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IN SEARCH OF SCIENTIFIC REGULATION: THE UHF ALLOCATION EXPERIMENT

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ABSTRACT

This paper reports the results of one attempt to introduce an objective, quantitative, scientific mechanism for making allocational regulatory decisions. The case is the allocation of UHF television stations among cities by the Federal Communications Commission. The mechanism is an experiment which is designed to reveal the preferences of the subjects with respect to alternative allocations. Pilot experiments were performed on FCC staff, the purposes of which were to refine the experimental design and instructions and to provide data for comparing different specifications of the final estimated equation. Participating in the final experiment were six FCC commissioners, nine members of the Commission's congressional oversight committee, and eleven members of the staffs of both groups.

Data collected from these experiments have been fitted to theoretical stochastic models of qualitative choice behavior to obtain estimates of allocation preferences as a function of market characteristics. These preference functions are then used (a) to check the coherence of preferences across individuals; (b) to examine differences in policy objectives between congressional oversight committees and the regulatory agency; (c) to determine whether individual preferences can be aggregated into a social decision function with normatively compelling properties, such as consistency with individual preferences or majority-rule equilibrium; and (d) to test the sensitivity of committee decisions to voting institutions and alternative agendas.

In Search of Scientific Regulation: The UHF Allocation Experiment

by

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The explicit purpose of regulatory agencies is to produce an allocation of resources that differs from the allocation that would result from unfettered private transactions. Presumably the resulting allocation is supposed to reflect socially important values that would otherwise be treated inadequately by private parties.

A major problem that faces anyone, including the regulator, who seeks to evaluate the allocation that results from a regulatory policy is to place values on the consequences of alternative actions. Regulators are rarely in the happy position of facilitating society's move to an allocation that is unambiguously superior (e.g. strictly Pareto dominant). Instead, some will lose and some will gain, and opinions will differ on which allocation is preferable.

Both political and economic reasoning provides a very pessimistic point of view on the ability of regulators to assemble convincing proof that their allocations, if not perfect, are at least preferable to some reasonable alternatives. Whether the decision-rule is market simulation through benefit-cost analysis or majority rule voting, theory teaches us that without placing restrictions on preferences or assigning social values to the income of each person, definite conclusions about the relative values of Pareto noncomparable positions cannot be reached.

Nevertheless, regulators are hired to make these allocations, and the search for a calculus for evaluating their decisions continues. Moreover, it is always possible that the distribution of people according to preferences and of the consequences of a particular decision are regular enough so that normatively interesting comparisons can be made.

This paper reports the results of one attempt to introduce an objective, quantitative, scientific mechanism for making allocational regulatory decisions. The case is the allocation of UHF television stations among cities by the Federal Communications Commission. The mechanism is an experiment which is designed to reveal the preferences of the subjects with respect to alternative allocations. Pilot experiments were performed on FCC staff, the purposes of which were to refine the experimental design and instructions and to provide data for comparing different specifications of the final estimated equation. Participating in the final experiment were six FCC commissioners, nine members of the Commission's congressional oversight committee, and eleven members of the staffs of both groups. To our knowledge this is the first instance in which decisionmakers at this level have been willing to permit the collection of preference data on such an important issue of public policy.

Data collected from these experiments have been fitted to theoretical stochastic models of qualitative choice behavior to obtain estimates of allocation preferences as a function of market characteristics. These preference functions are then used (a) to check the coherence of preferences across individuals; (b) to examine differences in policy objectives between congressional oversight committees and the regulatory agency; (c) to determine whether individual preferences can be aggregated into a social decision function with normatively compelling properties, such as consistency with individual preferences or majority-rule equilibrium; and (d) to test the sensitivity of committee decisions to voting institutions and alternative agendas.

The paper is organized as follows. Section I describes the allocational problem of the FCC that motivates the search for a scientific decision-making mechanism. Section II presents the basic microeconomic and econometric models that motivate the design of the experiment. Section III contains a detailed description of the experiment. The empirical findings from the experiments are reported in Section IV. Section V presents the analysis of alternative preference aggregation rules, and Section VI offers a brief summary and conclusion.

I. THE STATION ALLOCATION PROBLEM

One of the principal responsibilities of the Federal Communications Commission is to define and allocate rights to use the electromagnetic spectrum for communications purposes. Among the many claimants to this scarce resource are television broadcasters, and since the early 1950s the FCC has reserved a large portion of the spectrum for their use. Except for some possibility of tinkering at the margins, this element of spectrum allocation -- the reservation of a part of the spectrum for broadcasters -- has been resolved. A second element is still a live issue. This is the allocation of channel assignments to particular localities. Because nearly all VHF channel assignments have been made and are being used, the major task is to allocate the largely unused UHF spectrum, although the FCC is also investigating the technical feasibility of adding a few more VHF channel assignments as well.

Exactly why the FCC and Congress want to use administrative mechanisms to allocate television stations among cities is a matter of some dispute and controversy. A definitive treatment of this issue is beyond the scope of this paper. Suffice to say here that the policy derives from the "local service" doctrine, which holds that each community ought to have an "equitable" amount of locally controlled broadcasting outlets if it is large enough to make local stations economically viable.[1]

Whatever the justification, a major task of the FCC is to decide the maximum number of television stations that will be allowed to operate in each community. This task has three elements.

The first is to determine which allocations are technically feasible. The FCC seeks to make station signals receivable in the community in which they are located, but weak enough so that the same channel and the channels adjacent to it can be used in as many other communities as possible. The variables under the control of the FCC to affect signal reception are the antenna height, signal power, and signal direction of a station and the geographic spacing between stations. For several years the FCC has used a computer program to generate alternative allocations that are technically feasible and that satisfy some other standards of service, such as maximizing the proportion of the population that can receive some minimum number of local stations.

A second element of the allocation problem is to determine whether a particular station allocation is economically viable. One objective of the FCC is to allocate stations in such a way that as many as possible are claimed and used by broadcasters. To select one city over another for an additional station assignment serves no useful purpose if only in the latter city could an additional station generate enough revenue to operate. Because stations are required to report financial information to the FCC, some data are available for estimating the financial viability of additional stations, and since mid-1976 the FCC has been working on a financial model of UHF viability that will be incorporated into the technical allocation model. The result will be a model that generates alternative allocations that are technically feasible and economically promising.

The final part of the allocation problem is to choose among the alternative technically and economically feasible solutions. One dimension that affects the choice, by virtue of the local service doctrine, is the pattern of existing allocations among communities. Presumably the quantitative impact of local service is to work towards equalization of viewing options across communities. Another dimension is the number of people to benefit from an allocation, as measured by the population served by a station. This would tend to work against the local service doctrine by allocating more stations to larger cities than to smaller ones. Still another aspect of the problem is to decide what kind of station to create. The FCC decides directly whether a station will be commercial or noncommercial. Within each category it also decides indirectly what kind of programming will be broadcast by virtue of the patterns of programming that develop as stations are added to a market. For example:

- The first three VHF commercial allocations (or, with fewer than three commercial VHF stations, the first three commercial stations) will affiliate with a network;
- Independent commercial VHF stations, because of signal reception advantages, will outbid commercial UHF stations for the best programming that is not provided by the three major networks, so that the type and quality of programming on an additional UHF station depends on

whether its independent competition is from V's or other U's;

- Second or third noncommercial allocations, because of the scarcity of programming available for them, will focus on rerunning programs from the national noncommercial network and providing very inexpensive, discussion-oriented local programs.

With respect to commercial stations, the access to television advertising by local merchants (in comparison with national and regional businesses) will be affected by the number and spectrum location of commercial outlets. An advantage of local UHF commercial independents in the eyes of the FCC is that they provide an inexpensive advertising outlet for local business that enables them to compete more effectively with larger firms.[2] Multiple stations also foster "political competition" in local affairs by increasing the number of independent points of view that can be given access to channels. Finally, the heterogeneity of the community may affect the desirable number of allocations to it. To the extent that tastes in programs are related to cultural background, additional stations might provide more benefits to communities with a diverse ethnic background, by providing more specialized programs for each group, than to a homogeneous community.

For these and other reasons, political decision-makers have preferences among alternative station allocations that would

not be fully accounted for if allocations responded only to measures of the economic performance of a station. In recognition of this, the FCC authorized an exploratory study to determine whether and to what extent noneconomic aspects of allocation policy could be incorporated into the computer program that generates technically and economically feasible allocations. The idea[3] was to question a panel of "wise people" outside the FCC, including some members of Congress and some informed citizens, about their opinions concerning alternative allocations and to develop some mechanism that would convert these opinions into collective decisions about the relative value of alternative allocations.

From the perspective of the FCC, an automated decision-making process based upon a sample of informed opinions has two main advantages. First, a process that simultaneously allocates a large number of stations conserves decision-making effort by a very busy Commission that otherwise would have to assign stations on a city-by-city basis after hearing a potentially large number of opinions on the comparative advantages of Keokuk and Dubuque as homes for another UHF television outlet. Second, a process based on a survey of politically responsible and representative subjects provides a mechanism for making concrete the rather vague legislative directions to the FCC with respect to spectrum allocation. Whatever allocational policy emerges from the process, the resulting allocations would have an element of political legitimacy with Congress, the courts and potential appellants from allocation decisions that would be missing from a decision based solely on the opinions of commissioners. Thus, automated allocations based upon a variety of external opinions allow the FCC to make quick and inexpensive decisions that may reflect some consensus values and that are less likely to be turned aside by Congress or the courts.

Whether the idea of computerizing an ultimately political decision is practical is another matter. First, it is not obvious that meaningful, coherent information about peoples' preferences over alternative allocations can be collected. Second, once collected, it is not clear that these preferences are sufficiently harmonious that they can be aggregated in a nonarbitrary way and represented functionally in a computer program. These are the questions to be addressed in this paper. We attack the problem with a healthy skepticism that anything interesting and useful will result.

II. THE MODEL

As noted in the previous section, the purpose of the experiment is to gather information regarding allocation preferences. The most useful preference information is for a single individual and refers to the assignment of a single new station. The individual's preferred allocation can then be constructed from successive assignment of single stations, and questions regarding allocation preferences of a group can be answered by considering the individual preferences of group members. The first step, then, is the specification of a theoretical model of qualitative choice behavior. The model we propose is adopted from the random utility model developed by McFadden.[4]

Consider the behavior of an individual who is asked to assign a new station to one of M competing markets and to specify a "type"

restriction (commercial or non-commercial) on that assignment. The person's choice is between 2·M qualitatively distinct possible outcomes. Assignment preferences are assumed to depend on observable characteristics of the M markets, the current allocation of stations to each of the markets, and some unobservable factors that are assumed to be random. A plausible description of choice behavior is that a person assigns a numerical preference score to each of the 2·M alternatives, the value of that score being determined by the market, allocation and random factors noted above, and then chooses the assignment that receives the highest score.

A formal description of such behavior appears as follows:

$$(1) \quad S_{ij} = f_j\ (P_i, A_i, U_{ij})$$

$$(2) \quad Y_{ij} = \begin{cases} 1 & \text{if } S_{ij} > S_{i'j'} \text{ for all } (i',j') \neq (i,j),\ i' = 1,\ldots,M,\ j' = 1,2 \\ 0 & \text{otherwise,} \end{cases}$$

where the subscript i denotes market ($i = 1, 2, \ldots, M$); the superscript j denotes type ($j = 1$ for commercial, 2 for non-commercial); S_{ij} is the preference score for market i, type j; P_i is a description of characteristics of market i; A_i is a description of the current allocation of frequencies to market i, (i.e., an itemization of the number of commercial UHFs, non-commercial UHFs, commercial VHFs and non-commercial VHFs); U_{ij} is a random variable representing unobservable factors affecting the value of S_{ij}; and Y_{ij} is an indicator for the preferred assignment. Implicit in the specification of equation (1) is the assumption that the score S_{ij} assigned to market i is independent of scores $S_{i'j'}$ for any other market $i' \neq i$ and that differences between markets are reflected only through the factors P_i, A_i and U_{ij}, not through differences in the form of f_j. The function f_j may differ across types j, and, because S_{i1} and S_{i2} both depend on the same factors, P_i and A_i, they need not be independent, allowing for substitutability between station types within the same market.

It would be unrealistic to expect individuals to reveal their preference scores S_{ij}. Indeed, the model does not even require conscious assignment of numerical values. It merely requires that the choices be consistent with the assignment of numerical values in the following sense: there exists a function f_j and a distribution on the random variable U_{ij} that correctly predicts the relative frequency of outcomes Y_{ij} as the assignment task is repeated indefinitely. The preference scores are in a sense an artificial construct, and do not necessarily have any natural interpretation or meaning. (Two suggestive interpretations are the perception of an individual about the increment to "social welfare" resulting from a new assignment and the magnitude of the deviation of the current allocation, A_i, from some "target" allocation.) The scores merely provide a convenient measure of preferences among alternatives. For example, given either estimates or knowledge of the functions f_j, specific values of P_i and A_i determine expected scores S_{ij} that rank-order all alternative assignments.

The presence of the random component U_{ij} implies that S_{ij} and, in turn, Y_{ij} will be random variables with distributions derived from that of U_{ij}. That derived distribution for Y_{ij} provides a basis for the estimation of parameters from a sample of observations on the Y_{ij} and the exogenous variables P_i and A_i. In principle, the choice

probabilities ($\Pr(Y_{ij} = 1|P_i, A_i)$, i = 1 ..., M, j = 1,2) may be derived given any specific functional form for f_j and any distribution on U_{ij}. But arbitrary specifications will lead to choice probabilities which exhibit undesirable properties and are computationally cumbersome. We assume that the random term enters additively,

$$f_j(P_i, A_i, U_{ij}) = f_j(P_i, A_i) + U_{ij}$$

and that the U_{ij}s follow independent and identical Weibull distributions:

$$\Pr(U_{ij} \leq u|A_i, P_i) = \exp(-\exp(-u)).$$

This yields choice probabilities of the logistic form:[5]

$$(3) \quad \Pr(Y_{ij} = 1|A_i, P_j) = \exp(f_j(P_i, A_i)) \Big/ \sum_{i'=1}^{M} \sum_{j'=1}^{2} \exp(f_{j'}(P_{i'}, A_{i'})) .$$

The form of $f_j(P_i, A_i)$ is assumed to be:

$$(4) \quad S_{ij} = f_j(P_i, A_i) + U_{ij} = \beta_j' X_i + U_{ij},$$

where X_i is a k element vector of observable constants which are obtained from predetermined functions of P_i and A_i.[6] Now equation (3) for choice probabilities can be written as

$$(5) \quad \Pr(Y_{ij} = 1|P_i, A_i) = \exp(\beta_j' X_i) \Big/ \sum_{i'=1}^{M} \sum_{j'=1}^{2} \exp(\beta_{j'}' X_{i'}).$$

The choice probabilities in equation (5) are in the form required for the conditional logit model used extensively in econometric analysis of qualitative choice behavior. Maximum likelihood may be used for estimation of β_j, j = 1, 2, given a random sample of observations on Y_{ij} and X_i.

III. THE STATION ALLOCATION EXPERIMENT

The general structure of the station allocation experiment is that it asks a subject to make a sequence of station allocations among a group of cities that differ in population and their initial allocations. Although the original intent was to include ethnic diversity as well as population as a variable separating cities, incorporating these variables made the game too complex to satisfy two highly binding design constraints: The statistical techniques that were employed require a large number of observations, and the experiment could take no more than a few minutes if cooperation was to be obtained from the subjects, most of whom were highly placed government officials.

Although several forms of the experiment have been used, the following discussion describes the version that was used for the Commissioners, Congressmen and some high level staff members. The earlier variants were applied to some staff, and had different ranges of variation in independent variables and in the number of factors that were allowed to influence allocations. The final form of the experiment was based on experience gained from the earlier trials. The complete set of instructions to subjects and experimenters for the final version is contained in Appendix A.

At the beginning of the experiment, a subject is confronted with an existing allocation to four cities. The subject is shown a game board which indicates the population of the area served by stations in each city and the number of stations already on the air in each of four categories: UHF and VHF stations of the commercial

and noncommercial variety (Table 1). The subject is told that in any city the first three VHF commercial allocations (or the first three commercial stations if there are fewer than three VHF commercial allocations) will be network affiliates, and the rest of the commercial stations will be independents. The experimenter then gives the subject four tokens representing VHF stations, and a very large number of UHF tokens. The subject is told to begin allocating additional stations, in order of the subject's conception of the relative value of the alternatives, among the four cities. An allocation is made by placing a VHF or UHF token in one of the two station categories in one of the four cities.[7]

[TABLE 1 HERE]

The subject proceeds to allocate stations until one of two events occurs. If the subject believes that no more channels serve a useful social purpose, the subject announces that the experiment is over. Otherwise, the subject is told that the experimenter will call the experiment to a halt in a few minutes, based upon a random decision rule that is unknown to the subject. In practice, experimenters were told to stop the experiment after about twenty allocations or after about two minutes, whichever occurred first. The number of UHF tokens available to the subject was much larger than the maximum number of choices that could be made with this rule. The intent of the stopping rule is to reinforce the instructions that each

TABLE 1: SAMPLE INITIAL CONDITIONS FOR STATION ALLOCATIONS

Market	A		B		C		D	
Population	5,000,000		1,500,000		400,000		100,000	
	Comm.	Noncomm.	Comm.	Noncomm.	Comm.	Noncomm.	Comm.	Noncomm.
VHF	3	1	3	0	2	1	2	0
UHF	1	0	1	1	1	0	0	0
TOTAL	4	1	4	1	3	1	2	0

assignment is to be the best available alternative and not to be one element of an unordered set of several, essentially simultaneous allocations. Only in this case will the set of assignments satisfy the characteristics of a random sample that are assumed in the theoretical model and for the statistical procedures.[8]

The original plan was to have each subject go through the allocation experiment four times, each time with different initial conditions in terms of city populations and original allocations. But early experimental results indicated that in some cases this would provide too few allocations to support statistical determination of the underlying preference relation of the subject. The problem was that a surprisingly large minority of subjects did not like television and would stop allocating more stations after only a handful of allocations. Thus, the number of times the experiment was run on each subject was made a variable, and the experimenter was instructed to rerun the experiment enough times with varying initial conditions to generate at least fifty choices.

One feature of the experiment is that, for all but the first assignment in a run of the experiment, the initial conditions for any one choice are determined by the subjects previous allocations. This generates variance in the variables measuring the pattern of allocations that enter the scoring function as independent variables. Meanwhile, each time the experiment is run the population of the cities remains constant during all of the allocations. Populations are changed only when a run of the experiment is stopped and the subject is given a new set of initial conditions for the next experiment.

Another feature of the experiment is the absence of direct incentives to the subjects. To pay subjects was impossible because they occupy positions in either the agency that paid for the experiments or the congressional subcommittee that authorizes its budget. In any case, there is no natural way to construct payoffs to subjects while retaining the essential features of the FCC's allocation problem. A few well-publicized scandals to the contrary, FCC and congressional decision-makers do not receive direct monetary payoffs for allocation decisions. In terms of designing an experiment that parallels reality, the problem in experimental design that this creates is that there is no reason to believe that the responses reveal true preferences. This should introduce no particular bias into the results, but it may make them essentially observations on random variables rather than the result of rational comparisons.

Two features of the experiment could counteract the tendency to give random, poorly considered answers. One is that subjects were told the truth about the purpose of the experiment, which is that the subject's responses may be used to make real allocations. Stressing the importance of the exercise may induce the subject to take the experiment more seriously. The second is that the experiment was designed to be enjoyable. This required creating an interesting task in an interesting setting, and designing an experiment that is fast-moving and of short duration. The extent to which these elements succeed is measured by

the consistency of the choices made by the subject. Were the responses random, the estimated decision model would not explain the decisions that were made.

Although the authors administered the experiment a few times, most of the data were collected by two staff members of the FCC who were assigned to the UHF Task Force. The authors trained both in experimental techniques, and one of them was present during several experiments administered by the authors.

The experiment was administered in the following way. First, the experimenter read a short, general statement to the subject about the purpose of the experiment, and answered any questions that the subject asked in response to this statement. Second, the subject was given a detailed set of instructions, which the subject then read. The subject could ask questions of the experimenter during this reading. Third, the experimenter and the subject together made some hypothetical allocations. Fourth, when the experimenter was convinced that the subject understood how to perform the allocation tasks, the first set of initial conditions and a set of station tokens were given to the subject, and the first iteration was begun.

The final stage of the process was an interview, after the last iteration of the experiment was completed. The purpose of the interview was to provide some additional information that was thought to be valuable by the FCC staff, such as the reactions of subjects to the experiment and their opinions on whether other factors, such as ethnic diversity, would have affected the allocations. Because the interview took place after the subject made allocations, and because the experimenters were instructed not to discuss the issues covered in the interview with the subject except to answer specific factual questions until the interview was underway, experimenter influence on allocation decisions was minimized. Nonetheless, the likelihood is small that experimenter influence was avoided altogether because of the impossibility of keeping two experts on communications policy from discussing matters of mutual interest for the first thirty minutes of their conversation.

The experimenter was given a standard form for recording information from the experiment, as shown in Appendix A. The allocation data were collected by the experimenter, who wrote down the allocations of the subject as they were being made. Occasionally subjects allocated stations faster than the experimenter could write them down in which case the experimenter asked the subject to delay the next allocation or to repeat the last one. Usually the rate at which stations were allocated was slow enough so that experimenters had no difficulty recording the subject's decisions.

Experimental subjects were selected in the following way. All seven FCC Commissioners and fifteen members of the House Subcommittee on Communications were asked to be subjects. One Commissioner and six Representatives refused. Included in the sample are Commissioners Brown, Ferris, Fogarty, Lee, Quello and White, and Congressmen Brown, Core, Mikluski, Moore, Moorhead, Moss, Skubitz, Stockman and Van Deerlin. The staff members selected as subjects included assistants to four additional Congressmen (Murphy, Russo, Waxman and Wirth), three members of the staff of the House Subcommittee, two members of the staff of the Senate Subcommittee on Communications, and two FCC staff -- the General

Counsel and the Assistant to the Chairman. Four congressional staff responses were not used in the analysis because of problems in the experiment or because the data were given to us too late to be incorporated in the analysis. All subjects were promised that the results of the experiment would be presented in such a way that their responses could not be matched to their names.

IV. ESTIMATING PREFERENCE RELATIONS

The data generated by an experiment on a single subject consist of (a) the initial conditions (population and allocation of stations in each of M markets) for each trial and (b) the sequence of new frequency assignments within each of the trials. The current allocation in all markets upon which each new assignment is based can readily be calculated from the initial allocation and the sequence of preceding assignments, which represent increments to the allocation. Each subject participates in several trials which have different initial allocations and populations for the four markets. If the data for all trials on one subject are combined, and if T is the total number of new assignments made in all trials, then T observations ($t = 1, \ldots, T$) are collected on each of the following variables:

Y_{tij} : Indicator of assignment made

($Y_{tij} = 1$ if assignment was to market i, type j, and zero otherwise.)[9]

P_{ti} : Population in market i.

CU_{ti} : Number of commercial UHF stations in market i.

CV_{ti} : Number of commercial VHF stations in market i.

NU_{ti} : Number of noncommercial UHF stations in market i.

NV_{ti} : Number of noncommercial VHF stations in market i.

$$(i=1,\ldots,M, \quad j=1,2)$$

These data are used to estimate, for each subject, the conditional logit model of choice behavior described in Section II. For ease of reference, the essential elements of that model are repeated here. Let $A_{ti} = [CU_{ti}, CV_{ti}, NU_{ti}, NV_{ti}]$, X_{ti} be a vector valued function of P_{ti} and A_{ti}, $P_t\{P_{ti}, i=1, M\}$, $A_t = \{A_{ti}, i=1,\ldots, M\}$, and $Y_t = \{Y_{tij}, i=1,\ldots, M, j=1,2\}$, and recall that U_{tij} is the unobserved random variable. The unobserved preference scores S_{tij} are assumed to be determined by

$$S_{tij} = \beta_j' X_{ti} + U_{tij}$$

and the logistic choice probabilities appear as

$$\Pr(Y_t | P_t, A_t) = \prod_{i=1}^{M} \prod_{j=1}^{2} \left[\frac{\exp(\beta_j' X_{ti})}{\sum_{i'=1}^{M} \sum_{j'=1}^{2} \exp(\beta_{j'}' X_{ti'})} \right]^{Y_{tij}}.$$

The vectors β_1 and β_2 are the parometers to be estimated.

Though P_{ti} and A_{ti} contain only five components, these components may be combined in various ways in the specification of

X_{ti} to pick up linear, nonlinear, and interactive effects of population and allocation. Unfortunately the underlying theory of allocation decisions does not yield a precise specification of the scoring function and the limited number of observations for each subject rules out the option of a subject-by-subject empirical search for the "best fitting" model. To avoid the potential danger of "overfitting" the data, the bulk of experimentation with alternative specifications used data from the pilot experiments. Moreover, the same model was applied to each subject, and variables were added or deleted only if that change uniformly improved the fit across all pilot subjects. The result of that study was a model which included nine variables and seventeen coefficients. Finally, the model was fitted to the data obtained from the subjects of most interest, commissioners, Congressmen and high level FCC and Congressional staff members. Variables were eliminated from the model at this stage to the extent possible without sacrificing predictive power. The list of variables so obtained is contained in Table 2.

[TABLE 2 HERE]

Except for the constant term X_1, the independent variables in the model vary across markets and change from one assignment to the next. They are constant across type but enter the preference scores S_{tij} with different coefficient weights, β_j. Let β_{jk} be the weight assigned to variable k in the score for a type j assignment. The nature of the model and fewness of noncommercial assignments create an identification problem among the β_{jk}'s. To deal with this problem β_{21} was normalized at zero, and the following constraints

TABLE 2

LIST OF EXOGENOUS VARIABLES

X_1	DUMMY	--	A constant term introduced to allow for gross preference differences between commerical and noncommercial assignments.
X_2	#COM UHF	--	The number of commercial UHF stations (CU) currently allocated.
X_3	#COM VHF	--	The number of commercial VHF stations (CV).
X_4	#NON-COM	--	The number of noncommercial stations (NV + NU).
X_5	POP/# STA	--	Population divided by total number of stations.
X_6	POPULATION	--	Market population (P) (in millions).
X_7	LOG POP	--	Natural log of (population + 1).
X_8	NETWORK	--	Dummy variable for Networks (1 if fewer than three commercial stations, 0 otherwise).

were imposed: $\beta_{22} = \beta_{23}$ and $\beta_{28} = 0$. Thus there remain in the model eight variables and thirteen identifiable coefficients.

Coefficient estimates for six commissioners, nine members of Congress, and seven staff members are presented in Tables 3, 4, and 5, respectively. Significance tests must be treated with some caution, given the small sample sizes and the fact that the model was arrived at by some searching over alternative specifications. But overall the fit for each subject is reasonably good. The psuedo R^2s, computed as $1 - L(\hat{\beta})/L(\beta = 0)$ where L is the log likelihood, are nearly all above .4, values generally considered large for logistic models. The entries in the row labeled Chi-Sq are $-2[L(\beta = 0) - L(\hat{\beta})]$ and may be used to test the hypothesis that assignments are purely random, an hypothesis which is resoundingly rejected for all subjects. The estimated coefficients can be used to predict the rank ordering across all eight alternatives (four markets by two types) at each assignment. As indicated in the next to last row in the tables, between 55 percent and 97 percent of the actual assignments made by a subject were predicted by the model as being the first or second choice.

[TABLES 3, 4, 5 HERE]

The estimates suggest relations between preference scores and the other variables that are plausible. For example, the effect of increasing the number of stations of a given type in a particular market should be to decrease the preference score for another assignment of that type, an effect which holds uniformly across both subjects and types of assignments.[10] The direction of the effect of

TABLE 3

LOGIT MODEL COEFFICIENT ESTIMATES FOR SIX COMMISSIONERS*

Variable	SUBJECT XVII	XVIII	XXII**	XXIII	XXVIII	XXIX
COMMERCIAL SCORE COEFFICIENTS						
Dummy (β_{11})	-2.8906	4.7435	0.	1.7652	3.4733	8.9056
	(-1.5266)	(1.6483)	NA	(0.5427)	(1.3457)	(3.1698)
# Com-UHF (β_{12})	-2.7346	-3.764	-3.9349	-1.4686	-3.3189	-2.7498
	(-5.4033)	(-5.2204)	(-5.315)	(-3.0352)	(-5.492)	(-3.8214)
# Com-VHF (β_{13})	-2.8059	-2.8916	-3.9046	-1.483	-3.2568	-2.8926
	(-4.4935)	(-3.7873)	(-4.6637)	(-2.486)	(-4.7712)	(-3.2247)
# Non-Com (β_{14})	-2.9876	0.1618	-1.2154	-0.7496	-0.8579	-0.6818
	(-4.587)	(0.2936)	(-1.7693)	(-1.1058)	(-1.5031)	(-1.1261)
Pop/# Sta (β_{15})	-1.8951	1.3406	-2.407	6.3571)	-1.5296	4.7956
	(-0.9935)	(0.6152)	(-1.2658)	(1.5862)	(-0.698)	(1.35)
Population (β_{16})	-0.3381	-0.5463)	-2.244	-1.1809	-0.7711	1.2732
	(-0.732)	(-1.1201)	(-3.9999)	(-2.0353)	(-1.6998)	(-1.6804)
Log Pop (β_{17})	5.6186)	2.1516	11.5731	2.7253	6.409	2.5314
	(4.2634)	(1.5353)	(5.2638)	(1.7042)	(3.8157)	(1.7162)
NETWRK (β_{18})	0.5429	1.5364	2.0927	0.3376	2.63	1.8368
	(0.7947)	(1.3531)	(2.7923)	(0.4696)	(2.7406)	(-1.7886)
NON-COMMERCIAL SCORE COEFFICIENTS						
# Com UHF & VHF ($\beta_{22} = \beta_{23}$)	-1.5018	-0.6835	0.5679	1.0191	-2.0497	0.3281
	(-2.3709)	(-0.87)	(0.8019)	(0.9888)	(-2.6076)	(0.4401)
# Non-Com (β_{24})	-7.4841	-6.1992	-13.5325	-10.7792	-4.0281	-4.8844
	(-6.7672)	(-5.001)	(-5.2364)	(-4.5922)	(-4.0915)	(-4.1315)
Pop/# Sta (β_{25})	-2.0191	-2.3069	0.	3.0542	0.3795	9.019
	(-0.591)	(-0.3751)	NA	(0.343)	(0.0697)	(1.6339)
Population (β_{26})	-0.3155	-0.8001	0.	-1.2421	-2.1789	-2.88
	(-0.4113)	(-0.6562)	NA	(-0.9251)	(-2.0851)	(-2.25)
Log Pop (β_{27})	3.787	5.8052	-0.4436	4.228	9.8253	4.0961
	(2.0983)	(2.6711)	(-0.5027)	(1.2456)	(3.6621)	(1.675)
N	97.	75.	67.	74.	74.	52.
Chi-Sq	170.21	141.52	150.762	133.027	135.442	89.5424
(dF)	(13)	(13)	(10)	(13)	(13)	(13)
R^2	.42	.45	.55	.43	.44	.41
% 1-2***	79	84	81	72	82	79
% 3-4****	15	9	15	26	11	13

* Figures in parentheses are the ratio of coefficient estimate to estimated asymptotic st. error.

** Subject XXII made so few noncommercial assignments that the full model could not be estimated. Reported estimates were obtained constraining three coefficients to be zero.

*** Entries indicate the percentage of actual assignments which were predicted by the model as either the first or second choice.

**** Entries indicate the percentage of actual assignments which were predicted by the model as either the third or fourth choice.

TABLE 4

LOGIT MODEL COEFFICIENT ESTIMATES FOR NINE CONGRESSMEN*

	Subject XI**	XII	XX	XXI	XXIV	XXV	XXVI	XIX	XXXIII
COMMERCIAL SCORE COEFFICIENTS									
Dummy (β_{11})	0.	-2.4456	7.5508	-1.0638	-0.7238	9.0435	3.2195	7.9307	2.5789
	(NA)	(-0.9068)*	(2.3599)	(-0.5996)	(-0.478)	(3.1237)	(0.8969)	(0.9284)	(1.3153)
# Com-UHF (β_{12})	-4.255	-1.0616	-3.8003	-1.3356	-0.9336	-4.1121	-2.6405	-3.9461	-0.904
	(-4.5263)	(-1.2874)	(-4.5522)	(-3.4858)	(-3.035)	(-4.7539)	(-2.9489)	(-2.3296)	(-1.8016)
# Com-VHF (β_{13})	-3.763	-1.6753	-3.1947	-1.1527	0.2644	-3.9444	-1.9501	-4.4616	-1.2675
	(-3.7924)	(-1.7252)	(-3.4434)	(-2.2298)	(0.5889)	(-4.0175)	(-1.8492)	(-2.0671)	(-1.9849)
# Non-Com (β_{14})	-0.5425	-4.9495	-0.7801	0.4335	0.6519	0.0865	-0.1129	-1.8132	-0.3946
	(-0.5849)	(-6.1614)	(-1.0896)	(0.9069)	(1.6852)	(0.1295)	(-0.1412)	(-1.1149)	(-0.8829)
Pop/# Sta (β_{15})	-1.7723	-1.2865	1.7288	-4.0663	9.1582	0.0717	-2.473	-7.8841	-1.2601
	(-0.583)	(-0.5599)	(0.3724)	(-1.6946	(3.262)	(0.0278)	(-0.7569)	(-1.0579)	(-0.4156)
Population (β_{16})	-1.4288	-0.8953	-0.6663	0.205	-0.6524	-1.5535	-1.2412	-0.0991	-0.6464
	(-2.0292)	(-1.3963)	(-1.0686)	(0.5045)	(-1.6765)	(-2.5896)	(-1.6522)	(-0.077)	(-1.3913)
Log Pop (β_{17})	9.9825	6.8267	6.8887	2.9167	-1.1638	8.0743	10.4458	15.724	4.3484
	(4.038)	(3.5009)	(3.0399)	(1.9568)	(-0.9972)	(3.9886)	(3.3945)	(2.3509)	(2.3691)
NETWRK (β_{18})	0.8611	3.6033	0.7801	-0.3524	0.0382	0.1185	1.4617	0.8146	-0.0498
	(0.9821)	(3.4532)	(0.9683)	(-.7106)	(0.0715)	(0.1345)	(1.4898)	(0.6501)	(-0.0665)
NON-COMMERCIAL SCORE COEFFICIENTS									
# Com UHF & VHF ($\beta_{22} = \beta_{23}$)	1.0267	-0.4317	0.4579	-0.638	0.5592	0.5293	0.6801	1.9453	0.2501
	(1.0052)	(-0.8422)	(0.5459)	(-1.4194)	(1.7713)	(0.8168)	(0.5568)	(0.4941)	(0.7155)
# Non-Com (β_{24})	-15.8693	-5.9646	-5.8775	-3.2672	-3.1233	-5.6668	-3.1205	-13.4354	-1.6928
	(-4.1275)	(-7.4176)	(-5.0428)	(-4.4533)	(-4.6975)	(-5.9228)	(-2.6371)	(-2.1622)	(-3.7266)
Pop/# Sta (β_{25})	0.	-1.1255	0.7696	-2.4423	-9.5284	-12.4818	3.8209	-13.2518	1.0696
	(NA)	(-0.5286)	(0.1038)	(-1.036)	(-1.6809)	(-2.1549)	(0.7315)	(-0.3793)	(0.4784)
Population (β_{26})	0.	-0.7686	-1.478	-0.9397	2.1643	-0.039	-1.5825	-2.4761	-1.2547
	(NA)	(-1.4406)	(-1.5783)	(-1.6682)	(2.8336)	(-0.0496)	(-1.5621)	(-1.3084)	(-2.7154)
Log Pop (β_{27})	2.5056	4.9696	6.3916	7.6047	-1.6943	9.7448	4.9868	21.8729	5.5829
	(2.013)	(3.744)	(2.0265)	(3.8958)	(-0.7546)	(3.5207)	(1.2667)	(0.9527)	(3.2929)
N	55.	91.	72.	79.	94.	68.	39.	32.	69.
Chi-Sq	145.00	178.60	146.66	87.77	119.93	132.23	77.42	91.60	46.22
(dF)	(10)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)
R^2	.63	.50	.49	.27	.31	.47	.48	.69	.16
% 1-2***	89	82	86	66	68	81	82	97	55
% 3-4****	9	8	12	20	21	18	15	0	22

* Figures in parentheses are the ratio of coefficient estimate to estimated asymptotic st. error.

** Subject XXI made so few noncommercial assignments that the full model could not be estimated. Reported estimates were obtained constraining three coefficients to be zero.

*** Entries indicate the percentage of actual assignments which were predicted by the model as either the first or second choice.

**** Entries indicate the percentage of actual assignments which were predicted by the model as either the third or fourth choice.

TABLE 5

LOGIT MODEL COEFFICIENT ESTIMATES FOR SEVEN STAFF MEMBERS*

	XIII	XV	XVI	XXVII	XXX	XXXI	XXXII
COMMERCIAL SCORE COEFFICIENTS							
Dummy (β_{11})	0.8113	6.1177	-1.4023	2.3052	4.0716	2.5015	2.7082
	(0.4649)	(1.9007)	(-0.715)	(1.3742)	(2.0342)	(1.3638)	(1.1369)
# Com-UHF (β_{12})	-4.6034	-3.7621	-1.1527	-0.7639	-1.8425	-2.9223	-2.1545
	(-5.8985)	(-4.4773)	(-3.6684)	(-2.4141)	(-3.1983)	(-5.2859)	(-4.1393)
# Com-VHF (β_{13})	-4.9523	-4.0812	-1.1125	0.1236	-1.8777	-2.2505	-1.5705
	(-5.7541)	(-4.1999)	(-2.5399)	(0.2659)	(-2.7674)	(-3.7054)	(-2.6692)
# Non-Com (β_{14})	-0.8959	-1.2581	-0.3999	0.343	0.9441	0.5639	-1.2661
	(-1.61)	(-1.5261)	(-1.2221)	(0.8628)	(1.6208)	(1.2896)	(-2.5334)
Pop/# Sta (β_{15})	7.9769	-2.0866	-1.7586	2.1714	8.707	3.7091	-0.4076
	(2.9932)	(-0.7672)	(-1.0091)	(1.0517)	(2.4003)	(1.6735)	(-0.2163)
Population (β_{16})	-2.767	0.0051	0.1043	-0.8537	-1.777	-1.1568	-0.5382
	(-4.3927)	(0.0086)	(0.3286)	(-2.0639)	(-3.1921)	(-2.4045)	(-1.2881)
Log Pop (β_{17})	5.4046	4.0613	2.4926	2.7665	3.2823	2.182	3.6683
	(4.1235)	(2.6884)	(2.3927)	(2.1253)	(1.9415)	(1.8551)	(2.9918)
NETWRK (β_{18})	-1.8535	-0.3298	0.8794	0.4205	0.0125	0.3165	1.5022
	(-2.1768)	(-0.3647)	(1.6882)	(0.7877)	(0.0174)	(0.4242)	(1.8674)
NON-COMMERCIAL SCORE COEFFICIENTS							
# Com UHF & VHF ($\beta_{22} = \beta_{23}$)	-2.5229	-0.0718	-1.1141	1.2834	2.4258	-0.6952	0.431
	(-4.1001)	(-0.0846)	(-1.7119)	(2.7586)	(4.0238)	(-1.6595)	(0.7022)
# Non-Com (β_{24})	-6.0087	-7.8852	-4.2182	-4.065	-4.5247	-3.0329	-6.0578
	(-5.9532)	(-4.6325)	(-4.8772)	(-5.2347)	(-6.1992)	(-5.4365)	(-5.876)
Pop/# Sta (β_{25})	3.0602	-1.0772	-4.0928	3.3557	7.4774	-0.7584	-3.7659
	(1.0392)	(-0.1668)	(-0.8432)	(1.152)	(2.2415)	(-0.282)	(-0.8942)
Population (β_{26})	-1.5743	-0.6365	0.0855	-1.9708	-1.3209	0.3652	0.0528
	(-2.1643)	(-0.5997)	(0.1058)	(-3.0272)	(-2.4603)	(0.5651)	(0.0682)
Log Pop (β_{27})	4.6801	4.1319	3.8457	6.1314	1.9039	1.5319	3.2624
	(2.6794)	(1.8783)	(1.1985)	(2.3521)	(0.9237)	(1.0333)	(1.6269)
N	84.	63.	101.	88.	83	95	81
Chi-Sq	153.87	118.94	135.14	108.82	129.79	127.58	125.82
(dF)	(13)	(13)	(13)	(13)	(13)	(13)	(13)
R^2	.44	.45	.32	.30	.38	.32	.37
% 1-2**	80	84	74	61	70	82	73
% 3-4***	15	11	21	28	22	8	23

* Figures in parentheses are the ratio of coefficient estimate to estimated asymptotic st. error.

** Entries indicate the percentage of actual assignments which were predicted by the model as either the first or second choice.

*** Entries indicate the percentage of actual assignments which were predicted by the model as either the third or fourth choice.

stations of one type on preference for the other type varies across subjects, indicating different attitudes among subjects about the substitutability of one type of station for the other. The NETWORK coefficient varies both in sign and magnitude across subjects. But generally it is positive, reflecting either a nonlinearity in number of commercial stations or a feeling that all markets ought to have access to all three commercial networks.

The marginal effect of population on the preference score for a type j assignment is given by $\beta_{j5}/S + \beta_{j6} + \beta_{j7}/(P+1)$, and the second derivative is $-\beta_{j7}/(P+1)^2$, where S and P are the total number of stations and population in millions, respectively, in that market. The second derivative is negative for all but two subjects, suggesting diminishing marginal preference increments as population rises. The marginal effect of population itself tends to be positive, as one might expect, across both subjects and types. But its sign depends on the values of both S and P, and there are ranges within the data for which it becomes slightly negative.

Although there are a few exceptions, the general pattern is for the marginal effect of population to be essentially zero for larger cities but positive for smaller ones. For commercial assignments at the lower range of the population scale, assignment preferences uniformly rise with increasing population at all relevant levels of S. As population approaches the middle range (about 3 million), its marginal effect diminishes uniformly across subjects and in some cases becomes zero or slightly negative when the number of stations is small. At the upper range of the population scale

(5-6 million), the marginal effect of population fluctuates around zero for nearly all subjects, being slightly negative at some relevant levels of S and slightly positive at others. A similar pattern holds for noncommercial assignments, though there are a few more exceptions. What this means is that within the ranges of population and number of assignments included in the experiment, subjects almost always allocate more stations to larger cities, but they tend to place relatively little importance on population differences between large cities. This result may be a consequence of the experimental design; with more stations to allocate and more variance in the size of large cities offered as alternatives, greater differences in allocations among large cities might be observed.

Despite some anomalies noted above, coefficient estimates exhibit sign patterns that are consistent with intuition, but these qualitative effects are not global. The estimated preference score surfaces exhibit intuitively plausible gradients, but only within the range of the data, which are also within the range of current and proposed assignments. Caution must be exercised in extrapolating beyond this range.

As further evidence of the quality of the estimates, Tables 6 and 7 compare actual and predicted assignments for one trial (trial 2-b) for the six FCC commissioners. A prediction in this case represent a simulation of a full sequence of assignments, starting from an initial allocation. A comparison with the subjects actual assignment sequence illustrates how well the model "tracks" with actual behavior. While the tables illustrate the comparison for

only one of six trials, the chosen trial is representative; it is neither the worst nor the best case for any subject.

[TABLES 6 and 7 HERE]

As seen in Table 6, through ten assignments by subject XVIII the model predicted actual assignments exactly, and the differences for the remaining three were relatively minor. For subject XXII, the model delayed noncommercial assignments to market D from the eighth to the tenth round and to market C from the eleventh to the fourteenth round. Otherwise the predictions were exact. Disagreements between actual and simulated assignments appear more severe for subject XVII. In particular the first A-C assignment in the simulation was dramatically delayed, relative to actual, and the D-N and A-N assignments at rounds 5 and 6 were premature. Recall, however, that the model explicity assumes independence of preference scores across markets but non-independence across types. Regarding commercial and noncommercial assignments to the same market as partial substitutes and ignoring the assignment type, simulated assignments at rounds 3, 5 and 8 came two rounds early, and those at rounds 12 and 15 came one round too early, relative to actual assignments. In this light the differences appear less severe.

Though the timing differences between simulated and actual assignments are frequent, they are generally "made up" within a few assignments. The comparison in Table 6 may therefore overemphasize differences. Table 7 compares simulated and actual assignments from a different perspective to reveal this overemphasis. Entries in that

TABLE 6

COMPARISON OF SIMULATED AND ACTUAL ASSIGNMENT SEQUENCE FOR SIX SUBJECTS ON ONE TRIAL*

	SUBJECT											
	XVII		XVIII		XXII		XXIII		XXVIII		XXIX	
ASSIGNMENT	SIM	ACT	SIM	ACT	SIM	ACT	SIM	ACT	SIM	ACT	SIM	ACT
1	C–C	C–C	C–C	C–C	D–C	D–C	C–C	C–C	C–C	C–C	C–C	C–C
2	D–C	D–C	D–C	D–C	C–C	C–C	C–C	C–C	D–C	D–C	C–C	C–C
3	C–C	B–C	B–C	B–C	B–C	B–C	D–C	D–C	B–C	B–C	D–C	D–C
4	B–C	A–C	A–C	A–C	A–C	A–C	C–C	D–C	A–C	A–C	D–C	D–C
5	D–N	C–C	C–C	C–C	D–C	D–C	D–C	C–C	C–C	C–C	B–C	B–C
6	A–N	C–C	D–C	D–C	C–C	C–C	B–C	B–C	D–C	D–C	A–C	B–C
7	C–C	D–C	B–C	B–C	D–C	D–C	A–C	A–C	C–C	B–C	B–C	A–C
8	B–N	C–N	A–C	A–C	B–C	D–N	C–C	D–C	B–C	C–C	A–C	A–C
9	C–N	D–N	C–N	C–N	C–C	B–C	C–N	C–N	D–C	D–C	C–C	C–C
10	D–C	B–N	D–N	D–N	D–N	C–C	D–C	B–C	A–C	A–C	D–C	D–C
11	A–C	A–N	C–C	B–N	B–N	C–N	B–C	A–C	C–C	C–C	D–N	B–C
12	D–C	C–C	D–C	A–N	A–C	B–N	D–N	C–C	D–N	D–C	B–C	A–C
13	C–C	D–C	B–N	C–C	A–N	A–C	A–C	D–N	B–C	---	B–N	---
14	B–C	B–C	B–C	---	C–N	A–N	B–C	C–C	A–C	---	A–C	---
15	A–C	C–C	A–C	---	---	---	A–C	D–C	D–C	---	---	---
16	C–C	A–C	A–N	---	---	---	B–N	---	---	---	---	---
17	---	---	---	---	---	---	D–C	---	---	---	---	---

* Entries indicate an assignment of market-type where Market = A, B, C or D and Type = C (Commercial) or N(Non-Commercial). All subjects were FCC commissioners.

TABLE 7

COMPARISONS OF ACTUAL AND SIMULATED ASSIGNMENTS AT INTERVALS OF THREE
(Entries are current number of stations for Actual (Act) and Simulated (Sim) by Market and Type after indicated increments)

Subject			Market Type A–C	A–N	B–C	B–N	C–C	C–N	D–C	D–N
	Initial Assignment		2	1	2	1	2	1	2	1
	Assignments after +N Allocations									
XVII	+3	Act	2	1	3	1	3	1	3	1
		Sim	2	1	2	1	4	1	3	1
	+6	Act	3	1	3	1	5	1	3	1
		Sim	2	2	3	1	4	1	3	2
	+9	Act	3	1	3	1	5	2	4	2
		Sim	2	2	3	2	5	2	3	2
	+12	Act	3	2	3	2	6	2	4	2
		Sim	3	2	3	2	5	2	5	2
	+15	Act	3	2	4	2	7	2	5	2
		Sim	4	2	4	2	6	2	5	2
XVIII	+3	Act	2	1	3	1	3	1	3	1
		Sim	2	1	3	1	3	1	3	1
	+6	Act	3	1	3	1	4	1	4	1
		Sim	3	1	3	1	4	1	4	1
	+9	Act	4	1	4	1	4	2	4	1
		Sim	4	1	4	1	4	2	4	1
	+12	Act	4	2	4	2	4	2	4	2
		Sim	4	1	4	1	5	2	5	2
XXII	+3	Act	2	1	3	1	3	1	3	1
		Sim	2	1	3	1	3	1	3	1
	+6	Act	3	1	3	1	4	1	4	1
		Sim	3	1	3	1	4	1	4	1
	+9	Act	3	1	4	1	4	1	5	2
		Sim	3	1	4	1	5	1	5	1
	+12	Act	3	1	4	2	5	2	5	2
		Sim	4	1	4	2	5	1	5	2

Table 7 (cont'd)

Subject	Assignments after +N Allocations		A-C	A-N	B-C	B-N	C-C	C-N	D-C	D-N
			Market Type							
	Initial Assignment		2	1	2	1	2	1	2	1
XXIII	+3	Act	2	1	2	1	4	1	3	1
		Sim	2	1	2	1	4	1	3	1
	+6	Act	2	1	3	1	5	1	4	1
		Sim	2	1	3	1	5	1	4	1
	+9	Act	3	1	3	1	5	2	5	1
		Sim	3	1	3	1	6	2	4	1
	+12	Act	4	1	4	1	6	2	5	1
		Sim	3	1	4	1	6	2	5	2
	+15	Act	4	1	4	1	7	2	6	2
		Sim	5	1	5	1	6	2	5	2
XXVIII	+3	Act	2	1	3	1	3	1	3	1
		Sim	2	1	3	1	3	1	3	1
	+6	Act	3	1	3	1	4	1	4	1
		Sim	3	1	3	1	4	1	4	1
	+9	Act	3	1	4	1	5	1	5	1
		Sim	3	1	4	1	5	1	5	1
	+12	Act	4	1	4	1	6	1	6	1
		Sim	4	1	4	1	6	1	5	2
XXIX	+3	Act	2	1	2	1	4	1	3	1
		Sim	2	1	2	1	4	1	3	1
	+6	Act	2	1	4	1	4	1	4	1
		Sim	3	1	3	1	4	1	4	1
	+9	Act	4	1	4	1	5	1	4	1
		Sim	4	1	4	1	5	1	4	1
	+12	Act	5	1	5	1	5	1	5	1
		Sim	4	1	5	1	5	1	5	2

table are the number of stations by type and market after intervals of three new assignments. As revealed in Table 7, never do the actual and simulated allocations differ by more than one station in any market at any time.

V. SIMULATING COMMITTEE DECISIONMAKING

The primary intended use of the individual scoring functions is to determine the extent to which individual preferences can be aggregated to a consistent committee decision. This section analyzes the outcome of several different methods that might be used to aggregate the preferences of each of the three types of experimental subjects: FCC commissioners, members of Congress, and staff. The groups were treated separately so that differences among them could be identified.

The theoretical problem that motivates the following analysis is the Arrow paradox. The FCC and Congress are majority-rule institutions and, in general, if the preferences of individual voters in a majority-rule institution are randomly distributed, there is no equilibrium outcome to the voting process. The Arrow paradox is most easily demonstrated by a three-person, three-option example. Let A, B and C be the alternatives to people X, Y and Z, and let the rank-ordering of the alternatives for each person be as follows:

X	Y	Z
A	B	C
B	C	A
C	A	B

If each person votes sincerely, then the outcomes of pairwise majority-rule votes are: A beats B (2-1), B beats C (2-1), and C beats A (2-1). Thus, if alternatives can be reintroduced, the process never ends. Or if alternatives can not be reintroduced, the decision depends solely on the order in which the alternatives are considered, and the final decision has no interesting normative properties -- that is, it is not necessarily better or worse than the other possible outcomes.

Table 6 shows that FCC Commissioners do have different tastes with respect to allocations, but the preferences have some consistency as well.[11] For example, if the order of allocations is taken as a crude rank-ordering of the alternatives (which it is not exactly), the majority rule choices on the first six rounds would be C-C, D-C, B-C, A-C, C-C and D-C by votes of at least 5-1, 4-2, 4-2, 4-2, 5-1 and 5-1 respectively. A cycle might arise between assignments C-C, D-C and B-C at round 7, depending on the resolution of a tie vote. But such comparisons using actual allocations are invalid, since, except for the very first round of any experiment, the current allocation on which choices are based differ from subject to subject. They require, instead, use of the scoring functions that were estimated from the allocation data.

Six different methods for simulating committee decisions were investigated through repeated use of the scoring functions. Each method was used to simulate experimental trial 2b. Four of the methods were particular forms of majority-rule, while two were methods of adding preferences.

Majority-Rule Method A assigned a random number to each of

the eight possible allocations (combinations of market and type), and made pairwise, majority-rule comparisons of the alternatives in order of the magnitude of the random number assigned to them. Thus, the two alternatives with the highest random numbers were compared by majority-rule, and the winner was then compared with the alternative with the third highest random number. Because an even number of Commissioners were subjects, ties occasionally occured in the FCC simulations; they were resolved by declaring the alternative with the higher random number (which in this case is also the "status quo") as the winner.

Majority-Rule Method B was identical to Method A except that the order in which the alternatives were considered was the opposite -- that is, the alternative considered first in Method A would be considered last in Method B. Because the results of majority-rule decisions in the presence of an Arrow paradox depend on the sequence in which alternatives are considered, Methods A and B should produce different results if the actual preferences of subjects are sufficiently nonharmonious.

Majority-Rule Method C, which was applied only to the FCC Commissioners, uses still another method of sequencing the alternatives. The Chairman of a regulatory commission can set the agenda of the meetings. Thus, the sequence of Method C is the order that maximizes the chance that the Chairman -- Charles Ferris -- would get his first choice. It also resolves all ties in the Chairman's favor -- that is, it gives the Chairman two votes if the vote would otherwise be 3-3.

Majority-Rule Method D, which also was applied only to the FCC simulations, represents still another method of making allocations that has occasionally been used in FCC decisions. It assumes that the Commission first makes a decision about the market in which the station will be located and then, after the market is decided, votes separately to determine whether the station will be commercial or noncommercial. As in Method A, the alternatives in the first round -- here four market types -- were assigned random numbers, and the sequence of pairwise comparisons was determined by the magnitude of the random numbers. Ties were awarded to the alternative having the higher random number.

One criticism of majority-rule institutions is that they offer no systematic way to account for intensities of preferences -- four weak yes votes can beat three strong no votes. The Sum of Scores Method uses the actual scores of alternatives as measures of preference intensity. For each subject, the scores assigned to all eight alternatives were normalized so that the smallest score was zero and the remaining seven summed to one.[12] Then, for each of the three groups the alternative was selected for which the sum of its normalized score across all subjects in that group was greatest. The kind of voting institution that this would approximate would be one in which each agent had a large number of votes and was asked to divide the votes among the alternatives in a way that represented the relative attractiveness of the alternatives. A person with weak preferences, then, might assign roughly equal numbers of votes to each, while a person with strong preferences might assign all votes to the most preferred option -- assuming that each voted truthfully.

The final method is the Pooled Data Method. In this case, all allocations by all subjects in one of the three categories were treated as observations by a single, hypothetical decision-maker, and a single scoring function was estimated from these pooled data. These scoring functions are shown in Table 8. Allocations were then made according to the predicted scores of the eight alternatives obtained from this pooled preference function.[13]

[TABLE 8 HERE]

Table 9 shows the results of the allocations for the six FCC commissioners according to the six different methods. Because simulating decisions outside the range of the data is a questionable procedure, the table shows the distribution of eighteen assignments by each method. Moreover, to give some picture of the pattern in which these allocations were made, the table shows the sequence of allocations in groups of three. Thus, the first group of entries shows the change in allocations after three stations had been assigned, while the second group of entries shows how the first six allocations were distributed. The results show only scattered minor differences among the allocation methods, with even the few differences being rransitory. At the end of eighteen assignments, all methods produce identical results.

[TABLE 9 HERE]

The results are even more striking for the Congress and the staff. Majority-Rule Methods A and B generated identical sequences of allocations for eighteen assignments when applied to the nine members of Congress, indicating that the results are insensitive to the particular procedures of majority rule applied to these subjects. For staff members, each group of three assignments were allocated identically by the two methods, but for one bundle -- allocations #10,

TABLE 8

POOLED DATA COEFFICIENT ESTIMATES FOR THREE GROUPS*

Variable	Commissioners	Congressmen	Staff Members
COMMERCIAL SCORE COEFFICIENTS			
Dummy (β_{11})	1.1403 (1.3808)*	0.2925 (0.5462)	0.4358 (0.7506)
# Com-UHF (β_{12})	-1.8598 (-9.7334)	-0.5419 (-4.152)	-0.7717 (-5.9521)
# Com-VHF (β_{13})	-1.8538 (-7.816)	-0.3608 (-2.9837)	-0.6762 (-4.023)
# Non-Com (β_{14})	-1.0276 (-5.2201)	-0.5563 (-4.0298)	-0.0244 (-0.1789)
Pop/# Sta (β_{15})	-0.6399 (-0.8591)	0.7637 (1.1476)	1.7088 (2.5817)
Population (β_{16})	-0.5601 (-3.2364)	-0.5706 (-4.0903)	-0.6447 (-4.4948)
Log Pop (β_{17})	4.0199 (7.6794)	2.9653 (6.4331)	1.9748 (4.7178)
NETWRK (β_{18})	0.5836 (2.0654)	0.723 (3.4939)	0.5273 (2.4691)
NON-COMMERCIAL SCORE COEFFICIENTS			
# Com UHF & VHF ($\beta_{22} = \beta_{23}$)	-0.8727 (-3.7925)	-0.0126 (-0.1026)	0.0156 (0.1132)
# Non-Com (β_{24})	-3.9461 (-11.7005)	-1.0413 (-6.9117)	-1.9891 (-10.7011)
Pop/# Sta (β_{25})	-0.8655 (-0.4924)	1.6602 (2.0662)	0.9797 (0.9996)
Population (β_{26})	-0.9135 (-2.5814)	-0.5477 (-3.1148)	-0.4172 (-1.9031)
Log Pop (β_{27})	4.6972 (5.2357)	1.7044 (3.042)	1.5356 (2.4738)
N	439	599	595
Chi-Sq: H_o** (dF)	558.73 (13)	296.17 (13)	408.04 (13)
Chi-Sq: H_p*** (dF)	261.76 (65)	729.30 (104)	491.91 (78)

* Entries in parentheses are the ratio of coefficient estimate to asymptotic st. error.

** H_o is the null hypothesis that assignments are random.

*** H_p is the hypothesis that the decision rules (true coefficients) are the same for all members within a group.

TABLE 9: ALLOCATIONS BY SIX FCC COMMISSIONERS USING SIX DECISION METHODS (INITIAL CONDITIONS 2b)[a]

Decision Rule by[b]

# Assigned	Market	Maj. Rule A C	Maj. Rule A N	Maj. Rule B C	Maj. Rule B N	Maj. Rule C C	Maj. Rule C N	Maj. Rule D C	Maj. Rule D N	Sum Scores C	Sum Scores N	Pool Data C	Pool Data N
+3	A												
	B			+1									
	C	+2		+1		+2		+2		+2		+2	
	D	+1		+1		+1		+1		+1		+1	
+6	A	+1		+1		+1		+1		+1		+1	
	B	+1		+1		+1		+1		+1		+1	
	C	+2		+2		+2		+2		+2		+2	
	D	+2		+2		+2		+2		+2		+2	
+9	A	+1		+1		+1		+1		+2		+1	
	B	+2		+2		+2		+2		+2		+2	
	C	+3		+3		+3		+3		+3		+3	
	D	+3		+3		+2		+2	+1	+2		+3	
+12	A	+2		+2		+2		+2		+2		+2	
	B	+2		+2		+2		+2		+2		+2	
	C	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1	+4	
	D	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1
+15	A	+3	+1	+2	+1	+2	+1	+3		+2	+1	+3	
	B	+2	+1	+3	+1	+2	+1	+3	+1	+2	+1	+3	
	C	+3	+1	+3	+1	+4	+1	+3	+1	+4	+1	+4	+1
	D	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1
+18	A	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1
	B	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1	+3	+1
	C	+4	+1	+4	+1	+4	+1	+4	+1	+4	+1	+4	+1
	D	+4	+1	+4	+1	+4	+1	+4	+1	+4	+1	+4	+1

(a) Initial assignment 2-C, 1-N in all markets: Population (millions); A(.2), B(.4) C(6.0) D(1.8).

(b) For explanation of six rules, see text. C and N refer to commercial and noncommercial allocations, respectively. Entries in table are increments to initial allocation after the number of assignments shown in the first column.

#11 and #12 — the ordering was different. All other allocations were identical through eighteen assignments.

Obviously, the various methods produce no important differences in allocations within each group. Despite the differences in the sequences of allocations that different subjects would make, their preferences are sufficiently harmonious that, when several consecutive allocations are made, their differences apparently are resolved. This suggests that although each group (especially the Commissioners) might face difficulty in making a decision about where to put the next station, it would probably face less of a problem in deciding how to allocate a large number of stations.[14]

To check the robustness of these findings, the results of the FCC committee decisions were simulated a second time with a five-member Commission. To maximize the chance of getting a different result, the Commissioner that was deleted was selected because he was at the extreme in the allocations that he made during the experiment. His preferences exhibited the weakest correlation between allocations and population, the greatest preference for noncommercial stations, and the poorest measures of statistical fit for the scoring function -- that is, either the functional form represented his actual decisions least well, or his preferences were were most subject to random error. The results of these simulations were virtually identical to the results of the six-person simulation.[15] Thus, the results appear to be robust to fairly significant changes in the composition of the group.

Although the allocations made by each group are not sensitive to changes in decision-making procedures, the three groups did not

produce the same pattern of assignments. Indeed, there are some interesting differences among the three groups. Table 10 shows the pattern of assignments according to Majority-Rule Method A for the six Commissioners, nine members of Congress, and seven staff members. After eighteen allocations, the Congress simulation had assigned two more stations to the largest city and one fewer station to each of the two smallest cities than had the FCC simulation. The staff results are intermediate. Apparently the Congress is more sensitive to population differences than is the Commission, perhaps reflecting the population basis on which the Congress is elected.

[TABLE 10 HERE]

A second difference is the greater taste of Congress for noncommercial television. After eighteen assignments, the Congress had allocated two more stations to noncommerical use than had the Commissioners, with the staff again being in the middle. This particular phenomenon has many potential explanations. Perhaps the greater expertise of the FCC may give the Commissioners a better sense of the problems of noncommercial UHF outlets in acquiring programming and achieving economic viability.

VI. SUMMARY AND CONCLUSIONS

The motivation of the research reported here was an attempt, on the part of the FCC's UHF Task Force, to incorporate a consideration of subjective preferences in an automated scheme for the allocation of UHF channel assignments to localities. The feasibility of that task depends on a sufficient consistency of preferences across

TABLE 10

COMPARISON OF ALLOCATIONS BY THREE GROUPS*

# Allocated	Group	Market/Type** A C	A N	B C	B N	C C	C N	D C	D N
+3	FCC					+2		+1	
	Congress					+2		+1	
	Staff					+2		+1	
+6	FCC	+1		+1		+2		+2	
	Congress					+3	+1	+2	
	Staff	+1		+1		+2		+2	
+9	FCC	+1		+2		+3		+3	
	Congress	+1		+1		+3	+1	+2	+1
	Staff	+1		+2		+2	+1	+2	+1
+12	FCC	+2		+2		+3	+1	+3	+1
	Congress	+1		+2		+4	+2	+2	+1
	Staff	+2		+2	+1	+3	+1	+2	+1
+15	FCC	+3	+1	+2	+1	+3	+1	+3	+1
	Congress	+2		+2	+1	+4	+2	+3	+1
	Staff	+2	+1	+2	+1	+4	+1	+3	+1
+18	FCC	+3	+1	+3	+1	+4	+1	+4	+1
	Congress	+2	+1	+2	+1	+5	+2	+3	+2
	Staff	+2	+1	+3	+1	+4	+2	+4	+1

*Entries in one row indicate the distribution across the eight market-type alternatives of the specified total # allocated as simulated for a committee representing the specified group, using majority rule A as the decision rule.

**Initial Assignment: Two C's and one N in each market. Populations: A = .2, B = .4, C = 6.0, D = 1.8.

individuals to allow for aggregation into a social decision function and on the ability to elicit relevant preference information and summarize it in a quantifiable form amenable to computer implementation. These were the two key issues addressed here.

The mechanism employed for eliciting preference information was an experimental simulation of a station allocation task. The resulting data were used to estimate a logistic model of qualitative choice behavior, and the resulting preference function estimates were used to measure consistency across individuals and robustness across alternative aggregation rules. Whether the experimental subjects actually took the experiment seriously enough to make choices that more than crudely reflect their true preferences can only be conjectured. But the results of the analysis reported here indicate that something fairly consistent and rational underlies the data that were collected. Moreover, the stability of the simulations with respect to changes in institutional rules suggests that apparent differences between subjects within each group are substantially mitigated by the coarseness of the discrete choices involved. Yet differences between groups do exist. Although the differences are not dramatic, the congressional subjects appear to favor somewhat greater allocations to larger cities and to noncommercial outlets than do the Commissioners.

Our initial skepticism about the likely success of automation of a major part of the FCC's allocation decisions has been considerably softened by these results. Obviously, in a real policy-making environment caution should be exercised in too strict a reliance on allocations made by the method reported here. But we would argue that such a process could be effectively used to generate a tentative table of allocations, and that such a table might be found quite satisfactory by the Commission with little or no amendment.

Finally, we should emphasize the generality of the methods examined here. This paper has focused on the specific case of spectrum allocation by the FCC. But the procedures are applicable to many situations in which a decision-making body is faced with a large number of subjective and relatively expensive or time-consuming decisions. College admissions, merit scholarship awards, licensing decisions and contract awards are a few examples.

FOOTNOTES

*Part of the research reported here was financed by the Federal Communications Commission. We are grateful to Raymond Wilmotte for suggesting the project and encouraging its continuation, and to Gail Crotts and Alan Stillwell for carrying out the experiments. Of course, this report reflects the views of the authors, and should not be attributed to the Federal Communications Commission, the FCC's UHF Task Force, or any members of the staff of the FCC.

1. For a more thorough discussion of the development and implications of the local service doctrine, see R. G. Noll, M. J. Peck and J. J. McGowan, Economic Aspects of Television Regulation, Brookings, 1973.

2. There is some evidence that television advertising has reduced competition in a few industries. For example, televised sports has been cited as the cause of increased concentration in the beer industry because the number of opportunities to sponsor a sports broadcast are limited, and because national and regional networks give large firms an advertising advantage over small ones. See Ira Horowitz, "Sports Broadcasting," in R. G. Noll, Government and the Sports Business, Brookings, 1974.

3. The person who thought of this approach was Dr. Raymond Wilmotte, the coordinator of an internal FCC Task Force to study UHF allocation.

4. See D. McFadden, "Conditional Logit Analysis of Qualitative Choice Behavior", in P. Zarembka, ed., Frontiers in Econometrics, Academic Press, 1973.

5. McFadden, op. cit., has proved this result. He further shows that these choice probabilities satisfy certain desirable axioms. In our case the relevant axioms can be translated as (1) the probabilities are strictly positive and (2) the relative odds of choosing an allocation in one market over one in a second market are independent of the presence or absence of an unchosen alternative allocation in a third market.

6. An oversimplified example would take X_i to be a three element vector containing population, total number of commercial stations, and total number of noncommercial stations in market i.

7. In the simpler versions, at least one of the following differences in the experiment was introduced: subjects allocated only UHF tokens, the VHF/UHF distinction among stations initially allocated to a city was not made, and the populations of the four cities were not changed when the game was reinitialized. Thus, in the simplest version, subjects were told that each city had a particular population and a particular distribution among commercial network affiliates, commercial independents, and noncommercial stations. The subject was told that the first three commercial allocations would be networks and subsequent commercial allocations would be independents. The subject was then asked to allocate additional stations among the four cities, indicating commercial or noncommercial status, with no reference being made to the location of the station in the spectrum.

8. An alternative procedure for guaranteeing independence would be to ask for a single assignment in each trial and run many trials with varying initial conditions. But the time constraints and observation requirements noted make this approach not viable.

9. The UHF-VHF distinction was not made in the dependent variable. The reason was that in nearly all cases the four VHF allocations were made first, followed by a series of UHF allocations. Thus, by treating allocations of VHF and UHF stations as simply a homogeneous commodity ("stations"), the model assumes that the market and type of the next allocation does not depend on whether the next allocation must be UHF. This is probably incorrect for the mix of stations determines the kind of programming a new UHF station will offer. Unfortunately the number of observations available prevents including the UHF-VHF distinction among the dependent variables.

10. Subjects XXIV and XXVII have small, statistically insignificant coefficients on the variable measuring the number of existing commercial VHF stations in the equation for commercial assignments; however the coefficients for commercial UHF stations are strongly negative in both cases.

11. Table 6 data are from trial 2B which had a very egalatarian and relatively small initial allocation. All but one of the six commissioners opted for a commercial station to the largest market as the first assignment. In trials with initial allocations reflecting population sizes, subjects were more diverse in first round assignments. In one trial, for example, the six commissioners split 2-2-2 among three alternatives.

12. The normalization used is admittedly arbitrary but clearly some normalization is required to make estimated scores $\hat{S}_{tij} = \hat{\beta}_j' X_{ti}$ comparable between subjects. Even for a single subject, the conditional logit formulation implicitly pre-normalizes both the origin and scale of the true preference scores so that the estimated scores contain only ordinal information.

13. One might erroneously conjecture that, even if subjects made choices according to different preference functions, estimates attained from pooled data might represent the "average preference function" in some sense. A demonstration that logit coefficient estimates in such a case are not consistent for the meaning of the true coefficients, even to the extent that they may exhibit the wrong sign asymptotically, is found in D. Grether and F. Nelson, "The Effects of Pooling Across Populations on Estimates of Qualitative Response Models," mimeo, California Institute of Technology, Fall 1978.

14. The data reported here, having been obtained from one at a time assignments, is not appropriate for making hard inferences about "bundles" of simultaneous allocations.

15. The results were identical after six, twelve and eighteen allocations, and differed by only one allocation after three, nine, and fifteen assignments.

Appendix A

STATION ALLOCATION EXPERIMENT

WRITTEN INSTRUCTIONS TO PARTICIPANTS*

TELEVISION PREFERENCE SURVEY

The FCC is studying alternative ways to use and manage the portion of the spectrum that is allocated to television broadcasting. In the past, television channels have been assigned on the basis of engineering constraints, designed to prevent stations from interfering with one another, and economic considerations, related to how many stations each city or market can support. A factor that has not been considered, and one that we feel is very important, is the distribution of "program alternatives" from the viewer's point of view. By program alternatives, we mean the number of different programs from which a viewer can select at any given time. The number of program alternatives available in a market is equal to the number of stations broadcasting in that market.

Determining what is an acceptable distribution of program alternatives is a matter of individual judgment. The method we have chosen to find out what would be considered a good distribution is to ask a number of "wise people" to respond to the survey described below. An analysis of the results of the survey will give us an idea of the distributions most likely to be preferred.

---

*Raymond Wilmotte and Gail Crotts of the FCC assisted in the preparation of these instructions.

In the survey, you will be asked to distribute program alternatives to four hypothetical television markets. The only difference among the markets is their populations; they are assumed to have roughly the same social and demographic mix of citizens. The survey consists of several tasks. In the first task, the populations of the four markets will be:

Market A	5,000,000
Market B	1,500,000
Market C	400,000
Market D	100,000

These population figures will be changed slightly each time you take the survey.

For each task, you will begin with an initial allocation of VHF and UHF channels among the four cities. You will then be asked to allocate additional channels to the four markets, one at a time, until you are asked to stop assigning channels or until you believe that all four markets have enough program alternatives and that the remaining channels should be used for other communications services. Since you may be asked to stop at any time, it is important that each assignment of a station to a city be the most important and highly valued assignment that could be made.

You will also be asked to determine the particular kind of television station (program alternative) that will be permitted on each channel assignment. A channel may be used for either commercial or non-commercial service. When you assign a particular channel, you must designate whether it is for commercial or non-commercial use. For the

purpose of the assignment process, assume that the first three commercial assignments you make in each market will always be network affiliates; any remaining commercial assignments will be commercial independent stations.

To facilitate the allocation process, you have been provided with a table that has two columns for each market, one column for commercial stations and the other for non-commercial. Each time you take the survey, an initial number of stations will already be in place: the blue chips represent VHF channels and the white chips represent UHF channels. You will be provied with a number of additional chips of each color.

At each step in the allocation process, place a chip in one of the eight columns, thereby indicating which type of station you are creating and in which size city it is to be placed. Proceed with the allocation until you exhaust all chips, you believe that all cities have enough television and the remaining channels should be assigned for other communication purposes, or you are told to stop allocating channels.

ORAL INSTRUCTIONS TO PARTICIPANTS

The purpose of this survey is to determine your preferences with respect to the kinds of programming options available to television viewers. One way of grouping programs is according to the type of stations over which they are broadcast: commercial networks; commercial independents; and public/educational stations. The FCC has the power to influence the availability of these three types of program alternatives by its decisions on spectrum allocation and license awards.

We would like your opinion on the best distribution by size of market of these types of stations. We are interested in what national distribution of stations would produce the greatest viewer satisfaction.

Please read the instructions, and then we will see if you have any questions before you respond to the survey.

After answering any questions, then remind the player that:

1. It is important for him/her to place the alternatives in the order of importance. That is, when a chip is played, it should be as though this was the last choice that could be made. It is not, therefore, required that one market be taken care of before moving to another, and it is not necessary to play all of one type of program alternative before going to the next type. In light of the original allocation and the further allocations you have made, what, in your opinion, is the next best solution?

2. Keep in mind that we are interested in your opinion of the best distribution strictly from the viewer's point of view -- his or her personal satisfaction.

INSTRUCTIONS TO EXPERIMENTER

The Station Allocation Game is intended to be administered by an experimenter who is fully aware of its structure and purpose. Subjects are likely to have questions during the course of the game, and in any event need to have their actions carefully monitored.

The most important job of the experimenter is to record all allocations by the subject accurately. The subject and the experimenter should be close enough together that the experimenter can easily observe the actions of the subject without interfering with the subject's concentration and physical movements. Do not play vulture and hover over the subject; instead inobtrusively settle yourself in a spot that is convenient for observation.

The experimenter should be equipped with plenty of paper and writing instruments so that the game is guaranteed to continue to conclusion without interruption. The allocations should be recorded as follows. First, at the top of the first page of your notes write the name and title of the subject and the exact time that the experiment begins. The beginning of the experiment is the time that the instructions for the subject are given, and after small talk and introductions are over. Second, when the subject begins the first allocation program, write down the exact time just below the time that the instructions changed hands. Third, begin a column of recorded allocations by writing the Task Number of the allocation activity that the subject is doing -- the first time through, that will be Task 1a. Beneath the task number, begin recording the allocations in the following manner: number each allocation of a channel consecutively, and next to the appropriate number write the city in which the channel was assigned, whether the assignment was commercial or noncommercial, and whether the assignment was UHF or VHF. For example, suppose a subject began Task 1a by assigning a commercial UHF to B, then a noncommercial UHF to C, and then a commercial UHF to A. The first page of the record of the experiment would then appear as follows:

John Q. Subject	Instructions:	3:42 p.m.
President of the United States	Begin:	3:56 p.m.

Task 1a

1. B Commercial UHF
2. C Noncommercial UHF
3. A Commercial UHF

Allow the subject to continue allocating stations for a minute or two before calling a stop to the task. Subjects are likely to make their allocations more quickly as the game proceeds, so you may take this into account in calling stop. In order to encourage the subject to take seriously the possible imminence of your calling stop, be sure to stop Task 1a relatively quickly -- at the end of about 75 seconds or after 8 or so allocations, whichever comes first. For subsequent games, call stop after about twenty allocations or two minutes, whichever comes first. In all cases, do not stop each task at exactly the same allocation number of the same amount of elapsed time. Finally, after you stop a task, write down the exact time that you called stop just below the last entry recording the final allocation for that task. Continue on to the next task, repeating the same procedure that you followed for the first. When you have concluded the last task, write down the time that the subject finished it, and ask the subject if he or she has any additional comments to make about the game. Record as exactly as you can any comments, suggestions or criticisms. At the bottom of the page, print your name so that we can contact you in case we have any questions about your records.

A few matters of good practice for conducting an experiment of this sort are as follows:

1. Do not try to conserve paper -- the most important duty you have is to maintain a clear, complete record of the experiment;
2. Try to label and number all records so that others can easily interpret your records -- e.g., remember to number

the pages of your records and to write down task numbers;

3. Do not interfere with the decisions of the subject in any way — do not discuss his or her allocations as they are taking place, and do not engage in discussion in any general way about the comparative values of different kinds of stations; and

4. Answer all questions about the procedures of the game as clearly and politely as possible, but avoid engaging in needless small talk -- it affects the concentration of the subject.

After the subject has read the instructions, be sure that two points are completely understood by repeating them orally:

1. Each allocation is to be made as if it were the last, as well it might be because you might call stop at any point; and

2. No particular category of assignments need be exhausted before allocation begins in another category; e.g., the subject may intersperse allocations among cities, between commercial and noncommercial categories, and, when VHF allocations are available, between UHF and VHF.

Before proceeding with the game, be sure to ask the subject if there are any questions.

SET-UPS FOR EACH SURVEY

	Market A		Market B		Market C		Market D	
Population:	5,000,000		1,500,000		400,000		100,000	
	Comm.	Public/ Educ.	Comm.	Public/ Educ.	Comm.	Public/ Educ.	Comm.	Public/ Educ.
VHF	2	1	2	0	2	0	1	0
UHF	1	1	0	1	0	1	1	0
VHF	2	1	1	0	2	1	2	0
UHF	1	0	1	1	1	0	0	0
Population:	200,000		400,000		6,000,000		1,800,000	
VHF	1	1	2	1	2	1	2	1
UHF	1	0	0	0	1	1	0	1
VHF	2	1	2	1	2	1	2	1
UHF	0	0	0	0	0	0	0	0
Population:	1,200,000		75,000		500,000		4,500,000	
VHF	1	0	0	0	1	1	2	0
UHF	1	0	2	1	1	0	1	2
VHF	3	1	3	0	3	0	3	2
UHF	0	1	0	0	1	1	1	1
Population:	150,000		4,000,000		1,800,000		300,000	
VHF	1	1	2	1	1	1	1	1
UHF	0	0	1	0	1	0	1	0
VHF	2	0	3	0	3	0	2	1
UHF	0	0	2	0	1	0	0	0