

An Economic Theory of Travel Decisions

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An economic theory of travel decisions, including an introduction to the dimension of time, is presented. Four categories of travel were distinguished: travel that is (a) related to economic consumption, (b) related to noneconomic activities, (c) between places of production and consumption, and (d) for productive purposes. For travel related to economic consumption a utility function includes the utility derived from consumption, the effort of producing consumption goods or services in the household of the consumer and the utility (or disutility) of travel related to consumption. A budget constraint is presented on the basis of the cost of consumption goods and travel. Noneconomic activities do not lend themselves to economic valuation by definition; however, the budget constraint is extended to include travel for noneconomic activities. The choice of home and work locations is essentially a long-term one, depending on far more factors than the transportation situation; with regard to transportation, all types of journeys for all members of the household need to be considered. Travel for work appears to be far more similar to travel for private purposes than was generally believed. An introduction to the influence of the dimension of time is given, stating a time budget including time spent on work, economic consumption, noneconomic activities, and travel. Although the total time available per day is fixed, there are some options for using time for multiple purposes. Finally, it is stated that the study of transportation should be integrated into the study of human activities in general.

Consumption in an economic sense provides satisfaction, to be called utility, by satisfying needs of people with the help of scarce resources that may have other uses. These resources will be called goods and services, as opposed to resources that either are not scarce in relation to the need for them or have no alternative employment. The traditional example of the first category is air, essential for our life, but plentiful (but, unfortunately, not always of the best quality). An example of the second category is a letter that brings us news from a friend, which can be very important to us but is not of interest to other people, as opposed to a newspaper, which provides news of general interest.

TRANSPORT AS A COST OF CONSUMPTION

Theory of Consumption

The theory of economic consumption deals with the consumption of goods and services that can be obtained in the market. It does not generally consider private production of consumption goods. Preferences of individuals are taken as given, and no attention is paid to variations of preference scales of the same individuals over time.

In a market economy, goods and services are exchanged for a monetary price, and consumptive utility can be obtained

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by spending a certain sum of money. Making abstraction from indivisibilities, total utility can be maximized by equalizing the utility to be derived from the last unit of money spent on the consumption of each good or service. The proof of this can easily be given: keeping fixed the total budget to be spent, we can augment total utility by transferring money expenditure from one good to another as long as utility per unit of money spent on various goods is not equal. Applying this rule to individual commodities will not work: either we buy a certain book or we do not. If, however, we apply it to categories of goods or to goods that we use in larger quantities, it will hold at least approximately: in the equilibrium situation the last dollar we spend on books will give us approximately the same utility as the last dollar we spend on nonmental food.

In a very simple algebraic form, we can formulate

$$u = u(c)$$

denoting that the total utility derived from consumption depends on the quantities of all goods and services consumed (c). If we use p_c as the vector of the prices of all consumption goods and Y as income, a budget constraint can be formulated as

$$p'_c c \leq Y$$

Home-Produced Consumption Goods

Up to now we have followed the traditional consumption theory. However, in the line of arguments it is necessary to stress that some consumption goods can be produced at home as well as bought in the market and that they can be substitutes for each other. If we have a garden, we can grow vegetables in it. Instead of having our laundry collected and delivered, we can either go to a launderette or do our own wash at home.

Producing consumption goods or services in our own household not only will change the demand for goods in the market; it also implies that we have to put in some effort that can be considered as a negative utility. Assuming that the quality of the laundry done at the launderette is equal to that done at home, a comparison should be made between buying the full service, buying the use of the launderette and putting in some effort, and buying a washing machine or other equipment and soap and putting in the effort. This effort is labor we do not sell to an employer but use for our own purposes.

The effort needed for labor for our own purposes is sometimes felt to be less than the effort of similar labor done for market purposes: we value work in our own home differently

from work in other people's homes: we would rather knit a sweater for a relative than knit it to be sold in a shop. Some of these activities can even generate utility on their own right.

We can now write the general formulation of consumption as

$$u = u(c, e_c)$$

where e_c stands for the effort for the production of consumption goods and normally will have a negative sign—that is, it will be a disutility or cost—but can have a positive sign, which then would add to the utility derived from consumption itself.

The income constraint will not be influenced by the input of our own effort and therefore remains

$$p'_c c \leq Y$$

Transport and Consumption

Passenger transport for private purposes usually is considered a consumption good in accordance with these rules, but in doing so one is running into some difficulty. Normally, consumption goods are consumed only if they give satisfaction or positive utility. When utility or utility and effort combined are negative, we will not include the good concerned in our consumption basket. This relation, however, does not hold for transportation. In most cases transportation does not provide positive satisfaction; to the contrary, it is generally considered a negative element in total utility. It is in accordance with this situation that people generally will try to minimize transport, in that for reaching a given destination they will choose the shortest or least-difficult route.

When transportation is considered a consumption good, it is not possible to explain that people will travel at all. The obvious reason for the fact that people travel long distances while yet trying to minimize their travel is that it is not transportation itself, but reaching the destination, that provides utility. It is therefore often formulated that the demand for transportation is a derived demand and that the utility is a derived utility. It is not the journey to the theater that provides utility but seeing the play. When we explicitly or implicitly consider the pros and cons of going to the theater, the cost of the journey has to be added to the price of the ticket, and the disutility of travel has to be considered as a negative factor against the utility of seeing the play. It can now be seen why people who live far from theaters visit these buildings less often than those who live nearby (another reason will be introduced later, when we will discuss the influence of time).

When we carefully consider the various categories of consumption, we can see that frequently at least some travel is associated with it. We can therefore state generally that the satisfaction provided by consumption has to be compared not only with the money cost of the consumption goods but also with the money cost and dissatisfaction of travel. The tendency to equalize marginal utility of expenditures on all consumption goods therefore will not hold because individual consumption goods will involve different amounts of transportation. Only after the dissatisfaction resulting from travel is converted into monetary units can equalization of marginal

utility of consumption per unit of money spent (including generalized cost of travel) be reintroduced.

For the moment, we will limit our exposé to restating the consumption utility function as

$$u = u(c, e_c, v_c)$$

and the budget constraint as

$$p'_c c + p'_v v_c \leq Y$$

where v_c stands for all travel related to consumption and p_v , for the price or monetary cost of travel.

Approach to Analysis of Consumption Decisions

The utility of consumption of certain goods and the utility (or disutility) of effort and travel are variable between people and, for individual people, over time. Utilities and disutilities therefore are not stable quantities that can be measured easily but are quantities variable with all the differences between individuals and for each individual with circumstances and moods.

This situation will not only make quantitative studies in the field of consumption behavior more difficult but also have an influence on the next step of our theoretical considerations: the treatment of travel as a cost of consumption. As we have seen, obtaining satisfaction from economic consumption may cost us the price of the goods—effort for own production and travel.

The first is measured in terms of money, the second in terms of satisfaction, and the last involves both money and satisfaction. According to the usual definition of economic cost, this notion includes the minimum sacrifice needed to obtain a certain result. So, if a certain article is sold for \$2.50 in one shop and for \$2.75 in another, we would assume that the cost of the article is \$2.50, unless there are good reasons to pay the higher price: maybe it is not thought worthwhile to shop around until the cheapest price has been found, or that the shop selling the item at \$2.75 needs to be visited anyway (then there is a trade-off between money cost and transport cost), or that the shopper does not like to visit (or to be seen in) the shop selling the article at the lower price (in this case the goods are in fact not completely equivalent).

For transportation, the determination of minimum sacrifice is still more complicated because for each trip there may be alternative ways to travel, each with a different money cost and level of satisfaction, and a comparison of combinations of these two categories is necessary to determine the best way to make a journey. For this comparison, we need to add in our minds money expenditures and degrees of satisfaction. In studies on passenger transport demand, the result of this addition is indicated as generalized cost. At this stage, only two observations will be made.

As with consumer preference in general, preferences in the field of transportation vary with individuals and between individuals over time. We cannot expect generalized cost of travel to depend on a simple and stable formula.

The second observation goes partly contrary to the first one, but it is also in agreement with general consumption

behavior. There is an influence of habit formation and economy of search of optimal solutions in that for certain types of journeys a predetermined mode is chosen, such as a car for a visit to a suburban shopping center, and public transportation for shopping in the city center. Also, it has been shown that people are not always aware of all relevant aspects of journeys that they may have to make.

TRAVEL RELATED TO NONECONOMIC ACTIVITIES

Satisfaction derived from the consumption of economic goods and services is important to all of us, but this fact should not lead us to forget the role that noneconomic activities play in our lives.

Nobody can do without sleep and rest; we all need contacts with members of our families, friends, and other people with whom we share common interests or ideas; and many of us would rather do without theaters, concerts, cinemas, and other recreational services than miss the benefit given by spending at least some time in a natural environment, many of which are still plentiful.

Many social contacts need travel, and so does recreation in nature. In principle this travel is not different from travel related to economic consumption, but the satisfaction against which it must be traded off is of a noneconomic nature. That these trade-offs take place can be derived from the fact that we visit friends in faraway places less often than we do those nearby, and the same applies to other travel purposes in the noneconomic sphere.

Normally, noneconomic activities do not involve money expenditure and can therefore be left out of consideration in the budget constraint for economic consumption. When we consider travel not as a consumption activity in its own right but as ancillary to other activities that generally generate utility, whether economic or not, we have to enlarge the budget constraint:

$$p'_c c + p'_v v_c + p'_n v_n \leq Y$$

where v_n stands for travel related to noneconomic activities.

For the rest, the relation of travel to noneconomic activities is similar to the relation to economic consumption: to do both, we may have to incur travel cost and dissatisfaction of making journeys.

TRAVEL BETWEEN PRODUCTION PLACES AND CONSUMPTION PLACES

The journey between home and work traditionally has obtained much attention in theoretical studies and practical research in the field of transportation demand. This attention can be explained by the importance of the journey's purpose in peak demand and also by the relation it establishes between transportation and land use.

A particular property of the home-to-work relation is that it depends on decisions made over a long period. The locations being chosen provide two fixed places in daily travel patterns. Possibilities for variation do exist, however, because people

can make stops between home and work, vary their route and mode of travel, and make trips for private purposes from their workplaces.

Choices of home and workplace sometimes are made simultaneously or nearly so; for example, people take jobs far away from their original homes and look around to find a suitable place to live as soon as possible. Sometimes people change either homes or jobs without intending to change the other also. Decisions become more complicated, however, if more than one member of a household has a job or when one person has two jobs.

As for consumption, the financial and psychological burdens of the daily trip to and from work have to be traded off against the advantages of certain combinations of home and job or combinations of a home and several jobs when there is more than one job per household. This trade-off is far more complicated than in the consumption case: in that case we compared a costly or unpleasant journey, giving access to cheaper or better-quality consumption, with a cheap and short trip to less attractive consumption activities. This is not so for the journey to work, in which both ends are variable and in which both will be the starting point of other trips.

Let us first consider jobs. The first reason for needing a job (e.g., an independent professional activity with employment under one heading) is to provide an adequate income for financing consumption. Therefore, the income to be derived from a job is an important factor in choice. Of course, each job requires certain skills, and the more general these skills are, the more likely it is to find a job in a certain place. Another important factor is the level of satisfaction related to the job, which is determined by the type of work, its ancillary benefits (or lack thereof), and the status provided by it.

All of these elements are of variable importance for individual members of the employed population. Income seems to be a fairly stable element, but sometimes unequal pay is given for similar labor (when age or seniority plays a role in salary scales) or equal pay for unequal labor (when the quality of work is not reflected in salaries). In addition, the propensity to costly consumption is not the same for everybody, and fiscal arrangements can also play a role.

Satisfaction with a job is perhaps still a more personal question. Of course there are jobs that are generally found to be pleasant, but to a large extent pleasure in work is a question of the type of work being matched to one's skills. The more rare the skills are, the less likely it is that a satisfactory job can be found in a given place.

The factors influencing the choice of home are still more complicated. It is not only price, dimensions, and quality of the home itself that are important for our choices in this respect. The home is the place from which daily travel and activity patterns of all members of the household are organized. Trips to school, shops, recreation, relatives, and friends in many cases start from home. Insofar as travel has an influence on the choice of home, it is not only the journey to work that counts, but all the journeys that may be made from home. We can express these journeys as the potential accessibility to various types of destinations. The higher the potential, the more attractive is the location from the viewpoint of minimizing transport cost. These potentials are different for each member of the household, both as destinations and

as travel costs and dissatisfaction; for example, children travel to school mostly on foot or by bicycle and can use cars only when traveling with older people.

The following are factors that are involved in choosing a home and a job:

- Income of all employed members of the household,
- Work satisfaction of employed members of the household,
- Price of home,
- Dimension and amenities of home,
- Environment of home,
- Travel impedance from home to potential activities for all members of the household, and
- Travel impedance between home and work for employed members of the household.

The last factor cannot be expected to play an overwhelming role in the choice of home and job, and it is therefore not astonishing that many distribution models for home-to-work journeys do not satisfactorily explain this phenomenon (1).

TRAVEL AS PART OF PRODUCTION PROCESS

Many productive activities imply travel. Doctors visiting patients and maintenance staff working at installations in homes or other buildings travel between two successive activities. In the course of their work, some people need to meet other people who are not in the same building, or they must attend formal meetings, visit exhibitions, go to conferences, and so on.

The cost of a journey during work time can be considered to include, apart from the actual cost of travel (fare or the cost of a car), the wage cost (including all overheads) of the person traveling. When we consider the firm to aim at an economic optimum, the decisions of whether and how a journey will be made will depend on how important the journey is to the production process and the cost of alternative ways of making the journey, calculated in the above-mentioned way. In real life, however, there are many reasons that things happen otherwise. We will try to enumerate the most important of them, but this enumeration can never be exhaustive.

A firm can have widely varying dimensions: the firm can be a single person working for him- or herself or it can be a very large organization. In the latter case, not all decisions can be made by central management, so there will be much delegation. In many cases occasional journeys will be planned by the person who will actually travel. For trips made regularly, certain rules may be set.

An enterprise or other organization does not always strive for a minimum-cost situation. As long as costs can be met and travel patterns are not clearly extravagant, management may not bother too much about efficiency.

Productivity of working time is not constant throughout the day; for example, after a period of very intensive work, people need some relaxation, and a trip between two successive activities may well serve this purpose.

Apart from relaxation, travel time—in particular on intercity trains—can also provide the opportunity to work (or read) quietly, thus using that time twice for different purposes.

Netherlands railways even have “working compartments” in their intercity coaches, in which people are asked not to distract their fellow passengers by talking or other types of intrusion.

Travel during work is often considered as a fringe benefit, particularly when travel can take place in a pleasant way or to pleasant places, or both. Many workers prefer not to be clustered in the same place, and travel can give both variation and relaxation. These factors can even have an influence on the choice of job: the variation provided by travel can augment the satisfaction of work.

Apart from immaterial benefits, business travel can also provide material benefits. Some employers provide company cars that can also be used for private trips; other employers provide rail season tickets. When one of these situations exists, it will influence travel behavior as far as the choice of mode is concerned.

The same effect results from a reimbursement of car cost, including a part of the fixed annual cost of keeping the car. Workers with this type of arrangement will have an interest in making as many business trips as possible by car.

Many business journeys take place, at least partly, outside normal working hours without compensation for the time spent traveling. And, for some people, hours of work are determined not so much by office hours as by the workload: if time is lost during office hours, the remaining work may have to be done by working late in the office or at home. In these situations there are interactions between time spent for business travel and time spent for private activities.

The neat and simple model of optimization between travel cost, travel time, and work time must be made far more complicated. We have to be aware of imperfect decision processes, fringe benefits, discontinuities, and, perhaps most important, the interactions between work travel and private feelings. It is not just a problem of business calculations that determine if and how professional journeys will be made, but the travelers themselves are influencing and being influenced by decisions. Travel in the course of work has therefore more similarities with the other travel purposes than is normally expected and produces utilities and disutilities as other journey purposes do.

Institutional factors are again important, and they are relevant in two areas: reimbursement of travel cost for journeys during work, and treatment of travel time outside normal working time (payment of overtime or free time given in compensation).

INTRODUCING TIME

Allocation of Time

Until now, we have not explicitly introduced time as a factor that influences travel decisions. We have reasoned in terms of satisfaction, dissatisfaction, effort, income, and cost. Some of these are related to time.

We will now start discussing time as a separate element that influences our activity patterns and thereby our travel decisions. In general we can say that our work, consumption, noneconomic activities, and travel all cost time, and we can

therefore construct a time budget similar to the income budget as follows:

$$t_w + t_c + t_n + t_v = T$$

It seems trivial to state that T , the total time available, is 24 hr a day, but we can to a certain extent use the same time twice: it is possible to meet a friend during a meal, to read during a journey, or to knit while watching television. Nevertheless, the possibilities for such "double use" of time are limited, but we can see that those for whom time is very scarce are looking for a maximum of combinations.

Satisfaction and effort or utility and disutility can normally be considered as opposite categories. One could place time on the same side of the balance as effort: using time for a certain purpose takes away other options. On the other hand, spending time on pleasant things gives satisfaction: eating a good meal at leisure gives more satisfaction than eating it in a hurry; having to leave a theater before the play has ended is on most occasions very unfulfilling.

We can generally say that time is spent to obtain satisfaction, either directly by doing things one likes to do, or indirectly by working for an income, by producing consumption goods ourselves, or by traveling to a destination of one's choosing. There are trade-offs between doing pleasant and unpleasant things. On the one hand, we must do unpleasant things to be able to do pleasant things. On the other hand, a sequence of activities that are all of approximately the same level of pleasantness gives less satisfaction than a sequence of varying degrees of pleasantness and unpleasantness (2). It is as if we can appreciate pleasantness more if we can compare it with another, less pleasant, activity that is close in time. And, as stated by Scitovsky (2), it is not only pleasantness itself that gives satisfaction, but the change from a less pleasant to a pleasant state of activity.

For these reasons we cannot expect an organization of use of time that is based on trade-offs between individual activities. We can presume that there is a tendency to equalize the satisfaction of the last dollar spent on each activity, but this does not apply to minutes. Instead, we can expect people to organize their time in such a way that an optimal result is reached as an overall state of satisfaction.

When we use the word organize, it does not mean that the whole pattern of activities that people undertake is organized in advance. Some activities, such as going to work or school, are fixed for a long time, but others are undertaken when the idea comes up. It is an advantage in itself to be able to respond to ideas of the moment rather than having the whole day filled with planned activities.

Optimization does not mean more than choosing the best of the options available, according to our priorities at the moment of choice.

Time Budget for Transportation

We said earlier that the total time spent on all activities is not limited in the strict sense, because it is possible to combine some activities to be simultaneous. Nevertheless, we cannot circumvent the fact that our day contains only 24 hr. The

more time that is spent on one activity, the less time that is left for the others.

Travel can be useful only if there is some time left for activities at the destination. Most people do not want to spend too much time on travel. All of these circumstances imply a tendency toward keeping total travel time within some limits. There is, however, no reason to assume that there will be a strict limit on total travel time per person. This time can vary according to personal activity patterns and propensity to travel, and in fact individuals can spend very different proportions of their time traveling.

Time budget analysis can provide important information that is relevant to travel behavior, but it should not be limited to time spent on travel. It should show activities at home, outdoors, and travel, and make explicit the constraints imposed by factors such as work and school hours, opening hours of shops, and showtimes of theaters and cinemas. From such an analysis, it will be able to derive what changes can occur because of a shorter working day or other shopping hours.

Traditional forecasting techniques do not generally provide linkages between individual travel purposes, to allow the time needed for trips (travel and activity) for one purpose influence decisions on other purposes. In real life, people need to accommodate all activities within the time available. It is therefore improbable that those who travel a long distance between home and work will also make long recreational trips in the evening, simply because recreational activities are also located far from their home.

Value of Time

The value of travel time has been a classical subject in discussions on passenger transportation demand and project evaluation (3,4). Some governments even issued directives on values of time to be used in project evaluations (5). The subject also has been widely contested, mainly from a political approach.

To first bring terminology in order: travel time generally has a negative value; it should therefore be considered as a cost of travel. This is in line with the place of travel time in generalized cost. It is the saving of time that is a benefit to users and, therefore, a positive value in evaluation. Faster travel, however, does not always mean that a saving in time is realized. Even when we do not assume that total travel time is constant, it can be that faster travel will enable people to take longer journeys.

Attempts to derive values of travel time from value of productive time have been made. The most straightforward reasoning for this can be given for travel during work time, but even in this case there can be doubts, as was explained earlier. For other journeys, the argument that a savings in travel time can be used to work longer hours and in that way obtain a higher income does not hold for several reasons. First, many people are not in a position to determine their working hours at will, and if they are, they might decide to spend the time saved on travel for additional leisure activities instead of for more work. The most important argument against this relationship is that it considers time and money but not effort or level of satisfaction, or both. Oort has argued (6) that time

and effort (or exertion) cannot be isolated in analysis. Any estimate of value of time includes both the effect on total available time and an estimate of the effort or utility associated with the activities undertaken during that time.

Estimates that have been made derive values that are different from hourly income and that vary according to the ways in which time is spent (3). Most studies arrive at values of time as a proportion of hourly income that is variable according to the ways in which time was spent and sometimes travel purpose, but not, for example, time of day or direction of travel.

An analysis directed toward individual situations, however, will show that there are considerable differences between people, with respect to both the options they have to use their time and their evaluation of various kinds of effort. For the same person, there can be considerable differences according to the time of day and day of the week.

Value is nothing more (or less) than the expression of the importance of an economic good for a person's well-being. When we consider time as an economic good, it can have an economic value. When we want to express this value in terms of money, the money value of time is determined by both the value of time and the value of money. That is why values of time have been shown to vary with income, as income influences the (marginal) value of money.

However, the role of time in daily activity patterns does not vary with income in the first place. Household situation and employment or education are far more important factors. People who both have a full-time job and are in charge of managing a household (even a one-person household) have probably the smallest amounts of time, at least during some periods of the day. People who are retired may have difficulty in filling their days and can consider the time spent on a journey as a benefit to them, as long as the journey can be made in reasonable comfort.

In addition, a shorter journey time can make it possible to make a trip without staying away from home for the night or to combine activities in different locations in one day.

For all these reasons, we should not expect to find unique values of time, even when expressed as a proportion of household income. Values of time can be expected to vary, and any analysis in this field should be organized so as to show the extent of this variation, both between people and according to time and circumstances. Only in this way will it be possible to obtain information that can be useful for economic analysis of travel behavior and, later, for an evaluation of policy alternatives. The practice of applying standard values, also when expressed as a ratio of income, will lead to erroneous forecasts and discriminatory decisions.

SYNTHESIS

Human life can be considered to consist of a sequence of activities, some of them regular and dependent on rules, conventions, or decisions made for a long period; others dependent on decisions of the moment, perhaps made without thinking of other options. Sometimes activities can be combined during the same time (meeting a friend during a meal, reading on a train), but in most cases each activity takes up a definite period of time.

The activities can be categorized into production (in the course of employment or our own enterprise or for our own consumption), economic consumption, noneconomic activities, and travel. People can be presumed to organize their activities in such a way that they choose the most favorable combination of the options open to them. That people do not recognize all available options, do not always explicitly consider the pros and cons of each option they see, and sometimes act on impulse is not contrary to this presumption. The time and effort needed to make a choice are also part of the optimization process. For important decisions, such as taking a new job or buying a house, people tend to consider carefully all the alternatives they can think of; for unimportant ones, such as drinking a cup of tea in one place or another, or not at all, they do not spend hours making up their minds.

Travel is related to some of the other activities, and in general it is a cost of the activity, in that the income or utility can be obtained only when some time, money, and effort are spent on travel. On some occasions, however, the journey itself can provide utility, and then it can be considered as a part of economic consumption. In most cases the journey is at the cost of other activities; of course the journey will be minimized for each activity but will grow with the amount and quality of activities to be undertaken. This apparent paradox is similar to the growth of total cost of industrial production combined with diminishing costs per unit, which is the normal pattern of an advancing industrial society.

The cost of travel, measured in time, money, and effort, can be of a very different importance relative to the activity to which it gives access. It is therefore not expected that a satisfactory explanation of travel behavior can be obtained from variables relative to the transportation system only.

The study of transportation must be integrated into the study of human activities in general and cannot be pursued as an isolated subject of scientific work. Only when we gain some understanding about factors determining human activity patterns may we be able to also understand transportation decisions.

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