ECONOMETRICS AND APPLIED ECONOMIC ANALYSIS IN REGULATORY DECISIONS

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This article takes the form of a nontechnical survey. No equations or Greek letters appear. We hope by these omissions to have facilitated the communication process and at the same time maximized the number of pages needed to convey this short message.

Since economic principles and theories are often applied within the econometric context, it would be well to begin with a definition of econometrics, or at least a series of statements that will characterize the kinds of activities carried out by persons doing econometric work.

I

The Nature of Econometrics

Econometrics consists of the application of the principles of statistical inference to economic quantities. Statistical inference divides essentially into two parts, namely (1) testing of hypotheses and (2) the making of estimates. Both of these types of activity require the formulation of mathematical models, an exercise which may, in terms of resources expended, far overshadow the testing and estimating effort.[1] The model generally takes the form of an equation or a set of equations. Some form of basic multivariate analysis, commonly multiple linear regression, is the usual statistical technique.

The sequence of activities for the econometrician, then, usually consists of the statement of certain economic propositions and the translation of these into the form of mathematical functions; the combination of these functions into a model; the estimation of the parameter values of the model; the testing of the model by utilizing empirical data and statistical techniques; and the estimation (or "prediction") of economic quantities by means of models that have satisfactorily passed the statistical tests. Of special importance in this process are assumptions made as to the structure or environment to which the economic propositions are relevant. This importance derives from the fact that economic structures are usually not subject to complete control and are often highly unstable over time.

Perhaps an elementary example of the econometric procedure is in order. A fundamental proposition could be that the quantity demanded of a given tele-

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[1] It may be thought that econometrics requires all of economics to be translated into mathematical terms, regardless of how much is lost in the translation. We hope that this is not the prevailing view.

communications service depends upon the rate schedule or price of the service, the prices of feasible substitute services, and the incomes of customers. An equation can be formulated relating the quantity demanded to the other variables. But the relation expressed in the equation will not in application be an exact one, for not all sets of relevant values actually observed for the stated variables will satisfy the equation. Many sets of values may come close, but the relation must include an error term of an assumed form to account for inexactness or uncertainty deriving from the limited number of variables included in the model, the particular observations available for each variable, and (in some models) the errors of observation which unavoidably arise. Thus, the equation in the example would be formulated so that quantity demanded would depend upon price of service, prices of substitutes, incomes, and a certain residuum of error, the latter being represented by an "error term" or "disturbance term." If appropriate data are available, then one can estimate the parameters of the equation and test whether changes in the quantity demanded have in fact paralleled changes in the other factors as indicated by the model. Having found that the equation is a satisfactory model for representing quantity demanded, we may decide to utilize it in estimating (or "predicting") the quantities of service that will be demanded given certain values of the other factors. A possible assumption in this case would be that although the level of income changes, its distribution does not. Other assumptions could be that there are no relevant changes in technology or consumer tastes.

Data utilized by econometricians fall into one or the other of two broad categories, namely, cross-sectional or longitudinal. In the former case, the data are relevant to a particular point in time and give us a snapshot picture of an econometric relationship, whereas in the latter, the data are relevant to several different points in time and yield a picture of changes that take place with the passage of time. On occasion, the two types of data are combined in the same model, and, strange to say, one type of data can be mistaken for the other.

II

RISK AND UNCERTAINTY

The error term in the regression relationship is of special importance, for it is an indication of the amount of uncertainty that is assumed to exist in the relationship between the variables. In order to understand what is involved in this error term and to indicate just what it means by way of limitations of the econometric method, we need to examine carefully into its definition and treatment.

If we were concerned with risk instead of uncertainty, there would be very little difficulty in dealing with the error term so as to specify its probability distribution in a manner permitting objective verification. This is so because risk is defined as a contingency or chance of occurrence that can be accounted for on an actuarial basis, that is, something that can be evaluated in terms of objective probabilities. However, the essential distinction between risk and uncertainty is that the latter cannot be handled on the basis of objective probability. The concept of risk, then, entails the observation of data of such appropriate character and in such sufficient mass that a probability distribution can be established empirically for the events in question. (An example is the use of a mortality table to evaluate the probability that persons of various ages will live at least one more year. Limited or nil structural changes through time allow predictions to be made on the basis of the observed distribution.) However, in the case of uncertainty, the requisite observed data do not exist, so we must make assumptions, derive personalistic evaluations, or express hunches about the probability distribution of errors or disturbances. This situation does not mean that the theory of probability has been altered, but it does mean that there is a difference as far as the application of the theory is concerned.

An analogy may help to point up the contrast. The case of risk is like the situation where one tosses a die and keeps a record of the outcomes of a very large number of tosses. Assuming that there is very little wear and tear on the die, then the observed distribution of outcomes will give very good estimates of the outcomes that would occur in future experiments involving the tossing of this same die. However, the situation of uncertainty is considerably different, being indicated by the case of a person observing a die and making no experimental tosses, but instead formulating all sorts of assumptions, guesses, judgments, hunches, and so on, about how the die might turn up if it were actually tossed. A person contemplating such a die does not know how it will turn up prior to the actual tossing. He knows that the die may be symmetrical and of uniform density. He also knows that the die could very well be loaded. But he doesn't know for sure whether the die is loaded or not and if so precisely how it is loaded. He may have some theory as to how it is loaded or operate on the assumption that it is not loaded. Furthermore, if the die has been tossed one, two, or three times in the past by other experimenters, this record of experience may be of no use whatsoever in predicting any future tosses of the die, for its shape and density are changing over time.

Thus, econometric analyses, estimates, and predictions take place in a slippery realm, but important advantages of using an econometric model are that such a procedure makes a definite statement of factors involved in a posited causal relation and delineates the form of the relationship; it pinpoints the places at which judgments or assumptions are being made, and there is an awareness of the problem of uncertainty and the fact that it must be dealt with if any headway is to be made toward a solution of the problem at hand. It would, therefore, seem reasonable to conclude that skillful econometric analyses yield evidence that is generally superior to authoritative pronouncements of "experts" who know in their hearts that certain economic estimates or predictions must be so.

III

ECONOMETRICS IN THE COMMUNICATIONS FIELD

Although descriptive statistics and, to a limited extent, sampling techniques have been used in gathering evidence for use in regulatory proceedings, the use of econometric technique as a regulatory tool is relatively new in the communications field. However, there is a great need for the development of reliable econometric models in several areas, particularly in the demand and cost fields as an aid to decision making concerning rate levels and rate structure. Also, there is a need for models appropriate to the conduct of continuing cost of capital and rate of return studies. It is important to emphasize the term "continuing studies," for in a dynamic industry such as communications there are few areas, if any, in which "one-shot" solutions are appropriate. Except for domestic telegraph service, growth is rapid and technological changes frequent with continual shifts in the patterns of demand and costs.

Thus far, such econometric demand studies as have been made are concerned with the domestic message toll telephone service and the domestic public message telegraph service. These types of studies[2] are being pursued by both the carriers and the staff of the Federal Communications Commission. Less work has been done on the cost side, primarily because of the difficulty in obtaining data appropriate to the relevant economic cost concepts. It is often the case that data collected in accordance with the traditional accounting and reporting regulations have little direct relevance to important economic concepts. This incongruity indicates an area in which there is a great need for important economic research and an opportunity to make significant contributions in support of enlightened economic policy making.

A. The Gordon Model in the *Bell Rate* Case

In the cost of capital and rate of return area, Myron J. Gordon developed a model using cross-sectional data which not only included a stock price equation but also brought in the service demand factor by incorporating a relation involving the rate of investment in communications facilities.[3] The construction of this model showed considerable ingenuity and insight, and it holds great promise, if developed and extended, of forming an extremely useful basis for continuing studies in this area. The basic principle underlying the Gordon analysis is that given both the desired rate of investment of a utility enterprise and its financial policy, the allowable rate of return should be set high enough so that the utility will be able to carry out

[2] None has been published.

[3] *See* Testimony of Myron J. Gordon, FCC Staff Exhibit 17, American Tel. & Tel. Co., 9 F.C.C.2d 30 (1967).

its financing plans without depressing the price of its stock. To avoid such a depressing effect, the rate of return should be at least equal to the utility's cost of capital.

Since the Gordon model operates on the basis of this criterion, a very important element in the entire analysis is the stock price equation. This equation is a relationship wherein the price of the stock is said to depend upon the dividend yield, the rate of growth in the dividend, the leverage rate, and the rate of stock financing. The form of the relationship is log-linear. The coefficients in the model are estimated from data derived from a sample of electric utility companies. Once the coefficients are estimated, data for the particular utility under study, in this case the Bell System, can be injected into the relationship so as to give the stock price for that particular firm. But in the model the stock price equation is not an end in itself but rather is an analytical device for taking into consideration the effects of certain important policy variables. Briefly, the situation is as follows: A set of plausible rates of return is considered, and for each of these rates of return a series of different financial policies is examined. Then, for each combination of rate of return and financial policy, a relationship between stock price and investment rate is derived. The desired investment rate is a value to be determined by Commission policy. Thus, given an investment rate and a financial policy, that rate of return is selected that will cause the stock price to be highest at the desired rate of investment.

On the basis of his analysis, Dr. Gordon recommended an allowable rate of return for the Bell System in the range of 7.0 to 7.25 per cent. Although this recommendation was not the controlling factor in the final decision, the Commission noted that the technique utilized in producing it was promising and capable of becoming "a useful tool in this difficult and often vexing area of regulation."[4]

At the state level, a cost of capital model was developed by the late A. R. Colbert of the Wisconsin Public Service Commission. Recently this model has been modified and extended by Lionel Thatcher and Howard Thompson.[5]

B. Special Problems Encountered in Demand Studies

The first problem encountered—and this is a perennial one for econometric research—is the lack of appropriate data. Whatever is available was almost always collected for some purpose unrelated to demand analysis, so the researcher is forced to take what he can get and accept the necessary analytical constraints which inevitably follow. Data on the communications expenditures and incomes of sampled residential customers, business customers, and other customers would be very helpful, but they are not available. Monthly bills of the various customers could supply much of the information needed. Such data consistently compiled over time would permit

[4] American Tel. & Tel. Co., 9 F.C.C.2d 30, 87 (1967).

[5] *See* Testimony of Lionel W. Thatcher on Rate of Return, and Testimony of Howard E. Thompson on Rate of Return, Southwestern Bell Tel. Co., No. 16642 (Mo. Pub. Serv. Comm'n, June 1969).

the pooling of cross-sectional and longitudinal data, could shed a great deal of light on the effects of rate changes, and would help to provide reasonably good measures of elasticity coefficients. Data on communications traffic, revenues, and incomes between particular pairs of cities would help to delineate important geographical submarkets in the nation and show up important regional differences in growth and response to price changes. New efforts directed toward the collection of appropriate demand data now should yield important dividends for the future.

Some idea of the complexity of data required for demand analyses can be developed by noting that telephone conversations have many dimensions. Current long-distance rate schedules classify calls by distance (length of haul), time (length of call), time of day (day, evening, or night), and class of call (station or person); we may further classify by type of originating station (residence, business, public). Omitting the length of call, let us suppose there are thirty distance intervals, three times of day, two classes of call, and three types of originating station; then there are $30 \times 3 \times 2 \times 3$ or 540 different classifications of telephone conversations. By providing for many different lengths of call and many more times of day, the number of classifications can easily be expanded to several thousand. And the more we have, the thinner the data get for each individual case.

Another problem in demand analysis is the definition of an appropriate unit of service. Although the telephone conversation is usually taken as the appropriate unit of service in analyzing demand for long-distance exchange telephone service, the unique character of this entity gives rise to a price elasticity that is two-dimensional, for response to price changes can take the form of changes in number of calls or in length of calls. However, customers are not generally indifferent as between number of calls and length of call, so that a subunit, such as one minute of conversation going a distance of one mile, is not a satisfactory alternative choice.

Differential rate changes between different times of the day cause shifts in calling patterns as do differential changes between person and station rates. Furthermore, calls formerly classified as long-distance become local calls as metropolitan exchange areas expand.

In addition, various kinds of other services are more or less substitutable for long-distance phone calls, for example, message telegraph, wide area telephone service, and some types of private line service. It is important to have some idea of the cross elasticities involved. In fact, one could make a good case for the position that rate changes on one service cannot rationally be made without taking into account the effects on all other related communications services.

Finally, there is the problem of separating income and other growth effects on volume from price effects. The problem is made difficult by the frequent existence of linear relations among the independent variables of the demand model.

C. Problems Related to Costs

Probably communications common carriers have a clear idea of what their total costs are within reasonable margins of error, but it is doubtful that economic cost functions of various types, either short-run or long-run, have been estimated. In the case of many communications services it may be difficult to collect data unambiguously related to the short-run, long-run, or dynamic situations, for, as indicated previously, growth is extremely rapid and technological change is occurring at a very rapid rate.

Not a great deal can be said about the cost situation at present, except that serious efforts are being made to measure long-run incremental costs for various telecommunications services, such costs being considered useful for estimating minimum rate levels (revenue requirements) for various services. The establishment of such levels is just one aspect of the whole problem of pricing in its relation to costs. However, the importance of this particular element, its elusiveness and innate subtlety, it seems, sometimes requires explanation by way of "analogy." One such analogy took the form of the following story which was told to the writer not long ago.

It seems that once upon a time there was a small grocery store in which there existed a small area of unutilized space, perhaps no more than a couple of square feet on a wall that was within easy reach of any passing customer. One day a traveling wholesaler of peanuts happened to notice this unused space and indicated its availability to the proprietor. "Tell you what I'll do," said the wholesaler. "I'll supply you with a rack filled with bags of peanuts that you can hang in the vacant space. You sell the peanuts for five cents a bag and give me two cents a bag. Won't cost you a thing to use the space, and you'll make lots of money." Naturally the proprietor agreed to the deal and prospered as a result of his perspicacity in applying marginal cost pricing principles.

If each feasible alternative use of the space would yield less than the peanuts in expected net revenue, then the correct decision was made. But there is still some difficulty in discerning how the story related to the use of long-run incremental costs in the determination of service rate levels for a telecommunications utility.

A counter-analogy was suggested: Once upon a time there was a grocer upon whom public authorities had conferred a monopoly in the sale of salt. Naturally, under such an arrangement, demand for salt was quite inelastic. So the grocer raised the price of salt and lowered the price of peanuts, with the result that peanuts brought in revenues that were slightly less than their long-run incremental costs. Other sellers began to get out of the peanut business and new sellers would not enter. Salt revenues provided much more than enough to cover the peanut deficit, and it seemed evident that soon the grocer would be the only seller of both commodities.

The counter-analogy, it seemed, was thought to indicate a lack of understanding of correct economic principles and definitely to indicate a lack of good manners.

As far as specific rates (rate structure for a particular service) are concerned, it may be advocated that rates should at least cover "costs" and that, in addition, differential charges should be made to different classes of customers depending upon their elasticities of demand. However, it is not sufficient to look mainly at differential elasticities of demand. One must look to the causes underlying them. In public utilities such as telecommunications, low elasticity values arise because monopoly power has been conferred upon the seller. Many buyers have no alternatives. The regulatory commission is set up to protect these customers against exploitation due to the immense power (if unregulated) on the seller's side of the market. It would seem unwarranted, then, to allow rates to be raised highest on the classes of customers who need protection most. It may be the province of the econometrician to estimate elasticities of demand, but the problems of applied economics are by no means exhausted once he has completed this task.

IV

ECONOMETRICS AND THE ADVERSARY PROCESS

From the standpoint of the economist, the ideal setting for the consideration of econometric evidence would be an academic seminar. There the objective would be to discover the best evidence—that is, that which most accurately reflected the factual situation. There would be little concern with the idea of winning a contest, and the forum would be closed to anyone seeking to lobby or otherwise practice the arm-twisting arts. A public record could be kept. However, opportunities for this type of discussion are rare, if not totally nonexistent, within the regulatory framework. In regulatory proceedings, one or more parties may take a relatively fixed position and selectively gather evidence to support his stand. Most professional economists do not find such a situation congenial, deeming it an unpleasant task to attack, rather than constructively criticize, the work of others whom they regard as serious scholars. Nevertheless, econometric studies can fruitfully be introduced in adversary proceedings, provided that methodological summaries, data, computer programs, and results are made available by all persons who have conducted or sponsored such studies. This requirement would make it possible for all parties to replicate whatever portions of the studies they care to and offer alternatives if they so desire.

Rule-making proceedings, on the other hand, offer a much better milieu for the introduction of econometric studies as evidence in the course of the development of a factual record. Perhaps the best arrangement would be for the agency itself to offer the econometric model as a possible premise for its future regulatory efforts, inviting comments from persons likely to be affected. The rule-making proceeding might then focus on the model itself rather than on the merits of any action taken in reliance on it. The agency would make its underlying data and other supporting material available for criticism, and its experts might be made available for questioning as a means of pointing up on the record the weaknesses of the model, including the arbitrariness of its assumptions and the degree of risk and uncertainty. Other experts might propose modifications of the model, which the agency might adopt or reject, relying always on its own experts (perhaps including outside consultants) for technical advice.

Best of all perhaps would be an informal type of proceeding open to all persons having either a financial or an intellectual interest. A record should probably be kept and made available to the public. Here, on occasions when highly technical matters were being clarified, economists would be allowed to question each other. The prime objective would be clear understanding of the facts rather than vociferous argument for various viewpoints or positions, providing the agency and its staff an optimum basis for model building and decision making.

In any type of regulatory proceeding, it is extremely important that definite, up-to-date standards and rules for admitting and presenting statistical and econometric data be developed. Such rules could help greatly in clarifying techniques, methodologies, data, and results. Much time, labor, and money could be saved if the lengthy and complex process of drawing out information could be minimized by extensive use of prepared testimony and of stipulations regarding methodology, data, and other aspects of the model. Selective reticence, no matter how firmly entrenched, is hopelessly out of date in modern regulatory proceedings.

V

NEEDS FOR THE FUTURE

There is a great need for an expanded data base which will be more appropriate than traditional types of accounting information to the needs of applied economics and econometrics. With the aid of high-speed computers, immense amounts of information can be distributed, stored, retrieved, and analyzed efficiently on a continuing basis. Ongoing research efforts should be expanded in the areas of demand for telecommunications services, costs of providing the services, and the allowable rate of return to be earned on plant and equipment devoted to the provision of services. There are other areas that can profitably be explored by economists, but those mentioned are the ones needing major attention in the interest of more effective regulation.

Greater interchange of information necessary to the regulation of communications common carriers would improve the quality of regulation, not only at the federal level but at the state level as well. Furthermore, improving the information flow to nonprofit economic research foundations and university researchers would vastly increase the amount of talent brought to bear on regulatory questions. Thus the meager resources of the regulatory commissions would be significantly bolstered, and carriers as well as their customers would receive the benefit of improved research efforts. It is not unusual for an important econometric project to be passed up because of the lack of requisite data or the tremendous difficulties involved in the generation of such data.

In addition to better and more widely distributed data, there needs to be a closer interaction between theory and practice in the regulatory field. Some economic theories are couched in terms of nonobservable entities. Worse yet, theories may not be amenable to testing in terms of observable entities. Thus there is a need for theorists to work within certain constraints if a substantial body of feasible economics is to emerge. Problems demanding solution should not have to await some vague point in the future when the appropriate data may become available or the ingenuity of practitioners may devise an appropriate test of theories being currently formulated.

An area that requires a great deal of interaction of theory and practice is the study of investors' expectations. If better estimates are to be made of the cost of equity capital, progress here is essential. It is important to ascertain what kinds of past and current sense data are utilized by the investor in formulating his expectations and what quantifications, if any, he makes concerning chances of gain or loss. Also, there is need for much more research in the area of so-called business risk, which is really business uncertainty, for risks can be quantified objectively and their costs assessed. An inquiry into the nature of uncertainties facing communications common carriers is called for, with an attempt being made to shift uncertainty, where feasible, into the risk category, while at the same time seeking to find methods for placing maximum and minimum cost values on the residuum of uncertainty.

Thus, before improved regulatory decisions can be made, there must be accumulation and interchange of more data, improved interaction between theory and practice in the economics of regulation, and, to add an important point, a willingness on the part of both economists and attorneys to work together. After all, regulatory decisions are rather straightforward once the facts of the present are known and good estimates for the near future are at hand.