \quad (16)$$

Compute the federal income tax bill for the corporation in the i-th year, $x_i^{26}$

$$x_i^{26} = \left(x_i^{123}\right)\left(x_i^{15} - x_i^{29} - x_i^{30}\right) + x_i^{184}\left(x_i^{15} - x_i^{29} - x_i^{30} - 25{,}000\right) + .25x_i^{30} \quad (17)$$

Obtain the amount of federal corporate income tax paid in year i–1, $x_i^{28}$

$$x_i^{28} = x_{(i-1)}^{94} \quad (18)$$

Compute the state income tax bill for the corporation in the i-th year, $x_i^{27}$

$$x_i^{27} = \left(x_i^{121}\right)\left(x_i^{15} - x_i^{28}\right) \quad (19)$$

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[68] $x_i^{15}$ includes net long-term capital gains income.

[69] It is assumed that the deferred compensation plan provides for immediate vesting of fund contributions in the beneficiaries.

[70] It is assumed that one-half of the deferred compensation plan fund could, with adequate security given, be loaned to the firm as debt capital. The debt capital amount, transferred as $x_i^{111}$, serves as an input for debt capital borrowing activity $P_{33}$ of the i+1 year's linear programming matrix and enters the matrix at $R_{50}$. It is further assumed that such debt capital is repaid to the deferred compensation fund annually. Fund capital not invested in the corporation as debt capital is assumed to be invested outside the corporation.

[71] It is assumed that sows constitute the only asset sold that is eligible for treatment as a capital asset insofar as gains are concerned. In hog activities, sows are retained for two litters each and then are smoothed up and sold. Boars are sold before becoming eligible for treatment under I.R.C. § 1231, and losses are treated as ordinary losses. It is further assumed that sows are raised, are sold at a weight of 400 pounds, and have an income tax basis of zero.

Compute the total corporate income tax bill (federal and state) for the i-th year, $x_i^{25}$

$$x_i^{25} = x_i^{26} + x_i^{27} \tag{20}$$

For computer runs in which dividends are endogenously determined, compute the amount of dividends declared in the i-th year, $x_i^{78}$

$$x_i^{78} = .10\left(x_i^{15} - x_i^{25}\right) \tag{21a}$$

$$x_i^{78} = .40\left(x_i^{15} - x_i^{25}\right) \tag{21b}$$

For computer runs in which dividends are endogenously determined, compute the cumulative amount of dividends paid, $x_i^{79}$

$$x_i^{79} = .10\left(x_{(i-1)}^{100} + x_i^{15} - x_i^{25}\right) \tag{22a}$$

$$x_i^{79} = .40\left(x_{(i-1)}^{100} + x_i^{15} - x_i^{25}\right) \tag{22b}$$

Compute the amount of retained corporate earnings for expansion after payment of taxes, dividends, and debt capital obligations, $x_i^{34}$

$$x_i^{34} = x_i^{15} - x_i^{25} - x_i^{78} - x_i^{90} \tag{23}$$

Compute the taxable income of the j-th shareholder from exogenous sources and from the sale of corporate stock, $x_{ij}^{36}$

$$x_{ij}^{36} = x_{ij}^{96} + x_{(i-1)j}^{97} \tag{24}$$

Obtain the amount of outside debt capital investment of the j-th shareholder which is generated by the model, $x_{ij}^{37}$

$$x_{ij}^{37} = x_{(i-1)j}^{99} \tag{25}$$

Compute the total taxable income of the j-th shareholder in the i-th year,[72] $x_{ij}^{35}$

$$x_{ij}^{35} = .5\,x_{ij}^{16} + x_{ij}^{17} + x_{ij}^{18} + x_{ij}^{19} + x_{ij}^{36} + \left(x_i^{120}\right)\left(x_{ij}^{37}\right) + \left[\left(x_{ij}^{40}\right)\left(x_i^{78}\right) - 50\right] \tag{26}$$

For computer runs in which consumption by the employee-shareholders is endogenously determined, compute consumption by the j-th shareholder in the i-th year, $x_{ij}^{32}$

$$x_{ij}^{32} = \left(x_{ij}^{128}\right)\left(x_{ij}^{35}\right) \tag{27}$$

Compute deductions of the j-th shareholder for federal income tax purposes in the i-th year,[73] $x_{ij}^{48}$

$$x_{ij}^{48} = .10\,x_{ij}^{35} \Big| \text{ subject to } x_{ij}^{48} \leq 1{,}000 \tag{28}$$

Compute the amount of federal income tax paid by the j-th shareholder on income earned in the i-th year,[74] $x_{ij}^{43}$, $x_{ij}^{44}$, $x_{ij}^{45}$, $x_{ij}^{46}$, $x_{ij}^{210}$

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[72] $\left[\left(x_{ij}^{40}\right)\left(x_i^{78}\right) - 50\right] \geqq 0$ (the term computes the allowable dividend exclusion under pre-1964 tax law – see I.R.C. § 116; changes to reflect the post 1964 tax law on dividend exclusions are made in the main program for appropriate computer runs).

[73] It is assumed that each shareholder claims the standard deduction and does not itemize deductions. I.R.C. § 141.

[74] $.04\left[\left(x_i^{78}\right)\left(x_{ij}^{40}\right) - 50\right] \geqq 0$ (the term computes the dividends received credit under pre-1964 tax law – see I.R.C. § 34; changes to reflect the post 1964 tax law on the dividends received credit are made in the main program for appropriate computer runs).

$$x_{ij}^{201} = (x_i^{124})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48}) - .04[(x_i^{78})(x_{ij}^{40}) - 50] \quad (29a)$$
$$x_{ij}^{202} = (x_i^{181})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 1{,}000) \quad (29b)$$
$$x_{ij}^{203} = (x_i^{182})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 2{,}000) \quad (29c)$$
$$x_{ij}^{204} = (x_i^{183})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 3{,}000) \quad (29d)$$
$$x_{ij}^{43} = x_{ij}^{201} + x_{ij}^{202} + x_{ij}^{203} + x_{ij}^{204} \quad (29e)$$
$$x_{ij}^{44} = (x_i^{125})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 4{,}000) \quad (29f)$$
$$x_{ij}^{45} = (x_i^{126})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 8{,}000) \quad (29g)$$
$$x_{ij}^{46} = (x_i^{127})(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 12{,}000) \quad (29h)$$

The following equations were added in the computer program to handle the taxation of larger incomes:[75]

$$TEM1 = (CON5)(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 16{,}000) \quad (29i)$$
$$TEM2 = .04(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 20{,}000) \quad (29j)$$
$$TEM3 = (CON6)(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 24{,}000) \quad (29k)$$
$$TEM4 = (CON5)(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 28{,}000) \quad (29l)$$
$$TEM5 = .03(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 32{,}000) \quad (29m)$$
$$TEM6 = .03(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 36{,}000) \quad (29n)$$
$$TEM7 = .03(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 40{,}000) \quad (29o)$$
$$TEM8 = (CON7)(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 44{,}000) \quad (29p)$$
$$TEM9 = .03(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 52{,}000) \quad (29q)$$
$$TEM10 = (CON7)(x_{ij}^{35} - x_{ij}^{47} - x_{ij}^{48} - 64{,}000) \quad (29r)$$
$$x_{ij}^{210} = TEM1 + TEM2 + TEM3 + TEM4 + TEM5 + TEM6 + TEM7 + TEM8 + TEM9 + TEM10 \quad (29s)$$

Compute deductions of the j-th shareholder for state income tax purposes in the i-th year,[76] $x_{ij}^{55}$

$$x_{ij}^{55} = .05\, x_{ij}^{35} \Big\vee \text{subject to } x_{ij}^{55} \leqq 250 \quad (30)$$

Compute the state income tax paid by the j-th shareholder on income earned in the i-th year,[77] $x_{ij}^{50}$, $x_{ij}^{51}$, $x_{ij}^{52}$, $x_{ij}^{53}$, $x_{ij}^{54}$

$$x_{ij}^{50} = (x_i^{122})(x_{ij}^{35} - x_{ij}^{55} - x_{(i-1)j}^{116}) \quad (31a)$$
$$x_{ij}^{51} = (x_i^{122})(x_{ij}^{35} - x_{ij}^{55} - x_{(i-1)j}^{116} - 1{,}000) \quad (31b)$$
$$x_{ij}^{52} = (x_i^{122})(x_{ij}^{35} - x_{ij}^{55} - x_{(i-1)j}^{116} - 2{,}000) \quad (31c)$$
$$x_{ij}^{53} = (x_i^{122})(x_{ij}^{35} - x_{ij}^{55} - x_{(i-1)j}^{116} - 3{,}000) \quad (31d)$$
$$x_{ij}^{54} = (x_i^{122})(x_{ij}^{35} - x_{ij}^{55} - x_{(i-1)j}^{116} - 4{,}000) \quad (31e)$$

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[75] Limitations on computer storage capacity preclude use of additional subscripted and superscripted variables for the additional equations. Values for the variables CON5, CON6, and CON7 are provided in the FORTRAN program such that they are applicable both to the marginal rates of pre-1964 tax law and the marginal rates under the Revenue Act of 1964.

[76] It is assumed that each shareholder claims the standard deduction and does not itemize deductions.

[77] The formulation assumes a five-step marginal rate by $1,000 income increments. See IOWA CODE § 422.5 (1962).

Compute the total income tax bill of the j-th shareholder on income earned in the i-th year, $x_{ij}^{42}$

$$x_{ij}^{42} = \sum_{k=43}^{46} x_{ij}^{k} + x_{ij}^{210} + \left[ \sum_{k=50}^{54} x_{ij}^{k} - x_{ij}^{56} \right] \quad (32)$$

Compute the cumulative value of corporate earnings and profits before deducting dividends declared, $x_i^{80}$

$$x_i^{80} = x_{(i-1)}^{100} + x_i^{15} - x_i^{25} \quad (33)$$

Compute the value per share of corporate stock, $x_i^{71}$

$$x_i^{71} = x_i^{82} \left( x_i^{80} + x_i^{81} - x_i^{79} \right) \quad (34)$$

Compute the amount of new investment by the j-th shareholder in equity securities of the corporation,[78] $x_{ij}^{68}$

$$x_{ij}^{68} = \left( x_{ij}^{69} \right) \left( x_i^{71} \right) \left( x_i^{105} \right) \quad (35)$$

Compute the amount of new corporate equity capital disinvestment by the j-th shareholder in the i-th year,[79] $x_{i1}^{107}$

$$x_{i1}^{107} = \sum_{j=2}^{m} x_{ij}^{68} \quad (36)$$

$$x_{i2}^{107} = x_{i3}^{107} = x_{i4}^{107} = 0$$

Compute the portion of proceeds from the sale of corporate stock that is subject to income tax at ordinary rates,[80] $x_{ij}^{84}$

$$x_{ij}^{84} = .5 \left[ x_{ij}^{107} - \left( x_{ij}^{106} \right) \left( x_{ij}^{83} \right) \right] \quad (37)$$

Compute the portion of proceeds from the sale of corporate stock that is not subject to income tax, [81] $x_{ij}^{86}$

$$x_{ij}^{86} = x_{ij}^{107} - x_{ij}^{84} - .0004\, x_{ij}^{107} \quad (38)$$

Compute the amount of capital available for reinvestment by the j-th shareholder in debt or equity securities,[82] $x_{ij}^{67}$

$$x_{ij}^{67} = x_{ij}^{35} + x_{(i-1)j}^{98} + x_{(i-1)j}^{109} - x_{ij}^{41} - x_{ij}^{32} - x_{ij}^{42} - .5\, x_{ij}^{16} + x_{ij}^{174} + x_{ij}^{177} + \left( x_i^{119} \right) \left( x_{ij}^{21} \right) + \left[ \left( x_{ij}^{40} \right) \left( x_i^{78} \right) \right] - \left[ \left( x_{ij}^{40} \right) \left( x_i^{78} \right) - 50 \right] \quad (39)$$

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[78] If a shareholder cannot purchase the fraction of corporate stock represented by the variable $x_{ij}^{69}$ because of lack of current funds, $x_{ij}^{68}$ is permitted to reflect a purchase in any event, evidencing that the stock was purchased and immediately pledged to secure payment of the purchase price.

[79] It is assumed that only j=1 disinvests equity capital.

[80] It is assumed that gains from the sale of stock qualify for net long-term capital gains treatment in the hands of the individual vendor.

[81] The term $.0004\, x_{ij}^{107}$ represents the federal documentary stamp tax on stock transfers which is levied at the rate of 4¢ per $100 of stock value, with a maximum tax of 8¢ per share of stock. I.R.C. § 4321.

[82] The product of $(x_i^{119})\ (x_{ij}^{21})$ is to be added only if $x_{ij}^{21}$ is negative. The term, therefore, serves to reduce the j-th shareholder's capital available for reinvestment by the amount of interest paid on the amount by which consumption exceeds available income.

Compute the amount of capital available for new debt capital investment in the corporation by the j-th shareholder, [83] $x_{ij}^{70}$

$$x_{ij}^{70} = x_{ij}^{67} - x_{ij}^{68} \tag{40}$$

Compute the amount of new investment by the j-th shareholder outside the corporation,[84] $x_{ij}^{76}$

$$x_{ij}^{76} = x_{ij}^{67} - x_{ij}^{68} - x_{ij}^{70} \tag{41}$$

Compute the sum of corporate expenditures to be deducted from capital supply at the beginning of year i + 1,[85] $x_i^{129}$

$$x_i^{129} = \sum_{k=4}^{9} x_i^k + 1.32\left(x_i^{10} - x_i^{13}\right) + x_i^{13} + \sum_{j=1}^{m} x_{ij}^{16} + \sum_{j=1}^{m} x_{ij}^{17} + \sum_{j=1}^{m} x_{ij}^{20} + x_i^{25} + x_i^{78} + \left(x_i^{119}\right)(10{,}000) \tag{42}$$

Compute the current aggregate income tax basis of corporate stock held by the j-th shareholder,[86] $x_{ij}^{131}$

$$x_{i1}^{131} = x_{(i-1)1}^{139} - \left[\sum_{j=2}^{m}\left(x_{ij}^{130}\right)\left(x_{i1}^{83}\right)\right] - \left(x_{i1}^{106}\right)\left(x_{i1}^{83}\right)$$

$$x_{i2}^{131} = x_{(i-1)2}^{139} + x_{i2}^{68} + \left(x_{i2}^{130}\right)\left(x_{i1}^{83}\right) + \left(x_{i2}^{169}\right)\left(x_i^{105}\right)\left(x_i^{71}\right) \tag{43}$$

$$x_{i3}^{131} = x_{(i-1)3}^{139} + x_{i3}^{68} + \left(x_{i3}^{130}\right)\left(x_{i1}^{83}\right) + \left(x_{i3}^{169}\right)\left(x_i^{105}\right)\left(x_i^{71}\right)$$

$$x_{i4}^{131} = x_{(i-1)4}^{139} + x_{i4}^{68} + \left(x_{i4}^{130}\right)\left(x_{i1}^{83}\right) + \left(x_{i4}^{169}\right)\left(x_i^{105}\right)\left(x_i^{71}\right)$$

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[83] $x_{ij}^{70}$ may go negative and, if it does, indicates a loan from the corporation or causes a return of previous debt investment, if any, in the corporation.

[84] In accordance with economic theory of resource allocation, the value of $x_{ij}^{70}$ should be deducted only if the rate of return on investments in the corporation equals or exceeds the return on comparable external investments. The simplifying assumption is made herein, for computational purposes, that all capital made available to the corporation by shareholders will be borrowed by the corporation. It may be provided, with some modification in the model, that $x_{ij}^{76}$ could go negative, thus evidencing a loan from an outside creditor. It is assumed that the income from outside investments is net of such investment costs as brokerage fees.

[85] The value of $x_i^{129}$ is deducted from capital supply in the main program and the difference entered at $R_8$ of the i+1 year's linear programming matrix. The term $[1.32\ (x_i^{10} - x_i^{13})]$ represents the extent to which machinery and equipment acquisition costs have exceeded allowable depreciation. The term $[(x_i^{119})\ (10{,}000)]$ appears in the formulation in order to reduce the amount of capital available in year i+1 by the amount of interest on idle capital retained for current transactions.

[86] Upon death of the j-th shareholder (indicated by $x_{ij}^{169} > 0$ for any j) the following formulation obtains (assume $j = 1$ for purposes of exposition):

$$x_{ij}^{131} = \left(x_{ij}^{161}\right)(.6558)\left(x_{ij}^{40}\right)\left(x_i^{105}\right)\left(x_i^{71}\right) + (.3273)$$

$$\left[x_{(i-1)j}^{139} - \left(\sum_{j=2}^{m}\left(x_{ij}^{130}\right)\left(x_{ij}^{83}\right)\right) - \left(x_{ij}^{106}\right)\left(x_{ij}^{83}\right)\right]$$

Compute the amount of individual state income tax paid by the j-th shareholder in the i-th year, $x_{ij}^{133}$

$$x_{ij}^{133} = \sum_{k=50}^{54} x_{ij}^{k} - x_{ij}^{56} \tag{44}$$

Compute the total income tax bill for the firm and shareholders in the i-th year, $x_i^{135}$

$$x_i^{135} = \sum_{k=26}^{27} x_i^{k} + \sum_{j=1}^{m} x_{ij}^{42} \tag{45}$$

Compute the value of the j-th shareholder's equity investment in the corporation, $x_{ij}^{137}$

$$x_{ij}^{137} = \left(x_{ij}^{40}\right)\left(x_i^{105}\right)\left(x_i^{71}\right) \tag{46}$$

Compute the increase in income tax basis of corporate stock due to the death of the j-th shareholder, $x_{ij}^{141}$

$$x_{ij}^{141} = x_{ij}^{137} - x_{ij}^{131} \tag{47}$$

Compute the net worth of the j-th shareholder in the i-th year, $x_{ij}^{143}$

$$x_{ij}^{143} = x_{ij}^{137} + x_{ij}^{21} + x_{ij}^{76} + x_{ij}^{22} + x_{ij}^{145} + x_{ij}^{172} - x_{ij}^{173} \tag{48}$$

Compute the gross estate of the j-th decedent shareholder for federal estate tax purposes,[87] $x_{ij}^{147}$

$$x_{ij}^{147} = x_{ij}^{143} + x_{ij}^{146} - x_{ij}^{22} - x_{ij}^{170} - \left(x_{ij}^{171}\right)\left(x_{ij}^{137}\right) \tag{49}$$

Compute the gross estate of the j-th decedent shareholder for state inheritance tax purposes, $x_{ij}^{149}$

$$x_{ij}^{149} = x_{ij}^{143} - x_{ij}^{22} - x_{ij}^{170} - \left(x_{ij}^{171}\right)\left(x_{ij}^{137}\right) \tag{50}$$

Compute the costs of estate settlement for the j-th decedent shareholder,[88] $x_{ij}^{151}$

$$x_{ij}^{151} = 1590 + \left(x_{ij}^{185}\right)\left(x_{ij}^{149}\right) \tag{51}$$

Compute the adjusted gross estate for the j-th decedent shareholder, $x_{ij}^{153}$

$$x_{ij}^{153} = x_{ij}^{147} - x_{ij}^{151} \tag{52}$$

Compute the taxable estate of the j-th decedent shareholder, $x_{ij}^{155}$

$$x_{ij}^{155} = \left(1. - x_{ij}^{175}\right)\left(x_{ij}^{153}\right) - 60{,}000 \Big\vee \text{ subject to } x_{ij}^{175} \leqq .5 \tag{53}$$

$\wedge$

Compute the federal estate tax due (before credits) from the estate of the j-th decedent shareholder, $x_{ij}^{157}$

$$\begin{aligned} x_{ij}^{157} = {} & .03\, x_{ij}^{155} + .04\left(x_{ij}^{155} - 5{,}000\right) + .04\left(x_{ij}^{155} - 10{,}000\right) + .03 \\ & \left(x_{ij}^{155} - 20{,}000\right) + .04\left(x_{ij}^{155} - 30{,}000\right) + .04\left(x_{ij}^{155} - 40{,}000\right) + .03 \\ & \left(x_{ij}^{155} - 50{,}000\right) + .03\left(x_{ij}^{155} - 60{,}000\right) + .02\left(x_{ij}^{155} - 100{,}000\right) \end{aligned} \tag{54}$$

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[87] It is assumed that prior gifts by the j-th shareholder were not made in contemplation of death. See I.R.C. § 2035.

[88] The formula is based in part upon fixed rates of cost and is taken in part from Lampher, Problems and Implications of Intra-Family Farm Property Transfers in Grundy County, Iowa (1955), unpublished dissertation in Iowa State University Library.

Compute the federal estate tax due after allowance for credit for state inheritance and state estate taxes paid, $x_{ij}^{159}$

$$x_{ij}^{159} = x_{ij}^{157} - [.008\,(x_{ij}^{155} - 40{,}000) + .008\,(x_{ij}^{155} - 90{,}000) + .008\,(x_{ij}^{155} - 140{,}000)] \tag{55}$$

Compute state inheritance tax due from the estate of the j-th decedent shareholder for property passing to the surviving spouse and children,[89] $x_{ij}^{163}$

$$\begin{aligned} x_{ij}^{163} = {} & \Big[(.01)\,[(x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - 40{,}000] + (.01)\,[(x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - 50{,}000] + (.01)\,[(x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - 65{,}000] + (.01)\,[(x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - 90{,}000] + (.01)\,[(x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - 140{,}000]\Big] + \\ & \Big[(.01)\,[(1. - x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - (15{,}000)\,(x_{ij}^{162})] + (.01)\,[(1. - x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - (15{,}000)\,(x_{ij}^{162}) - 10{,}000] + (.01)\,[(1. - x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - (15{,}000)\,(x_{ij}^{162}) - 25{,}000] + (.01)\,[(1. - x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - (15{,}000)\,(x_{ij}^{162}) - 50{,}000] + (.01)\,[(1. - x_{ij}^{161})\,(x_{ij}^{149} - x_{ij}^{159} - x_{ij}^{151}) - (15{,}000)\,(x_{ij}^{162}) - 100{,}000]\Big] \end{aligned} \tag{56}$$

Compute the total amount of estate and inheritance taxes due from the estate of the j-th decedent shareholder, $x_{ij}^{165}$

$$x_{ij}^{165} = x_{ij}^{159} + x_{ij}^{163} \tag{57}$$

Compute corporate net worth, $x_i^{167}$

$$x_i^{167} = \sum_{j=1}^{m} x_{ji}^{137} \tag{58}$$

Compute the amount of property other than corporate stock available for distribution from the estate of the j-th decedent shareholder upon final settlement of the estate after simulated death for some j (death of shareholder number one only is simulated in this study), $x_i^{176}$

$$x_i^{176} = x_{11}^{143} - [x_{11}^{180} + x_{11}^{137} + x_{11}^{151} + x_{11}^{165}] \tag{59}$$

Compute the amount of property other than corporate stock available for distribution to the j-th shareholder from the estate of shareholder number one upon final settlement of the estate after simulated death of shareholder number one, $x_{ij}^{177}$

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[89] If $x_{ij}^{163} < .008\,(x_{ij}^{155} - 40{,}000) + .008\,(x_{ij}^{155} - 90{,}000) + .008\,(x_{ij}^{155} - 140{,}000)$ then $x_{ij}^{163}$ is to be set equal thereto. If $x_{ij}^{163}$ is greater than or equal to the quantity indicated, then $x_{ij}^{163}$ is to be taken at its computed value. This test is made to determine whether it is necessary to levy additional tax at the state level to take advantage of the full federal estate tax credit. See, *e.g.*, IOWA CODE § 451.2 (1962).

$$x_{i1}^{177} = (x_{ij}^{161})(x_i^{176}) + x_{i1}^{146} x_{i1}^{195}$$

$$x_{i2}^{177} = \frac{(1. - x_{i1}^{161})(x_i^{176})}{x_{i1}^{162}}$$

$$x_{i3}^{177} = \frac{(1. - x_{i1}^{161})(x_i^{176})}{x_{i1}^{162}} \qquad (60)$$

$$x_{i4}^{177} = \frac{(1. - x_{i1}^{161})(x_i^{176})(5)}{x_{i1}^{162}}$$

Compute the limitation on capital borrowing in i + 1,[90] $x_i^{198}$

$$x_i^{198} = .6(x_i^{167}) \qquad (61)$$

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

The model described herein has several potential applications in first and second level legal-economic research[91] and in disciplinary practice.

The formulation of the model with the simulator representing the corporate form of organization has been made operational in tests of performance of the microlegal structure in attaining specified economic objectives.[92] Tests of comparative economic efficacy of alternative forms of organization are the next step in development of the model. It is anticipated that simulator structures will be developed for the general and limited partnership, trust, and the sole proprietorship.[93] Application of the resulting models to particular fact situations would provide a set of differences in values of key variables for economic evaluation of the alternative legal forms and permit testing of hypotheses relative to the choice between organizational forms.

A further extension of the model, following logically the intensive study of individual firms, lies in formulating aggregate models of an industry or economic system. Aggregate models might be useful to provide more accurate forecasts of economic behavior or to provide demonstration data on the effects of hypothetical shifts in the legal framework. For example, the

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[90] In this study it is assumed that the debt capital may be borrowed to the extent of up to 60 per cent of corporate net worth. $x_i^{198}$ is transmitted to $R_{41}$ of the linear programming matrix for year i+1.

[91] See Harl, *Modifying Institutional-Legal Relations Among Private Parties to Facilitate Adjustments in Agriculture,* 46 J. FARM ECON. 953, 955-59 (1964).

[92] See note 41 *supra* and accompanying text. The results of ninety computer runs (forty-five for the regular method of corporate income taxation and forty-five for the Subchapter S method of corporate income taxation) are reported elsewhere. See Harl, *op. cit. supra* note 62, ch. VI.

[93] The sole proprietorship simulator could include variations such as the conventional landlord-tenant relationship, the sole proprietorship with employees, and the contractual father-son agreement.

inter- and intra-industry effects generated by the organization of farm firms into corporations of various specified sizes could be ascertained. Similarly, changes in the legal or tax structure could be examined in terms of behavior of key industry or economy variables based upon actions of each firm and interactions among firms.

At a less theoretical level, some sections of the model may, with suitable modification, be utilized in professional disciplinary practice. Thus, the portion of the simulation model representing the personal estates of owners of the firm may be adaptable for use in estate planning. At relatively low cost and extreme rapidity, a vast amount of data could be generated for professional evaluation based upon the application of alternative estate plans to a particular set of estate planning data provided by a client. Similarly, the decision-making precision as to choice of form of business organization for a client could be improved by applying, statically or dynamically, the various formulations of the model to a client's factual situation.

The ISU-USDA model may be modified to include additional elements for testing. Introduction of dynamic decision-making processes would add precision to investment activities of the firm and investment activities of the individual shareholders. Further relaxation of linear programming restraints with appropriate modification of production coefficients would provide information on growth patterns of firms' overtime. Consideration of multiple classes of corporate stock, although promising to increase computational complexity, would add an additional dimension to the model.

## COMMENTS

James K. Logan*

I enjoyed very much reading this paper. It was scholarly, well written, and had something to say, just what we have come to expect from Neil Harl. I especially enjoyed his oral presentation which I think added a great deal in supplementation of the paper.

I agree with most of what Harl said in his general commentary. He is entirely correct in his statement that there is not sufficient interdisciplinary research in the overlap between law and economics. One reason, of course, is that to make meaningful interdisciplinary contributions requires a great deal of scholarly study in both areas, including formalized education. Very few will follow his personal example and acquire both a law degree and a doctor of philosophy in economics. We will have to depend largely on two-man teams, I believe, for much of the interdisciplinary re-

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search, or upon studies which are primarily law or primarily economics but where findings in one area can be applied in the other.

In other papers, referred to in his discussion, Harl has stated that there are three levels of legal-economic research.[1] The first level involves taking relevant law already enacted or established and subjecting it to economic analysis, to examine the effects of this law in practice. I agree with him that this level is the most familiar and the easiest to utilize in interdisciplinary studies. Unquestionably, most present legal-economic research is of this level.

It seems to me that every farmer is making crude economic studies on a rough approximation basis when he decides whether he should incorporate, make a son a partner, or continue operating as a single proprietorship. The action is the same as the approximation solution of a complicated calculus problem we all make when we decide to pass an automobile in front of us when another car is coming toward us in the other lane some distance away. The aid provided by linear programming and simulation at this level is simply a more accurate and more scientific decision from the point of view of achieving economic goals.

Harl suggests a second level in which the law is considered as flexible and amenable to change, where law can be cast in the role of a dependent variable. Economic studies at this level can show how the law ought to be changed; for example, that there should or should not be an agricultural exemption from the workmen's compensation laws. I believe that in many areas the law is already flexible enough that good economic materials can influence the decision makers without new legislation. Situations where a court is asked to apply common law principles, as in the tort area, or to interpret broad statutes, as the antitrust laws, are of this sort. The traditional approach of the law is *stare decisis*, of that there is no question, and I think it is entirely proper. If a case comes before a court, the first inquiry is normally to ascertain whether a substantially identical problem has been before the courts before. If it has, there is a presumption that this case should be decided in the same fashion, unless it can be demonstrated that the earlier decision was wrong or this case should be governed by different principles. This presumption of continuity establishes the element of reliability and predictability in the law. Many civil law countries pay little

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[1] Harl, *Modifying Institutional-Legal Relations Among Private Parties to Facilitate Adjustments in Agriculture*, 46 J. FARM ECON. 953, 956-59 (1964); Harl, *The Role of Law in Achieving Policy Goals for Agricultural and Industrial Organization*, in Proceedings of a Seminar on Federal, State, and Local Laws Affecting Marketing, Research Committee (NCR-20) Number 5, North Dakota Agricultural Experiment Station Bull. 455 (1965).

heed to *stare decisis,* with the result that their legal systems are more the rule of men rather than the rule of law.

In the area of this second category, pertinent economic analysis is tremendously important and will influence the decision makers. Virtually all lawyers want and will use the economic data they can obtain in their role as representatives presenting arguments to the decision makers. One lawyer, later a famous Supreme Court Justice, used the factual brief, containing economic and other data, with such skill and persuasive effect that since we have come to refer to this kind of presentation as the "Brandeis brief."

From the time when I was law clerk for a judge of the U.S. Court of Appeals, I remember several instances where economic analysis and factual argument were extremely important in a decision that court made. For a single example, in one case the judges had to determine whether rest periods prescribed by management in a factory in Denver which manufactured neckties should be included as hours worked for purposes of the federal minimum wage law. If the rest periods were included, many employees who were working on a piece-work basis were not receiving the minimum wage. There was testimony to the effect that the employees, all women, had at first demanded the rest periods because they could not otherwise stand the long working hours. Management had reluctantly consented to optional rest periods; but when production records showed more neckties being produced in the over-all eight-hour period by the employees who took the breaks, it made two fifteen-minute rest periods compulsory. This was an accidental economic discovery, but the evidence that production was higher with the rest periods helped convince the court that the periods should be regarded as essential parts of the work day for purposes of the minimum wage law.[2] That, of course, is not a complicated economic analysis of the type that would normally be of the subject of computer programming, but it is an example of economic data which influenced the law.

This is the area where I agree that much more effective studies can be made and utilized by both disciplines. This is the level we are discussing at this conference, for the most part. It takes time to gather economic data and to formulate conclusions. Law professors and economists must anticipate possible areas of future conflict which will come before the legislatures, courts, and administrative agencies and provide studies of use to these groups. For example, we are all aware of the thousands of corporate mergers and the trend of major companies to seek broad diversification since World War II. Are these trends of benefit to society, or should the laws be changed to control or channel the development? In the agricultural

[2] Mitchell v. Greinetz, 235 F.2d 621 (10th Cir. 1956).

context we might ask whether the cooperative principle is being abused for the detriment of society, or whether cooperatives in their actual operations are realizing the hopes of the Congress, which has given them income tax advantages and antitrust exemption. If we choose good issues for legal-economic studies, we may be assured that individual lawyers arguing before courts and legislative or administrative agencies will use the studies (whenever results favor their position) to secure acceptance of the results into the law.

Neil Harl recognizes a third level of interdisciplinary relationship, and that is the effect of law on the various disciplines, including economics. I am encountering this constantly in studying the farm surplus problem. There is no doubt that government policy, expressed in laws and regulations, has profoundly affected the economic structure in agriculture. The farm problem cannot be studied without taking this into account, and it makes the task of suggesting possible solutions even more complicated. This is the most difficult of all, and I am not sure even computer programming can help greatly in handling such variables.

I cannot get excited over whether law (or economics) is a "science," except that it is important to know whether empirical research can provide basic data useful in decision making. Lawyers have not entirely neglected empirical research. A great deal of the empirical research done by lawyers alone is meaningful, unquestionably. But I enjoyed an account in the recently published autobiography of Thurman Arnold, the former head of the Antitrust Division of the Department of Justice in which he describes an empirical research study which he and Mr. Justice William O. Douglas did when they were both Yale law professors:

> [We] set up offices, engaged research assistants, and rented a Holorith Card Machine, the predecessor of the modern computer. We then proceeded to count everything that happened in courts in Connecticut. We found the exact number of demurrers and every other kind of pleading that had been filed over the course of a year. We counted the time it took to finish the cases. We learned how many cases were decided for the plaintiff and how many for the defendant. In addition, we counted everything else that we or anyone else could think of. All this information was transferred to cards with holes punched in them and run through the trusty old Holorith machine. The result was the most fascinating body of legal statistics that has been collected in this century. They had only one flaw. Nobody then and nobody yet has ever been able to think of what to do with them. They are presently enshrined in government archives awaiting the coming of the Prince who will awaken their true beauty.[3]

If we are to use linear programming and simulation, we should think out first whether we believe the effort will provide helpful data. I do not

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[3] ARNOLD, FAIR FIGHTS AND FOUL 63 (1965).

understand fully enough Harl's linear programming and simulation example: I wish I could have read his doctoral dissertation and seen his computer runs. His oral explanation did help tremendously. I am impressed by the great amount of work which he has put into it. I believe it will work at least to the extent of telling individuals which is the optimum legal form for their use, among the present possibilities. That is legal-economic research at the first level mentioned above.

Whether data can be of use at the second and third levels is more questionable. Some factors are going to be hard to put into any computer in a meaningful way. For example, in one sense the value of the shareholders' limited liability available in the corporate form of ownership is the cost of the insurance premiums which would have to be spent to protect the unincorporated firm from this loss. However, only certain kinds of losses can be protected by insurance.

My own studies of farm machinery efficiency indicate that in this area it cannot be assumed that the cost of producing 1,000 bushels of wheat will be twice the cost of 500 bushels. And if this assumption cannot be made, as Harl recognizes, it greatly complicates computer programming. I would also like to see how he has worked into the simulation process the average propensity of a particular shareholder to consume out of current income.

Obviously Harl's work is important in that tasks which we formerly thought impossible to work out because of their complexity are now manageable, by the use of computer programming. The computers can handle a much larger number of variables and produce answers infinitely faster. Even where a problem is incapable of exact solution, by simulation or game theory, computers can give approximations which tell us the directions in which to travel. Harl's paper and his work are valuable contributions to both methodology and methods of legal-economic studies.

# MEASUREMENT AND INFERENCE IN LEGAL-ECONOMIC RESEARCH

Gene Wunderlich*

". . . the application of mathematical techniques of analysis and synthesis both to legal data and to specific factual situations, should permit the development of a calculus of legal prediction that will be of considerable assistance in establishing probability statements for the determination of specific legal issues."[1]

The relationship between legal and economic research has been long[2] and generally useful. If there is a deficient aspect of this interdisciplinary activity, it is in quantification. A likely source of this deficiency is an inadequate appreciation of differences in the methods of law and economics and of the strengths and limitations of analytical techniques.

In the past, the discourse on legal-economic research was virtually limited to the philosophical issues of inquiry,[3] with relatively little attention being given to specific problems of measurement. Recently, more efforts are being made to apply quantitative methods to jurisprudential problems.[4] These efforts, combined with the storehouse of available methods in social science, provide an ample foundation for measurement approaches to legal-economic research. In this paper we will review methodological foundations, but will concentrate on descriptions, applications, and potentials of the more common statistical techniques.

## JURIMETRICS, LOGIC, AND MEASUREMENT

Obviously, a complete exposition of statistical theory and methods is beyond the scope and purpose of this discussion. Many excellent texts in

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[1] Loevinger, *Jurimetrics: Science and Prediction in the Field of Law*, 46 MINN. L. REV. 255 (1961).

[2] For perspective, with emphasis on resource economics, see: Harris, *Introduction;* Chryst, *Some General Considerations of the Theoretical Foundations of Legal-Economic Research;* and Timmons, *Methodological Problems in Legal-Economic Research,* in LEGAL-ECONOMIC RESEARCH, Agric. Law Center Mono. No. 1 (1959).

[3] Cook, *Scientific Method and the Law,* 13 A.B.A.J. 303 (1927); Timmons, *Integration of Law and Economics in Analyzing Agricultural Law Use Problems,* 37 J FARM ECONOMICS, 1126 (1955); Harris, *Legal-Economic Interdisciplinary Research,* 10 J. LEGAL ED. 452 (1958).

[4] Two overviews of jurimetrics containing measurement efforts are contained in: 27 LAW & CONTEMP. PROB. (1963) and 33 GEORGE WASHINGTON L. REV. (1964). Both of these volumes contain extensive references.

statistics and statistical inference are available, and the researcher should use these tools as the need demands.[5]

We are more concerned with the basic notions of measurement and statistical inference than with an enumeration of techniques and computational procedures. In general, the choice of a research method, such as the statistical method, or an analytical technique such as linear regression, is directly related to the *way* in which one thinks about a problem. When we make a generalization about human behavior, as in a "legal relationship," we can assume it to be invariant or deterministic, or we can assume that it is probabilistic, that is, that a certain likelihood attaches to a relationship among two or more events or things. Arthur L. Corbin[6], discussing "Legal Analysis and Terminology," refers to a "legal relation" as "a rule concerning human conduct, established by those agents of an organized society who have legislative power." He goes on to say, "When a rule of law has been reduced to words, it is a statement of the legal effect of operative facts." In such a statement, we simply have a logical relation of "If A, then B," and our research consists of verifying the logical consistency and confirming that A does exist. But then Corbin continues ". . . i.e., it is a statement that certain facts will *normally* be followed by certain immediate or remote consequences in the form of action or nonaction by the judicial and executive agents of society." I stressed "normally" to emphasize that the consequence, B, does not *always* occur. Our research thus might be directed at an estimate of the *probability* that B will occur. We might, for example, test the statement "If A, then B," by seeing whether B in the presence of A occurs more frequently than by chance, i.e., in the presence of "A" and "not A" combined.

Whether we follow a legal research method of searching recorded cases and building a case on analogy or searching statutes and codes to see if an event can be classified by one provision or another, or whether we follow traditional social science methods of empirically verifying or rejecting hypotheses which stem from a general model of behavior depends upon the question asked. One question suggesting a complex chain of legal research and reasoning is: "Is he or is he not guilty of a misdemeanor?" An-

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[5] For an elementary, but thorough, text CROXTON & COWDEN, APPLIED GENERAL STATISTICS (1955) is recommended. For a basic understanding of statistical inference, WALKER & LEV, STATISTICAL INFERENCE (1953) is recommended. A forthcoming volume by the Interregional Land Economics Research Committee, Methods for Land Economics Research, will be available later in 1966.

Much of the basic statistics upon which this paper relies can be found in OSTLE, STATISTICS IN RESEARCH (1963); TORGERSON, THEORY AND METHODS OF SCALING (1965); SIEGEL, NONPARAMETRIC STATISTICS (1956); and HARMAN, MODERN FACTOR ANALYSIS (1960).

[6] In FRYER & BENSON, CASES ON LEGAL METHOD, 615 (1949). Also in HENSEN, LANDMARKS OF LAW, (1960).

other question implying an economic theory and some specific quantitative procedure is: "What is the relation between age and income in areas of slow economic growth?" The methods depend upon the question, and the difference in legal and economic methods depends upon the way questions are asked in each of the disciplines.

Similarly, the choice of a statistical technique (assuming we wish to state and answer our questions within the statistical method) depends upon the question asked. Use of such techniques as regression, analysis of variance, rank correlation, and factor analysis will depend upon the form of question asked and the degree of accuracy required, both of which may be related to data available.[7]

Legal-economic research in this Chapter is limited to that part of jurimetrics[8] which Loevinger called ". . . a calculus of legal prediction . . . establishing probability statements for the determination of specific legal issues."[9] We are concerned with the procedures for making valid inferences about how the behavior of persons is affected by law. Emphasis is on quantification of legal-economic relationships.

> ". . . jurisprudence is primarily an undertaking of rationalism; jurimetrics is an effort to utilize the methods of science in the field of law. The conclusions of jurisprudence are merely debatable; the conclusions of jurimetrics are testable. Jurisprudence cogitates essence and ends and values. Jurimetrics investigates methods of inquiry."[10]

Both economics and law have some, but not all, of their roots in logic. Statistical method is viewed here simply as an extension of logic.[11]

Both law and economics rely upon systems of propositions (theories) which are constructed on logical bases. The theories of law[12] and econom-

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[7] The effect of data on method is treated by Strohbehn in a preceding Chapter.

[8] Allen, The American Association of American Law Schools Jurimetrics Committee Report on Scientific Investigation of Legal Problems, 7 ST. LOUIS L. REV. 39 (1962), included in jurimetrics: programmed learning, symbolic logic, information retrieval, semantics, quantitative methods, and other developments of science for law.

[9] Loevinger, *Jurimetrics, supra* note 1.

[10] See Loevinger, *Jerimetrics: The Methodology of Legal Inquiry*, 28 LAW & CONTEMP. PROB. 8 (1963).

[11] The direct application of logic such as that by Allen, Allen and Caldwell, Kort and others, extends beyond the scope of this paper, but is suggestive for other aspects of legal-economic research. See, for example, Allen, *Symbolic Logic: A Razor-Edged Tool for Drafting and Interpreting Legal Documents*, 66 YALE L. REV. 834 (1957), Allen and Caldwell, *Modern Logic and Judicial Decision Making*, 28 LAW & CONTEMP. PROB. 213 (1963); Kort, *Simultaneous Equations and Boolean Algebra in the Analysis of Judicial Decisions*, 28 LAW & CONTEMP. PROB. 143 (1963).

[12] "Close verbal analysis of judicial decisions, statutes, and similar materials have for almost a century formed the stuff of legal scholarship. . . . This method depends on conventional logic and resort to analogy supplemented by the 'artificial reason of law,' that is, understanding of its technical vocabulary and conventions." Brown, *Legal Research: The Resource Base and the Traditional Approaches*, 7 AM. BEHAVIORAL SCI. 6 (1963).

ics, however, rest upon the assumption that the propositions are known in relation to the "real world." Statistics as a method of inquiry is a scheme for inferring relationships in the face of incomplete knowledge.

*Logic*

A study of the relationships between logic and probability statements helps to weld the frame of law and economics to the body of statistics.[13] Interdisciplinary research in law, economics, and statistics will be on a firmer base if it is carried back to some fundamental common grounds. One of the common grounds is formal logic. Suppose we illustrate the logic form with a simplified legal relation of adverse possession. Out of a universe of legal relations, illustrated as the rectangle in Figure 1, are two events A and B. A is occupation of parcel of land. B is an open and notorious declaration to possess. A without B is not adverse possession. B without A is not adverse possession. Without either A or B adverse possession does not exist. Only the area AB, called the product of A and B, meets the criteria of adverse possession.

Two other logical relationships, shown by Figures 2 and 3, also have legal significance. Figure 2 simply states that A is identical to B; for example, a lawyer attempts to prove that property damage A and property damage B are the same, from the relevant legal criteria, so that a judgment that had been accorded to A is a basis for judgment to B. Figure 3 states that B is entirely included in A; for example, all theft (B) involves taking of a property (A), but not all taking of property involves theft.[14]

Much of the practice and research of law is based on such logical relationships. These logical relationships also are the foundation of economic theory and statistical method. The logic of probability that underlies statistics can follow directly from the same logic illustrated with legal terms above.

*The Sample*

The heart of statistics is the "sample."[15] The "sample" is a representation of the population of which it is a part. In order for us to treat sample information within the same logical structure as we would an entire population, we must assume certain relationships between the sample and the

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[13] A more extensive, formal, and rigorous exposition is contained in Chapters 1-3 of Ostle, *op. cit. supra* note 5.

[14] From the standpoint of legal analysis, the direct applications of the logical relationships in Figures 1, 2, and 3 are rather trivial. The actual process of legal decision rests on establishing the truth of the premises not the correctness of very simple logical relations. The purpose of these illustrations is merely to suggest one set of common roots among law, economics, and probability, not to demonstrate a research technique.

[15] Fels, *Some Statistical Methods for Lawyers*, MULL 9 (March 1963), discusses the sample concept at length from an intuitive viewpoint.

entire population. For our purposes, this set of assumptions can be called "representativeness." A sample is representative if the probability of a characteristic appearing in the sample is the same as the probability of the characteristic appearing in the study universe (sometimes called the population).

Figure 1.

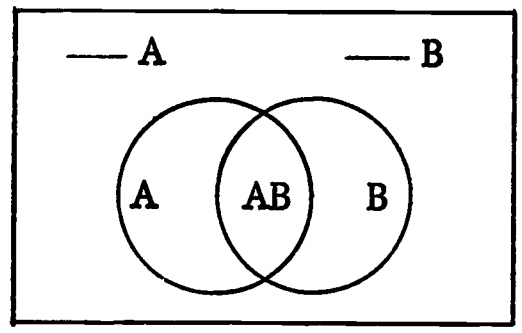



Figure 2.

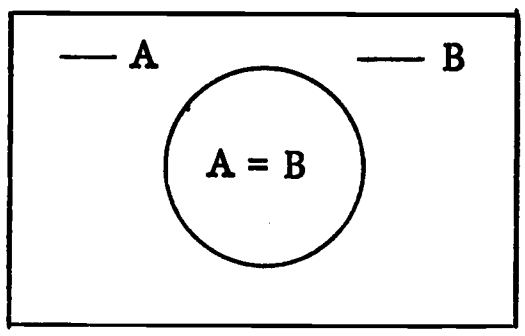
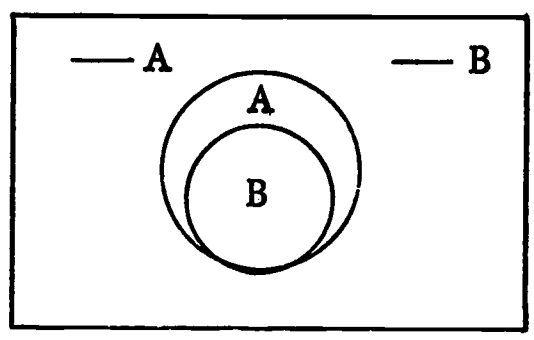



Figure 3.




The study universe is the total of all observations possible, that is, the phenomena about which inferences are to be made. For example, a study universe might be defined as all ownership tracts in a state, and shown by the rectangle in Figure 2.

If the number of ownership tracts, N, is defined as the number of owners (that is, tract = all land owned by one person), the probability of a tract being held by specified class of owner, A, is simply the ratio of the number, n, of class A owners to all owners, N, or $P(A) = n/N$. Graphically, the probability, P, of any point falling within A of Figure 2 is the ratio of the area A to the rectangle in which it is located. If one drew a random sample of owners in the state, one would assume a proportion of n/N class A owners in the sample. This assumption is equivalent to saying the sample is unbiased.

*Probability*

The bulk of statistical problems in social science deal not only with sampling from a universe, but also with the relationship among variables,

and many of the questions of quantification pertain to whether the observation of variables together can be accounted for by chance.

The probability of either of two characteristics A or B occurring in a study universe is simply the sum of the probability of A and B less their joint occurrence AB. Formally,[16] $P(A \cup B) = P(A) + P(B) - P(AB)$ with $0 < P \leq 1$. When there is no chance of both occurring, $P(A \cup B)$ becomes simply $P(A) + P(B)$.

The probability of a characteristic B occurring, knowing another characteristic, A, has occurred, is defined as:

$$P(B|A) = P(AB) / P(A)$$

Similarly for $P(A|B)$.

Thus, the joint probability of A and B, in terms of conditional probability for both B and A, is:

$$P(AB) = P(A) \cdot P(B|A) = P(B) \cdot P(A|B)$$

Characteristics A and B are said to be statistically independent if $P(A|B) = P(A)$ and $P(B|A) = P(B)$; that is to say, the occurrence of B adds nothing to the likelihood of A and vice versa. Then $P(AB) = P(A) \cdot P(B)$. In Figure 1, A and B would not overlap.

Thus, we have suggested that (1) law, economics, and statistics have common bases in logic,[17] and (2) law, economics, and statistics can be combined to yield useful research results. However, the relationship among law, economics, and statistics would more closely resemble that of Figure 1 than Figures 2 or 3, and little is to be gained by claiming more for an area of interdisciplinary research than can be followed up with results. Because so little quantification of legal-economic relationships has been attempted, more than the usual amount of each research effort should be devoted to a review of fundamental propositions and assumptions of measurement, interdependence, prediction, and inference.

## ESTIMATION AND INTERDEPENDENCY

We are accustomed to make statements (theories) about whole classes of situations and things on the basis of experience with only a fraction (sample) of the units comprising the situations or things. A *parameter* is a measure of a characteristic of the class of phenomena. It is the measure (usually unknown) of the whole study universe. The average acreage of land owned by all owners in the United States is a parameter which is

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[16] The symbol "U" means union, or combination of (A and B in this case). The symbol "$<$" means "less than," and "$\leq$" can be read "less than or equal to." The expression "B|A" can be read "B, knowing A exists." The oblique slash / is simply a sign for division, e.g., ratio of P(AB) to P(A).

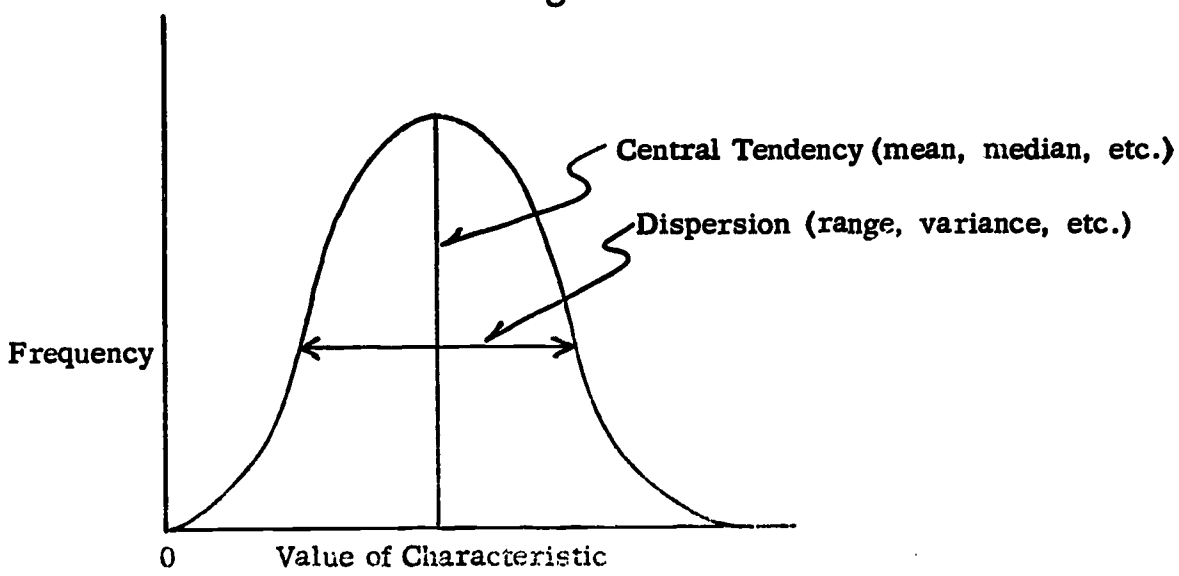
[17] Koopman, *The Bases of Probability*, 46 BULL. AM. MATH. SOC. 763 (1940), reprinted in KYBURG & SMOKLER, STUDIES IN SUBJECTIVE PROBABILITY (1964) is recommended for readers facile in symbolic logic.

unknown but presumably exists. Statements about the parameter are inferred from statistics, which are calculated from a *sample*. An unbiased sample of less than 1 per cent of all owners, for example, would probably tell us, accurately enough, what we would need to know about land ownership to make good decisions on laws regulating transfer.

When we attempt to characterize a class of things, we seek to simplify by using terms such as hard, poor, warm, wide, opaque, or tall. These expressions suggest some norm or standard from which we can measure. These expressions also suggest some variation among elements of a class. These norms and deviations are the meat of statistics.

The very idea of a class such as A and B suggests some boundaries around sets of elements or units which are enough *alike* to fall in the same class. If we wish to characterize the size of farms, we might exclude all plots on Manhattan island, all plots on elevations over 15,000 feet, and all plots under one-half acre. From the remaining units we could then divide acres into size classes and count the number of units in each class, thus yielding a *frequency distribution* (see Figure 4). This frequency distribution is a good, but cumbersome, way of describing size of farm.

Figure 4.




Another way of describing farm size is referring to the middle of the frequency distribution. But what is the middle? Midpoint from highest to lowest? Most frequent size? We are most accustomed to think of the *arithmetic mean* as the best middle, i.e., the total value of a characteristic of the members divided by the number of members. The *mean* is the most common measure of central value.

The dispersion or spread around the mean could be expressed as a *range* (highest value and lowest value) but is somewhat more completely de-

scribed by the *variance*. Variance is an average deviation around the mean, calculated by squaring the deviations to eliminate minuses. The *standard deviation*, another common measure of dispersion, is merely the square root of the variance. Statistics such as the mean, variance, and standard deviation are used to estimate their counterpart values, that is, parameters, in the study universe.

Because we generally do not know the parameters of a universe (if we did, there would be small reason to estimate it from a sample), we *assume* that the universe distribution takes a given mathematical form. The statistical tests involving regression, correlation, and analysis of variance assume, for example, that the characteristic being estimated is "normally" distributed[18] in the study universe. Especially in legal-economic relationships where quantitative knowledge about the universe is rather scanty, assumptions about the universe should be made cautiously.

The relation between two or more variables is the heart of legal-economic research. The degree of association between a given contract provision and the duration of the contractual relationship, for example, could be important information to a lawyer. The ability to predict with inexpensive data the quantity of a variable on which data were expensive to obtain could mean important savings to managers or researchers.

The form of the relationship between variables, and thus the statistical technique designed to test the hypothesis, depends upon the way the question in an analysis is asked. Examples of different types of questions (and possible techniques) are: "What change in Y can be predicted from a change in X?" (regression). "How closely do changes in the value of $X_1$ and $X_2$ correspond?" (correlation). "Are A and B in the same class or different classes?" (analysis of variance). "Do attributes of A correspond to attributes of B?" (Chi-square).

Some of these relationships among variables will be discussed in terms of a few of the families of statistical techniques.

## REGRESSION AND CORRELATION

Many analyses involve the relationship between two or more variables. Theories or models of economic behavior are often expressed in terms of changes in the quantity of one variable associated with changes in another variable. Theories of legal behavior also can express the relation of variables, although not always quantitatively; for example, a legal theory[19]

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[18] A "normal distribution" is bell-shaped, symmetrical, and follows a particular mathematical form.

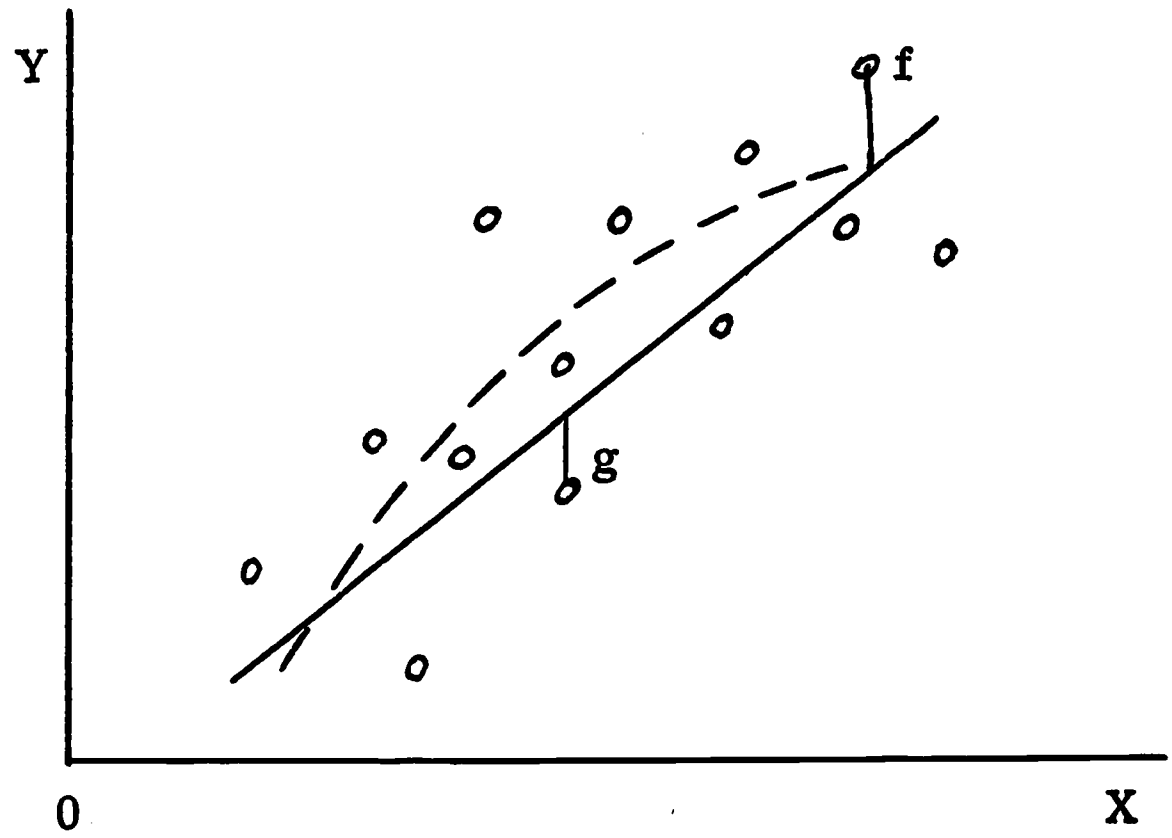
[19] Hohfeld's systematic partition of legal relationships were applied in the A.L.I. RESTATEMENT, PROPERTY (1936). See especially vol. 1. Hohfeld's basic concepts are contained in HOHFELD, FUNDAMENTAL LEGAL CONCEPTIONS (1919) (Yale paperbound 1964).

might describe or predict certain relationships among rights, duties, liabilities, and so on. Regression techniques permit us to express the form (direction and amount of changes) of the relationship between a dependent (predicted) variable, Y, and an independent (predictor) variable, X. Correlation permits us to express the closeness with which Y and X move together.

*Regression*

Regression techniques of varying complexity are often used to "predict" the outcome of some observed condition or state. This does not necessarily imply forecast, although regression is sometimes so used. If one wishes to predict the price, Y, of a product by withholding amount, X, of the product for the market, he is assuming, explicitly or implicitly, some *functional* relationship between Y and X. If one wishes to predict Y prosecutions from X number of trespasses, he is assuming some *functional* relationship between legal actions and property violations. If one predicts Y tax actions from the Internal Revenue Service as a consequence of recommending a particular reporting procedure to X clients, he is assuming some *functional* relationship between reporting procedure and tax actions. As

Figure 5.



machines eliminate human caprice, perhaps these predictions can become more accurate.

Statisticians often feel some compunction on the subject of prediction and place a warning label on functional relationships such as the following:

> Just because a particular functional relationship has been assumed and a specific computational procedure followed, do not assume that a causal relationship exists among the variables.[20]

In fact the analyst of a legal-economic problem *will* often build his model with a cause-effect relationship in mind. As Blalock[21] reminds us, cause-effect cannot be demonstrated directly, but it can be a useful way of thinking about relationships. For purposes of understanding functional relationship in regression, worry about cause-effect seems unnecessary and would not have been mentioned except for the frequency with which discussion on this subject appears.

For an actual analysis of presumed functional relationship between X and Y, the values of Y and X can be plotted on graph paper to produce a scatter diagram. Figure 5 portrays a relationship, for example, that as the number of words in a contract, X, increases, the number of ambiguities, Y, increases. This relationship might correspond to the theory that short, symbolically constructed contracts contain fewer ambiguities. We could as well theorize the reverse relationship, but the scatter diagram shows that as X increases so does Y. So the scatter diagram helps to develop a theory or model as well as to test a model.

But suppose we want to state the relationship between X and Y more precisely. If we draw a line such that it minimizes the distances between the observations (the f and g of Figure 5) and the regression line, we are "fitting a curve" (or straight line) to the data. This line (or curve as shown by the broken line) becomes our best estimate of the relationship between words in contracts and ambiguities in contractual relationships.

But a value of Y cannot always be best predicted by a single value of X. *Multiple regression* models permit us to say how much of Y is due to $X_1$, $X_2$, and so on. Munger[22] in a study of nonagricultural land values in Northern Wisconsin used seven independent variables to predict open country values and nine independent variables to predict values of lake-shore properties. He was faced with interesting problems of including attribute data, (that is, has only value of 1 or 0) and observations involving

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[20] Ostle, *op. cit. supra* note 5, at 160. This type of statement seems to assume that cause-effect does exist—some doubts about this assumption are contained in the last section.

[21] BLALOCK, CAUSAL INFERENCES IN NONEXPERIMENTAL RESEARCH (1961).

[22] Munger, *Components of Rural Land Values in Northern Wisconsin,* 40 LAND ECON. 86-91 (1964).



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judgment evaluations. Maier, Hedrick, and Gibson[23] estimated the value of tobacco allotments, using in one stage or another of their analysis ten variables (four of them attributes) and compared a number of different models. Bailey, Muth, and Nourse used regression to analyze aggregative aspects of the land value problem.[24] Back and Tarver[25] demonstrated that non-economic factors were more important than economic factors in predicting changes in personal income, 1940-50. In their model they divided predictor variables into eight population (age, education, race, and so on) variables and six economic (government payment, unemployment, and so on) variables.

*Correlation*

The function of Y to X is only one dimension of their relationship. The variation that appears in values of one variable, given the other, describes the closeness of their association. The measure of this association (correlation) shows how closely the observations conform to a postulated functional relationship (line or curve). Harris and Hines[26], in their study of land contracts in Iowa, made extensive use of simple correlation coefficients to show the relation of several financial, personal, and contractual variables. Their analysis was limited to the array of simple correlation coefficients, so no accounting for the collective degree of association was used. Their variables included a scale for general quality of the contract.

Regression and correlation are highly developed statistical techniques, liberally used in the social sciences, and particularly useful in economics. One of the reasons for the successful application of regression techniques in economics has been a concurrent development of static firm theory whose models were directly translatable into the regression model. Another important reason for the successful use of regression in economics is the convenient value scale—money—with which many important variables can be expressed.[27] Both of these advantages are lacking in several aspects of legal-economic research. Much more effort is needed in developing theory, and much more effort is needed in specifying and meas-

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[23] Maier, Hedrick, and Gibson, *The Sale Value of Flue-Cured Tobacco Allotments*, (Va. Polytechnic Institute Bull. 148) (1960).

[24] Bailey, Muth, & Nourse, *A Regression Method for Real Estate Price Index Construction*, 58 JOUR. AM. STAT. ASS'N. 933 (1963).

[25] Back & Tarver, *Interedependence of Population and Economic Variables in Personal Incomes*, 40 SW SOC. SCI. QUART. 22-32 (1959). Back and Tarver present an excellent discussion of methodology pertinent to regression analysis.

[26] HARRIS & HINES, INSTALLMENT LAND CONTRACTS IN IOWA, AGRIC. LAW CENTER MONO. No. 5 (1965).

[27] Perhaps put a bit more cynically, variables which could not be expressed in money were not important. As Joan Robinson said, "the economists' preference for money is like the tanners' preference for leather." ECONOMIC PHILOSOPHY (1962).

uring the critical variables before legal-economic research can make extensive use of relatively sophisticated tools such as regression. Harl[28] used the functional form to discuss the integration of law, economics, and other variables. The functional relationship that is the basis of regression is a useful expository device, but it will have little scientific value until variables are isolated and refined. Legal-economic research currently should aspire to regression rather than use it.

## CLASSIFICATION AND MEASUREMENT: FACTORS AND SCALES

Two critical problems facing the researcher who wishes to quantify legal-economic relationships are (1) the reduction of extremely complex situations to a few simple relations so that a general theory or model can be stated, and (2) the expression of legal-economic variables in terms of scales or measures that can be manipulated mathematically. These two problems can be addressed as two topics: (1) classification, within which techniques such as analysis of variance (Anova) and factor analysis can be included and (2) measurement, within which the features of various scales can be discussed.

### *Classification*

Because the universe of phenomena we experience appears infinitely varied and complex, we seek to "understand" it by grouping experiences into "things different" and "things alike." Similarly, in an analysis, we seek to develop a model or theory which permits us to explain the relationship among classes of variables sufficiently well to satisfy ourselves that we understand it. Before any model or theory of behavior is expressed, then, the researcher must be satisfied that the groups of things or situations being observed are classified in some relevant, meaningful way. Some classifications are ready made, that is, we accept them without much question: For example, the *Index of Legal Periodicals* or the *Index of Economic Journals* provide classes of written articles. The Bill of Rights or the Ten Commandments rest on a classification of human conduct. Traffic rules, property laws, and financial transactions fit specific acts or situations into classes of behavior. Other classes must be built, that is, we cannot, or choose not to, view things or situations through a lattice of common usage. Many problems in legal-economic research will involve the building or establishment of classes.

A *class* is defined by members who possess the requisite characteristic. Landowners, for example, could be defined as those persons whose names

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[28] Harl, *Modifying Institutional-Legal Relations Among Private Parties to Facilitate Agricultural Adjustments*, 46 JOUR. FARM ECONOMICS 953 (1964).

appear on land titles as "owner." This idea of a class depends on a "concept" as a set of properties which can be applied to determine whether one qualifies as a member of a class.[29] A subclass is a class entirely included in another class. For example, in Figure 3, B is entirely included in A, that is, all the members of B are also members of A. In Figure 2 the members of A are included in B *and* the members of B are included in A. But the A and B of Figure 1 have a different membership, even though some members are found in both.

We can use these ideas of classes—translated rather freely—in terms of two quantitative techniques, analysis of variance and factor analysis. If classes have been given or specified (concepts have been predetermined), we can simply group our observations, then test statistically with an analysis of variance whether these groups differ. If we cannot describe a class, we can use factor analysis to collect several measures of characteristics and derive the concepts (factors) which define a class.

*Analysis of variance*[30] tests whether the variation among classes of observations is greater than for the same observations unclassified. Stated alternatively, are the differences among classes more than could be accounted for by chance? Analysis of variance tests the differences among the averages (means) of two or more classes. The test is based on the fact that if the means of classes differ greatly, the variance of groups combined is much larger than the variances of the separate groups, resulting in a larger F ratio. An illustration of the use of analysis of variance to test differences among several classes of vertical integration contracts can be found in the December, 1964, issue of MULL.[31] In that article I also used a multiple means test to determine which classes accounted for most of the variation. The multiple means test extends the use of analysis of variance by not only specifying whether the groups differ by more than can be accounted for by chance, but by specifying which of the groups account for most of the variation.

*Factor analysis* is a family of techniques which may be of value to legal-economic research. The principal function of factor analysis appears to be in defining the variables of research. Faced with very complex relationships such as found in contracts, liabilities, estates, agencies, tenancy, governments, and ordinances, the researcher may first want to define the rele-

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[29] "A class, then, may be defined as the extension [range of applicability] of a concept." LANGER, AN INTRODUCTION TO SYMBOLIC LOGIC 130 (1953). For diagrammetric treatment of logical relations of classes, see also LANGER, A SURVEY OF SYMBOLIC LOGIC, 173-84 (1960).

[30] DIXON & MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS (1957) contains a section on the several forms of analysis of variance.

[31] Wunderlich, *Measurement of Legal-Economic Content of Vertical Integration Contracts in Agriculture,* MULL 121 (Dec. 1964).

vant or crucial variables with minimum recourse to *a priori* notions, hunches, or models. Factor analysis permits the combination of a large number of variables into a minimum of classes needed to classify a situation or relationship. From the standpoint of the methodology of legal-economic research, this technique is nearer to an inductive approach than the other statistical techniques.

The origins of factor analysis theory extend back to the beginning of this century, but most of the development took place during and since the 1930's.[32] The technique has been most closely associated with psychological research, and many of the early advances are attributed to L. L. Thurstone[33] who, incidentally, has contributed much to the specification and measurement of utility.

Relationships, situations, or things which must be described with many attributes are complex. Science is antipathetic to complexity.[34] Factor analysis is a quantitative technique for reducing complexity.

Complexity can be defined in terms of dimensions, for example, the volume of a cube can be described completely with three dimensions. If our imagination will permit dimensions to run in any direction—plus or minus—we have vectors. These vectors, labeled and positioned, are the factors generated by factor analysis.

Collar circumference and sleeve length may be enough factors to specify the size of a ready-made shirt, but how many factors are needed to describe the "size" of a lease? In a legal-economic analysis, as with a shirt, the requirements of fit are what eventually determine the number of factors. If we can tolerate some error, we can be satisfied with few factors. If we insist on explaining every minute contour of the legal or economic relationships involved (or both), we must pay the price of a large number of variables.

Factor analysis can be described by reference to Figure 1. Let us assume that a movement in B depends upon the grip, AB, that A has on B. The firmer the grip, the more likely we could predict (explain) B's movements by observing A. In the extreme of Figure 2, we could say that a movement of A is equivalent to a movement of B, and so we would need to speak only about A (B is just an alias). If C, D, and E were equivalent to B in Figure 2, then any of the five dimensions could explain the other four. In terms of an earlier discussion, if one dimension is highly correlated with another dimension, only one is needed. "Factors" are groups of highly correlated dimensions.

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[32] A chapter on *Structural Applications*, in MILLER, MATHEMATICS AND PSYCHOLOGY (1964) contains history and perspective of factor analysis as well as a reprint of Thurstone's 1931 article in PSYCHOLOGICAL REVIEW.

[33] THURSTONE, VECTORS OF THE MIND (1935).

[34] Feuer, *The Principle of Simplicity*, 24 PHILOS. OF SCI. 109-122 (April 1957).

The computational routine of factor analysis begins with all dimensions (variables) correlated with all others. This matrix of everything correlated against everything else is manipulated mathematically (and graphically as in the centroid method) until the fewest dimensions (factors) possible remain. These dimensions are then rotated so that the variability of observations around the factors is evenly distributed.

Literature abounds with illustrations of the use of factor analysis in relation to psychological research,[35] but uses in legal-economic research are not so numerous. Schubert[36] explained with a factor analysis model the structure of the 1961 Supreme Court in terms of decisions on civil rights, economic liberalism, and general liberalism, and from his model predicted the rank of judges in terms of their 1962 decisions in the three areas. Wunderlich,[37] from data contained in an Agricultural Law Center study, used factor analysis to reduce the various provisions of vertical integration contracts to four critical dimensions—ownership of resources, operating decisions, risks on work in process, and risks with final products. Hobbs[38] used factor analysis in a farm management study to isolate factors which best described beliefs and values, skills, and socio-economic environment. MacEachern, Thomas, and Eisgruber[39] analyzed human attributes affecting the performance of tenants and from their analysis isolated six factors: status seeking, success satisfaction, large farm environment, small farm environment, education, and job mobility.

Perhaps one of the best known uses of factor analysis in an area of social science related to legal-economic research is the level of living index developed by Hagood.[40] Factor analysis is a systematic procedure for isolating a few critical variables to represent a much larger number of variables. For this reason, it is a device for constructing indexes.[41]

The extraction and description of a few factors in a legal-economic relationship is a major step in the direction of a predictive model in legal-economic research, but it does not provide the functional relationship presumed for a theory. For such theories, regression models may be necessary. The role of factor analysis in the current state of legal-economic

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[35] An excellent bibliography is contained in: HARMAN, MODERN FACTOR ANALYSIS (1960).

[36] Schubert, *Judicial Attitudes and Voting Behavior: The 1961 Term of the United States Supreme Court*, 28 LAW & CONTEMP. PROB. 100 (1963).

[37] Wunderlich, *supra* note 31.

[38] Hobbs, *Use of Factor Analysis in a Farm Management Study*, Symposium, Columbia, Mo. (Jan. 1965).

[39] MacEachern, Thomas, & Eisgruber, *Analysis of Human Attributes and Their Relationship to Performance Level of Farm Tenants*, Purdue Res. Bull. No. 751 (1962).

[40] The procedure for constructing the level of living index is discussed at length in a chapter on factor analysis in HAGOOD & PRICE, STATISTICS FOR SOCIOLOGISTS (1952).

[41] Waugh, *Factor Analysis: Some Basic Principles and Application*, 14 AGR. ECON. RESEARCH 77-80 (1962).

research is isolating the important variables and demonstrating the internal structure of a system of legal relationships. Some examples might be (1) critical authorities in zoning ordinances, (2) economic and social status factors affecting the personal view of the law, (3) features of special districts affecting revenue and costs, (4) impacts of contract provisions on the balance of landlord-tenant transactions, (5) economic dimensions of tax law, and (6) location of resource control in tenure arrangements. A particularly challenging area of basic legal-economic research might be the conversion of a "legal relationship" into quantitative terms.

*Measurement*

If variables can be expressed in terms of some measure, factor analysis shows how one variable can be expressed in terms of another. However, factor analysis (or any other statistical technique as such) still leaves unanswered the question of how a variable is to be measured. How do we put values on things? One of the critical problems in approaching legal-economic research from the scientific viewpoint is the measurement of pertinent variables, as Torgerson puts it, "Until empirical interpretation can be given to a sufficient number of its terms, the model, along with all of its terms, lacks empirical import, and does not constitute a scientific theory."[42]

Measurement is a concept for separating certain qualities out of an experience in a way that permits comparison among experiences. Measuring, with a thermometer, the temperature of a kettle full of hot water is by no means a *complete* experience of the kettle of hot water. Neither is it a *direct* experience (not as direct as a burn might be). The thermometer, with its scale of degrees, is an intervening concept which permits us (1) to separate heat experiences from whole experiences, and (2) to compare temperatures of different things, or of the same things at different times or places.

Measurement presumes the selecting of a criterion. In the foregoing example it might be more important to know whether the hot liquid was water, gin, or castor oil than to know its temperature. The selection of measures in legal-economic research, too, will rest on some idea of what is important in an analysis.

The concepts chosen for measurement should have meaning in terms of the theory, law, or relationship being tested. Each of the concepts of a theory should be convertible into other concepts as, say, in an equation $Y=a+bX$. The finer the distinction among different degrees of concepts, the wider will be the range of statistical techniques that can be used.

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[42] TORGERSON, THEORY AND METHODS OF SCALING 4 (1958). Torgerson presents a succinct overview of measurement in social science based to a large extent on MARGENAU, THE NATURE OF PHYSICAL REALITY (1950).

Recalling the discussion of concepts and classes above, measurement can be defined simply as representing a property with a number.[43] The features of these numbers are that they are ordered, that differences among the numbers (relative distances) can be ordered, and that a number series has only one origin. The relation between the number system and quantities of a property being measured must be *isomorphic*, i.e., one-to-one so that each quantity of a property can have one and only one number.

For our purposes, we can consider three types of scales—ordinal, interval, and ratio.[44] Of most interest to legal-economic research are the ordinal and interval scales. As their names imply, an ordinal scale shows rank only, and an interval scale shows rank and distance. For example, an ordinal scale shows that field A is larger than field B, but an interval scale shows that the area of field A is eighty acres and of field B is forty acres. The ratio scale is the same as interval plus a true zero origin, i.e., ratio of two scale points is independent of unit used. For example, the ratio of two temperatures is the same whether both are expressed in Fahrenheit or both are expressed in centigrade.

Statistical techniques such as regression, correlation, factor analysis, and analysis of variance require data expressed in interval or ratio scales. Yet many legal-economic variables may be very difficult to scale even ordinally. Where ordinal scales are possible, some nonparametric tests may be used. But no techniques will yield results any better than scales of measurement used to describe the data. Long-run success in the quantification of legal-economic relationships will depend to a large extent on progress in measurement and scaling.

## NONPARAMETRIC STATISTICS

Nonparametric statistics, as the name implies, do not rely on many of the assumptions about parameters required for the statistical tests described above. They are a diverse collection of techniques, many of which can be used on data not suitable for parametric procedures. Often they are simple and are easy to compute. In the early development of a statistical analysis of legal-economic relationships these procedures may be very helpful.

Statistical tests, such as the F test of the analysis of variance previously

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[43] The relation of class to number is cleverly developed in Russell, *Definition of Number*, in 1 THE WORLD OF MATHEMATICS 537 (Newman ed. 1956). See also Campbell, *Measurement*, in 3 *id.* at 1797.

[44] Some authors, such as Siegel, add another type called nominal, which is just the assignment of an arbitrary number for identification (a license plate, for example) rather than showing rank or measurement. Siegel, incorrectly I believe, identifies several statistics tests employing enumerative (frequency distribution) data with nominal scales. But the nominal "scales" could simply be called A, Q, and X. The *value* of each group is frequently contained in each group. SIEGEL, NONPARAMETRIC STATISTICS FOR THE BEHAVIORAL SCIENCES (1956).

described, rely on assumptions about the form of the frequency distribution of a characteristic in the study universe. One of these assumptions is that the distribution is "normal." These assumptions about the (unknown) parameters of the population distribution permit us to use the sample to *estimate* the parameters and apply standard criteria of reliability in our estimates. Each time a parametric statistical test is applied, therefore, an acceptance or rejection of a hypothesis carries a number of implicit assumptions. If we have some judgment that the actual form of the distribution in the population departs very much from the assumed distribution, we may wish to qualify or abandon the test in favor of a nonparametric (i.e., distribution-free) test.

From the standpoint of legal-economic research, a more important reason[45] for using nonparametric tests is their less imposing data requirements. Some nonparametric tests require only ranks and others require only a plus or minus sign.[46] Valid tests can be performed with small samples. Many of the tests are simple and "open" to compute—"open" in the sense of revealing relationships directly as an aspect of the calculation.

Scores of names of nonparametric tests can be found in literature, but many of these techniques are minor adaptations within a half dozen or so classes of nonparametric methods.[47] These techniques can test hypotheses in the following types of questions:

1. Does the sample frequency of a characteristic differ from the distribution known, or assumed to be in the population? In a given sample, does the proportion of landowners over sixty-five who are women differ from what we would expect (say, the proportion of the total population over sixty-five who are women)?
2. Are two samples different when other conditions are held constant? For example, among matched pairs of borrowers, does the repayment experience of one set of loan terms differ from another set?
3. Do two samples actually come from two different populations? For example, do farmers in area A have more written leases than farmers in

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[45] Tucker explains that the assumptions about normality of distribution are not terribly severe, and that rather wide departures from normality will have no effect on accepting or rejecting hypotheses. See Tucker, *Analysis of Variance and Covariance*, METHODS FOR LAND ECONOMICS RESEARCH (1966) (in press).

[46] Other tests rely on groupings of similar quantities or values or changes in such quantities or values. An example of the use of two "run" tests for determining whether crop yields were random over time or were bunched into run of good years and run of poor years. See: Ying-shiang Lin, Hildreth, & Tefertiller, *Nonparametric Statistical Tests for Bunchiness of Dryland Crop Yields and Reinvestment Income*, 45 J. FARM ECON. 592 (1963).

[47] Siegel uses six chapters to cover the types of nanparametric statistics. SIEGEL, NONPARAMETRIC STATISTICS FOR THE BEHAVIORAL SCIENCES (1956). For a critical review of Siegel's book and comparison with other sources, see Savage, *Nonparametric Statistics*, 52 J. AM. STAT. ASS'N. 331 (1957). See also SAVAGE, BIBLIOGRAPHY OF NONPARAMETRIC STATISTICS (1962).

area B, or, from the standpoint of leases-in-writing, could the two areas be regarded as one?

The techniques suggested by the questions above can be extended to comparisons of three or more groups. Variations of these questions can be accommodated by the wide variety of tests. Another family of nonparametric tests are concerned with measures of association; they are a way of showing correlation without the strict assumptions of parametric correlation—the *contingency coefficient* and *rank correlation* are two such techniques.

*The Contingency Coefficient*

The contingency coefficient can be used to illustrate one of the nonparametric techniques in a legal-economic problem with severe measurement limitations. It also shows how valid inferences can replace judgments and assertions, even when scales of characteristic under study are not available.

Suppose we wish to see if there is a relation between legal provisions covering liability and the economic structure of a firm. For extreme simplification, assume there are three possible sets of liability provisions represented by A, B, and C. There are no measures or scales of liability, but we can determine whether a given contract is in category A, B, or C by whether the grower does or does not have specified potential liabilities. Suppose also that we are able to classify the economic structure of the grower's firm into three groups, I, II, and III, by some standard such as ratio of gross to net earnings.[48]

Table 1. Contingency Table Relating Liability to Financial Structure.

| Liability Classes (r) | FINANCIAL STRUCTURE (k) I | II | III | |
|---|---|---|---|---|
| A | 16 (11) | 8 (11) | 8 (10) | Observed (Expected) |
| B | 5 (9) | 15 (8) | 5 (8) | $\underline{X}^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} = 27.37$ |
| C | 5 (10) | 5 (10) | 20 (10) | $C = \frac{\sqrt{\underline{X}^2}}{N + \underline{X}^2} = .49$ |
| | | | | N = 87 |

[48] If both classifications could be expressed in numbers or ratios, we probably would use a more powerful test. Because the classes A, B, and C cannot be expressed in

The classes which make up the rows and colums of the contingency table need not be in a numerical relation to one another; they need not even be ordered. The data–$O_{ij}$ "Observed," and $E_{ij}$ (in parentheses) "Expected"–are frequencies occurring in the $r$ x $k$ cells. The expected values can be any values based on *a priori* knowledge which was used to state the hypothesis. In this illustration, the "Expected" frequencies are stated to test the null hypothesis that: differences among financial structures are not related to liability classes. Thus the three numbers in each of the three rows, A, B, and C, are nearly equal. The illustration of Table 1 shows the correlation, in terms of a contingency coefficient, to be .49. The test of significance for this test is customarily the $X^2$, calculated in the same way as for the $X^2$ test of independence. The hypothetical data show wide differences between observed and expected. These differences induce an $X^2 = 27.39 > X^2_{.001}$, which in turn causes us to reject the null hypothesis that: "there is no relation between liability and financial structure." Another way of stating it is: There is less than a thousand to one chance that an $X^2$ could be as large as 27.37 and yet have no association.

*Rank Correlation*

Rank correlation is another test of association, more powerful than the contingency coefficient, but requiring data that are at least ordered. If, for example, we knew the order of a set of farm incomes in a community (and did not know the dollar figures), and we knew the social status ordering of the same farmers, we could test the relationship between income and social standing in a farm community.

For tests of association or tests of independence, there are a wide variety of effective techniques.[49] If the data are adequate and the parametric assumptions of normal distribution and independence of observation are met, the parametric tests are more powerful, i.e., they are less likely to discard information. However, if the distribution of a population characteristic is peculiar or data can be only ordered or observations can be given a value of only "yes" or "no," nonparametric statistics are useful. They are often simple and easy to compute. The simple nonparametric tests represent, from the standpoint of inference, a far greater step from judgment and assertion than the step from nonparametric methods to parametric methods such as multiple regression. Nonparametric methods might well be what jurimetrics needs to relate the empirical world to theories of justice and value.

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ordinal or ratio scale, we find it convenient to convert Classes I, II, and III to a "nominal" classification.

[49] Boxley, in addition to an excellent review of strengths and limitations of nonparametric tests, describes several techniques that might be useful in legal-economic problems. Boxley, *Nonparametric Statistics*, METHODS FOR LAND ECONOMICS RESEARCH (1966) (in press).

*Decisions and Subjective Probability*

Probability thus far has been considered in terms of scientific method. But the notion of probability certainly impinges on our lives in ways other than scientific investigation. Scarcely any enterprise is undertaken without some feeling about the likelihood of success. In fact, the entire structure of our economy and society is conditioned upon notions of hope, expectation, uncertainty, risk, anticipation.

Decisions[50] are made on the basis of some likelihood of possible events and consequences. A thread of probability runs through all aspects of law —property, torts, crimes, contracts. For example, if A buys Blackacre farm, he purchases a property with rights and privileges to which he attaches a certain probability of proof and enforceability. Similarly, an action which may be tortious or criminal presumably is undertaken by person B with some idea of the likelihood of his being apprehended, prosecuted, and punished.[51] A contract between X and Y implies a probability evaluation by each of the parties of relevant events and performance of the other party.

Recent developments in theory of probability[52] permit us to extend considerably our ideas of quantification in legal-economic research. Some speculations, however tentative, may lead toward useful analyses; and for illustration perhaps we might soon be able to relate contracts, economic expectations, and subjective probability.

"Wealth," says Pound, "is made up largely of promises."[53] Some of these promises are contracts; they are valuable, yet their outcome is uncertain to the parties that form them. Contracts are uncertain because of (1) events which make up the context of the contract, and (2) acts which the other party may take. If both parties had exactly the same evaluation of the likelihood and effect of events involved in the context of the contract, the contract could be viewed as a simple game between two parties, each attempting to maximize his own position subject to the minimum the other party would accept. But the values and the probabilities attached to the context of the contract usually are not to be the same for both

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[50] Strictly speaking a decision is simply a way of characterizing behavior, that is, people behave *as if* they were deciding something. We have no way of observing a decision so we find it convenient to use the concept of a decision as a means for explaining behavior.

[51] For illustrations of probability in the "courtroom," see Mode, *Probability and Criminalistics*, 58 J. OF AM. STAT. ASS'N. 628 (1963).

[52] The works of WALD, STATISTICAL DECISION FUNCTIONS (1950), and SAVAGE, THE FOUNDATIONS OF STATISTICS (1954), are commonly regarded starting points for current Bayesian approaches.

[53] POUND, INTRODUCTION TO THE PHILOSOPHY OF LAW, 133 (Yale paperbound 1954).

parties. Therefore, contract negotiation consists, in part, of exchanging views about the values and probabilities of events which make up the context.

Although contracts often contain provisions for the consequences of contingencies ("If A occurs, then B shall be done"), the explicit assignment of probabilities is obscured in the negotiation process. In short, contracts are drafted with no distinction between an event that has a 95 out of 100 chance of occurring and an event with 1 chance out of 100 of occurring. Perhaps a useful part of every contract would be a table showing all relevant events, the value (or importance) of each of the consequences of these events, and probability attached to each of the events by each of the parties. Even if contracting parties could not use such explicit probability charts in negotiation, jurimetricians might compare the values and probabilities in predicting outcomes of contracts.

In the past two decades, the technology of decision making has undergone revolutionary development. Some of this development is discussed and illustrated by Harl in relation to firm and household decisions in farm organization.[54] The techniques for decision making under uncertainty now comprise a vast literature in several sciences.[55] Among the decisions made under uncertainty are those related to scientific investigation. The researcher must decide: "Do the available facts verify or reject a specified hypothesis?" In the sketch of statistical techniques above, the acceptance or rejection of a null hypothesis rested upon the strict application of a prior-selected, conventional, and arbitrary level of confidence to a specified sample. Recent developments of the so-called Bayesian approach to statistics permit the addition of successive amounts of information to the test of a hypothesis and thus allow the researcher some judgment as to how much information he needs and when to accept or reject. Perhaps the most important feature of the Bayesian approach from the standpoint of legal-economic research is that it allows a subjective interpretation of probability.[56]

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[54] See Harl, *Research Methods Adaptable to Legal-Economic Inquiry: Linear Programming and Simulation*, in this volume. Also, Harl, *Modifying Institutional-Legal Relations Among Private Parties to Facilitate Adjustments in Agriculture*, J. FARM ECON. 953 (1964).

[55] Shubik, *Bibliography on Simulation, Gaming, Artificial Intelligence, Allied Topics*, 55 J. AM. STAT. Ass'N. 736 (Dec. 1960).

Cowan, *Decision Theory in Law, Science and Technology*, 140 SCIENCE 1065 (June 1963) reprinted at 17 RUTGERS L. REV. 499 (1963).

The relation of decision theory to planning is treated by Dyckman, *Planning and Decision Theory*, 27 J. AM. INST. OF PLANNERS 335 (Nov. 1961); his article contains an excellent bibliography.

For theoretical discussion of decision making, see Pratt, Raiffa, & Schlaifer, *The Foundations of Decisons Under Uncertainty*, 59 J. AM. STAT. Ass'N. 353 (June 1964).

[56] Edwards, Lindman, & Savage, *Bayesian Statistical Inference for Psychological*

*Models and Causation*

The social scientist can view law as a process in terms of at least two dimensions: (1) a description of the participants and their behavior, (2) a body of changing rules that are standards of behavior. Both descriptive and normative approaches rest upon simplifications or generalizations about behavior. From these generalizations (theories, models) of behavior are formed classes or groups of actions (Suzanne Langer might say "concept") that permit us as judges, juries, and scientists to combine things "alike" and separate things "not alike." Once we have connected what we have observed with the generalizations, models, and concepts, we have a way either of (1) predicting consequences (descriptive) or (2) recommending action (normative). Either in law or science, then, the notion of "constructs," as stated by Margenau and Torgerson,[57] seems a useful reminder that *what is seen, what we see,* and *what we think* are not the same things.

We are attempting in this volume to bring together law, economics, and quantitative methods. Protests have been and will continue to be made by many persons[58] that such ventures are doomed to the same failure as cross-breeding chickens and elephants. We recognize that we are not addressing the whole of any of the three. We are concerned mainly with that aspect of law called jurisprudence. Our economics is necessarily institutional, and our quantitative techniques may be a remote colony in the world of mathematics and statistics. In the course of this eclectic enterprise some time will be devoted to "fundamentals." Harris, Hines, and others explored these fundamentals at length so that I would venture to add only a few tentative notions that pertain to the testing of hypotheses in the analysis of legal-economic problems. I think a commonality among law, statistics, and economics can be expressed through three ideas: (1) law is a semantic process, (2) statistical inference connects cause-effect mod-

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*Research*, 70 PSYCH. REV. 193 (1963).

KYBURG & SMOKLER, *op. cit. supra* note 17 contains historic and current articles from Venn to Savage.

[57] "Science can be thought of as consisting of a theory on the one hand and data (empirical evidence) on the other. The interplay between the two makes science a going concern. The theoretical side consists of constructs and their relations to one another. The empirical side consists of the basic observable data." (p. 2) ". . . a satisfactory theory contains constructs that are also defined, not in terms of other constructs in the set, but rather, directly in terms of abservable data . . . [but] it is *not* necessary that *all* constructs possess direct operational definition. . . . It is rather necessary only that a sufficient number in any system be operationally defined." . . . "Constructs with neither direct nor indirect empirical meaning can serve no explanatory purpose at all." (p. 5) TORGERSON, *op. cit. supra* note 5.

[58] One particularly vehement attack on jurimetrics is Weiner, *Decision Prediction by Computers: Nonsense Cubed-and Worse,* 48 A.B.A.J. 1023 (1962).

els with observations, and (3) economics provides operational concepts of value.

Law is a semantic process in the sense that law finding and law making are essentially articulations of the social process, including its values and goals.[59] The main issues of law are the meanings of value, actions, and conduct. When these meanings have been adjudicated, codified, and imposed through sanction or force, they represent a model of behavior.

According to semanticists, "meaning" is the product of experience. Models of experience, therefore, will permit us to predict, hopefully with precise measures of confidence, what meanings will be. An illustration of these meanings is found in the studies of judicial decision making where various experience factors helped to predict the outcomes of court decisions.[60] Models of experience are the subject of the social sciences, including economics. The findings of economic research will add to meaning (understanding) of human behavior and thus are a part of law.

Statistical procedures, a few of which were sketched above, are means for relating empirical data to hypotheses. These hypotheses are intended to be the crucial or critical relationships in a theory—they are crucial in the sense that the theory stands or falls on the basis of acceptance or rejection of the hypothesis. Statistical procedures do not test causal relationships. Blalock states this pointedly:

> There appears to be an inherent gap between the languages of theory and research which can never be bridged in a completely satisfactory way. One *thinks* in terms of a theoretical language that contains notions such as causes, forces, systems, and properties. But one's *tests* are made in terms of covariations, operations, and pointer readings. (p. 5) . . . But this does not mean that it is not helpful to *think* causally and develop causal models that have implications that are indirectly testable.[61]

The concept of cause is deeply inbedded both in law[62] and in economics.[63] A large body of law which articulates causes of action rests upon

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[59] Another closely related aspect of articulation involves the connections among words and concepts. The "meaning" of a sentence in a contract or an article in a constitution is as much a function of the word relationships as "meaning" of each word. The importance of syntax has been ably demonstrated by Layman Allen in a number of articles; for example: Allen, *supra* notes 8 and 11. If semantics is permitted to embrace the meaning of word combinations as well as single words and symbols, it can include syntax.

[60] Schubert, *Quantitative Analysis of Judicial Processes: Some Practical and Theoretical Applications*, 28 LAW & CONTEMP. PROB. 164 (1963). Schubert's article contains extensive references to similar analyses.

[61] BLALOCK, CAUSAL INFERENCES IN NONEXPERIMENTAL RESEARCH 4, 6 (1964).

[62] In the sense of "to be the cause or occasion of; to effect as an agent; to bring about; to bring into existence; to make," BLACK, LAW DICTIONARY (4th ed. 1951).

[63] For an outline of some of the issues of causality in economics, see Garb, *The Problem of Causality in Economics*, 17 KYKLOS 594 (1964).

what seems to assume a mechanical, determined relation between events. That p implies q is not empirically demonstrable, even when they occur together invariably. Nevertheless, empirical techniques can be used to *eliminate* theories, models, and variables that appear *inconsistent* with observable facts. The findings of social science (even if at times rather negative) will contribute to concepts of cause in law.

An interpretation of value is basic to virtually all discourses in jurisprudence as it has been in theories of economics. Pound, for example, in reviewing a series of the conceptions of law,[64] acknowledged that "lawmaking and adjudication are not in fact determined by the weighing of interest," but that there will be less "subconscious warping if we have a clear picture before us of what we are seeking to do and to what end." Then he states: "Difficulties arise chiefly in connection with criteria of value."[65]

Economics does provide operational concepts of value. It does not, of course, solve the problems of ultimate ends or interpersonal comparisons of utility,[66] but economics does have a surrogate for community preferences —the market—which can be modified. Economics does have theories of substitutability that treat problems of ranking or ordering preference.[67] Economic concepts, such as the Paretian[68] optimum, can be operationally useful in the construction of contracts, statutes, or regulations. Law can find within economic theory some useful concepts for evaluation. To suggest further inquiry into problems of value is to suggest philosophic treaties much beyond the scope of this paper, but very much within the responsibilities of those who would thrust themselves into the area of legal-economic research.

## Summary

The aspect of jurimetrics concerned with quantification of legal rela-

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[64] Pound, *op. cit. supra* note 53 at 25-47. Some of the conceptions were: (1) divinely ordained rule, (2) tradition of old customs, (3) wisdom of wise men, (4) philosophically discovered system of conduct, (5) immutable moral code, (6) agreements among men, (7) reflection of divine reason, (8) commands of sovereign authority, (9) freedom of wills, (10) harmony of actions, (11) rules of a dominant class, (12) pragmatic rules based on economic and social rules.

[65] Pound, *op. cit. supra* note 53 at 45. See also *id.* at 25-47 *passim.*

[66] Thurstone, and more recently Edwards and others, have worked on the valuation of utility directly.

[67] Kenneth Boulding has treated the relation of economics to general theory of value in an easily read article. Boulding, *Some Contributions of Economics to the General Theory of Value*, 23 PHILOS. OF SCI. 1 (1956).

[68] Vilfredo Pareto, social philosopher and economist of late nineteenth century, has given his name to a welfare criterion that can be briefly described as: Pareto optimum, that condition that exists when no one can be made any better off without making someone worse off.

tionships is still relatively underdeveloped. The connection between the logical basis of legal concepts and the logical foundations of probability may be helpful in developing the methodology for quantifying legal relationships. A similar tie of social science to logic suggests some common ancestry of law and economics and thus perhaps one basis of legal-economic research. Some operational contributions of economics to the study of jurisprudence are, first, a system of rigorous and relatively widely accepted causal relationships to explain behavior, and, second, a system of useful (if not exhaustive) concepts of value.

Legal-economic research rests, to a large extent, on explaining or describing relationships. These relationships can best be expressed in terms of hypotheses which can be verified or rejected by statistics. The statistical method to be used will depend upon the form of question asked. Although some of the more "sophisticated" statistical methods, such as regression and analysis of variance, are useful conceptually and in certain instances where the stringent data requirements are met, there are a number of simple but powerful tools (for example, the nonparametric tests described above) that could be employed in the earlier stages of legal-economic research.

Advance in legal-economic research requires some attention to foundations—logical and semantic—but much more attention to methods for quantifying legal-economic relationships.

## COMMENTS

William B. Lord*

Gene Wunderlich has been assigned a task of exposition; of explaining to lawyers the nature and use of some of the research tools of the economist. Fashion dictates that comment on such an exposition be directed to two aspects. Criticism of the ideas themselves is inappropriate simply because the purpose of an exposition is to clearly present an established set of ideas rather than to propose a radical new set. Consequently, the critic customarily evaluates the quality of the exposition (in relation to the nature of the intended audience) and then proceeds to engage in that form of academic nit-picking which is intended to demonstrate the critic's superior command of the subject matter.

My comments will be distinctly unfashionable because, as a non-lawyer, I am unable to assess the impact of this chapter on the legal mind and because I cannot pretend to rival Wunderlich's competence in this subject

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matter area. For whatever it may be worth to the lawyer, however, the reaction of at least one economist to this chapter is one of enthusiasm. It should be widely read by economists, whatever its value to lawyers.

Too often our courses in economic statistics spend too little time on fundamentals and pass on too quickly to descriptions of the techniques of analysis themselves and the computational procedures necessary to implement them. Mathematical statistics courses, on the other hand, while certainly attendant to fundamentals in one sense, seldom give enough attention to the applications which will be made of statistical tools. Just as both good recipes and sound dietetics are necessary but not sufficient for successful meal planning, so our traditional treatments of statistics are also lacking. Wunderlich's broad and unencumbered view of the relationships between research problems and statistical tools provides a needed element akin to the sort of culinary knowledge that Lobster Thermidor and Chambertin, while both delightful by themselves, just do not go together.

Statistical techniques are tools of science, of course, and they may be useful in legal-economic research only to the extent that such research is scientific in nature. Law is not ordinarily regarded as a scientific discipline, and even economics and its sister "social sciences" are beyond the pale in the view of many natural scientists. It may be useful, then, to reexamine briefly the role of statistical techniques in scientific activity and the relationship of legal-economic research to such activity.

Let us adopt a broad definition of science, after John Dewey, as the process of resolving problematic situations in a purposefully experimental manner. Such a definition has the merit of including within it (and relating to each other) both the process of forming generalizations and the process of using generalizations to solve particular problems. It would exclude that evolutionary social process, the Anglo-American legal system, on the grounds that, whatever else may be the aspects in which it resembles science (and they are many), it has not yet institutionalized purposeful experimentation.

If a great virtue of the pragmatic concept of science has been that it emphasizes the relationship between theorizing and practicing, perhaps a great vice has been that it de-emphasizes the distinction between them. This distinction, like any other categorization, cannot always be imposed without difficulty on an amorphous real world. Nonetheless it is a useful distinction, and failure to recognize and employ it accounts for the state of arrested development (or early demise, according to some) of the field of land economics. Throughout the bright youth of this discipline its scions made great contributions to the solution of pressing social problems through the application of selected economic generalizations, conscious empiricism, and plenty of good common sense. Before long, however, land econo-

mists had mined their lode of applicable generalizations. Although they continued to offer trenchant criticism of the theories of others (a virtue of their strong empirical orientation), they did not succeed in creating a conceptual framework for their own discipline. Their failure to do so may be traced in no small part to an attitude toward the process of generalization which ranged from inadequate appreciation on the part of some, through misunderstanding on the part of most, to outright distrust on the part of many.

The statistical techniques employed by contemporary social scientists are tools used in the process of generalization. This process is conceptually distinct from, although related to, the process of application. Consequently, statistical techniques may not appear very useful to the practitioner of law or of economics or of their intersection. They are not meant to be. They will be useful in the process of forming generalizations about that part of human behavior which can be described as legal-economic.

The legal researcher's methods outlined by Dolson in this volume have little to do with the statistical techniques presented by Wunderlich because the former are the tools of the practitioner while the latter are the tools of the generalizer. An economist could present an analogous outline of the library research procedures and sources employed to locate economic generalizations applicable to particular problems. Such an outline does not appear in this volume, and this may be an unfortunate omission. This outline would be useful to one engaged in the process of solving particular legal-economic problems by designing laws which will alter human behavior in the direction indicated by certain economic norms. The role of economics in this process is, as Wunderlich states, to provide operational concepts of value. Such activity is an important kind of legal-economic research, but it is not the only kind. It will be both appealing to and readily understood by lawyers so that it can be passed by without further discussion.

Another kind of legal-economic research may not be so easily appreciated by lawyers because it involves less familiar terrain. It is to this area, the formulation of legal-economic generalizations, that Wunderlich's paper is mainly addressed. And let it be said at the outset that laws, whether made by legislatures, courts, or administrative bodies, are generalizations, but not the type of generalizations in point here. Laws are rules of behavior established by a society. In a sense they are intermediate data only. Legal research must be concerned not only with what the law "is," that is, what it purports to say, but with how law is made and what it means in terms of human behavior.

Research into how law is made will involve investigations of how problems get to legislatures, courts, and administrative bodies, and how solu-

tions are conceived, adopted, and incorporated into what the law "is." Legal research of this type intersects all of the social sciences, including economics, but is most obviously related to political science. (Indeed, only the imposing edifice of the law as compared to the so far quite limited body of verified and useful generalizations produced by the various social sciences forestalls a definition of law as applied social science in the way that engineering might be defined as applied physical science.)

Many legal-economic researchers, both lawyers and economists, have successfully participated in the formulation of new laws (such as the Iowa water law and the Nebraska income tax law). Such researchers often have an impressive understanding of how law is made, but find it difficult to describe this process in general terms. Very few have attempted systematic research to develop such generalizations. Whether it is in the domain of political science, jurisprudence, or legal-economic studies, research of this type is badly needed. In fact, our fund of generalizations on how law is made is so scant that statistical techniques may not yet be widely useful in this area. Case studies, to which political scientists and land economists are much given, may be most appropriate as possible sources of new hypotheses (which later may be subjected to statistical tests).

Research into the behavioral meaning of law will involve investigations of the influence of laws on the actions of individuals and groups. For example, a study of the impact of rural zoning, measured not by the number of counties which have enacted such ordinances, but by the attendant changes in the ways in which people use land, would be original and timely. Much institutional innovation in land and other resource law has occurred in the past half century. The significance of these changes has been the subject of much discussion but little systematic investigation. Such studies are appropriate to the interests of both economists and lawyers and offer fertile opportunities for legal-economic research. Their results can be highly influential if, as seems likely, we are entering another period of institutional innovation in the resource field. Above all, it is in such studies that the statistical techniques so aptly described by Wunderlich can be put to immediate and fruitful use.

# ORGANIZATION FOR LEGAL-ECONOMIC AND RELATED RESEARCH

Harold Ellis,* Gordon Rose,** and J. H. Beuscher***

Previous papers in this workshop have dealt with legal-economic research generally and with research methods and techniques. This paper will consider problems of organization for such research. At the outset, it should be acknowledged that no particular organization can guarantee effective legal-economic research because such effectiveness depends in large measure upon the interests, attitudes, training, background, personalities, and abilities of the persons who will be doing the research. The ability of two or more persons in two or more disciplines to work effectively together ordinarily is a prime requisite to effective interdisciplinary research. Nevertheless, the type of organization can play an important part in facilitating or obstructing such research.

Attention will be given first to some general problems and possibilities in organizing for legal-economic research, then to some problems and possibilities involved in organizing for research regarding a complex subject such as water resources, and finally to some considerations involved in researching regional problems.

## SOME GENERAL CONSIDERATIONS REGARDING LEGAL-ECONOMIC RESEARCH

Important considerations in organizing for most kinds of research may include the definition, nature, and general objectives of the research and criteria for evaluating its effectiveness. The effectiveness of organizational arrangements for research may vary with such factors as the existing institutions, agencies, or organizations in which the research is done; how they and their personnel are organized and collaborate with others; the type of persons employed to do the research and the supervision provided; the amount, continuity, and source of financial support; the intellectual freedom permitted and time allowed for research projects; policies regarding salaries, promotions, and other personnel matters; the location and office accommodations for research personnel; the availability of library facilities and equipment; and the type of required training and policies for fostering needed additional training.

Such factors may have an important bearing on the environment within

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which research is conducted and may promote or hinder the attainment of highly competent research. The felt needs and satisfactions of the researchers is an important general consideration which will significantly affect the end product of their research endeavors. Much has been written or could be said about such matters.[1] However, this discussion will deal only with some considerations that seem particularly relevant for legal-economic research.[2]

Those concerned with the organization of legal-economic research should be concerned not only with how to effectively conduct individual research projects, but also with the long-run accumulation and organization of knowledge regarding relationships between law and economics and research methods and techniques. Such knowledge may be built up through the accumulative findings and research methods employed in various research projects, supplemented by imaginative thinking and suggestions concerning legal-economic relationships and existing or untried research methods. Means of facilitating such accumulation of knowledge may include exchanges of publications among legal-economic researchers and their administrators and mutual contacts and associations to discuss their experiences, findings, research methods, and ideas. Much of the learning process takes place within the minds of individuals. But it may be stimulated, augmented, and redirected through contacts and associations with others. This legal-economic workshop has made an important contribution in this connection, particularly in regard to research methods and techniques. In appropriate instances, it also may be desirable to jointly plan a larger framework within and to which individual research projects may contribute. Such possibilities are suggested later in the discussions of considerations regarding water resources and regional research.

Legal-economic research implies some type of multidisciplinary or interdisciplinary undertaking. This aspect of such research has particular relevance for organizational considerations. Of course, it is possible for legal and economic research to be undertaken completely independent of each other. However, the economic researchers may not know about or understand the laws or legal institutions that are relevant to their research and the legal researchers similarly may not be aware of or understand economic

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[1] See, for example, ACKOFF, DESIGN OF SOCIAL RESEARCH (1953); RAUDSEPP, MANAGING CREATIVE SCIENTISTS AND ENGINEERS (1963); THELEN, DYNAMICS OF GROUPS AT WORK (1954); THOMPSON, *Bureaucracy and Innovation.* ADMINISTRATIVE SCIENCE QUARTERLY, Vol. 10, No. 1. (June 1965); WHYTE, ORGANIZATION MAN. (1956).

For these references and other helpful suggestions the authors are indebted to Dr. Gene Wunderlich, Economic Research Service, USDA.

[2] The definitions and objectives of legal-economic research and other general considerations have been discussed in the foregoing paper by Harris and Hines. Attention is given here to some considerations which appear to have special significance in organizing for such research.

considerations. This danger probably is greatest when neither has any training in the other discipline and there are no available publications or unpublished manuscripts in the other discipline that deal directly with the subject at hand.[3] Even a few conferences with someone in the other discipline in the planning of one's research may be quite profitable. Important hypotheses may get considered that otherwise may have been ignored or they may get sharpened or remolded by obtaining the viewpoint of a good mind trained in the other discipline.

Depending upon the nature of their respective research undertakings and other considerations, it often may be helpful for the researchers in the different disciplines to jointly develop plans for a research project. Once such a project has been jointly planned, it may be feasible for the economists and lawyers to conduct certain segments of the study largely independent of each other, with each having primary responsibility for certain segments. However, each should bear in mind the over-all goals of the study and in what ways his segment is expected to contribute to them; frequent contacts between the researchers will help to assure the accomplishment of the over-all goals. Other segments of the study may be more effectively accomplished by continuous joint conduct of the research throughout, although it would be impractical to do everything jointly.

The extent to which the various steps of a study are conducted jointly is an important, but by no means the only, measure of the degree to which the study is interdisciplinary in nature. The research might instead be done by one individual trained in both disciplines, as discussed later. The foregoing paper by Harris and Hines has classified legal-economic research into three possible categories:

(1) "cooperation," which they say has resulted in a "layering" of law and economics in a single publication;
(2) "coordination," which is directed toward the discovery of the relationship between law and economics; and
(3) "integration," in which coordination has become so complete that the two separate disciplines essentially have merged.[4]

The degree of joint collaboration that might be needed for effective research may vary with the type or stage of the research. For example, there

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[3] The growing complexities of each discipline and of our society will likely increase such dangers.

[4] But the authors question the extent to which lawyers and economists should abandon their quite different special methods of analysis in favor of some kind of hybrid. The lawyer's methods of analyzing statutes and reported court decisions surely will continue and make significant contributions to legal-economic research. But in the conduct of field and other research to evaluate the economic effects of the laws in operation or of alternative laws, each may throw up variables and institutional factors that may strain the other's customary tools and he may have to adopt and inventively modify them.

may be at least four major stages of a comprehensive legal-economic study involving some area of law: (1) library research to find out what the law is and its historical development as reflected by applicable statutes, constitutional provisions, and reported court decisions,[5] (2) field or other research to find out how the law has operated in actual practice,[6] (3) research to ascertain the law's impact or lack of impact upon economic activity and other factors, and (4) research to evaluate the law, its operation and impact, and alternative measures that might be employed within the existing legal framework or that would require new legislation or court decisions. Such major stages need not necessarily be always undertaken in this order and all such stages tend to shade into one another. A legal researcher may be expected to do a reasonably effective job of library research on the applicable statutes, constitutional provisions, and reported court decisions without working jointly with an economist, except perhaps in formulating the problem or question. On the other hand, he might especially need to work jointly with an economist in conducting research on the economic impact of the law.

Some research workers, for various reasons, might work more effectively if they work entirely or at least largely alone rather than as a member of an interdisciplinary team. But their work, nevertheless, may benefit by contacts with researchers in the other disciplines and perhaps also by some joint planning endeavors. Factors which may weigh against the desirability of certain joint research undertakings may include the inability of some persons to work effectively with others or certain persons, the problems of distance, location, and travel,[7] and the nature of certain types of research projects or segments of projects. There may be general tendencies toward independent research efforts and a general reluctance to join in team research undertakings.[8] A "shot-gun marriage" of such research workers is not likely to be effective, but even they may be encouraged to work together in various ways.

Effective collaboration between such research workers often may result primarily from prior contacts and associations. Through such contacts each may come to feel that their respective interests, attitudes, personalities,

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[5] This also may include an analysis of the reasons for and circumstances that prompted them (which may require more than library research).

[6] Among other things, this may include an analysis of administrative practices and contractual arrangements.

[7] However, the relatively new Centrex Federal Telecommunications System, and similar telephone systems may facilitate frequent and extended long-distance phone conversations between researchers.

[8] Harris and Hines' foregoing paper suggests some possible reasons for such general reluctance. They especially may be reluctant to join a large team of researchers representing several disciplines in which they may tend to lose their identity and communication problems may be multiplied. Such research is considered later.

abilities, and operational methods are reasonably compatible, and each may come to see important benefits from such collaboration. However, such collaboration and opportunities for such prior contacts may either be encouraged or hindered by organizational factors.

One frequent difficulty in arranging for legal-economic research is that a number of law schools or colleges,[9] especially those without graduate level programs, may have few regular or other funds allotted for research purposes. They may give nearly all their attention to the training of law students, so that almost all of their staff may have full-time teaching loads. In such schools the law professors may be largely teaching, rather than research, oriented.[10] The only sizable block of time that a law professor might have to devote to legal-economic research may be in the summer and even then summer-school teaching assignments may compete for such available time. However, with the law students available to assist in such research during the summers, considerable research could be accomplished during such periods. Furthermore, in a number of law schools the law professors are encouraged to prepare scholarly articles for law reviews. For such purposes, some may be encouraged to do research and prepare articles that relate to legal-economic studies in which university departments of agricultural economics or other agencies are interested. Some may even be an integral part of such studies.

Some law school deans and law professors who have recognized the benefits of legal-economic research have sought and obtained supporting funds from various sources. But much of the initiative and financial support for such research in a number of states has come from the departments of agricultural economics or comparable departments. Such departments have access to state and federal research funds through the agricultural experiment stations of which they are a part and which engage in considerable research. A number have employed the services of an interested law professor, with or without making formal arrangements with his law school. Others have instead directly employed legally trained persons as a part of their own permanent faculty, as has the U.S. Department of Agriculture, which has often cooperated in such endeavors. Such arrangements may have accomplished a closer working relationship between such persons and the economists on their staffs and may have promoted a greater awareness of and interest in each others' disciplines.[11] But this also may be

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[9] Many law schools are now a "college of law," but the term "law school" will hereinafter be used in this paper as a matter of convenience.

[10] See Brown, *Legal Research: The Resource Base and Traditional Approaches,* AMERICAN BEHAVIORAL SCIENTIST 7 (4): 3-7 (1963).

[11] This may also enable more direct supervision over the scope, planning and conduct of the research, if desired. Some agricultural economics departments, however,

accomplished by suitable arrangements with a law professor and law school (which may be made easier if they are located on the same campus). Such an arrangement may facilitate a useful exchange of information and ideas between the two disciplines and open up or facilitate contacts with each others' professions and sources of data that may be helpful in their research and in other ways.

The U.S. Department of Agriculture has recognized the value of such associations by locating some of its employees at three different law schools —at the Universities of Iowa, Wisconsin, and Mississippi—with cooperative arrangements with the agricultural experiment stations in those states. In two of these states, a center or institute has been established in the law school. In Iowa it is called the "Agricultural Law Center," in Mississippi the "Legal Institute for Agricultural and Resource Development," and in North Dakota the "Agricultural Law Research Program."[12] Arrangements at the law school in Wisconsin are more informal.

Another possible difficulty in legal-economic research is that legal and economic researchers may well have different interests and goals and may employ different research methods. This difficulty may be alleviated by their agreement upon more common goals and research methods for the purposes of their joint research or upon segments of the study which each has a special competence to conduct. One may wish to obtain more detailed information than the other concerning matters within his particular area of concern, which may be more than is reasonably necessary for the conduct of the interdisciplinary research. By cooperative effort, however, such research may be programmed to accomplish its needs as well as to constitute a segment of more detailed research that may be separately conducted by one or more of the researchers.[13]

Legal-economic research often may be accomplished in whole or part by persons who are working on graduate degree theses in economics or law. This often is a fruitful way of accomplishing needed research as well as advanced training, but it presents some difficulties. The research project may need to be adapted and timed to fit in with the student's thesis requirements. Moreover, the thesis is supposed to represent largely independent, not collaborative, work on the part of the student. However, by expeditious planning, the student's thesis work may become an important seg-

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may be located in another university or city that has no law library facilities that compare favorably with those in a law school.

[12] Some other universities have established somewhat different types of centers or institutes that may engage in legal-economic research undertakings, such as the Institute of Government at the University of North Carolina.

[13] This also may enable such expeditious arrangements as a legal researcher's adding some questions of a legal nature on a schedule used in a field study conducted by an economist.

ment of a legal-economic study. This ordinarily will be easier to accomplish if the student has dual legal-economic training.

Legal-economic research theoretically may be most effectively accomplished by one or more persons who are fully trained in both law and economics. This may minimize the difficulties encountered by persons trained in only one discipline in attempting to converse and work with and understand the views and writings of persons trained in another discipline. Dual-trained persons may also tend to have a broader outlook. Such considerations suggest the desirability of more of such dual training and of administrative arrangements to encourage it. But financial and other considerations (such as the substantial time and effort required and perhaps a lesser interest or ability in one of the disciplines) may militate against the accomplishment of such dual training to the fullest degree, that is, to the attainment of both a Ph.D. in economics and an LL.B. or higher degree in law.[14] Even one trained in both disciplines may have more interest or ability in one discipline than the other, and, even if not, it may be difficult for him to keep abreast of new techniques and other developments in both disciplines over the years. This suggests that, even for such persons, frequent contacts and perhaps joint undertakings with others may be desirable. Moreover, the size or geographical scope of some regional or other interdisciplinary research undertakings may be too much for a single researcher to handle, and the complexity of some subjects may make it desirable to work jointly with, or at least to have close or frequent contact with, persons trained in one or more other disciplines besides law and economics, as discussed later. If a dual-trained person participates in such undertakings, he may help to alleviate the communication and perhaps other difficulties encountered among the single-discipline trained persons who work on such projects.

In any event, the extent and nature of interdisciplinary legal-economic research efforts will be influenced by broader developments. Let's consider, for example, the general development of organizational arrangements for legal-economic research at the University of Wisconsin. The experience at this university indicates that the ways in which a university is organized and operates in general may be as or more important to a sucessful joint

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[14] In this connection, it may be noted that the U.S. Department of Agriculture has been unable to date to establish a civil service job category in which credit can be given for both law and economics training, forcing such dual-trained persons to be employed either as economists or as lawyers. (Other federal agencies, and perhaps other organizations, may have similar difficulties.) Such difficulties may be mitigated to some extent by the Department's ability to foster and help finance such dual training of a few employees. It also appears that some universities have relaxed or altered their requirements so as to reduce somewhat the time required to obtain such dual training, such as arrangements for law minors in graduate economics training.

research effort than the administrative arrangements for a specific research project or program. Geographic factors have been favorable, as the agricultural economists are on the same campus with the law professors. But organizational opportunities for regularized contacts between economists and law teachers have been more important.

The agricultural law course in the agricultural economics department is manned by a member of the law faculty. A generous university policy about teaching credit has encouraged members of both faculties to conduct joint interdisciplinary seminars which, among other things, have been a means of getting acquainted with graduate researchers from the other disciplines.[15] Members of both faculties also have conferred over the theses of graduate students in both law and economics and a number of economics graduate students have enrolled for law minors. In addition, there has been joint participation by law and economics faculty members in agricultural extension activities. There have been frequent informal contacts at luncheon in regard to all such activities, as well as joint participation in formal or informal conferences or meetings.

The presence at Wisconsin of a living tradition of close working relations between the university and agencies of state government (aided by the close proximity of the state capitol) also has been of inestimable help.[16] There is a remarkable feed-back of challenges for needed research from this association, and many of these challenges demand the competence of both lawyers and economists. This association has brought law teachers and economists into close contact with each other as co-members of a study team or advisory committee. For these and other reasons, the faculty has gotten used to conferring and working across their respective departmental outer limits.

Having gotten to know each other through contacts of the kinds just listed, it has been relatively easy for a law and an economics professor to "team up" in some manner for research purposes. This "teaming up" may range all the way from a joint and intimate association through an entire research effort to no more than a few conferences at the research formulating or planning stage or to review certain procedures to be employed in the study. Even the latter type of cooperative effort may be very fruitful.

The legal and economic researchers at the University of Wisconsin have seldom worked together in a center or other formal organizational structure

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[15] Each faculty member is given teaching credit for the full number of the hours involved in such seminars irrespective of the number of faculty members who participate.

[16] A legislatively or executively established study group has sometimes provided the organizational umbrella for joint research on policy-oriented issues such as policies about county forest lands, eminent domain takings, land subdivision, or water allocation and use.

designed for such purposes. Instead, they have usually worked together through rather informal arrangements among the researchers in the different academic schools or departments, some of which have been simply an informal association between two professors and their graduate students. In recent years, however, the university has established a Land Tenure Center and a Water Resources Center, as discussed later.

## SOME CONSIDERATIONS REGARDING WATER RESOURCES RESEARCH

Let's turn now to the consideration of some factors that may be particularly involved in conducting legal-economic research regarding a complex area such as water resources. Much of the complexity in this area stems from the flowing, vagrant, or renewable nature of water resources, their geographic and temporal variations in quantity and quality, their combination of beneficial and damaging potentialities, their multiple and re-use and developmental possibilities, and the myriad variety of possible externalities and conflicts among water users. These and other factors, including relevant interstate and federal, state, and local relationships, make studies involving water resources a very complex but interesting and challenging undertaking.

In view of the foregoing and other factors, consideration often may need to be given to possibilities of even broader interdisciplinary research than legal-economic research. It is possible for legal-economic research in this area to be conducted apart from research in the physical sciences, engineering, and related fields if the legal-economic researchers draw upon the published or otherwise available findings in related fields of research and consult with the researchers in those fields. But such factors as the complex interaction of various water resources and the variety of existing and potential techniques for conserving or developing water resources[17] and abating pollution, may make it particularly desirable to conduct at least some of the more policy-oriented aspects of such research in a broader interdisciplinary framework of some type.[18] Such a framework may facilitate the effective utilization of relevant aspects and findings of each discipline in such research projects and in the long-run accumulation of research findings and knowledge regarding research methods. It sometimes may be as or perhaps even more important than working with each other

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[17] These may include, among other things, techniques for retarding evaporation and seepage losses, on- and off-stream impoundments, diversions between watersheds and into or out of groundwater acquifers, and desalinization techniques.

[18] Recall the earlier discussion that such a framework might range from joint conduct of the research throughout, to segmentation of the research, or merely joint planning, and so on.

for legal or economic researchers to work jointly or closely with such scientists as hydrologists, geologists, agronomists, engineers, and political scientists.[19]

The available published data on such things as the existing state of water resources, their complex interrelationships, and conservation and developmental techniques and possibilities may be limited or not readily adapted for such purposes as the evaluation of alternative water laws or policies. This would make it even more important to consult directly with the researchers in these fields and to encourage them to do more of such research within an interdisciplinary framework or otherwise.

No doubt at least partly in recognition of the interdisciplinary nature of water resource problems, several universities have established water resources institutes or centers. Some encompass an even broader subject matter area. For example, the Pennsylvania State University has an Institute for Research on Land and Water Problems, recognizing the interrelatedness of such problems, while Colorado State University and the University of New Mexico have established natural resources centers.

The establishment of water or equivalent institutes or centers received a major stimulus by the enactment of the Water Resources Research Act of 1964,[20] so that each state now has such an institute or center.[21] This legislation provides for substantial federal financial support of research on water resources, the bulk of which is allocated to or through such institutes or centers. This program is administered by the newly created Office of Water Resources Research in the Department of the Interior. The supported research may include, among other things, research on the hydrologic cycle, supply and demand for water, conservation and best use of available supplies and methods of increasing them, and economic, legal, social, engineering, recreational, biological, geographic, and ecological aspects of water problems. Provision may be made for the training of scientists through such research.

Increased attention is being given to problems of organizing a water resources or similar institute or center. The historically developed attitudes, practices, and customs in a particular university or state will, of course, influence the type of administrative organization. The older organizational structures may have been very well suited to the situation existing when they were devised, but they may not be entirely adequate to meet emerging needs and problems. Hence interested persons in several states may

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[19] For example, Stanford University has established an Institute of Engineering-Economic Systems.

[20] 78 Stat. 329 (1964).

[21] See Renne, *The Federal State Cooperative Water Research Program*, in WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH, Agr. Policy Institute, N.C. State Univ., A.R.I. Series 16, Aug., 1965 at p. 145.

be giving serious thought to possible methods of organization not yet tried out in those states.

A number of the institutes or centers may have no or few permanent employees other than their administrative staff, although some may have temporary employees for particular projects. Such institutes or centers may serve primarily as a supplemental financing conduit for and as a coordinator of research concerning water resources being conducted in the various colleges and departments of their university and perhaps in other universities, institutions, agencies, or organizations in their state. Such coordination might include active promotion of interdisciplinary types of research in problem areas where such research is needed. The institute or center might sponsor, initiate, or participate in the planning of such research and continue as an active adviser in the conduct of the research. The institute or center's sponsorship may be formal or informal. Formal sponsorship of a particular project might depend, for example, on the extent of *interdisciplinary* research envisaged and the project's importance to water resources policy issues. Continuance of the sponsorship might depend on periodic reviews of the project's progress and results.

Some institutes or centers may play a much less active role in this regard, but the designated institute or center for a given state that is to receive federal funds allotted under the Water Resources Research Act of 1964 at least would act as central conduit for the distribution of such funds as are allotted to it and, as such, would serve as some kind of a clearinghouse for research proposals to be supported with such funds. Additional functions of institutes or centers may include arrangement or at least encouragement of contacts and exchanges of information and publications between the researchers and administrators in the various related disciplines who are concerned with research plans, findings, and techniques (including conferences or seminars of an interdisciplinary nature), the promotion of interdisciplinary training, the dissemination of information about or findings of the various research projects to the public, and procurement of supporting funds from various sources.

In a recent discussion of water resources institutes or centers, Dr. John Frey, Director of the institute at Pennsylvania State University, mentioned above, favored the creation of an institute within a university that would employ and bring together a variety of research talents, provide a desirable climate for interdisciplinary research, overcome many communication barriers, and arrange for long-term research contracts. He stressed the need for more attention to economic, social, and institutional aspects of water resources research and more emphasis on interdisciplinary research and group efforts, adding that the knowledge and skills required are often so complex as to exhaust individual competence. He also favored more

centralized direction of research. His institute apparently has such attributes. It is administered by the university's Office of the Vice President for Research. Dr. Frey noted that his university has established a number of such institutes or centers and each has many of the same features.[22]

The University of Wisconsin's Water Resources Center has been established administratively in the graduate school, but it has no permanent research employees to date. It is governed by a director who is advised by an interdepartmental advisory committee which develops policy guidelines and reviews research proposals and products. The center's work is guided by senior staff members of academic departments most directly concerned with water resource problems. When research is proposed by one of them, someone in another discipline may suggest issues, topics, goals, or procedures that ought to be included and may ultimately "team up" or otherwise participate in the research.

The center is organized and functions in a manner rather similar to the university's Land Tenure Center, although that center is administratively located within an academic department, the Department of Agricultural Economics. That center's advisory committee and several of the research workers are on the staff of different departments.[23] Disciplines involved include economics, law, political science, rural sociology, anthropology, commerce, and agricultural journalism.

Some college deans and department heads concerned with such research may tend to be suspicious of separate centers over which they have little budgetary or other control and fearful of raiding of their faculty and competition for limited funds. In such an atmosphere the institute or center may have to fight for available funds and personnel. Moreover, employees of the center, if they have no departmental status, might be thought of and treated as second-class citizens in the university, and they may tend to feel cut off from their colleagues in their discipline in an academic department.[24] They also may have less financial security and

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[22] See Frey, *A Commentary on Water Resources Research*, WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH, *supra* note 21 at 155-58. Dr. Frey's paper was one of five papers discussing water resources institutes. *Id.* at 143-72.

Dr. Frey has indicated that a study of the economic and social impact of highways (which is being conducted by a variety of economists and sociologists and regional and transportation planners) is being jointly conducted by this institute and the University's Institute for Science and Engineering and Highway Impact Research Project in cooperation with the State Department of Highways and the Bureau of Public Roads, U.S. Department of Commerce.

[23] This includes senior university staff members and graduate students working for degrees in different departments. However, some research assistants who are not graduate students and a number of research workers located in foreign countries are employed directly by the Center.

[24] This might especially be true if they move to a new office in an institute or center. On the other hand, such a central complex of offices may tend to promote

more problems in obtaining tenure and promotions. Hence, they may be reluctant to accept permanent research assignments with such a center, although they may more willingly accept temporary assignments during the summer or otherwise. Such temporary assignments have certain advantages, but they may impair continuity in the research work of the institute.

To help alleviate such problems in the Pennsylvania institute, Dr. Frey indicated that all employees with faculty status who work in the institute are also given appointments in academic departments and are encouraged to teach in them.[25] The latter recognizes the desire of a number of university faculty persons to combine teaching and research. He also said that his institute strives to be self-supporting. It may be noted in this connection that the probability (although not certainty) of continuous federal financial support under the Water Resources Research Act of 1964 may make it more feasible for an institute or center to directly employ permanent research workers, and persons in academic departments might be less reluctant to take such assignments. Much of the federal funds available to such institutes or centers do not require matching local funds.

There obviously would be some problems in deciding what research can be most effectively done within such an institute rather than by coordinated research in the academic departments. Dr. Frey indicated that his institute gives major attention to those interdisciplinary research projects that cut across college boundaries within the university and to new rather than existing lines of research.

Some institutes or centers may have an executive governing committee or board (especially if they are a cooperative venture of two or more universities) and one or more larger advisory committees. The latter may be composed of administrators or research workers in several different disciplines within the university where the institute is located as well as in other universities, institutions or organizations, federal, state, or local governmental agencies, or private businesses within the state.[26] The Pennsylvania institute draws upon numerous technical committees for assistance, but Dr. Frey has warned against the overburdening of interdisciplinary research with "top-heavy" interdisciplinary administrative arrangements.

The directors or other top administrators of such an institute or center will not have been trained in all of the disciplines involved in water re-

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and facilitate frequent interdisciplinary contacts and joint interdisciplinary research and planning.

[25] Such joint appointments of various types may be worked out in several universities. However, they may present some problems with respect to promotions and such matters that may be hard to solve.

[26] Such institutes also may temporarily employ or arrange for the services of non-university researchers in the conduct of research projects.

sources research, but they should have a broad outlook and some experience in working with or contacts with other disciplines.[27] If the director is trained primarily in the social sciences, it may be desirable for him to have an associate director trained in the physical sciences, or if he is a physical scientist, as many are, he might have a social scientist as an associate.[28]

## SOME CONSIDERATIONS REGARDING REGIONAL RESEARCH[29]

An earlier discussion of the methodological problems in legal-economic research has indicated that much of the interdisciplinary research involving law and economics is suited to the regional approach.[30] Regional research in this case, and through most of the following discussion, has reference to regions composed of two or more states rather than to regions within a state. Two major advantages of a regional approach were given in the discussion. First, the variations in legal means between states may be appraised in relation to each other. Second, regional research provides a means for more efficient use of scarce research personnel and funds.[31] Examples given of cooperative interdisciplinary regional research were the Legal Aspects Subcommittee of the North Central Land Tenure Research Committee (NCR-6), North Central Region Project NC-15 "Problems and Practices of Young Farmers in Getting Established in Farming," and North Central Region Project NC-57 "Economic and Legal Factors in Providing, Using and Managing Water Resources in Agriculture."

The organizational structure of these examples is that developed to conduct cooperative regional research authorized by section 3(c)3 of the Hatch Act, as amended.[32] The fund for supporting regional research is

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[27] It may be noted that the University of Wisconsin has initiated a master's degree program in water management which provides broad interdisciplinary training.

[28] Or, in the case of a very large institute, it may be feasible to have two or more assistant directors each of which might be trained in a different discipline from the director and each other.

[29] While the following discussion touches upon a number of general considerations that may be involved in any type of regional research, particular attention is paid to such considerations in relation to legal-economic research. Furthermore, regional water resources studies have been chosen as particular cases in point as a logical extension of the foregoing discussion of legal-economic and related research regarding water resources generally. The fact that a regional study is concerned with water resources may give rise to somewhat different considerations than other types of regional studies. Also, certain difficulties encountered may be due to the nature of either legal-economic, regional, or water resources research, or to some combination of some or all three considerations.

[30] Timmons, *Methodological Problems in Legal-Economic Research*, LEGAL-ECONOMIC RESEARCH, Agric. Law Center Mono. No. 1 at 37 (1959).

[31] *Ibid.*

[32] See 7 U.S.C. §361c(c)3 (1964).

designated as "Regional research fund, State agricultural experiment stations." Hereinafter, this fund will be referred to as simply Regional Research Fund or RRF. This structure will be reviewed and evaluated with reference to the legal-economic research presently under way under NC-57.

The Regional Research Fund was established with the objectives of:

1. Stimulating and facilitating inter-state cooperation on research of a regional and national character, both between agricultural experiment stations and with the U.S. Department of Agriculture;

2. Planning and coordinating research to avoid duplication in research effort; and

3. Organizing regional technical committees consisting of state and federal representatives to plan and coordinate work on regional and national problems.[33]

Regional research in this framework is seen as having two distinguishing characteristics that sets it apart from other types of research:

1. The research must focus on a specific and important problem of concern to two or more states, which can be attacked more effectively by a regional approach than by individual stations working independently along the same lines; and

2. The research must be planned and conducted as a concerted team effort in which the participating scientists are mutually responsible for accomplishing the objectives.[34]

The administrative organization for the Regional Research Fund begins with the Secretary of Agriculture. He, in turn, has delegated his responsibilities to the Cooperative State Research Service. This agency administers the RRF and, in consultation with the Committee of Nine and the state experiment station directors, sets forth the procedures for regional research. The Committee of Nine is a statutory committee of the U.S. Department of Agriculture, elected by and representing the directors of the state agricultural experiment stations. The primary duty of the committee is to recommend cooperative regional projects for approval by the Secretary of Agriculture. The committee also develops broad policies and procedures for regional research, reviews and evaluates progress in regional research, recommends changes in scope and direction, recommends allotments of the RRF, and promotes interregional coordination.

The directors of the experiment stations are organized into regional associations, one for each of the four agricultural regions of the United States. These associations select problems, prepare annual research programs, approve regional publications, and designate administrative advis-

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[33] USDA, *Cooperative State Research Service*, MANUAL OF PROCEDURE FOR COOPERATIVE REGIONAL RESEARCH, Washington, D.C., November 1963, p. 2.

[34] *Ibid.*

ers for technical committees. Each association has a regional research committee to assist in reviewing and making recommendations regarding regional research.

The administrative direction of the planning and operation of a regional project rests upon a research administrator designated by the regional association of directors to be the administrative adviser. This person organizes the technical committee and presides at its first meeting pending election of a chairman. After the committee is organized, he performs in an advisory capacity and in a liaison role between the committee and the regional association of directors.

The regional technical committee has the key responsibility of planning and conducting an approved regional project. The committee includes a technical representative from each of the experiment stations in the region, a representative of each cooperating federal agency, a non-voting consulting representative of the Cooperative State Research Service, the administrative adviser, and other consultants as deemed appropriate. The committee prepares the regional project outline, reviews plans and progress of participants, reviews and evaluates research progress, provides leadership in preparing publications, and coordinates research activities of the participants. The committee may hire a regional coordinator to assist in the conduct of the project. This person performs a liaison function between participants and assists the committee in the preparation of reports and manuscripts including participation in the gathering and analysis of data.

Each experiment station director has a key role in the conduct of regional research. He must determine if his station can make an effective contribution to the project and insure that it receives adequate support, both financially and otherwise.

This rather detailed organizational structure would appear to provide the means of pursuing regional legal-economic research so as to achieve the two main advantages cited earlier. In fact, such research is currently under way in regional project NC-57. Its technical committee, of which some of this workshop participants are members, is composed of both lawyers and economists.

The objectives of NC-57 describe the legal-economic character of the project. They are:

1. To determine the economic considerations that affect use and management of water in agriculture and competing uses.

2. To identify and describe rights in water and the administrative arrangements that regulate water use in the several states.

3. To analyze the economic consequences of different systems of water law with particular emphasis on the laws of the states in the North Cen-

tral Region, but including comparisons with legal systems in use in other regions.

4. To develop principles which will serve as guidelines in efforts to bring about optimum management and use of water resources.

The NC-57 technical committee is composed of a representative from each of the state experiment stations in the North Central Region and from the Economic Research Service, USDA. Non-voting or consulting members include the administrative adviser, a representative from the Cooperative State Research Service, USDA, and the regional coordinator. Technically speaking, the lawyers on the committee usually are not voting members. This has occurred largely because the state experiment stations do not contain a law school, and thus the directors cannot possibly appoint lawyers to a regional committee unless the economics or other departments within their station have lawyers on their staffs. The current membership list of the committee contains one lawyer as a voting member and four lawyers as non-voting members. Two of these individuals are trained as both lawyers and economists.

The executive committee of NC-57 is composed of the chairman, vice-chairman, secretary, the immediate past-chairman, and the administrative adviser. This group is authorized to conduct the business of the technical committee in the interim period between annual meetings. This includes reviewing projects proposed as contributions to the regional project, reviewing publications, coordinating the work of contributors, and such other tasks as may become necessary in the conduct of the project. The executive committee does not currently include a lawyer as a member. This is a possible weakness in that the legal research of the project may not receive adequate expert attention throughout the period between annual meetings.

Currently, nine of the thirteen states in the North Central Region and the Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture have projects contributing to the regional project objectives. By and large, the economic and legal research in these projects have progressed independently of each other. The legal research thus far has consisted mostly of determining and describing water law and water rights within the states. Economic research has concerned itself with various economic aspects of water use problems important to each state. The general approach so far is toward a "layered" type of research product. Joint research attempting to combine the two disciplines appears to have been limited to only a few projects. However, some interdisciplinary research planning has been accomplished and discussions in the committee meetings have made the persons trained in one discipline more aware of

and knowledgeable about the other discipline, and more research of an interdisciplinary nature may thus be generated (although a number of the lawyers have not regularly attended the meetings as the meetings have been limited primarily to those who are actual committee members).

Lawyers have been brought into this research framework by two means. The first of these is by having the respective state experiment stations and federal agencies employ lawyers or lawyer-economists directly on their staffs and perhaps appointing them directly to the technical committee. The other is by economist committee members seeking out and enlisting the aid of lawyers in their respective state law schools by various means of transferring funds. Two basic problems may need to be overcome in the latter method. The first may be to find a lawyer interested in the particular research problem who is also willing to engage in a cooperative effort. The second may be that even if such a person is found, the unfavorable situation or attitude of some law schools regarding such research, discussed earlier, may hinder the efforts to formulate a joint project. However, one of the most basic problems yet to be resolved is only partially affected by an administrative organization. That problem is concerned with how to effectively merge law and economics into a single research effort. The experiences under NC-57 seem to indicate that there is much work yet needed to adequately conceptualize a research problem to optimize the joint contributions of these two disciplines. As noted, the NC-57 committee's work has so far largely resulted in a layering of economic and legal knowledge about water use in the North Central Region. The group has not yet found the key to effectively combine these layers of knowledge into a truly interdisciplinary treatment of water problems.

Why is this so? Perhaps the approach being used is yet too general. The objectives for this project are quite general in that they do not deal with any specific problems. The region included in the study is quite broad in a geographic sense, and a wide variety of water use problems are present. The result is that the primary concern of the individual states is widely varied. This is further complicated in that there is a wide variation in state water law within the region. Some of the states are in the humid eastern side of the country while others are in a semi-arid part of its western side. Therefore, the committee felt that a broad general regional project was necessary to permit participation by all the states of the region. It was further thought that not enough was known about water resource problems throughout the region and various methods of conducting research on such problems to intelligently select one over-all problem for investigation. The result is that the project does not focus on a single regional problem but includes a wide range of water use problems in a general knowledge-seeking approach. There is a definite need to consider specific

situations to determine how and to what degree water law interrelates with economic factors to influence water use and allocation among uses and users. The committee should perhaps utilize the knowledge accumulated from its research to select specific-type situations in selected states for intensive interdisciplinary effort.

Although this particular type of regional research framework provides a means of using scarce research resources in a more efficient manner, there are several practical problems in implementing regional interdisciplinary research. The problem of working legal research and lawyers into the state experiment station research program has been mentioned. One further aspect of this may be the problem of convincing some state experiment station directors or department heads of the need for spending limited research funds for the services of law school personnel which are under a separate administrative structure or even in another university. Communication and coordination of the separate contributing agencies is another problem. The problem increases with the number of participating agencies. It is also more critical if the regional project is a specific problem requiring specific interrelated parts to be accomplished by separate agencies before the final results of the whole project may be determined. Such a specific project may require that certain contributing efforts be completed before others dependent upon the results may go ahead. A more general approach with separate independent contributing projects does not require the same degree of coordination.

It also can be argued that a committee-type organization may not be particularly efficient. It may draw upon the talents and resources and may tend to coordinate the efforts of several persons and institutions or agencies. But it may be more difficult to reach agreement on such things as the research problems, goals, and methods of procedure. Each state representative may have a different attitude regarding the problem to be attacked. This has tended to be the case in NC-57 where the specific problems important to each state are different. The result may be a generalized approach that may not fully exploit the advantages of a regional approach. However, it has promoted research on a variety of water problems and may help to delineate the major problems in the region or its subregions regarding which more coordinated research may be conducted later. It also has promoted the testing of various research methods.

The particular method of administering monies from the Regional Research Fund may inhibit regional research. Funds from the Regional Research Fund are allocated to each state experiment station for the director to allocate to eligible research contributing to an approved regional project. This means that although a representative on the technical committee from an experiment station may have a regional research responsibility,

the decision as to whether the research is funded rests entirely with the director. If the director feels that the project is of low priority, he may choose not to fund it. At one time, the policy was to allocate the regional project funds to the technical committee for allocation to eligible contributors. This procedure would seem to permit greater flexibility in the use of funds, particularly if the committee felt that the funds should be concentrated in a few locations to make use of particular facilities and personnel, although it may, of course, tend to reduce the individual director's powers and flexibility.

The Water Resources Research Act of 1964 mentions regional research that may be conducted by the water institutes or centers provided for in the legislation. Under Title I, Sec. 100 the act states, ". . . two or more states may cooperate in the designation of a single interstate or regional institute, in which event the sums assignable to all of the cooperating states shall be paid to such institute." The specific organizational structure of such an institute is not provided for in the act and would probably have to be determined by the cooperating states. No such interstate institute has been established to date.

The act alludes to another type of regional research organization in Sec. 101 under Title I where matching funds, when appropriated, ". . . shall be available to match, on a dollar-for-dollar basis, funds made available to institutes by states or other non-federal sources to meet the necessary expenses of specific water resources research projects which could not otherwise be undertaken, including the expenses of planning and coordinating regional water resources research projects by two or more institutes." Again the specific administrative organization of such regional projects would presumably be left up to the cooperating institutes. The difference between these two types of regional research appears to be that in the first case a single regional institute would be established, whereas in the second case cooperation between two or more institutes is envisioned. No such regional projects have been initiated as yet in the region encompassed by NC-57; but the water resources institutes or centers in the northeastern states have recently held a regional meeting, and some cooperative research possibilities have been considered. The NC-57 technical committee conceivably may be able to enter into some type of cooperative arrangement with such regional projects, institutes, or centers.[35] However, legal

[35] As a minimum, the NC-57 committee might sponsor or participate in regional conferences in which water resource institutes or centers also participate. The Northeast Regional Research Economics Committee and the Cornell University Water Resources Center have co-sponsored such a conference to which water resource institutes or centers were invited as well as a number of state and federal agencies. See Preliminary Report, The Northeast Research and Training Conference on the Supply and Demand for Water, Cornell University Water Resources Center, June 1-2, 1965. The

requirements in the formation and operation of such a committee may present some difficulties in endeavoring to obtain the cooperation of non-agricultural scientists, if desired.

Some mention also should be made of various organizational vehicles for conducting intrastate regional research of an interdisciplinary nature. It may be noted, for example, that the Louisiana Water Resources Research Institute has initiated a study of alternative measures for protecting groundwater resources in the Baton Rouge area from degradation due to the intrusion of saline water. The study was proposed and apparently is being conducted by researchers in four different disciplines—civil engineering, geology, law, and economics.[36]

Recent requests for help made to the University of Wisconsin from "regional" planning commissions in the state and from the state planning division have resulted in the initiation of a pattern of working relationships involving two or more disciplines which promises to expand in the future. For example, a law professor and an economist are currently working on some problems of implementation to achieve planning goals in southeastern Wisconsin. This work is being done under the auspices of the Southeast Wisconsin Regional Planning Commission representing seven counties containing 45 per cent of Wisconsin's population. This advisory agency was created by the governor under enabling legislation some years ago. Here the regional or state agency provides the formal organizational structure for the joint research. Members of the university's interdepartmental river basin planning seminar have been particularly successful in building contacts with these agencies, contacts which now promise to bear fruit in wide-ranging research carried out by university personnel.

In subject-matter areas such as water resources, the boundaries of relevant areas for such regional studies, such as river basin areas, may overlap state or national boundaries and may call for the consideration of interstate or international organizational arrangements. Just a few of the numerous possible examples include the Great Lakes Commission, the Wabash Valley Interstate Commission, the Ohio River Valley Water Sanitation Commission, the Delaware River Basin Commission, and the International Joint Commission (United States and Canada). Although some of these bodies may be primarily concerned with the development or execution of

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NC-57 committee has voted to invite a representative of the Office of Water Resources Research, U.S. Department of the Interior, to attend its next regular meeting to discuss the role of such institutes or centers and possible avenues of cooperation. It may be noted that some members of the committee are also associated with such institutes or centers.

[36] See Dantin & Kazmann, *Louisiana Water Resources Research Institute*, WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH, *supra* note 21 at 165-72.

policies, some may have research staffs or may let research contracts that may involve research of an interdisciplinary nature. Other bodies that may similarly get involved in such research include the various temporary river basin planning commissions authorized by the Congress or commissions created under the Water Resources Planning Act of 1965.

Various federal agencies, public or private foundations, or other institutions or organizations may provide funds through grants or contracts to conduct regional research (as well, of course, as research that may directly concern only one state). For example, the U.S. Department of Agriculture contracted with the University of Wisconsin to conduct a study of legal and economic aspects of water rights in four midwestern states (Minnesota, Wisconsin, Indiana, and Ohio).[37]

Federal governmental employees may directly take part in legal-economic or other research of an interdisciplinary nature and may be of particular assistance in helping to plan and conduct regional or nationwide research that may be beyond the scope of research usually conducted in any one state or even beyond the usual scope of regional groupings of states. For example, the University of Wisconsin's research on legal, economic, and related aspects of water resources is augmented by the work of two of the authors who are employees of the U.S. Department of Agriculture located at the university.[38] One is an economist and the other is a lawyer and economist. One is coordinator of the regional NC-57 technical committee mentioned earlier. The other provides leadership for a series of studies of water rights and related laws in the thirty-one eastern, sometimes called "humid area," states.[39] Both cooperate with the university in its related research on water resources and, among other things, are providing leadership for a legal-economic analysis of irrigation in Wisconsin which hopefully will make a contribution to the solution of problems within the state as well as to the broader research programs in which the Department is engaged.

Federal agencies also may be of special service in disseminating useful information among research workers. For example, the U.S. Department of Agriculture has prepared a bibliography of publications in the United States on water rights and related subjects.[40] The new Office of Water

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37 R.M.A. Contract No. 12-14-100-1010(43). One of the authors, J. H. Beuscher, served as the supervisor of this research while another, Harold Ellis, served as the Contracting Officer's Designated Representative. It also may be noted that the Public Health Service has provided funds for a study of arrangements to secure sources of water in North Carolina undertaken by the Institute of Government and School of Public Health, University of North Carolina.

38 See note 1, *supra*.

39 Somewhat similar research also is in progress regarding the western states.

40 Turney & Ellis, *State Water-Rights Laws and Related Subjects: A Bibliography*. USDA Misc. Pub. 921, Dec., 1962.

Resources Research in the Department of the Interior has prepared a compilation of federally supported research projects,[41] to be followed by one on non-federally supported research projects. These are but some of the ways of facilitating exchanges of information or other communication among the research workers dealing with related research problems throughout the country and the world.[42]

## COMMENTS

E. S. Bagley*

In preparing my discussion of this paper, I made the unresearch-like prejudgment to have nothing but praise for it because of the uneven match —three authors to one discussant. Fortunately for me, one of the co-authors is not present. Fortunately also, these people are seasoned veterans whose work affords outstanding examples of legal-economic research. If anyone knows what he is talking about on this subject, they do, so I was confident beforehand that anything they said would be praiseworthy.

I do not feel qualified to discuss this topic, but this seems to be part of the master plan for this workshop—economists' papers are discussed by lawyers and lawyers' papers by economists. I have had no experience in organizing or administering research, and what knowledge I have on the subject has been acquired by being on the receiving end of organizational efforts. For that matter, I am not sure that anyone knows much for sure about organization for research. This is a question which itself needs to be researched more fully. And it is not an easy question to answer, partly because of the difficulties in evaluating research. Valuable research is often unappreciated and virtually unnoticed for long periods of time, and great volumes of work is done in the name of research which is not worth much.

At the outset, may I say that I found the paper to be highly informative and interesting. It contains more material than could possibly be discussed in the time assigned, and I have decided not to comment on two matters which the paper deals with which appear to be somewhat tangential to the main topic, although not irrelevant.

The first of these is the discussion of the Agricultural Experiment Station organization for regional research in law and economics pertaining

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[41] Water Resources Research Catalog, Part 1 Federally Supported Research in Progress. OWRR-1/1, vol. 1, Feb., 1965.

[42] Examples of national organizations that have promoted such communication include the Universities Council on Water Resources and the National Academy of Sciences.

The Food and Agriculture Organization of the United Nations, among other organizations, has conducted research on related foreign laws and institutions. See, for example, Groundwater Legislation in Europe, F.A.O. of the U.N., Rome, 1964.

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to water resources. This is an excellent description of this somewhat intricate organizational arrangement. I learned more from it about how these activities are carried on than I have from several years participation in them. It deals more with the problem of regionalizing such research, however, than with the problem of integrating legal and economic disciplines. I concur in the judgment that to date the legal and economic efforts in these projects represent "layers" rather than "compounds."

There are obvious inherent defects in this organizational arrangement for legal-economic research on water. The law schools are not in the schools of agriculture and often not even on the same campuses. The agricultural emphasis is itself a limitation in research on water law and economics. The authors have noted ways which have been devised to overcome these deficiencies, and in some cases they have apparently rendered the deficiencies inconsequential. In the field of water research, as the authors have also noted, the new Water Research Institutes will not suffer from the constraint of being housed in schools of agriculture which might be expected to facilitate an interdisciplinary approach to water research.

The other question which I shall not discuss is the problem of involving researchers outside the academic field in legal-economic research. There is interesting discussion in the paper of how government researchers in the Department of Agriculture, for example, are brought into research efforts with academicians and of how public planning agencies and administrators of laws are utilizing academic researchers. This question is also somewhat indirectly related to the main topic of organizing for legal-economic research. It may be quite relevant, however, for the specialization and fragmentation of disciplines which occurs on the campus may itself be a handicap to legal-economic research. Organizations outside the university, which are problem-oriented, such as public planning agencies, may find it easier to take an interdisciplinary approach in their studies. My vested interest in the academic institutions leads me to hope that ways can be found to overcome the barriers of disciplinary narrowness, and I believe, moreover, that the universities have some unique advantages for research, especially basic research. The Water Research Institutes afford an example of an organizational arrangement, within the academic field, which may help surmount the walls of disciplinary provincialism.

It may also be apropos to repeat the oft-stated complaint that public policy determinations frequently do not make use of academic research findings. More coordination here is indeed needed. In the water field again, for example, we have in Kansas academic types in two universities, a water resources planning board unconnected with the universities, a division of water resources which administers the Kansas water law, and

several other action agencies with responsibilities in the water field, all engaged in some research activities. And now we have the new Water Research Institutes. All of these agencies are charged to cooperate with one another, but to date there has not been much truly joint effort in research. The new Kansas Water Research Institute has representation on its governing commission from both universities and from the water resources planning agency, which should promote coordination in research efforts.

I have already used up much of the time telling you which topics in the paper I was not going to discuss and why. I do have a few comments about the main topic of the paper—organization for legal-economic research.

First of all, I would have appreciated a distinction between the question of organization for research generally and that of organizing for legal-economic research. Many of the observations made by the authors appear to be applicable to organizing for research of any kind and not unique to legal-economic research.

The main points made about organization for legal-economic research centered around the problem of getting both lawyers and economists involved in the same research endeavor. Numerous organizational arrangements which have been devised for legal-economic research are cited and commented on. The impression comes through that the authors have found existing organizations not well-designed for such research. Many of the examples cited appear to be expedients to remedy weaknesses in existing organizational setups.

The authors seemed especially concerned with difficulties in drawing lawyers into the joint efforts. The point was made that the law schools are not research-oriented. They are said not to have funds for research and to be preoccupied in performing their teaching functions. Typically, legal-economic research is initiated outside the law school, and lawyers, if involved at all, are brought in as consultants, in some sense as outsiders, a role not attractive to them. As an economist who has on occasion endeavored to interest legislative planners in the water resources field in economic analysis, I find this situation in legal-economic research somewhat surprising, to say the least. The field of water resource law-making and administration has not been characterized by reticence on the part of the legal profession. Indeed, this aspect of water resource activities has traditionally been the domain of lawyers and physical scientists—it is the economists who have been outside looking in. Economists have participated in water resource planning only in a few states and then only recently. In some cases the participation might be better described as intrusion. It may be true that attorneys on law school faculties have remained some-

what aloof from legislative planning—if so, the above comment may not be entirely warranted.

While I would concur in the recommendation for training more versatile researchers, I do not believe we can rely on or wait for such generalists as economist-lawyers, or better still (in the water field) economist-lawyer-hydrologists. I would venture the conjecture that much of the best legal-economic research in the field of water resources to date has been the product of individuals—individuals not trained as generalists but who have developed broad interests and understandings. I would cite the work of Hutchins, Trelease, Wantrup, Thomas, and Ellis. In this group are attorneys, a geologist, and an economist. Whether this is evidence that versatile individuals rather than groups of cooperating specialists will be most productive in legal-economic research I do not know—I do not make this claim. The result might be due to the difficulties heretofore experienced in organizing cooperative endeavors in legal-economic research. In any case, in these days of increasing specialization, I suspect that specialists will continue to be needed. At the research planning level individuals with a broad outlook and varied training and experience can be particularly useful, but we will continue to find it necessary to call on the specialists to contribute their bits and pieces to the whole. After all, law and economics are only two of the disciplines which should be included in well-rounded research for planning purposes. In water, for example again, hydrologists, geologists, and many others in technical fields are needed. It may be possible to train a lawyer-economist who is outstanding in both fields, but it is highly unlikely that many people can become expert lawyer-economist-hydrologist-geologist-engineers. We will have to try to avoid both dilemmas illustrated by the old sayings, "Jack of all trades and master of none" and "too many cooks spoil the broth."

Although it may be extraneous and, in an already overlong discourse, uncalled for, I would like to make a plea for more legal-economic research.

The problem of technical research data not being suitable for economic analysis is well known. In many cases, had economists been consulted in planning the research, data in the form suitable for economic analysis could have been obtained. Similarly, statutes intended to achieve certain economic ends would be better designed to do so if economists participated in their drafting.

It should be remembered, of course, that economic considerations are not necessarily the only factors of importance in legislation. Consider the following quotations from a report on water rights law made by the Kan-

sas Water Resources Board.[1] Concerning the appropriation doctrine it is stated:

"In times of water shortage a system of priority seems harsher and less just than a system based on the idea of proration."

"It insures necessary investment stability, spurring water resource development and protecting the interests of those who develop."

". . . a sound appropriation doctrine stimulates a free enterprise system of water resource development."

And concerning the correlative rights doctrine, we find in the same report the statements:

". . . the emphasis on sharing a common supply for reasonable beneficial uses embellishes the rule with a certain dignity and fairness . . . at least to those entitled to use the waters."

"It gives a relatively few individuals control over a vital, transitory resource to the prejudice of rural and urban communities."

In these statements both economic and non-economic criteria are employed. Fairness, justice, equality are mentioned, as are also stimulation of water resource development and promotion of a free enterprise system.

The question for the researcher is whether or not these doctrines do in fact have such results, not the question of which ends to choose. It is obvious that interdisciplinary research is needed to assess the various kinds of effects. The statements above were made by lawyers and engineers, not by economists, although they assert economic effects.

It is interesting to note that Piper and Thomas, U.S. Geological Survey hydrologists, have a different view of the effects of the appropriation doctrine on free enterprise. They stated in 1958, "one principle of the appropriation doctrine—that ownership of all water supplies rests in the 'public' collectively—will become widely accepted . . . in other words, the appropriation doctrine will become coupled to the police power of the state, to the end of optimum advantage to the general public welfare."[2] In still other words, they seem to be saying that this doctrine seems to facilitate public rather than free market decision making in water allocation. This is the kind of a question economic research might be expected to help answer and it is a question which will undoubtedly be of significance in policy formation. If economists participate with other investigators in analyzing these doctrines, the findings on economic effects are more likely to be reliable and probably better coordinated with non-economic analysis.

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[1] *Report on the Laws of Kansas Pertaining to Beneficial Use of Water,* Bulletin No. 3, Kansas Water Resources Board, 1956.

[2] Piper & Thomas, *Hydrology & Water Law: What is Their Future Common Ground,* WATER RESOURCES & THE LAW, University of Michigan, 1958.

Returning to the subject assigned to me, I would call attention to one disappointment I felt in reading the Ellis-Rose-Beuscher paper. I did not find any recipes for organization to conduct legal-economic research. There was an interesting recital of arrangements being used and some perceptive observations concerning their efficacy, but no blueprints for a panacea. It is perhaps an indication of the state of knowledge on this subject and reflects credit on the authors that they refrained from making lightly supportable proposals.

I am inclined to agree with the statement in the first paragraph of the paper that success in legal-economic research depends on the attitudes and abilities of the people involved and cannot be guaranteed by organization. I also suspect that the assertion that organization is nonetheless important is also valid, but the paper does not offer many testimonials or other evidence in support of this.

Surely organizational arrangements which keep lawyers and economists apart in research efforts or fail to provide financial support for joint efforts are not conducive to legal-economic research. Beyond this, I am not sure what else can be said on the subject at the present time with any degree of certainty.

# SUMMARY OF WORKSHOP

Clayton Yeutter*

The intent of this paper will be to: (1) re-emphasize the major points of each individual paper; (2) critique the papers, hopefully without duplicating comments by the discussants, and (3) foresee and contemplate legal-economic research of the future.

*Legal-Economic Research in Theory and Practice*[1]

Harris and Hines have done a superlative job of placing legal-economic research in a vivid, historical perspective. Although research in this area has expanded rapidly over the past two decades, the authors point out that it has usually grown like Topsy. Perhaps, they suggest, it is time that some thought be given to just what legal-economic research is and to how it should be conducted.

The authors define legal-economic research as:

> [B]asic and applied research accomplished by the use of recognized methods of both law and economics, and designed to integrate the learning and analytical techniques of the two disciplines in the study of agricultural problems that overflow disciplinary lines in their causes, effects, and possible solutions.

This definition is a bit long and quite innocuous, but comprehensive and certainly satisfactory. Then, however, the authors stray into a terminological maze by attempting to define the objectives of basic and applied legal-economic research. Included as basic research efforts are: (1) developing underlying theory, (2) discovering fundamental principles, (3) establishing interrelatedness between the legal-institutional situation in which agricultural commodities are produced and the economic well-being of those engaged in the productive process, and (4) proposing realistic alternative means of remedial action to improve the legal-institutional milieu and the economic framework in which agricultural production takes place. The first two points are fully recognized as being essential elements of basic research, but the third is too nebulous, and the fourth shades into applied research. The objective of applied research is then declared to be that of presenting the legal and economic facts under which agricultural production takes place to all decision-making groups, in order to furnish such groups with ways and means of improving their decision-making process. I find little in the authors' statement or discussion which would differenti-

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[1] The reader will note that more attention is given this paper than any other. The reason for this is that it is a broad, general, keynote-type presentation which is more adaptable to use in a summary than are the more specific papers.

ate this from the fourth objective of basic research. Nevertheless, so long as researchers are functioning, the title by which their efforts is delineated would seem to be relatively immaterial.[2]

Harris and Hines classify legal-economic research into three stages—*cooperation*, *coordination*, and *integration*. The first is described as a layering of law and economics, with representatives of the two disciplines working and writing separately, but in the same general problem area. This undoubtedly characterizes most legal-economic research, even today, and the authors hope to spur some soul-searching on this point. They chide their colleagues (in both disciplines) by elucidating the benefits of research coordination, where the lawyer and economist work together in defining the problem, collecting and analyzing information, and reporting research results. Harris and Hines suggest integration as an ultimate goal for legal-economic research, but do little in the way of distinguishing integration from coordination. Presumably the trek from cooperation to integration is a matter of degree. The latter term can, of course, be defined most readily by reference to persons who have both a law degree and a graduate degree in economics. Despite the obvious advantages of such a combination, it is unlikely that much future integration will be accomplished in this manner. Few people are willing or able to make the sacrifices of time and money that are required; and, beyond this, even these integrated individuals will have particular interests that will be reflected in their research activities.

The Harris and Hines three-stage system connotes cooperation as being better than nothing in the way of legal-economic research, but not much better, with integration being the desired type. Such a connotation may, however, inadvertently and unintentionally mislead researchers. It would be unfortunate if lawyers and economists would seek to integrate *all* their research efforts, and even more unfortunate if they were to discard research proposals simply because the legal and economic aspects could not be fully integrated. Research must be *problem* oriented and *people* centered. Many problems are primarily legal, and only secondarily economic. With others the emphasis is just the reverse. In either of these instances, a layering of effort may be desirable. Why ask an economist to participate in all steps of a legal research project that has nominal economic implications? This would ignore the opportunity cost that must be placed on the contribution of the person representing the supporting discipline. In addition, the physical factor of distance may often prohibit integration, even where such would be most desirable. Integration may readily be achieved at the Iowa Law Center, where the economist and lawyer are officed in the same build-

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[2] Except perhaps to administrators.

ing, or at the Universities of Wisconsin or Nebraska where the Law College and Department of Agricultural Economics are on the same campus; it is not so readily achieved, for example, at South Dakota or Kansas where they are located at separate institutions. And, finally, integration will occur only when the lawyer and economist are personally compatible. Personal whims *could* have an adverse effect on cooperation; they more likely *would* have an adverse effect on coordination and integration.

In integration, Harris and Hines find that the duality of law and economics has disappeared and that the two disciplines are joined together to make "one whole, entire, unified product." This statement proves to be too much. One doubts that even integrated legal-economic research should be characterized as perfection epitomized.

The authors go on to suggest that with this legal-economic nexus, a separate discipline will emerge, something akin to nineteenth-century political economy. But researchers are in business to solve problems, not to establish disciplines. If a problem has both legal and economic implications, representatives from both fields should be used in solving it. They should cooperate, coordinate, or integrate, whichever is most appropriate in a given situation. By the same token, if the problem has both political and legal implications, political scientists and attorneys should join in achieving a solution. In neither case is the development of a new, composite discipline an essential, if even a desired, result. Admittedly, the problems of today are far more interdisciplinary than they were 100 years ago. This is one variable that is certainly significant in explaining the surge of legal-economic research that has occurred. But other disciplines as well can, should be, and are integrating, within a problem-oriented, not "discipline"-oriented, approach.

Legal-economic research should be broad in scope, with a philosophy capable of dealing with a multitude of issues. Attorneys and economists engaged in this type of activity must continually re-evaluate their programs to insure that the scope has not become inordinately circumscribed. The North Central Land Tenure Research Committee has, for example, created a special Subcommitee on Legal Aspects. Over the past ten years, the subcommittee has made many fine contributions to the development of legal-economic activity in teaching and extension, as well as in research. But there is always a danger of interests becoming too narrow, particularly among the lawyer members. If and when this occurs, other subcommittees and committees may be deprived of legal research assistance that would make a more valuable contribution to the over-all regional research program.

Harris and Hines suggest that almost all the ills of legal-economic research fall into two categories: an unhealthy intellectual climate and in-

adequate methods and techniques. With respect to the intellectual climate the authors list a number of factors which continue to hamper interdisciplinary research. Included are:

1. The presumption of inferiority that each discipline often accords to research performed in collaboration with the other.
2. The insistence by each discipline that the other merely justify, facilitate, implement, complement, or supplement research endeavors of the former.
3. The omnipresent technical vocabulary of each discipline that not only frightens the other, but most of the rest of society as well.
4. An exaggerated and unjustified attitude of self-sufficiency—an adult, "I would rather do it myself," philosophy.
5. A professional pride that permits one discipline to do no more than peacefully co-exist with the other.
6. An urbanized bias against agricultural research.

The discussion of the above points is one of the highlights of the Harris-Hines presentation. Lawyers and economists alike should read the dissertation and absorb it on a personal basis.

The authors accurately, in my opinion, conclude that economists are less provincial in their attitude than lawyers. For centuries law has been a specialized profession. Agricultural economics, on the other hand, is but one of many allied agricultural fields. Law traditionally has confined its research efforts within rather clearly defined boundaries, usually allied with practitioners rather than with academicians. As a consequence, the first step in legal-economic research generally has been taken by the agricultural economist. There are always exceptions to such a generalization, and time may alter this pattern, but it is not likely to do so in the immediate future. This means that if legal-economic research is to spawn, the initiative ordinarily will have to come from the economist.[3]

As to methodology, the authors recommend that researchers: (1) state their problem, (2) determine their objectives, (3) formulate hypotheses, (4) select a research method, (5) determine and gather the evidence needed, (6) examine and analyze the evidence, (7) formulate conclusions, and (8) report their results. These research steps are not at all new,[4] but

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[3] Part of the difficulty here arises because most law professors are paid to teach. Research adds little, if anything, to their academic reputation or their personal pay scale. In this respect, one might contend that law schools need to join the twentieth century. The day in which a law college may ignore its public responsibilities in the areas of research and extension may soon pass. In the meantime, though, many law professors are on nine-month appointments and would like to engage in research during the summer months. Agricultural economists might wish to "exploit" this fact.

[4] GEE, SOCIAL SCIENCE RESEARCH METHODS (1950) is an excellent publication on this topic.

their reiteration is by no means inappropriate. Both attorneys and economists should, and generally do, follow this sequence when engaging in research, though often not in written, outline form. Attorneys, particularly those who have been in private practice at some time, are more likely to short-cut the procedure than are economists. Research requires patience and deliberation, a point which Harris and Hines seek to emphasize.

Before undertaking a project, the researcher must always make a basic decision as to whether or not the project is worthwhile. Both legal-economic research funds and the researcher's time can be assigned an opportunity cost which must be taken into consideration. How should this be done? Harris and Hines suggest: (1) that the problematic situation be clearly definable,[5] (2) that the research project be designed to point toward an action solution, and (3) that research focus on acute and strategic issues with broad applicability.

The issue of *whether* or not to conduct research is equally as important as the issue of *how* to conduct it. Harris and Hines aptly point out that both are deserving of the utmost in consideration.

*The Legal Researcher's Methods*

This was an audio-visual presentation, the primary purpose of which was to acquaint economists with the basic principles of legal research. Every possible avenue of researching a legal problem is covered in a most comprehensive fashion. Lest economists be dissuaded from ever entering a law library, it should be added that attorneys do not follow each of these steps every time they research a problem. The legal search continues until the attorney decides that its results are adequate for his purposes. "Diminishing returns" is a legal, as well as an economic "law" or phenomenon.

Dolson asserts that ". . . the search for legal authorities involves (1) analyzing the problem, (2) framing the question to be answered, (3) using an appropriate search method, and (4) checking the subsequent history of the primary authority." Note that this procedure is not much different from the research steps enumerated by Harris and Hines. Furthermore, law is becoming com[illegible]terized, just as is agricultural economics. Dolson describes the pioneering influence of the University of Pittsburgh, which has placed numerous statutes, as well as administrative rules and regulations, on computer tape. In the North Central Region, the University of Nebraska has just finished taping and indexing all of Nebraska's statutes. As these endeavors expand to other states, statutory legal research will be

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[5] Meaning that the researcher cannot solve all the problems of the world with one project.

greatly simplified. A research task of the type posited by Dolson, however, will not attain computer feasibility for many years to come.

Dolson gives some attention to *field* research, which contrasts with the usual library research performed by attorneys. As an example, he discusses his own study of the use of installment land contracts in Wisconsin. This involved the examination of recorded contracts in several counties and the interviewing of buyers, sellers, lawyers, and lenders. The purpose of the study was to discover how, where, and why the installment land contract was being used. Much more of this kind of field research needs to be done on specific legal problems as well as on interdisciplinary problems. Lawyers often limit their research activities to issues which may be resolved in a library. As a consequence, they ignore issues, perhaps of major importance, which can be resolved only through work in the field.

*Acquisition of Primary and Secondary Data in Economics*

Among the research steps delineated by Harris and Hines is that of determining the evidence or data needed to test hypotheses, along with gathering and analyzing said data. This is the crux of the Strohbehn paper.

The author points out that much economic research is conducted by use of various sampling techniques. Generally, the cost, in money and time, of testing or examining every element of the population in question is prohibitive. In addition, it may be unnecessary, since a well-designed sample should yield results that are sufficiently accurate to meet project objectives.

If a sample is to be used, where is it to be taken and how large should it be? Strohbehn notes that the question to be answered or the problem to be solved will usually dictate who is to be included in the population, and where that population exists. The size of sample, in turn, depends on which of many possible designs is selected, the degree of accuracy desired, and the cost of collecting data. Since research funds are limited, a judgment decision must be made on all the above items before the researcher embarks on a study.

In gathering information, the economist has a choice of primary data, secondary data, or a combination of the two. *Primary* data come directly from the observational unit. An example might be a personal interview with a farmer. Strohbehn classifies primary data as follows:

1. *Internal records*—account books, income tax reports, etc.

2. *Individual public records*—tax information in the county assessor's office, land title information in the register of deeds office, records in the county office of the Agricultural Stabilization and Conservation Service, and so on.

3. *Surveys–*

(a) *Enumerative questionnaires*–Information of an objective nature obtained by direct questions. Included are input-output data of firms, income and expenses of individuals, and so on. Personal interviews, telephone questionnaires, and mail questionnaires are used in order of decreasing preference (but also of decreasing cost).

(b) *Motivational or attitudinal questionnaires*–Information of a subjective nature also obtained by direct questions. The researcher seeks to determine deep, unobservable, psychological reasons for certain conduct by an individual or firm. An example would be an attempt to discover why people prefer Brand A milk to Brand B milk, or coffee to postum.

Primary data are preferred by the researcher, but often may be too expensive to obtain in the quantity desired. Secondary data, on the other hand, are readily obtainable from sources other than the observational unit. Included are the censuses and many governmental reports, commercial publications of a statistical nature, commentaries on state and federal statutes, and scores of others. Secondary data are often important in the formulation of a problem and in determining its priority. Because they are accessible at little cost, they also are almost always used in the research project itself. Strohbehn adds that secondary data are often presented in series covering several years, thereby affording the researcher with a reliable indication of economic trends.

The author provides two examples of the survey method of collecting primary data, one of which was legal-economic in nature. Dolson's field research on land contracts would be analogous thereto.

*Research Methods Adaptable to Legal-Economic Inquiry: Linear Programming and Simulation*

This article exemplifies fully integrated legal-economic research. Harl, trained in both disciplines, uses both well in a very lengthy and difficult study.

The author is cognizant of the major role played by the doctrine of *stare decisis* as a variable in the law-making function. New law is heavily influenced by both statutory and court-made prior law because of the need for certainty and stability in the political system. Any other result would lead to anarchy and chaos. But Harl also recognizes the growing, expanding influence that social sciences have on the law. If, then, sociological, political, and economic factors are relevant in law-making today, a new dimension has been added to legal research. Now, more than ever before, attorneys must know something about the research methods and methodology of economics and the other social sciences. Without such knowledge legal research, at least for law-making purposes, will be inept and unsatisfactory.

Harl then expands his discussion, declaring that not only do the social sciences affect law, but the converse is also true; law may have an important impact on economic performance at both the micro and macro levels. The author's own research has been conducted at the micro or firm level. His intent was to discover whether a particular legal form of organization affects a firm's economic activity. If it does, perhaps the firm should be reorganized, through legal procedures, so that it may attain its objectives (which, incidentally, need not and may not be economic). Although economists have long assumed a firm's major, if not sole, objective to be maximization of profits, Harl cites recent arguments to the effect that the objectives of a firm might include: survival, maximization of profits, maximization of sales, attainment of "satisfactory" profits, and others. In a close corporation, not only the objectives of the firm, but also the objectives of the shareholders as individuals, are at issue.

Harl sought to measure the economic effects of the corporate form of organization by use of a model encompassing linear programming and simulation techniques. The linear programming portion of the model generates an optimal production plan based upon *ex ante* price and yield expectations.[6] An *ex post* solution, based on actual prices and yields, is then obtained, and relevant portions thereof are transmitted to the simulation portion of the model. The simulator reflects the legal framework involved and provides data for the subsequent linear programming matrix and the subsequent simulation. The process is repeated for the number of years considered by the study.

Simulation permits complexity and thereby achieves more realism than is possible with most statistical models, but Harl concedes that it also leaves the optimum solution somewhat in doubt.

Harl used many variables in this demanding study. And yet the results could furnish inadequate guidance in the future planning of the firm which was studied, and in planning other corporate firms. Real world variables are infinite in number, and many cannot be quantified. This does not mean that mathematical models of this type should be discarded. They are a noteworthy scientific advancement, for, until now, we have had only subjective guidance in most legal-economic relationships. But it does mean that they must be handled with extreme caution. In the computer era, the expression "What comes out of a machine is no better than what goes in" is trite but accurate (and, unfortunately, often forgotten or ignored). If the major variables in a study are quantifiable, and if they are included in the data used, the machine will be able to achieve predictive accuracy. But if the major variables are non-quantifiable, or are purposely or acci-

[6] Calculated through the use of trend formulas.

dentally omitted from the data, machine predictions may be expected to err significantly.

It is now quite feasible to develop similar models for sole proprietorships, partnerships, and trusts. When this is accomplished, these various forms of business organization may be compared as to their effects on the firm. Harl believes that his model may even be extended to serve at the macro level in forecasting economic behavior, for example, predicting the effects of congressional legislation. Further micro uses may come in the area of estate planning.

*Measurement and Inference in Legal-Economic Research*

This is a narrative exposition of some of the major mathematical or statistical techniques that are available to guide a researcher in (1) choosing his method of gathering data and (2) analyzing the data after it has been collected. The basic principles of sampling, probability, regression, correlation, analysis of variance, and factor analysis are covered in exemplary fashion. Whether a statistical technique is to be used at all depends, of course, on the question asked. The same can be said for choice of statistical technique, and even for choosing between traditional social science and legal research methods.

Wunderlich's efforts are directed toward indoctrinating the lawyer member of a legal-economic research team in basic econometrics. If a statistics text were to be made required reading for lawyers engaging in legal-economic research, the cooperative endeavor would disintegrate in a hurry. But, with a few exceptions, Wunderlich describes some of the most technical facets of economics in such lucid fashion that his paper should be required reading for both disciplines.

It will be a long time before many lawyers get excited about terms such as multiple regression and analysis of variance, but the mathematical gap between the two fields may be breached much more easily by nonparametric statistics. Wunderlich's discussion on this point is perhaps his most valuable contribution to the workshop. He emphasizes the elements of nonparametric statistics that would appeal to lawyers, less imposing data requirements, fewer assumptions, and simplicity of computation. And he illustrates the technique with examples that permit analogizing to many legal and legal-economic problems. Lawyers do not disparage quantification, but neither are they willing to participate in joint research if they can neither understand nor interpret the procedures and results. Nonparametric statistics have much to offer in bringing the two disciplines together on a compromise mathematical ground.

*Organization for Legal-Economic and Related Research*

This paper deals with basic research organization, rather than with

method or methodology. It realistically recognizes that administration and organization, at any and all levels, can be a prime factor in either hindering or helping a research effort.

One section of the paper is devoted to the various ways in which water resources research has been organized, with emphasis on institutes and centers (particularly those fostered by the Water Resources Research Act of 1964).

A second section of the paper discusses the administration of regional research that is being conducted under the Hatch Act. Again, a water research project (NC-57) is used as an example. Water is an ideal subject matter area for legal-economic research because its problems consistently transcend these two disciplines, and often many others as well. Yet Rose, the regional coordinator for NC-57, has found that almost all research produced on that project thus far has been layered. Why? In his view, it may be accounted for by (1) the general objectives of the project, with little attention being given to specific problems, and (2) the wide variation in state water law within the region. One might, therefore, hypothesize that legal-economic integration may be even more difficult to achieve on the regional or national level than on the local or state level.

The third section of this paper discusses some of the personalized problems of interdisciplinary collaboration. Though all lawyers and economists are cognizant of this issue, it received no other attention in this workshop except in the introductory paper by Harris and Hines. Sometimes, say this trio of authors, a study should be jointly planned, but conducted by economists and lawyers largely on an independent basis. At other times, part or all segments of the study should be conducted jointly. In still other instances, the pendulum should swing to the opposite extreme where only conferences between the two disciplines would be merited. The degree of collaboration will vary with the type or stage of the research, and four stages of legal-economic research are posited: (1) library research to determine what the law is, (2) field research to determine how the law operates in actual practice, (3) research to ascertain the law's impact upon economic activity and perhaps other factors, and (4) research to evaluate the law, its operation and impact, and alternative measures that might be employed within the existing legal framework, or that would require new legislation or court decisions. Stage (1) would usually be carried out by a lawyer working independently. It would appear that Stage (4) can easily be interpreted to encompass the remaining two stages, both of which can thus be ignored. Stage (4) will require legal-economic collaboration, but the degree thereof will depend on the problem to be solved. The delineation of these stages, therefore, has added little to the presentation.

The authors suggest various ways in which lawyers may be encouraged

to undertake joint research of this type. Among these are (1) hiring a law professor for the summer months, (2) hiring law students on a part-time basis during the school year and in the summer, (3) employing a lawyer as a permanent faculty member in agricultural economics, (4) establishing a separate law center or institute involving people from both disciplines, and (5) fostering interdisciplinary seminars which may include architects, engineers, general economists, political scientists, and others.

## GENERAL CONCLUSIONS

A workshop of this nature is bound to be a success, simply because such would be inevitable even if there were no formal presentations. It is an invaluable achievement simply to bring lawyers and economists together on a common battleground. For in the give and take of both formal and informal discussion, the seeds of interdisciplinary research are sown. As a consequence, one cannot appraise the merits of this workshop today. Its benefits may not appear for many years.

Our concern here has been of a specialized nature. A study of methods is designed to assist in discovering "how" research should be done. It might now be appropriate to direct our attention to "what" research should be done. This may well be the more formidable problem. If the reader were to prepare a list of potential legal-economic research topics, he would find it to be endless. So would my list, and the two probably would not duplicate each other. But research funds are not limitless, and this means that priorities must be placed on research projects. It also means, subjective as this may be, that those priorities must reflect opportunity cost principles, and not just our own personal preferences. Too many of us make value judgments without considering "value." And, conversely, too many of us fail to realize that when we refuse to make value judgments, we make them by default, or permit someone else to make them for us.

If lawyers and economists will carefully appraise the "what" of legal-economic research, they just might find that there is much that may be accomplished on a coordinated or integrated basis. For example, there is a great need to improve our institutional framework in areas such as water, taxation, and rural-urban fringe problems. No one would challenge the importance of these issues. They are among our most crucial domestic problems. And yet there is much interdisciplinary work, both in research and extension, that may be done in these areas without the use either of sophisticated mathematical techniques or voluminous legal searches. It is here that legal-economic research should spawn most vigorously. These problems are discussed freely and easily, and in the same language, by both lawyers and economists. So why not place projects of this type at the top

of our priority lists? *After* they are completed, we can concentrate our efforts on more intricate and complex legal-economic relationships. By that time, lawyers may have discovered that economists are not such bad fellows after all—and vice versa.