depreciation of a paved road. The impact is taken to be the difference between the two rates of depreciation.

But will this procedure yield valid measures of impact? The derived measures of property value depreciation apply only if stable patterns of road utilization can be assumed. Put another way, it is necessary to know if the structure generating observed values will change when roads are improved. 3/

This question posed the second problem for statistical analysis. It was desired to know if propensity to travel for any purpose varied from road surface type to road surface type.

VERIFICATION OF THE MODEL

The model for this portion of the research was also a regression model. Trip frequency was compared with road surface type in light of (1) different types of trips that may be made and (2) a presumed tendency for trip frequency to diminute with length of trip in a non-linear manner. The latter occasioned the transportation of the model to logarithms. Differences in road type were introduced into the calculations by using a separate term in the regression for each type of road. This gave the postulated relationship:

$$\log F = \alpha + \sum_{i=1}^{n} \beta_i \ (\log X_i + 1) + \epsilon$$

in which F = trip frequency (trips per week); α = a constant term; X_1 = distance via paved roads to the usual terminus of a trip type (distance in miles); X_2 = distance via gravel roads; X_3 = distance via dirt roads; and β_i = the parameters to be estimated. The problem to be solved is a compromise. The postulated relationship attempts to recognize both the presumed tendency of trip frequency to diminute with increased distance and the presumed tendency for trip frequency to vary with the type of road over which the trip is taken. A separate model was used for each type of trip (for example, the journey to work).

The results of calculations using this model tended to verify measures developed with the regression model discussed earlier. In general, relationships could not be developed in the form specified. This is an indirect sort of verification, of course, but it does illustrate another place where regression was found useful in a road impact study.

Obtaining Data for a Highway Impact Study

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How do highway improvements affect areas? The answer to this question obviously depends on a number of considerations. Thus it is not surprising that research designs addressed to the question incorporate a variety of data and data gathering techniques.

Steps used in obtaining data for a recent study in Washington State

3/Put still another way, it was desired to know if the model could be considered to be a "uniequational complete model."

serve to illustrate data collection problems. 1/ This study was concerned with rural lands and the original hypothesis was that impact of road improvements could be measured using property value. For each observed parcel of property it was desired to obtain: (1) a measure of property value, (2) measurements of the location of the property from several reference places, (3) measurements of the location of the property in terms of the quality and quantity of service roads, and (4) measurements of other characteristics of the property that might affect property values.

These measurements were achieved in six steps:

1. A parcel of land was selected for study and the value of the property was obtained from sales records.

2. An interviewer visited the study parcel to determine the size of the parcel, the type of land utilization, and the location of the property in reference to the towns and roads.

3. The size of parcel interview data was checked against public records and the property value was converted to a unit base (one acre).

4. If the parcel was a farm or part of a farm, a land capability rating and, in cases, other ratings relating to the utility of the land were assigned using data from public records.

5. Location characteristics were assigned to each parcel using four or five reference points, depending on whether or not the parcel was used in farming, and using information from the interviews. The reference places were usually but not necessarily towns. The location reference places were:

(a) The place of usual household shopping or "convenience goods" shopping. For example, the place where food is usually purchased.

(b) The place of usual seasonal or "shopping goods" shopping. For example, the place most frequently visited for the purchase of clothing.

(c) The terminus most requently visited for purposes of amenities. Trips to church and to grange activites are examples of trips used to define this type of termini. Amenity travel when the travel was a means rather than an end (pleasure driving) did not enter into the analysis.

(d) If the study parcel was a farm, the place of the usual or most frequent purchase of supplies used in the operation of the farm business.

(e) If the study parcel was a farm, the place of the usual sale by the farmer of products of the farm business.

(f) If the study parcel was the site of a non-farm residence, the terminus of the journey to work.

6. Measurements of the quality and quantity of road service to the study parcel were then made using route data from the interviews. Based on experience with the interviews it was decided to recognize, when practicable, three kinds of roads separated on the basis of type of surface: hard surfaced, gravel, and dirt. Each of these road types was allowed to vary in quantity by the assignment of a linear scale. Two scales were used:

(a) Miles to a terminus. If, for example, a study parcel was ten road miles from the terminus of usual household shopping and four of the miles were via gravel roads, none via dirt roads, and six via paved roads,

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1/William L. Garrison, "The Benefits of Rural Roads to Rural Property," Seattle: Washington State Council for Highway Research, Part IV, of the Allocation of Road and Street Costs, 1956.

the study parcel would be assigned location quantities of 4, 0, 6 relative to the terminus.

(b) Miles traveled per year to a terminus. The unit of time—one year—was used for convenience. In the case used in the example in (a) above and if one year of travel over the route amounted to 500 miles, the location quantity assigned would be 200, 0, 300.

The six numbered steps listed above were used in the gathering and organization of the data. For each parcel of land studied there was an observed property value (obtained in step 1). Other items of information were obtained and organized (steps 2 through 5) in such a manner that they could be used to explain or account for the observed property value. Although the data were organized in a simple manner, the necessity of recognizing types of locations, types of roads, and variations in the use of roads lead to complex arrangement of data. A single farm might have, for example, an observed property value and: (a) a land capability class; (b) an irrigated or not irrigated rating; (c) a type of farming rating; (d) a set of linear distance measurements, up to fifteen in number; (e) a set of trip distance measurements, up to fifteen in number.

The list (a) through (e) above reveals the rather complex structure of the final aggregation of data. From the standpoint of the discussion of the studies and the analysis of the data this complex structure leaves much to be desired. On the other hand, there is no evidence that the problem is a simple one.