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Issues and Approaches in Applied Valuation

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ISSUES AND APPROACHES IN

APPLIED VALUATION

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1. **INTRODUCTION**

The previous two papers in this series have established what is meant by economic values and how those values may enter into project evaluation and policy making. The purpose of this paper is to provide a link between theory and measurement. We will not examine all of the details of the statistical techniques that are used to measure economic values in different settings. Many of the techniques are quite complex from the point of view of both statistical theory and numerical analysis (when they are implemented). The major techniques have been contributed to and discussed within the economics literature. Survey articles, edited volumes, journal articles and working papers are available for those wishing a specialized understanding of the field. In contrast to a specialized understanding and, in keeping with the approach of the preceding papers, the goal of this paper is to provide an introduction and overview to the process of applied measurement of economic values for managers and policy makers. Theory and statistical approaches are examined to provide a basis for understanding the meaning and implications of the results of a given applied study. Specific details about the quality of a study can always be assessed by sending it out for blind expert review.

Before describing the order in which the major issues are introduced and addressed in this paper, we first provide some very general observations about applied valuation and
the values that can be measured. It is useful to keep these issues in mind while reading the remainder of this paper.

The first set of observations has to do with the process of applied modelling. As in all areas requiring statistical modelling, good applied analysis is very difficult. There are several reasons for this. First, the applied researcher must understand the underlying theory and must be prepared to adapt or expand it depending on the characteristics of the available data. Second, the researcher must obtain a clear understanding of the process by which the available data were generated. This includes both an understanding of the sampling process whereby the data were collected and the way in which the sample corresponds to the theoretical behaviour of economic agents. Third, the researcher must find a way of analyzing the data that is consistent with the principles of rigorous statistical analysis but which is also sensitive to the fact that no data set is ideal. There are usually errors and inconsistencies in data samples. These errors arise in measurement and recording. As well, the process by which the data are gathered often imposes a structure in the sample that may confound the discovery and measurement of the true underlying economic structure. The issue here is one of randomness of the sample. In particular, is the available sample of data random with respect to the economic structure that is to be estimated? Typically, the sample is not (completely) random and the estimation strategy must compensate for this feature. Fourth, and related to the third point, it is usually the case that as the applied analysis progresses, further problems with a given data set become
apparent. Most valuation studies are now based on data generated from samples of individual economic agents. Often the researcher analyzing the data is not the person who designed and implemented the sampling process. As a result, sample information may be ambiguous (because of the design of the questionnaire) and, if critical questions were not asked, incomplete in the sense that the researcher may not be able to use the data to sharpen or otherwise distinguish between some competing hypotheses about economic behaviour.

The second set of background observations deals in part with what might be thought of as the philosophy underlying applied economic analysis in general and valuation in particular. Recall from the previous two papers that the goal of economic theory is to develop a set of assumptions and a formal process of reasoning to represent individual economic decision making and which further can be used to predict behaviour. The theory can never be complete enough to describe exactly the decision making of an individual chosen at random in a society. Rather, it is meant to describe and predict the behaviour of a representative individual. As a direct consequence, we should not expect the same precision from applied statistical analysis in economics that may arise in double blind controlled experiments in the physical and biological sciences. What we must often settle for are indications (for or against) the existence of structure in the data that is broadly consistent with economic theory. The nature of available data is such that we cannot and should not always attempt to draw wide-ranging conclusions about estimated
economic values. Often, the most that can be reliably concluded is that the value of a particular resource or characteristic of a resource is relatively small or large. Even these conclusions must be tempered by practical experience and by an awareness of any 'special' or 'unexpected' features of the estimated model that may have contributed to the results.

As a final background point we repeat the purpose of the applied analysis. We wish to obtain measurements of the economic values associated with recreational sites and with characteristics of those sites. In the other two papers in the series we have examined measures of the value associated with the consumption of specific flows of services from recreational sites. Two of these values (equivalent and compensating surplus) are directly linked by a demand curve to the use or consumption of the flow of services from the site and its characteristics. Within the literature these values are referred to as 'use' values. As such, they are distinguished from 'nonuse' values. Nonuse values can be thought of as the value associated with the certain knowledge that a resource exists or that it will continue to exist (existence value) or be maintained (option, bequest value). While there can be no doubt that nonuse values may exist and be of significant size, it is also important to realize that they represent a second level of abstraction. As with characteristics of recreational sites, they are not traded in well-defined markets. As well, though, they are not observable and it is not clear that they correspond to a good or service that is comparable across individuals. It seems perfectly reasonable to ask
individuals how much they would pay for the return (at a certain level) of a currently extinct species. It is equally reasonable to expect that use and nonuse values may be inextricably linked or confounded for resources that currently exist.

In the remainder of this paper we will examine the two major techniques that are currently used to measure values for nonmarket resources. These techniques are referred to as the travel cost and contingent value methods or models, TCM and CVM respectively. TCM uses data on the observed or measured economic decisions of individuals to deduce the values associated with goods and services that they consume. Because these goods and services are not purchased in markets, the behavioral data is only indirect. Alternatively, CVM can be thought of as the hypothetical and sometimes experimental construction of these missing markets. Surveys and questionnaires are used in various ways to simulate the market decisions of individuals. For example, an individual may be asked to state the value he or she puts on consumption of a resource. The data are then analyzed as if they came from real markets. In the literature, this is referred to as the direct approach.

Both TCM and CVM share a formal validity in the sense that they both address valuation notions rooted in economic theory. Almost all attempts to value resources employ one or both of these techniques. In what follows we will examine each technique in turn. We will begin with the goals and major operating characteristics of each
approach. Summaries of the success (both real and potential) are presented for each of the techniques. These summaries include both the positive and negative aspects of each approach. The negative aspects are further broken down into potentially resolvable problems and potentially unresolvable problems. The paper concludes with an attempt to isolate the pivotal issues involved in using TCM and CVM to value resources.

As a final point in this introduction, I feel it important to point out that this paper is very strongly influenced by the work of V. Kerry Smith. It is difficult to think of a valuation issue that he has not directly researched or otherwise thought and written about in a careful and insightful way. Of course, he cannot be held responsible for what follows. At the same time it is important to emphasize the extent of his contribution to the field.

2. **TRAVEL COST MODELS (TCM)**

*Introduction*

The travel cost literature\(^1\) began as an attempt to place an economic value on entire recreational sites. Early insight into the problem was provided by Hotelling (1947). He observed that while individuals do not interact in a market for recreational sites, they indirectly reveal their preferences by travelling to recreational sites. In effect, one can

\(^1\)An excellent survey of the literature at a more technical level can be found in V.K. Smith (1989).
value a site by determining the economic value of trips, visits or travel that bring individuals to a site. Early applied research was directed at estimating travel demand functions and then using economic theory and the estimated demands to estimate the value of sites.

**Early TCM**

Early value estimates were pieced together from a minimum amount of information. Any given recreational site often kept records of visits perhaps in terms of license plates or more exactly in terms of the origin of the visitors. This provided information on distance travelled and frequency of trips. Price and income information was also obtained. Costs of round trip travel were calculated at various levels of sophistication ranging from crow-flies measuring of distance and average fuel consumption to map-measured distances. Income, when included, was taken as the average income in the geographic zones of origin of the visitors. Variation in price and income (needed to statistically identify the demand for trips) came from grouping individuals into a set of origin zones at varying distances from the site.

It was generally the case that, other things being equal, fewer trips per capita were taken by individuals living in more distant zones of origin. Since a trip from a more distant site also cost more, a negative relationship was estimated between price and number of trips. This became the demand curve for trips and, indirectly, for the site. An
estimate of the value of the site for a representative individual from a zone could be obtained by rationing trips to zero. The total value of the site is obtained by adding the value of trips of all visitors to the site.

Modern travel cost models began to develop as more complete survey information became available. It was no longer necessary to model average travel rates by zone of origin. Individuals make decisions and it follows that this behaviour and not the behaviour of averages of data is what should be modelled. The better data also offered the opportunity to estimate separate demands for the characteristics, such as isolation and fish species, of a site.

Modern TCM

Modern survey data typically includes information by individual sampled on the number and duration of visits to various sites, estimates of the costs of travel, other socioeconomic characteristics such as wages and income, location of residence, experience etc. as well as characteristics of the various sites including measures of congestion, pollution, huntable or fishable species, density etc. A variety of approaches have been developed to analyze these data and generate estimates of economic values.

Generalized TCM
One group of models has developed from extending TCM to the case of micro-level survey data and site characteristics. Those models, suggested by Vaughan and Russell (1982) and V.K. Smith et. al. (1983, 1985), involve estimating standard travel cost models for individual sites and then relating difference in the estimated travel/visit demand curves to differences in site characteristics. Variations in site characteristics are thereby linked to changes in estimated economic values. For example, this technique could be used to estimate the value of increased fish density at a given site.

Hedonic TCM

Hedonic travel cost models attempt to estimate the specific implied demand curves for the characteristics of given sites. The approach, as outlined in several papers by G. Brown, involves two steps. In the first stage the travel cost information is used to obtain estimates of the (marginal) costs faced by an individual attempting to obtain one more unit of a specific site characteristic. For example, how far do you have to travel to obtain a fish density that is larger by 1 unit? The actual statistical procedure involves a decomposition of costs known as a hedonic decomposition. In the second stage these estimated costs or prices of the site characteristics are used to estimate individual demands for characteristics. The economic value of a given characteristic can be measured from this estimated demand curve.
A variation on the first step of this process has been suggested by V.K. Smith et. al. (1991). The new approach involves estimating first stage costs using a linear programming estimate of the ‘envelope’ relationship between costs and characteristics.

**Random Utility Models (RUM)**

Random utility models differ from the travel cost model described to this point. RUM is not based on the explicit derivation and estimation of traditional curves. Rather, in random utility models the argument is made that individuals reveal their preferences by their choice of sites. Individuals choose a given site (or set of sites) because it (or the collection) is optional. Explicit linear forms for utility are postulated and estimated using multinominal discrete choice statistical methods. Hanemann has written extensively on this topic and has shown how the estimated models can be used to generate estimates of economic values.

**Frontier TCM**

Leith and Smith (1982) have recently suggested a new approach to valuing site characteristics. They point out that travel cost payments represent a consistent underestimate of the maximum that an individual would be willing to pay for the set of characteristics that define the site. They then point out how this information can be used to estimate the most that an individual would pay and that this is just the economic value that is sought. Estimates of values of individual characteristics follow in a straightforward
manner. This approach directly provides an estimate of the value frontier as opposed to the travel cost frontier of V.K. Smith et. al. (1991).

Advantages of TCM

There are three major advantages associated with TCM. First, the estimated economic relationships such as demand curves and preference functions tend to be consistent with the underlying theory. This does not mean that the estimated values are accurate or even always reasonable. Nonetheless the value estimates are derived from estimated models that economic theory suggests we should observe. Second, the standard survey data is becoming more widely available and often is not expensive to obtain. Finally, to a large extent, the demand and valuation analysis follows the traditional economic paradigm of model, implied structure and estimated structure. The framework for understanding and judging the results has become well developed.

Potentially Resolvable Problems with TCM

One of the biggest issues found by TCM researchers is the measurement of the costs of travel. While some types of costs such as fuel, bait and entry permits are relatively straightforward, there remains the problem of assessing the value of time of the individual used in travel and on-site activities. These costs arise because the travel and recreational activity came at the expense of another activity such as a sport or more work depending on the flexibility in the individual job. One approach in the literature has been
to approximate the "opportunity cost" of travel by the foregone earnings of the individual. Not surprisingly, there has been considerable debate on this issue and it remains unresolved. It is further complicated by the fact that survey data often does not contain enough information about an individual's foregone alternatives to quantify many of the proposed solutions. The problem is further complicated by the fact that there may be many purposes of a given trip and many sites may be visited.

Another important issue involves the measurement of site characteristics. Not all individuals seem to perceive a site in the same way. As well, there are often (visited or unvisited) substitute sites and it is often difficult to incorporate these substitution possibilities into the analysis.

Finally, there are issues related to best econometric practice in searching for the structure in the data. These issues range from the specification, measurement and transformation of variable and equations entering the empirical model to the choice of stochastic assumptions and attendant estimation algorithms. Different assumptions can affect the size of the estimated economic values.

Overall, all of these problems are important and any one is sufficient to severely bias the statistical results. At the same time, knowing that these problems are present (as they are in one way or another in all applied work in economics) allows for the adoption
of defensive statistical strategies. The researcher does what she or he can with the available data but is very careful to report any discovered sensitivity of the reported results to violation of the assumptions. Good applied economic analysis is very much like good detective work. You do not jump to accept the first confession that comes along. A good case is woven from the facts and relationship that are discovered and seem to reappear regularly. As with detective work, good applied analysis is mostly slow, careful and methodical with the odd flash of understanding. There is no room for dogmatism and a good reviewer will usually be able to spot the weak aspects of the analysis.

Potentially Unresolvable Problems with TCM

TCM relies upon indirect market data. As such, it is not able to provide measures of nonuse values for individuals who have not participated in or been observed in a market setting related to the resource that is to be valued. On the other hand, individuals who, for example, form part of a data sample may also have nonuse values. Assuming, as seems reasonable, that nonuse preferences for existence and preservation affect decisions to participate in an activity, TCM will include nonuse values in total measured value.

3. CONTINGENT VALUATION MODELS (CVM)

Introduction and Background
In order to focus attention on the issues it is useful to consider first a tangible and measurable good or activity that is not marketed in the traditional sense of having the observed quantity and price respond to forces of demand and supply. Such goods (or bads) include most environment-based goods and services as well as ‘bads’ such as pollution. Next, we ask whether it is possible to create an experimental setting in which individuals are given the opportunity to behave or, in the more typical survey and questionnaire setting, anticipate their behaviour in a market for the good or service. That is, can useful experimental or hypothetical markets be created and can the ‘pseudo’ data from these experimental markets be used much like ‘real or observational’ market data to model the decision-making behaviour of individuals and further estimate the economic value of the nonmarketed goods and services?

CVM provides several approaches to constructing markets and analyzing the resultant data. CVM is considered a direct approach to economic valuation. In many cases participants are directly asked to disclose what an economist would interpret as economic values.

Approaches to CVM

This section will not cover all of the developments of CVM. As in the case of TCM, the purpose is to suggest the essential characteristics of the approach. The literature in this field has grown quickly. A thoughtful evaluation paper has been provided recently
by V.K. Smith (1991). To this can be added many other important references such as: Mitchell and Carson (1989), Freeman (1979), Cummings et. al. (1986), Bohm (1972) and Bishop and Haberlein (1979), Randall et. al. (1974), Sellar et. al. (1985, 1986) and Durden and Shogren (1988).

A convenient way to characterize different approaches to CVM is to consider providing individuals in hypothetical markets with different amounts of power. Suppose first that the individual had the ability to set the price for a good. We could ask the individual what price would he set or what he or she would be prepared to pay for the good. Some care needs to be exercised in interpreting the declared price as the maximum or minimum that would be paid. This declared price by the buyer is one approach to CVM for nonmarketed goods.

A second setting arises when there is some sharing of power by buyers and sellers in a market. Bargaining and negotiation (both of which take time and are thus costly) arise in markets for relatively and absolutely expensive goods and services. A range of prices will arise depending upon information, bargaining strength and preferences. The second form of CVM adapts the bargaining or bidding approach when interviewing individuals about the economic value they place on goods and services that are not marketed. The interviewer attempts to negotiate or determine the highest price that an individual would be prepared to pay. Since the interviewer is not usually giving up
anything, the negotiation process can be thought of as sharpening the attention of the individual being interviewed.

The final market setting arises when the buyer has no market power. This is closer to the competitive market model presented in economics textbooks. The buyer is presented with 'take-it-or-leave-it' prices by a seller. In the market simulated by some CVM studies, the individual being interviewed is presented with one price and asked if he or she would pay that amount of the nonmarketed good being studied. Variation in the amounts that surveyed individuals are willing to pay and in the acceptance decision at a given price serves to identify the preferences of the individuals and economic values of the good or services.

As a final point it is important to note that CVM researchers try to define and adopt best practice survey techniques. As well, the survey data is analyzed with a statistical techniques that continue to be improved and developed. Some recent developments can be found in Cameron (1988) and Cameron and James (1987). An excellent discussion of the process of analyzing the data and drawing conclusions from a CVM survey can be found in Kriström (1990).

Advantages of CVM
If the CVM technique is valid then it holds many potential advantages over the TCM approach. For example, the potential exists to focus questions on issues of quantity and quality and the associated economic value of nonmarketed goods. CVM can establish or estimate both user and nonuser values for nonmarketed goods. As long as the costs of sampling are not prohibitive there is much to be gained from being able to focus on issues by means of direct questions.

**Potentially Resolvable Problems with CVM**

CVM, because of its dependence on surveys and interviews, is potentially influenced by the biases that can arise in these types of data generating processes. The adoption and development of best practice techniques lessens these biases. As with TCM, no data set or statistical analysis will ever be fully ideal.

There are several types of bias that may arise. For example, a strategies bias exists if the respondent feels there is something to gain by choosing to answer other than truthfully. Even a truth-teller may be confused or misled by either a question or the process by which it is asked. The answer given may depend upon the type of survey. telephone, mail or, perhaps, direct contact. As a final example, answers may depend upon the market power attributed to those being interviewed and the interviewees interpretation of any hypothesized market structure.
Potentially Unresolvable Problems with CVM

There is one major issue here: Can we be assured that CVM is valid? Will it lead directly to reliable estimates of economic values? It is important to realize that this is not a question about bias in implementation of the survey. Rather, it concerns whether the economic decisions reported by surveyed individuals (in the absence of any biases) should be accepted as accurate estimates of what these individuals would in fact do if they were in a real market environment.

Some of the best insights into this problem can be found in comments prepared by one of our Nobel Laureates, K. Arrow (1986).

Professor Arrow is quick to cut to the heart of the issue. He asks what is the systematic methodology that allows the researcher to translate verbal responses to questions into assured actions? Alternatively, how do you translate CVM survey "words" into equivalent "deeds"? There is considerable scope for concern here because the necessary methodology seems to be absent in most other fields. For example, even though the theory (physics) of weather is well understood, this theory, according to Professor Arrow, is only mildly helpful in forecasting weather. Another example concerns new product launches. Only 50% of new products actually brought to market are successful. This is despite the best survey practices purchased by businesses and the collective experience of those associated with introducing the products.
It would appear that much can go wrong and much can be different in verbal answers as opposed to deeds. Even if we agree that CVM provides an accurate measure of how people feel at a point in time, it still must be demonstrated that, on average, they will do what they say. It is not at all clear that such a demonstration is possible. Suppose, for the moment that the survey provides the individual with all the objective information necessary to describe a nonmarketed good, service or resource and that the interviewee then answers a hypothetical valuation question. It would appear that all subsequent information received by the individual (say, on the availability of substitutes) and all subsequent events (such as expenditures on other goods and services) will tend to reduce the amount that an individual would actually spend. As an example of part of what can go wrong, suppose that a surveyed individual states that preserving a fish species is worth $100 to him or her. Suppose that the individual then agrees to and actually does make a contribution to another charity. There may be no money left for the fish species. It does not seem reasonable to continue to argue that the fish species is worth $100 to the individual. Regardless of the intent of the individual, the reality is that nothing may be spent in support of the resource. How can the CVM researcher take this into account in preparing an estimate of the economic value of a resource?

In summary, it would appear that the case has not yet been convincingly made that we have a good idea of the possible error bounds or confidence intervals around CVM estimates of economic values. As both Arrow and V.K. Smith note, it is further not clear
what can be concluded from the sometimes consistency of estimates between TCM and CVM approaches. Both approaches could be wrong. Professor Arrow notes that something may be learned from conducting CVM studies for marketed goods where independent direct estimates of values can be calculated and compared. V.K. Smith (1991) refers, however, to research by Pratt et. al. (1979) where it was found that even in competitive markets for ‘marketed’ goods, one observes ratios of maximum to minimum price paid ranging from 1.11 to 6.67. Economic data inherits considerable ‘noise’ from the activities of individuals in markets. As noted in the introduction to this paper, we must be very careful in framing our goals from applied research.

4. **CONCLUSIONS**

The foregoing sections lead to the conclusion that, notwithstanding the care that goes into the economic theory, the design of experiments and the theory and practice of statistical analysis, the confidence intervals around estimates of economic values are likely to be large. Professor Arrow suggests that we should not dismiss outright the notion of errors on the order of 3:1 or 5:1. Professor Arrow further suggests that this may not be unusual for most sciences. Economic reality, it would appear, only shows itself through a mist.

Two final issues should be raised in concluding this paper. First, as noted by V.K. Smith (1991), the valuation exercise does not conclude with a statistical analysis of the
determinants of economic value in a sample of individuals. The sample was taken as representative of a population of individuals. If we wish to determine the total economic value of a nonmarketed good or resource we must develop a methodology of translating our sample results to the population. This is a nontrivial problem that is certainly more complex than simply "grossing-up" the sample results. If we don’t know the size and extent of the population then we do not know how, exactly, the sample relates to the population. As well, this is only one side of the market... the demand side. There is also a supply side. The total value of a good or resource also depends upon the extent to which substitute goods exist or could be created.

Finally, it is worth raising the issue of how or even if value estimates at a point in time can be used to forecast a future stream of values from the resource. Products and even industries regularly turn over or fail and goods and services come into and drop out of favour in irregular cycles. Even economic variables with a seeming ‘regular’ history prove very difficult to track let alone forecast. The problem of forecasting future economic values therefore remains a major challenge.
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