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Proposed Technique for Identification of Market Potential for Low-Cost Air Travel

Martin M. Stein*, Abt Associates, Inc., Cambridge, Massachusetts
Mark E. Tomassoni*, Simat, Helliesen, and Eichner, Inc., Washington, D.C.
David L. Bennett, Maryland State Aviation Administration, Baltimore
Denis Lamdin, Maryland State Highway Administration, Baltimore
Michael Sasso, University of Maryland, College Park

A mail-back survey conducted by the Maryland State Aviation Administration to assess the interest of Maryland residents in a low-fare, no-frills air service from the Baltimore-Washington region to the West Coast is described. The questionnaire used was designed to determine whether or not respondents had traveled by air from the Baltimore-Washington area to California during the past 24 months and whether they would have traveled more often to California (or for the first time) if a $99 one-way fare had been in effect between the Baltimore-Washington region and the Los Angeles and San Francisco areas. Results were tabulated and analyzed on a computer by using the Statistical Package for the Social Sciences. In addition to analysis based on statewide population data, tabulations were developed at the zip code, county, and regional levels for more detailed analysis of potential markets. The proposed technique shows how the use of existing computerized data on area population can be conveniently converted to a representative sample for public policy purposes.

The diversion of air passenger traffic from one market to another was an important factor in the economic regulatory environment of the Civil Aeronautics Board (CAB) prior to the recent passage of legislation deregulating the airline industry. The more diversion there was, the less likely the CAB would be to award the new authority. By attempting to show that additional air passenger demand could be produced by the new service, an argument could be made for allowing additional air carrier supply without apparent diversion of traffic from existing services. Such an argument removes one of the principal grounds for CAB disapproval of low-fare proposals.

With the evolution of a more procompetitive regulatory policy, the need for carriers (and communities) to argue the absence of diversion for new service has been eliminated. Moreover, communities are now in a position to seek to convince suitable air carriers, rather than the CAB, that their market would be the most advantageous for a carrier to commit its limited equipment and resources.

In an effort to demonstrate that new air passenger travel would be generated by low-fare, transcontinental service, the Maryland State Aviation Administration conducted a mail-back survey designed to measure objectively the additional traffic that would be produced by new service. The survey had, as a major constraint, the need to produce a mailing list that was representative of the entire geographic area under question—in this case, the state of Maryland.

In the design of surveys to elicit the general opinion of this potential market, it is inappropriate to use commonly "manufactured" mailing sources that may tend to be biased toward higher-income groups or to concentrate geographically on urban areas. In addition, it is

Figure 1. Proposed technique for identifying market potential for low-cost air travel.

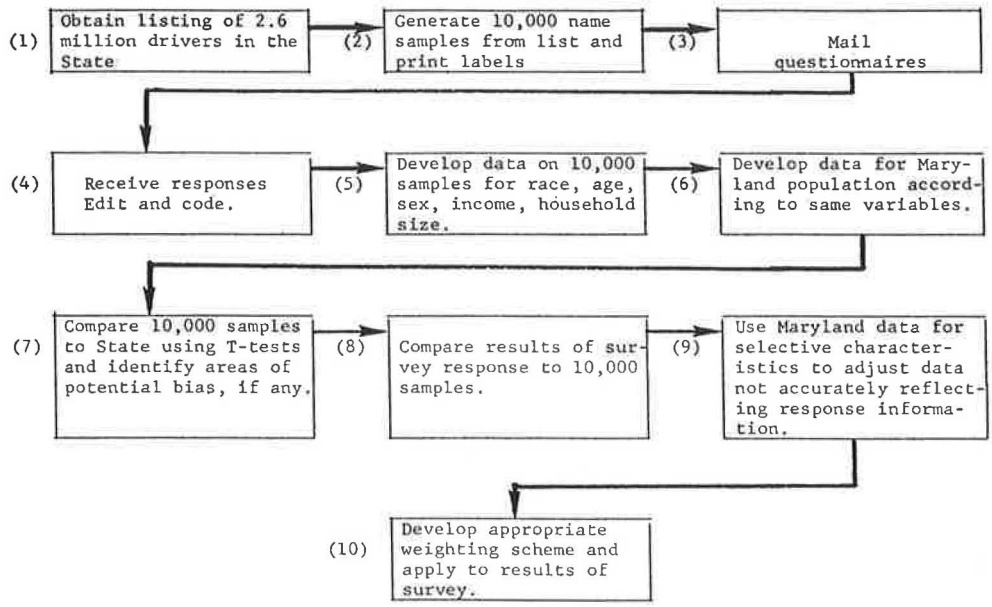

Table 1. Comparison of survey respondent characteristics with statewide population characteristics for variables of race and income.

Variable	Sample Response		Households Statewide		
	Number	Percent	No. (000s)	Percent	Ratio[a]
Race					
Black	90	5.5	215.3	15.6	2.80
White	1545	94.0	1156.0	83.8	0.89
Other	8	0.5	8.3	0.6	1.20
Total	1643	100.0	1379.6	100.0	1.00
Income ($)					
< 10 000	158	9.6	345.0	25.0	2.60
10 000-15 000	251	15.3	234.6	17.0	1.11
15 000-20 000	332	20.2	220.8	16.0	0.79
20 000-25 000	296	18.0	179.4	13.0	0.72
>25 000	606	36.9	400.2	29.0	0.79
Total	1643	100.0	1380.00	100.0	1.00

[a]The ratio of sample respondent characteristics with statewide population characteristics was compared to determine if there was a statistically significant difference in the proportions of the sample responses. If the sample response was significantly different, adjustments to the survey responses were developed to account for the differences.

necessary to identify a broad cross section of the market that includes residents of nearby areas who may be induced to take longer ground trips to take advantage of lower air service rates. By designing a computerized process to identify a representative sample of residents, a major step in developing an innovative and efficient procedure to rapidly elicit responses to air travel changes was created. With minor modifications, this procedure could be used in other states to produce similar results. Results of the analysis are weighted to deal with problems of reporting bias observed for low-income blacks, and a computerized matching program, in which zip codes from the original file of names are related to respondents' completed forms, is used to permit submarket analysis of particular geographic areas.

COMPUTERIZED TECHNIQUE

The sample selection program was constructed in the FORTRAN language for execution on a Burroughs 6700 series computing system. The program operated in two phases. First, a pseudorandom sequence of 10 000 floating point fractions (in the range 0., 1.), with a uniform distribution, was generated (see Figure 1). Each member of this sequence was multiplied by the number of records in the driver's-license master file, and the integer portion of the result was used to identify a record to be selected. A linear congruential method was used to generate the uniform sequence.

The second phase of this program was designed to read the driver's-license master file; it produced an output file that consisted of those records whose position in the input file was identical to a value in the transformed pseudorandom sequence. The resulting sample file contained 9923 records. Each record specified a value for the data fields: name, address, date of birth, sex, race, and survey number. The number of responses returned was 1702; these were keypunched and entered into a file that was manually edited, and 1643 responses were retained.

Another FORTRAN program was written to add the demographic variables—race, age, sex, and zip code—to each record in the respondent file that contained 27 variables. The first 22 are based on survey respondents' experience and preference. Income level was supplied by the respondent, whereas the other four demographic variables were obtained from the sample file.

A third FORTRAN program was written to partition the sample file into two subfiles. One subfile contained sample records that corresponded to respondents, and the other subfile represented nonrespondents. The selection criteria were based on the existence of a common set of record identifiers in both the sample and the respondent file.

A t-test comparison of sample means was performed for the variables of race, sex, and age. The two samples corresponded to the two subfiles, and tests required two independent samples. Tests given either common or unequal population variances were performed based on an F-test of sample variances. A pooled estimate of variance was used for the t-test on sex, whereas separate estimates of variance were calculated for the race and age tests. Only the null hypothesis (equal population means) for the variable of race was rejected at the 0.01 level of significance.

On the basis of the above statistical tests, joint multiplicative weights were computed. These weights were obtained by calculating the ratio of the proportion of each

Figure 2. Probability tree for analyzing sample responses.

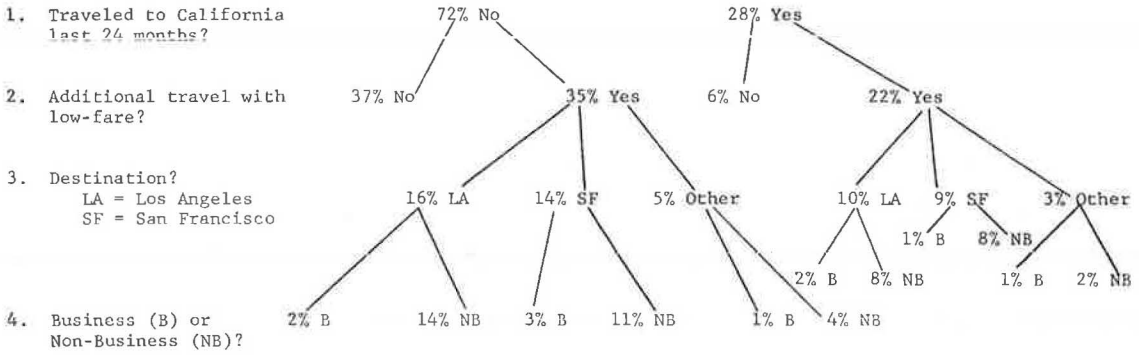

Table 2. Data on households whose members had previously traveled to the West Coast and would make additional trips if one-way fare were $99.

Trip Destination	Households Surveyed		Number of Maryland Households
	Number	Percent	
Los Angeles only	132	8.1	111 568
San Francisco only	119	7.3	100 780
Other California destinations only	27	1.7	22 819
Los Angeles and San Francisco	42	2.6	35 809
Los Angeles and other destinations	8	0.5	7 267
San Francisco and other destinations	9	0.6	7 965
Los Angeles, San Francisco, and other destinations	7	0.4	6 033
No response	26	1.6	22 399
Total	374	22.8	314 640

Note: Results are based on expanded results of Maryland State Aviation Administration survey. Use of the percentage of households surveyed causes minor errors in household estimates.

Table 3. Data on households whose members had not previously traveled to the West Coast but would travel if one-way fare were $99.

Trip Destination	Households Surveyed		Number of Maryland Households
	Number	Percent	
Los Angeles only	171	10.5	144 263
San Francisco only	154	9.4	129 490
Other California destinations only	50	3.1	42 556
Los Angeles and San Francisco	94	5.8	79 514
Los Angeles and other destinations	14	0.9	12 020
San Francisco and other destinations	8	0.5	7 235
Los Angeles, San Francisco, and other destinations	27	1.7	23 066
No response	25	1.6	21 396
Total	547	33.3	459 540

Note: Results are based on data from the Maryland State Aviation Administration. Use of percentages causes minor errors in household estimates.

level (value) of a given variable in the respondent file to the proportion of the same levels of the given characteristic of the population. This was done separately for the variables of income and race (see Table 1). There were 15 weights of income and race:

Income ($)	Black	White	Other
<10 000	7.38	2.31	3.12
10 000-15 000	3.15	0.98	1.33
15 000-20 000	2.24	0.70	0.95
20 000-25 000	2.04	0.64	0.86
>25 000	2.24	0.70	0.95

These weights were computed for each combination of income level and race category by multiplying the ratio of proportion for income by the ratio of proportion for race. They are based on the number of survey respondents who have particular characteristics. For example, there were 7.38 times the number of low-income blacks in the state as there were in the survey. The survey results therefore required a factor of 7.38 to adjust the responses so that there would be an accurate representation of statewide population characteristics.

The weights were conditionally assigned to respondents through the Statistical Package for the Social Sciences (SPSS) case-weight intrinsic variable (1). All weighted sample sizes were rounded to the nearest integer value. Adjusted frequency tables for all variables in the respondent file were computed by the SPSS procedure FREQUENCIES.

The SPSS COMPUTE and conditional compute (IF) facilities were used to generate composite variables for each entry in the respondent file. Eight variables were generated on the basis of survey results:

B = previous business travel,
NB = previous nonbusiness travel,
BINC = additional business travel,
NBINC = additional nonbusiness travel,
NTBINC = new business travel,
NTNBINC = new nonbusiness travel,
T = total previous travel, and
TINC = total additional travel.

These variables were aggregated by accumulating the sum of particular responses from the survey for each of the variables. For example, B = VARO2 + VARO3 + VARO4 and NB = VARO5 + VARO6 + VARO7. The difference between additional and new travel is, of course, that the former is generated by those who previously traveled and the latter is produced by those who previously did not.

Another computation of variables was performed to ensure that each set of variables could be defined in a mutually exclusive manner. This permits the use of probability-tree analysis such as that shown in Figure 2. For example, total previous travel is partitioned into three components:

TPB = total previous business travel,
TPNB = total previous nonbusiness travel, and
TPBNB = total previous business and nonbusiness travel.

Thus, a given entry in the respondent file will have a nonzero value for the computed variable TPB only if the value of the computed variable B (defined above) is nonzero and the value of the computed variable NB (defined above) is zero.

The sample was partitioned into 54 conditionally computed variables that represented all possible mutually exclusive combinations of previous, additional, and new travel for business and nonbusiness purposes to all possible combinations of California destinations.

The definition of the survey, the use of weighted results based on statistical tests, and the use of mutually exclusive variables are analytic features of the program that permit a clear and logical interpretation of the survey results. The use of various computer programs to manipulate files of survey data, socioeconomic data, and driver's-license data facilitates the development of a comprehensive and detailed set of data that can be used to generate an estimate that is representative of statewide and regional responses to proposed changes in air service.

RESULTS OF APPLICATION OF TECHNIQUE

By expanding the survey to encompass all Maryland households, the following conclusions can be drawn. First, 28 percent of total Maryland households (392 000) had traveled by air from the Baltimore-Washington region to California during the past 24 months. The response data on this question, which are based on expanded survey results, are given below:

Response	Households Surveyed		Maryland Households
	Number	Percent	
Yes	466	28.4	391 920
No	1176	71.6	988 080
Total	1642	100.0	1 380 000

Of the total expanded households, 23 percent (315 000) indicated that they would have made additional trips to California from the Baltimore-Washington International Airport (BWI) if the one-way fare had been $99. The greatest percentage of these respondents were interested in traveling to Los Angeles or San Francisco (see Table 2).

As data given in the table below indicate, 31 percent (121 000) of all respondent households that had traveled to the West Coast during the past 24 months had done so for business purposes, 47 percent (185 000) for nonbusiness purposes, and 20 percent (78 000) for both purposes:

Purpose	Households	
	Number	Percent
Business	121 103	30.9
Nonbusiness	184 986	47.2
Both business and nonbusiness	77 992	19.9
No response	7 839	2.0
Total	391 920	100.0

Seventy-three percent (231 000) of the respondent households in which one or more members made at least one air trip to California in the past two years indicated that they would have made additional trips for nonbusiness purposes if the $99 fare had been instituted:

Purpose	Households	
	Number	Percent
Business	31 464	10.0
Nonbusiness	230 631	73.3
Both business and nonbusiness	30 206	9.6
No response	22 339	7.1
Total	314 640	100.0

Eighty-one percent of the households that had not made trips (371 000) indicated that they would have traveled for nonbusiness purposes if the low fares had been in effect:

Purpose	Households	
	Number	Percent
Business	35 385	7.7
Nonbusiness	370 389	80.6
Both business and nonbusiness	32 168	7.0
No response	21 598	4.7
Total	459 540	100.0

The results presented in the final three tables above are based on expanded results of a Maryland State Aviation Administration survey.

Of the households that had not traveled to the West Coast during the previous 24 months, 33 percent (460 000 households) would have made trips with the reduced fares but 38 percent (529 000 households) would not have made trips (see Table 3).

Figure 2 shows this system of questions and responses presented in percentile figures in the form of a probability tree. Each branch of the tree represents one logical split in the respondent's set of decisions. A yes and no split, a destination, or a trip purpose are the three categories of decisions that face the respondent. This probability tree helps in analyzing, in a logical and unambiguous format, the results of a set of survey questions. The tree can be used to isolate particular elements of the travel decision-making process for further evaluation and comparison. For example, it is relatively easy to identify the proportion of respondents who have not previously traveled to the West Coast and would not take a West Coast trip if fares were reduced. This proportion of respondents can be identified by locating the relevant branch of the probability tree. Thus, the second level of the left branch shows 37 percent who made no previous trips and would not take additional trips if fares were reduced.

In addition, responses by income groups were classified by geographic area. In this way, an attempt was made to determine the number of trips that would be added from the Baltimore area versus those for Prince George's and Montgomery Counties in the Washington, D.C., area.

According to the survey results, the greater a person's income was, the more likely it was that he or she would have made a trip to the West Coast during the previous 24 months. For example, 42 and 46 percent of the households in the highest income category had traveled to the West Coast during the previous two years from the Baltimore and Washington suburban areas, respectively.

In the $20 000-$25 000 income range, there is nearly a doubling of the households in both areas that would have taken trips with the lower fares. In the $15 000-$20 000 bracket, approximately 2.5 times as many households would have traveled than actually traveled with the low fares. Finally, in both the $10 000-$15 000 and <$10 000 ranges, approximately three times as many

persons as actually traveled would have traveled had the lower fares been in effect.

CONCLUSIONS

Changes in air service are usually the result of a complicated process that involves carriers, airport management, and various government agencies. The establishment, expansion, or contraction of service may have a vital impact on successful airport operation and is a matter for public policy analysis. Service expansion, if not supported by a potential market, could result in actual loss of service if existing service is eliminated because of the failure of the new service to develop a viable market. The economic vitality of regions depends on access to markets for goods and services; in our increasingly service-oriented economy, rapid service often requires air access. The methods currently used to test market availability and sensitivity range from small, nonrepresentative samples to the use of elasticity ratios to indicate whether new service will be acceptable and successful.

The technique proposed in this paper shows how the use of existing computerized data on the population of an area can be conveniently converted to a representative sample for public policy purposes. Although the technique requires the use of computers and the availability of socioeconomic data, the results of the application described here served as a cost-effective tool in policy development. This represents a new area for the application of methods of socioeconomic analysis in the formation of public policy as it relates to transportation improvements.

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M. M. Stein and M. E. Tomassoni were with the Maryland Department of Transportation when this research was performed.

Airline Deregulation and Its Impacts on Intercity Travel Demand

Chong K. Liew and Chung J. Liew, Department of Economics, University of Oklahoma, Norman

Some of the policy questions that arise as a result of deregulation of the airline industry are examined. A national intercity travel demand model that is different in many respects from the conventional aggregate or disaggregate models is presented. The model uses travel distance as a variable of interest, calibrated on nonsurvey industrial data. The model is consistent with the neoclassical theory of consumer behavior and uses a representative consumer concept. It answers many transportation-related policy questions, such as questions about the impact of air-fare reductions and the impact of the introduction of faster aircraft on the intercity market shares of public transportation.

Economic efficiency through competition is the basic motivation behind the deregulation of the airline industry. The deregulation creates many interesting transportation policy questions. How does deregulation change the market structure of the intercity transportation industry? How does the fare reduction affect the demand for air travel and the other competing public modes? How does the introduction of faster airplanes, such as supersonics, affect the market structure of intercity passenger industries? What is the best strategy for the airline industry to expand its intercity market?

To answer these questions, we introduce a national intercity travel demand model that is, in many respects, different from conventional aggregate or disaggregate models (1-5). Conventional models use number of trips as the variable of interest, whereas the model discussed here uses distance of travel. Use of travel distance instead of trips simplifies the understanding of intercity travel demands by eliminating many trip-related variables such as origin, destination, and length. It ties in directly with many policy-related variables such as the energy consumption in intercity transportation, market shares of the intercity transportation industry, accident frequency, and pollution control measures. Distance, which is a continuous variable, can be meaningfully added to answer those policy questions.

Our demand model is designed to evaluate national transportation policies. Our interest is not to identify the travel behavior of individuals but to answer broad intercity travel-related policy questions, such as the impact of airline deregulation on market shares, energy consumption, substitution behavior, and so on.

Conventional travel demand models, both aggregate and disaggregate, are calibrated on survey data. Our model is calibrated on nonsurvey data. Survey data may reflect the travel behavior of an individual in the survey area. The problem of transferring survey data to other geographical areas and over time is still unresolved. Instead of answering national transportation policy questions from an aggregation of the disaggregate model, we answer those policy questions directly from a national intercity travel demand model that was built on national nonsurvey data.

The basic properties of the theory of consumer behavior—summability, homogeneity, and symmetry—are imposed. The substitutability of public travel modes is measured in terms of compensated cross elasticities. Conventional travel demand models have a loose tie with the neoclassical theory of consumer behavior, and market cross elasticities are a popular form of measuring substitutability. A previous study shows that compensated cross elasticities are theoretically more defendable and empirically more reliable (6).

Finally, we use the concept of the representative con-