INCORPORATING ECONOMIC CONSIDERATIONS IN THE PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS

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This paper sets forth a practical, systematic approach to incorporating economic analysis into the preparation of environmental impact statements. Although the guidelines presented are not intended to be all-encompassing, taking explicit account of economic effects according to the approach suggested will lead to more complete environmental impact statements than are now executed and will provide meaningful insights into the effects of specific projects. The first portion of the paper is devoted to a discussion of the general questions that must be addressed in choosing an acceptable set of indicators of economic impact. How other people would be affected by the highway improvement is considered to be a better criterion for judging impact than how much better off or worse off the road use would be. Other general questions addressed are the incidence of effects and welfare versus redistribution effects. The other major portions of the paper consist of a discussion of appropriate indicators and the corresponding formulas for them. Care has been taken to include only indicators and formulas for which the necessary data are easily accessible.

•TRADITIONALLY, public finance theorists have viewed roads and highways as public goods. The basis for this view lies in the fact that, over a broad range of travelers, the use of the highway by an additional consumer does not prohibit those already using it from receiving the full benefits. More specifically, within certain congestion limits, the highway service can be extended to an additional user at no marginal cost. Furthermore, the benefits of the highway and its activity cannot be limited to the direct recipients of the services, that is to say, those who would purchase the product if it were privately produced. In this sense, highway services are what Carl Shoup (20, p. 67) calls a

> group consumption good, that is, a good or service that can be supplied in a given amount to a given group of households or firms in a given area more efficiently [at a lower cost per capita] under a non-marketing technique of production and distribution, that is, a technique whereby the good must be supplied simultaneously to all members of the group, no particular one of which can be excluded from enjoying the service.

The idea that transportation facilities are a group consumption good has often been used as an argument to justify the construction of more and better highways. Most economists would agree that the construction and operation of new highways and improvements produce nonuser, or external, effects. That is, the operations of new highways produce many effects on the community at large quite apart from the benefits or costs to the actual traveler. There are few, however, who would accept the suggestion that one can, on deductive grounds, always expect external benefits to be greater than external costs, a suggestion that must be accepted for secondary benefits to be a sole justification for expanding the highway network. It is, in fact, because of the concern over external costs such as pollution, noise, and disruption of the quality of life that the Congress has passed legislation requiring that the social, economic, and environmental effects of federally funded highway projects be appraised as early in the planning stage as possible.

One important step that is taken in complying with such federal regulations is the preparation of an environmental impact statement (EIS). Frequently, professional

consultants or consulting firms have been engaged to prepare a portion or portions of the EIS for projects that are expected to have extensive economic or environmental effects. On projects of narrower scope, the appropriate personnel write the EIS or prepare a negative declaration, which is a written document in support of a determination that, should the proposed highway improvement be constructed, the anticipated effects on the human environment will not be significant.

Although emphasis has been given in the EIS's to effects on the physical environment, little systematic attention has been given to what are called economic effects. However, under legislation that requires that states develop an efficient action plan, (Action Plan Process Guidelines, Section 1, Part 795) the following is explicitly called for:

> (a) Identification of potential social, *economic,* and environmental effects, both beneficial and adverse, of alternative courses of action . . . as early in the study process as feasible. Timely information on such effects should be produced so that the development and consideration of alternatives and studies can be influenced accordingly. Further, the costs, financial and otherwise, of eliminating or minimizing possible adverse social, *economic,* and environmental effects should be determined. (emphasis added)

PURPOSE

This paper attempts to develop a systematic analysis of economic effects that will assist in preparing more complete EIS's than are now executed and that will provide meaningful insights into the effects of specific highway projects. The information presented here also can be used to critically appraise the analyses of economic effects presented in the EIS's that are prepared by consulting firms.

SCOPE

Although I have surveyed a large body of literature on the subject of economic effects as they relate to highway improvements, I have not included extensive discussions of the literature in this paper unless they are crucial to the justification of the economic indicators being discussed. The first part of the paper consists of a discussion of the general considerations that must be taken into account in developing an acceptable set of indicators of economic impact. The second part consists of a list of the indicators that the researcher deems appropriate and a brief justification of each. The third major section includes the evaluation techniques, or the formulas for calculating impacts, to the extent that they are currently developed.

BASIC ECONOMIC CONCEPTS AS THEY RELATE TO HIGHWAY IMPACTS

Defining an Appropriate Criterion for Judging Impact

To develop an acceptable set of indicators of economic impact, one must first select the appropriate criterion for judging impact. There are 2 criteria from which to choose: (a) how much better off or worse off the road user will be as a result of the highway improvement, and (b) how other people will be affected as a result of the improvement. The choice is made easier when highway construction, maintenance, and use are recognized to cause significant external effects.

Buchanan (1, pp. 462-464) argues that one should view the road as a public utility because the benefits from use are divisible and motor fuel taxes, licenses, and registration fees act as user prices. If the user were to be the only party significantly affected by the building of highways, the focus of study for an EIS would obviously be those indicators relevant to use only: time savings, a reduction in loss of life, and savings in oil, motor fuel, and other operating costs. As a result of the substantial

growth in traffic volume, external effects in the form of noise, scenic disruption, and air pollution, which previously had been considered insignificant at the margin (2), have taken on greater importance to nonhighway users. It is appropriate then that this paper, which deals with the preparation of the economic portions of EIS's, be concerned mainly with indicators of economic effects on nonusers. Only in recent years has this broader viewpoint been adopted (6, pp. 105-114).

Separating Factors Influenced by the Highway From Factors Not Influenced by the Highway

Ideally, when one studies economic effects of any sort, one would like to be able to say that the results reflect only the change in economic activity brought about by the situation in question. In reality, conditions in which all other relevant factors remain unaltered cannot be maintained. A hypothetical example may serve to illuminate this idea. Suppose that a bypass is built around a town and that all of the components of retail sales in the town are discovered to have experienced a 15 percent increase compared to the sales level before the facility was built. It is obviously not appropriate for the public officials of this town to infer that retail sales have grown 15 percent because of the new facility. To arrive at a realistic estimate, one must compare the percentage of change in retail sales in this town and the percentage of change during the same period in an economic region similar to the town being studied. Frequently the U.S. Bureau of the Census combines counties with homogeneous economic, political, and social bases into economic areas (27). With the aid of such information, the task of identifying areas suitable as control regions is made simple. In Virginia, homogeneous economic areas have been defined by the Taylor Murphy Institute of the University of Virginia (28, 29). Just as accounting for regional or areawide economic activity is necessary in a before-and-after study, giving explicit attention to regional or aggregate activity is important in preparing EIS's. Failure to do so can, in many cases, result in misleading predictions.

Incidence

If considering only cost and benefit estimates at their final resting point were practical, costs could be subtracted from benefits to derive a net benefit figure. This, in turn, could be compared to net benefits of alternative projects. If the choice criterion were maximizing net social benefit, the project with the largest net benefit could be chosen. In practice, however, identifying the final resting point (who actually is made better off or worse off by the transportation improvement) is no easy task.

Zettel (26) considers this same question in a slightly different context. His concern is over how the surplus of benefits from highway use in excess of costs to the user should be distributed. In addition to discussing effects of highway improvements on the distribution of income, Zettel and his colleagues raise many points that are valuable in setting the stage for the proper consideration of changes in land values in EIS's (26, p. 148). For example, land values rising as a result of highway improvements is often claimed to be an advantage. But implicit in such an idea is a confusion concerning rent theory and the source of the difference in property values. For most types of land use, transportation improvements do not add to or subtract from fertility or productivity of the land; rather, any enhancement comes from accessibility values (which themselves are a function of preexisting transportation networks). Obviously, if land values fall, someone will lose. But the loss on the sale is the gain of the new owner. In short, there has been a redistribution of income but not necessarily a loss in overall welfare (unless the new owner is adversely affected to a greater extent than was implied by the capitalized reduction in land values). The contention that reduced property values (if they actually result) imply economic tragedy is misguided reasoning. The reduction is the result of a change in accessibility or site value but not likely a destruction of real wealth or productivity.

How does all this fit into double counting problems? Land values are frequently

presented in studies of highway improvements without ever being placed in any logical framework. So, too, are other representations of nonuser effects. The sticky problem is whether certain nonuser benefits and costs can be included in benefit-cost ratios that are used as a criterion for choosing one alternative over another. The danger, of course, lies in statements such as these: Land values rose by 15 percent during the study period for a total of $78,000; user savings were calculated as $40,000 for a total benefit of $118,000. The likelihood that some or all of these user savings were capitalized into land values is very great. Still, there is no conclusive evidence on the extent to which benefits and costs are shifted. This lack of evidence creates a dilemma for those who attempt to calculate the net costs and benefits of highway improvements. Double counting can be totally avoided if one looks only at costs and benefits to users, but in doing this, one totally ignores the external effects that might arise. Although this dilemma cannot be easily avoided, some ground rules can make efforts to calculate net social benefits more sensible.

First, isolated or narrow studies using benefit-cost ratios that include both user benefits and benefits in the form of changes in land values are more likely to misstate the ratio than studies of an entire highway system that uses both measures. Such overestimation or underestimation results because the changes in land values often attributed to a specific project more likely are a direct result of a change in the transportation system of which the project is a part. Second, measures of changes in land values offer the preparer of an EIS more than information about the tax base. Zettel (26, p. 160) points out that "the main purpose in studying land values may well be to get a better measure of user benefits." (They are most likely a reflection of the surplus of user benefits above what the user has to pay for use of the facility.) In other words, as user gains that are not charged become capitalized into land values, a key source of data is created for what nonmeasurable comfort and convenience are worth to people.

Separating Redistribution Effects From Welfare Effects

An important aspect of economic analysis is whether the economic effect in question is a redistributional or a welfare effect. With one exception [the RMC study (12)], this aspect of analysis has not been explicitly considered in transportation economic impact studies. Redistribution effects are those effects on a neighborhood that are counterbalanced by another impact within the same or a different neighborhood. For example, a shift of consumers from one shopping mall to another is not a net gain to the neighborhood if both malls lie within the defined study area. If the mall from which consumers were attracted lies in a different neighborhood, then the study area gains, but it gains at the expense of others. In either case, the result remains a change in the distribution of income, not an addition to or subtraction from the overall level of demand. Welfare effects are those economic effects that change community well-being. That is, they involve overall changes in output or income.

Several reasons exist for separating effects on the basis of their being either a redistributional effect or a welfare effect. First, the relevance of redistributive effects in answering yes or no to a certain change in the highway network is not at all clear. This is not to say that such questions are not important; certainly, they should be addressed. The economist, however, is no more competent than anyone else to say that a particular situation is desirable if it has unfavorable effects on some members of society. This important limitation of welfare economics derives from the fact that no scientifically meaningful way exists to compare the level of well-being of different individuals. In other words, no logically acceptable way exists to deduce that a piece of cake gives one person more satisfaction than it gives another person (9, p. 414).

Second, welfare effects are clearly relevant to decision making because they represent net changes to the neighborhood. For example, suppose an improvement in the highway network reduces transportation costs to such an extent that a mining operation that had not previously been undertaken becomes feasible. If the operation of the mine creates jobs for individuals previously unemployed, there would be a great net addition to social welfare.

Third, even though economists have been reluctant to involve themselves in questions of equity, the very nature of an EIS and citizen involvement dictates that effects that lead to redistribution be explicitly recognized and that their magnitudes be cited for policymakers.

Effects on business income such as that of service stations, hotels, motels, and restaurants will often represent redistribution effects especially where bypasses lead to closing of in-town businesses and the opening of new businesses abutting the new facility. If there is an absolute growth in income above what would normally have occurred for the business category, then there is an overall change in welfare.

Employment effects on residents can be either redistributional or welfare. If industrial employment is replaced by highway-oriented employment, the effect is redistributional. If x number of jobs are lost in industry but no employment opportunities are created, then there is a loss of welfare.

Tax losses apparently do not represent a reduction in welfare, even in the short run. Assume that the remainder parcels are not reassessed after the taking of right-of-way for construction of a highway. This means that local government revenue is reduced. Now, if the public services being provided by the locality have positive value to the citizenry, then utility is lost because some services must be curtailed. But tax liability has been reduced as well. In short, income has been redistributed from the government to those citizens whose property was acquired, and, unless there is evidence to the effect that the public services that had to be curtailed provided externalities, alleging that tax losses are welfare effects is not justified.

Bypassed Towns

Although the main purpose of this section of the paper has been to provide a conceptual basis on which to develop techniques for evaluating economic impact, I believe that providing several general conclusions that may be useful to highway department field personnel in answering the questions of concerned citizens is worthwhile. In addition, these generalizations should be helpful in writing EIS's on projects similar to those described here.

For bypass studies in particular, it is appropriate to break retail sales into separate categories. If one is concerned with answering questions in a public hearing, one should be explicit in one's answers rather than being overly dependent on aggregate data. To answer the service station attendant who is concerned over a potential loss in sales by saying, In general the result of the new facility will be to increase economic activity, is unsatisfactory.

If the bypass route remains in close proximity to the main street and land of an easily developable type abuts the proposed route, then the building of the facility should have little, if any, detrimental effect on gasoline sales or retail activity, because such a facility does not significantly alter the flow of traffic through the town. Consequently, little justification exists for expecting demand to be materially altered.

It is unusual, especially for the case of limited-access facilities, that bypasses fit the special conditions noted above. Usually, how a bypass will affect a town is less easily foreseen, but some qualified forecasts can be made. Towns with smaller populations (below some reasonable level) are generally expected to be more adversely affected by a bypass. This should not be taken as a strict rule, but very small towns often lack an industrial base and therefore are, to a great extent, dependent on transient traveler demand (3, p. 137). In contrast, towns in which the highway-oriented businesses (service stations, restaurants) depend mainly on local demand will likely experience little change in welfare (22, pp. 17-18). Affected hotels and motels can pursue one of several economic alternatives. They can encourage travelers to spend the night in town by means of advertising, build a new establishment close to the bypass, or alter the existing business so that a different product can be sold. This last alternative raises a question that those who draft EIS's for bypasses should always attempt to answer: Can the highway-oriented firms (service stations, restaurants, motels), without an undue amount of new investment, adjust to the production of a new or different product that

will maintain former income levels? Gasoline stations may be able to adjust to the production of garage and towing services if they had previously been dependent on transient demand. But little can be said deductively about the ability of hotels and motels to adjust (5; 7; 22, pp. 19-20; 27).

Although it has rarely been discussed, one potential effect of a limited-access freeway and bypass is that it may enable a small community to become a quiet, well-serviced residential enclave. It is unlikely that this could occur except in communities close to large metropolitan labor centers. Furthermore, assuming that a community is quiet, is relatively pollution free, and offers the desired level of public tax supported services, it will still not become a bedroom community unless there is easy access to the central business district. Bypassing the community with a high-speed freeway between 2 major metropolitan areas can fill this easy-access requirement and, in so doing, alter the pattern of demand for land and housing (22, p. 28).

Although the level of economic activity is altered shortly after construction, such changes may not always be short-lived. The improvements may provide impetus to growth, which then leads to increased demand for not only housing but also commercial sites. For purposes of information in the EIS, forecasts about the relative magnitude of transitory changes in demand are appropriate in addition to the long-term projections. However, no routing decisions should be based on effects that are temporary in nature.

INDICATORS OF ECONOMIC IMPACT

Potential Tax Losses

Although the acquisition of right-of-way does, at the time of taking, reduce the property tax base and cause an immediate tax loss until reassessment, it does not follow that the tax base will be reduced permanently. The improvement may cause land values to rise faster than they would have (if other prerequisites for development exist). The implication is, of course, that long-term consequences are the most relevant. However, it is important that EIS's present estimates of short-term losses in tax base so that local public officials will be able to adjust their budgetary process accordingly.

If no change in the nominal tax rate or assessment ratio is assumed, then the effect on tax revenue can be calculated as follows: For each year from the date of acquisition of the right-of-way until a reassessment occasioned by the highway improvement occurs, the loss in tax revenue due to the condemnation of the right-of-way equals the estimated market value times the assessment ratio times the tax rate. Ideally, one would prefer data representing bona fide sales of parcels to substitute for the market value in this equation. However, the acquisition of property by the state does not represent such sales in the strictest sense. The concept of market sale implies that a seller has mutually agreed with a buyer on a fair price for the property. Although such explicit bargaining does not take place between the owner of property and the state during condemnation, a relatively small proportion of those owning condemned property do exercise their legal right to a court settlement (10). Therefore, a workable estimating procedure is to take actual acquisition costs as a close approximation to market value of the right-of-way at the taking. An estimate of acquisition cost figures for each proposed route can be obtained from the highway department.

Several words of caution are in order regarding the use of the simple equation just given. First, the entire right-of-way is not usually acquired in a single year. Rather, a portion is acquired each year from the date that a final location is decided on to a date just before construction. This means that an adjustment has to be made for the normal change in market value that occurs from year to year. Second, condemnation awards frequently include damages to the remainder parcel in addition to the award for the land. Amounts representing damages should not be included when estimating market value. Third, it is not at all clear that, if one were to conduct a cost-benefit analysis, one should include the change in property tax revenue for purposes of calculation. The answer to this question hinges on what is happening on the expenditure side of the locality's budget and how land values and use will change if one alternative

route or interchange point is chosen instead of another. To clarify this idea, consider the following example. Assume that a new limited-access highway is to be built to connect 2 urban areas. Suppose also that, among 3 alternative routes (each of which lies in a different locality), 2 are estimated to have a greater loss of tax revenue than the third during the period of time before the completion of the project. This provides little help in deciding on route location. It does not allow the decision maker to choose the third alternative unless a good case can be made that minimizing tax revenue losses in the short term is an appropriate decision-making criterion. Neither does such revenue loss information rule out the other 2 routes; it says nothing about the possibility that a short-term revenue loss can be completely offset by changes in land use and the associated reassessment that usually follows. Even though losses from the tax base usually are made up through reassessment after changes in land use and value, the lag between the time that the change in value occurs and the reassessment is variable and frequently long (23, 24, 25).

Theoretically, arriving at a figure representing the net change in tax revenue attributable to the building of the facility is desirable. In other words, one must determine whether the value of remainder parcels and other land in the taxing jurisdiction will increase beyond what it normally would have in the absence of the highway so that at some time in the near future the highway-induced loss from the tax base will be more than offset. Ideally, one would like to be able to calculate net change in revenue as the market value of condemned right-of-way times the effective tax rate plus any change in land value of the remainder parcel times the effective tax rate. But as will be discussed under the section on land values, land value estimation for future periods is an extremely difficult and tedious task. Any estimates over long periods should be viewed with skepticism. Therefore any estimates of long-term net change in revenue due to highways cannot be precise in any sense. Additional comments on this subject are in the section on evaluation techniques for potential tax losses.

Employment Gains and Losses

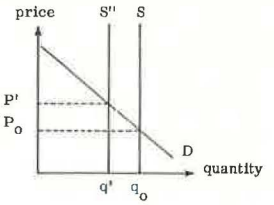
Impacts on employment may include indirect losses and gains from takings and replacements and actual changes from construction activity itself. Those changes induced by construction activity are short term and are best described as transitory. As a practical matter, transitory changes in employment that occur when the facility is being constructed are relatively more easily estimated than the longer term, indirect effects of highway construction. Wallerstein (23, 24, 25) suggested the following as rules of thumb: "One direct construction job creates between one and two jobs in support services; each $1,000 spent in new construction results in the creation of about 224 man hours of work." Although rules of thumb are useful when one considers alternative routes, these are much too high for the minieconomy affected by the project. (Multiplier effects also take considerable time to work themselves out and are not likely to be very important because of the transitory nature of highway construction.) Highway construction is not agreed to be a means of alleviating unemployment problems. But if it is 1 of 2 alternatives equal in all respects and the other has significantly more adverse effects on employment, then highway construction obviously should be chosen.

An important question one should attempt to answer when writing an EIS is what portion of the money spent by the contractor will be spent outside the minieconomy affected by the highway. The answer depends of course on whether the contractor hires local labor and buys supplies locally. (The former is more likely to occur than the latter.) Obviously, the impact will vary greatly between these 2 options of purchasing inputs. If the contractor uses a substantial portion of local labor, additional summer jobs will likely be created, and some people in the labor force who had been unemployed will find that, at least for the duration of the project, a buyer's labor market no longer exists. Furthermore, if businesses are to be displaced by the facility, then the rise in unemployment so occasioned may be offset partially by the contractor's demand for labor. By the time the project is completed, the labor market may have adjusted so that the displaced members can be absorbed into permanent jobs. If the employment

Figure 1. Form for information on effects of highway on employment.

Alternative	Liquidated Firms (−)	Relocated Firms (±)	Firms Remaining, But Possibly Affected (±)	Firms Attracted by Facility (±)	Net (±)
A					
B					
C					

Figure 2. Housing stock supply curve.



situation at the time of construction is particularly acute, even a reduction in unemployment from an increase in transitory employment may give the economy of the area a welcome boost.

Frequently, the building of a transportation facility necessitates displacing business firms. This implies that a certain number of jobs are no longer available. Estimates of this impact will require some basic data collection. Ideally, information is desired that indicates how the highway affects net unemployment. Figure 1 shows a sample form to use. (Both employment in firms directly affected by the highway taking and the multiplier effect on other related firms should be taken into consideration.)

Local Government Operation

Closely related to changes in the tax base, yet an effect that appears to have been given little attention in most studies of impact, is the way in which proposed improvements might alter local government operation, particularly financing of and demand for services. Although, in the past, the magnitude of such effects has been marginal, these effects likely will take on more importance. This is to be expected particularly because of the increase in the number of bedroom communities and changes in the resident-to-employment ratio that accompany the increased accessibility that results from highway improvements. Furthermore, an improvement may bring about urban sprawl or other undesirable forms of land use and thus raise the cost of public services and discourage alternative forms of transit. In addition to the immediate reduction in tax base, which has been discussed, the construction of a facility or network may have any or all of 3 consequences.

1. Construction may change the demand for local-tax-supported public goods and services. For example, better accessibility occasioned by a highway improvement may spark increased building in the perimeter of a jurisdiction. Subsequently, additional sewage treatment, police and fire protection, and school facilities may be required.
2. Construction may preclude local expenditures on other priority groups or projects because of limitations on local tax or grant income.
3. Construction, in rare cases (usually in highly urbanized areas), may lead to the relocation of a substantial portion of the population outside the jurisdiction. If this occurs, the per capita basis on which grants may be allocated will be reduced.

It is important in any environmental impact statement that these potential effects on political jurisdictions be addressed. Although most projects will not be expected to materially alter political decisions such as the supply of services and budgeting, that some project might do so makes it a worthwhile consideration for the EIS.

Housing Market

Before I discuss the housing market, I wish to note that little empirical work has been

done on the housing market except at aggregate levels. For purposes of planning, aggregate information is not very valuable. In fact, research opportunities are almost endless on the aspect of highway and transportation impacts dealing with the housing market.

If a highway improvement requires that a certain portion of the housing stock be demolished, then the result in the short term (that is, when the supply is fixed) is that the price per unit of housing must rise. Although it is not a welfare effect, such a redistribution of income from renters to landlords should not be ignored in an environmental impact statement. A substantial amount of primary data is needed, such as (a) number of units demolished categorized according to price (or some other appropriate criterion); (b) the number of persons or families displaced; (c) the vacancy rate for the area, which tells how many dislocated persons can be absorbed without any change in the stock of housing; (d) the net change in housing stock of each specific type; and (e) the elasticity of demand for housing.

Concern here will be mainly with the short-term or price change effects. The building of a facility, if any homes are taken, theoretically involves the reduction in the supply of housing stock, which causes a decrease in normal vacancy rates, which, in turn, creates excess demand in the housing market. In the short term, price must rise because quantity is fixed. Figure 2 shows this. In the short term, the supply curve is vertical. S denotes the supply before the taking of right-of-way. S'' denotes reduction in housing. If demand D does not change, then housing service is reduced to q' and a new price P' is established. For the long term, price should return to equilibrium. Supply must be replaced because section 206 of the Federal-Aid Highway Act of 1970 requires that housing be constructed as a last resort when sufficient replacement housing is not available.

Certain preliminary steps need to be taken before the formula for estimating the change in the price of housing services, which is presented in the section on evaluation techniques: formulas, can be used.

1. Appropriately separate the housing units demolished into price classifications. For apartment houses, some attempt should be made to capitalize the yearly rental price of each unit into a market price by discounting over the expected life of the units.
2. Assume that normal vacancy rates are 1 percent for owner-occupied housing and 5 percent for tenant-occupied housing (12, p. A-18).
3. Subtract the assumed normal vacancy rate for the housing classification in question.

Slum Costs

Some estimates of the reduction in social costs arising as a result of removal of slums because of highway construction are presented in the RMC study (12). If a highway is built through a slum area, one can logically contend that there is a reduction in the potential cost of fire. It is not clear, however, that any significant cost reduction will occur. Furthermore, if any kind of monetary tag could be placed on the value of removing a slum, it would be redistributional in nature because the removal of slum housing in one area simply leads, by way of market demand forces, to the springing up of slums elsewhere (11, 19).

Land Values

Under the topic of land values, I will synthesize some recent work on the subject into practical guides where possible and note misconceptions that should be avoided. The reader is reminded to be conscious of the discussion on incidence and double counting so that changes in land values can be kept in proper perspective when preparing EIS's.

Several generalizations can be made about the relationship of highway improvements and land values.

1. Improvements are usually undertaken in areas already substantially developed and, in some sense, are a result rather than a cause of development and increasing demand for land. There is little doubt, however, that highway improvements hasten any change in land values already under way. (A notable exception is interchange development.)
2. The value of land and its use are closely related. The most frequent result of a highway improvement is that the land in close proximity is rezoned to more intensive use. Although some persons have suggested that industrial parcels appreciate more than unimproved land, it is not clear that this should hold in the majority of cases (23, 24). One can argue that industry would not have located on a parcel had not adequate transportation facilities been available. On the other hand, one would expect vacant land, especially at interchanges, to receive the greatest increment in value because the highway or the improvement increases accessibility and ripens the land for commercial or industrial purposes.
3. Land values are important because beneficial or harmful effects of highways will likely be capitalized into higher or lower property prices. An example will best serve to explain the concept of capitalization. A piece of property has value because of the flow of services it yields through time. The services yielded by a residential parcel might be such things as peace and quiet, easy access, the availability of water and sewer services, pretty views, clean air, and good neighbors. The flow of these services has some monetary value each year. By predicting, within reason, the life of the asset, one can convert this yearly service flow to a present value figure (see later discussion on housing market impact calculation) with use of the current discount rate. (This value usually ranges from 6 to 9 or 10 percent.) Assume that, before the highway improvement, a residential parcel was valued at $17,000 by this procedure. Suppose also that, as a result of increased average daily traffic, noise and air pollution immediately reduces the flow of services from the parcel. The result is a reduction in the market price. In this instance the increase in pollution has been capitalized into a lower property value (17, 18).
4. Because use and change in value are so closely related, reliable results can be maintained only by grouping parcels of comparable use together as residential, commercial, industrial, and agricultural parcels.
5. No easy to apply method exists for estimating, before the fact, what change will occur in land values as a result of a highway improvement. Land use modeling is still a young science, and most models require a great deal of data. Until reliable use models are developed, the accurate prediction of price change is almost impossible. This does not mean that no basis exists on which to make educated guesses about land value changes and highway improvements.

With the aid of multiple regression analysis, data from past highway improvement projects can be gathered by researchers to determine whether variables such as noise, air pollution, and accessibility significantly alter land values. A team of economists conducted research of this nature on 4 residential communities bisected by Interstate Highways (4). For the 85 parcels abutting I-495 in North Springfield, Virginia, they found that the value of a parcel was reduced by $69 for each increase of 1 dBA of noise. This finding should not be taken as a strict guide for estimating changes in property values that are due to noise, but on limited-access facilities such as I-495 one at least has an estimate of the order of magnitude of such effects.

The most appropriate closing for the discussion on land values is to note that little solid evidence is available. Statements concerning changes in land values as they relate to highway improvements should be viewed with caution until more evidence can be developed.

EVALUATION TECHNIQUES: FORMULAS

No techniques are proposed to estimate local government operation effects or changes in slum cost.

Potential Tax Losses

A discussion concerning tax losses attributable to highways must consider the situation in which no reassessment is made for time during which an EIS is being written and the case in which the assessment ratio changes.

Reassessments usually are not made each year; sometimes 5 or more years may pass before a jurisdiction changes the assessment ratio. Assume that a limited-access facility route was decided on in 1968 and that a portion of the right-of-way has been acquired each successive year. The estimated right-of-way costs as of 1968 probably would not closely approximate the taxable value of the area taken because of the long lag in acquisition. A generally close figure can be estimated, however. Real estate assessments (obtainable in courthouse records) per acre (hectometer^2) can be collected for the base year and the last year in which right-of-way was acquired. Then the average assessment per acre can be calculated and compared for the 2 years. For example,

A_1 = 1968 average assessment per acre (hectometer^2) (including buildings),
A_2 = 1974 average assessment per acre (hectometer^2),
$A_{1,1}$ = assessment ratio for a certain year (such as A_{68}), and
$K = A_2 - A_1$.

Now adjust A_1 and A_2 to average market values per acre (hectometer^2) by the assessment ratio for the respective years. After assuming for the sake of simplicity that the change in market value is equally distributed through time, divide K by 6 (the number of years between 1968 and 1974). Then K/6 is the average market value increase per acre (hectometer^2) for each year in which right-of-way was acquired.

Suppose that K/6 = \$80 and that A_1/A_{68} = \$800. Suppose also that 100 acres (40 hm^2) was acquired for the corridor in 1970 (two years). The market value in 1972 would be \$960/acre (\$2,400/hm^2), that is, 800 + (2 × 80), and the total market value taken = \$960 × 100 = \$96,000. This figure represents the estimated market value of right-of-way, and, when multiplied by the assessment ratio for the locality in 1970, yields the loss in tax base that year. The estimated loss in tax yield is then the loss in tax base times the sum of millage rates for all property taxes.

Employment and Wage Impact Calculation

The RMC study (12) offers a method of estimating the employment and wage impact in a neighborhood disturbed by the construction of a highway. I have altered this method slightly. Currently little else is available from which to work, but caution should be exercised in using the factors that the RMC study (12) presents.

I suggest that, when field work is required for the gathering of other pertinent information for the EIS, the average number of employees for businesses totally dependent on the former facility be substituted as an estimate of the employees per liquidated business in equation 1 (12, p. A-3):

$$Z = a(E) \cdot d \cdot B \qquad (1)$$

where

Z = labor force change in liquidated businesses,
a = proportion of employees that are residents of the study area,
E = employees per liquidated business,
d = proportion of liquidated businesses, and
B = number of condemned firms.

Note that equation 1 requires another factor—the proportion of firms liquidated. Early

in the planning stage, it is difficult to know with any degree of accuracy what percentage of dislocated firms will actually fail. As the time for moving approaches, entrepreneurs will have to predict the ability of their firms to move. Depending on the type of improvement, businesses that could be considered as marginal and dependent on the existing facility will fail. First, non-highway-oriented businesses likely will be hardier. Second, the larger the firm is, the less likely it is to liquidate. Third, businesses that have a well-established, local clientele will likely relocate successfully. Kinnard and Malinowski estimate that between 22 and 40 percent of firms liquidate (8, p. 45). These estimates are likely high for geographic areas where vacant land is plentiful. To the extent that additional employees are required in businesses that supply substitute goods of those businesses liquidated, there would be no loss in wages to the community.

Housing Market Impact Calculation

Several preliminary steps necessary for estimating changes in the price of housing were listed in the earlier discussion on the housing market. Step 1 requires discounting the income stream over the life of the housing stock to present value. A dwelling, whether owner occupied or tenant occupied, costs the dweller an annual dollar amount to retire the mortgage or retain the lease. This can be thought of as being appropriately divided over the life of the asset, however. Because future dollars are less valuable than current dollars, income streams must be adjusted or discounted by the interest rate one could receive if one invested the same number of dollars in the bond market rather than the housing market.

Consider a rental property that pays incomes of Y_1, Y_2, and Y_3 at the end of year 1, year 2, and year 3 respectively. Then, assume an interest rate i, and the present value, that is, the capital value, of this rental property is

$$Y = \frac{Y_1}{1+i} + \frac{Y_2}{(1+i)^2} + \frac{Y_3}{(1+i)^3} \tag{2}$$

or

$$Y = \sum_{t=1}^{3} y_t \cdot (1+i)^{-t} \tag{3}$$

In general,

$$Y = \sum_{t=1}^{3} y_t \cdot (1+i)^{-t} = \frac{y_1}{1+i} + \frac{y_2}{(1+i)^2} + \cdots + \frac{y_n}{(1+i)^n} \tag{4}$$

An example may prove helpful. Assume that a house has an expected life of 3 years. Also assume that its rental value is $1,000/year. At an interest rate of 7 percent, the present value of the house is

$$Y = \frac{1{,}000}{1.07} + \frac{1{,}000}{(1.07)^2} + \frac{1{,}000}{(1.07)^3}$$

$$= 934.57 + \frac{1,000}{1.145} + \frac{1,000}{1.225}$$

$$= 934.57 + 873.36 + 816.32$$

$$= \$2,624.25 \quad (5)$$

For each classification of housing, the immediate impact is the reduction in stock occasioned by demolition or a reduction in vacancy rates. The percentage of change in housing supply in each classification $\%\Delta S^*$ is calculated as

$$\%\Delta S^* = \frac{\Delta S_t}{S_{t-1}} = \{C_t - [(V_{t-1} - V^*_{t-1}) \cdot S_{t-1}]\} \div S_{t-1} \quad (6)$$

where

ΔS_t = change in supply of occupied units during time because of condemnation,
S_{t-1} = number of units during the period before construction,
C_t = number of units of the class of housing in question that were demolished,
V_{t-1} = actual vacancy rate for the period before construction, and
V^*_{t-1} = normal vacancy rates (assume 1 percent for owner-occupied units and 5 percent for tenant-occupied units).

To estimate the change in rent or price of housing (a rental stream can be converted to present value by discounting), the demand for housing must be assumed not to change significantly. Evidence indicates that such an assumption is not unwarranted. Few individuals dislocated by highways leave the immediate area permanently (13). Under this assumption about demand, the change in rent is equal to the price elasticity of demand times the percentage reduction in housing stock times the average rent before construction, or

$$\text{Rent}_t = \eta_d \cdot \text{rent}_{t-1} \cdot \%\Delta S^* \quad (7)$$

where

η_d = price elasticity of demand for housing [estimates are $1.0 \leq \eta_d \leq 1.6$ (14, 15, 16, 21)], and
rent_{t-1} = average rent before construction of the type of housing in question.

Price elasticity is the percentage of change in quantity demanded that is associated with a 1 percent change in price. In this instance, rents rise because supply has been reduced with no immediate change in demand. The extent to which they rise depends on how large the reduction in stock of housing is and how fast price must rise to ensure that demand is curtailed in proportion to the reduction in stock. Judgment is important in deciding what estimates of η_d to use. Where there is severe pressure on the existing stock of housing, η_d is expected to be near the upper limit.

Land Values

The subject of land values needs additional research. In addition to the estimates on noise effects given by Gamble, Sauerlender, and Langley (4), the following may

serve as a guide for air pollution effects. However, it should be noted that, in the Gamble, Sauerlender, and Langley study (4), there was a high degree of multicollinearity. Therefore, air pollution effects as well as noise effects showed up in the coefficient estimates on the noise pollution variable. Only when a model that solves the multicollinearity problem is used can double counting be avoided if estimates of air pollution effects are added to estimates of noise pollution effects on land values. Additional comments on the Pennsylvania State University study are available elsewhere (31).

The present value of the cost of air pollution due to a highway facility is

$$P_c = \sum_{t=1}^{n} \frac{1}{(1+r)^t} \cdot \%\Delta \text{ pollution} \cdot \text{pollution elasticity} \cdot \text{residential land value} \cdot \text{residential area} \quad (8)$$

where

t = number of years for which estimating the cost is deemed necessary;
r = appropriate discount rate;
%Δ pollution = percentage by which pollution is increased;
pollution elasticity = percentage by which residential property values fall for each 1 percent increase in measured air pollution [if the Ridker and Henning study results (15) are used, then 0.05 percent ≤ pollution elasticity < 0.10 percent];
residential land value = residential land value per acre (hectometer^2) (this figure should be an average for the area in question); and
residential acreage = residential acreage affected.

SUMMARY AND CONCLUSIONS

This paper presents for consideration a number of factors that may, depending on the particular project or improvement being considered, be relevant to transportation decision making. The factors presented here should not be construed as making up a comprehensive procedure for analyzing impacts. The paper is intended to provide the transportation community with a point of departure for analyzing economic impact and for fitting such analysis into the context of an EIS. Furthermore, the paper is intended to help distinguish the areas in which the tools of economics can help provide information on which to make decisions from the areas in which economics is ineffectual. The reader should in no way conclude that the factors discussed should be used to develop a cost-benefit ratio. Transportation decisions are much too complex for such a tool to be used. No formulas are provided for estimating changes over time in land values, employment, and the distribution of income, but these are important effects and should be addressed by the EIS and discussed in as knowledgeable a way as possible.

In conclusion, EIS's, regardless of their emphasis, should be viewed as sources of information not only for the public at large but for decision makers as well. Furthermore, because of the complex nature of transportation decisions, it is crucial that those who prepare the EIS's not only be competent in their disciplines but also have a keen awareness of the purpose of an EIS.

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REFERENCES

1. J. Buchanan. The Public Finances. Richard D. Irwin, Homewood, Ill., 1970.
2. J. Buchanan and W. C. Stubblebine. Externality. Economica, Nov. 1962.
3. A Bypass Economic Impact Study. Ohio Department of Highways, March 1970.
4. H. B. Gample, O. H. Sauerlender, and C. J. Langley. Adverse and Beneficial Effects of Highways on Residential Property Values. Transportation Research Record 508, 1974, pp. 37-48.
5. J. W. Harrison. Methods Used to Study Effects of the Lexington, Virginia, Bypass on Business Volumes and Composition. Virginia Highway Research Council, Charlottesville, Va., 1958.
6. A. S. Lang and M. Wohl. Evaluation of Highway Impact. HRB Bulletin 268, 1960, pp. 95-119.
7. S. D. Tyndall. Highway South Dakota 50 Bypass Study. South Dakota Department of Highways.
8. W. N. Kinnard and Z. S. Malinowski. The Impact of Dislocation From Urban Renewal on Small Businesses. Univ. of Connecticut, 1960.
9. E. Mansfield. Microeconomics, Theory and Applications. W. W. Norton and Co., New York, 1970.
10. D. G. Merrill. Condemnation Alternatives for Virginia. Virginia Highway Research Council, Charlottesville, Va., Jan. 1973.
11. E. O. Olsen. A Competitive Theory of the Housing Market. American Economic Review, Sept. 1969.
12. Physical and Economic Measures of Neighborhood Change. In Highway Improvement as a Factor in Neighborhood Change, Vol. 1, Resource Management Corp., March 1971.
13. M. A. Perfater. The Social and Economic Effects of Relocation Due to Highway Takings. Virginia Highway Research Council, Charlottesville, Va., Oct. 1972.
14. R. F. Muth. Urban Residential Land and Housing Markets, Issues in Urban Economics. Resources for the Future, 1968.
15. The Demand for Non-Farm Housing. In The Demand for Durable Goods (Arnold Harberger, ed.), Univ. of Chicago Press, 1960.
16. T. H. Lee. The Stock Demand Elasticities of Non-Farm Housing. Review of Economics and Statistics, Feb. 1964.
17. R. G. Ridker and J. A. Henning. The Determinants of Residential Property Values With Special Reference to Air Pollution. Review of Economics and Statistics, May 1967.
18. R. G. Ridker. Economic Cost of Air Pollution. Praeger, New York, 1967.
19. J. Rothenberg. An Economic Evaluation of Urban Renewal. Brookings Institution, Washington, D.C., 1967.
20. C. S. Shoup. Public Finance. Aldine Publishing Co., Chicago, 1969.
21. W. F. Smith. Aspects of Housing Demand—Absorption, Demolition and Differentiation. Center for Real Estate and Urban Economics, Univ. of California, 1966.
22. R. S. Wallace and J. H. Lemly. Analysis of the Economic Impact of Highway Change on Two Small Georgia Communities. State Highway Department of Georgia, 1966.
23. L. B. Wallerstein. Economic/Environmental Considerations in Highway Location: Some Opportunities and Constraints. Federal Highway Administration, 1973.
24. L. B. Wallerstein. Some Economic-Environmental Considerations: Inventory Analysis Techniques. Federal Highway Administration, 1973.
25. L. B. Wallerstein. Identification of Selected Economic Impacts and Their Relationship to the Highway Environment. Federal Highway Administration, 1973.
26. R. M. Zettel. The Incidence of Highway Benefits. HRB Special Rept. 56, 1960, pp. 153-164.

27. P. Zickefoose. Economic Survey of Ratan, New Mexico. New Mexico State Univ., 1968.
28. Income Estimates: Virginia SMSA's and Other Economic Areas, Selected Years 1929-1968. Taylor Murphy Institute, Univ. of Virginia.
29. Estimates of the Population of Virginia Counties and Cities: Various Years. Taylor Murphy Institute, Univ. of Virginia.
30. Newton-Interstate 80 Bypass Study. Traffic and Highway Planning Department, Iowa State Highway Commission, 1969.
31. G. R. Allen. A Critical Review of "Community Effects of Highways Reflected by Property Values." Virginia Highway and Transportation Research Council, Charlottesville, Va., June 1974.