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A Theory of the Allocation of Time

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A THEORY OF THE ALLOCATION OF TIME

I. INTRODUCTION

THROUGHOUT history the amount of time spent at work has never consistently been much greater than that spent at other activities. Even a work week of fourteen hours a day for six days still leaves half the total time for sleeping, eating and other activities. Economic development has led to a large secular decline in the work week, so that whatever may have been true of the past, to-day it is below fifty hours in most countries, less than a third of the total time available. Consequently the allocation and efficiency of non-working time may now be more important to economic welfare than that of working time; yet the attention paid by economists to the latter dwarfs any paid to the former.

Fortunately, there is a movement under way to redress the balance. The time spent at work declined secularly, partly because young persons increasingly delayed entering the labour market by lengthening their period of schooling. In recent years many economists have stressed that the time of students is one of the inputs into the educational process, that this time could be used to participate more fully in the labour market and therefore that one of the costs of education is the forgone earnings of students. Indeed, various estimates clearly indicate that forgone earnings is the dominant private and an important social cost of both high-school and college education in the United States.¹ The increased awareness of the importance of forgone earnings has resulted in several attempts to economise on students' time, as manifested, say, by the spread of the quarterly and tri-mester systems.²

Most economists have now fully grasped the importance of forgone earnings in the educational process and, more generally, in all investments in human capital, and criticise educationalists and others for neglecting them. In the light of this it is perhaps surprising that economists have not been

¹ See T. W. Schultz, "The Formation of Human Capital by Education," *Journal of Political Economy* (December 1960), and my *Human Capital* (Columbia University Press for the N.B.E.R., 1964), Chapter IV. I argue there that the importance of forgone earnings can be directly seen, e.g., from the failure of free tuition to eliminate impediments to college attendance or the increased enrolments that sometimes occur in depressed areas or time periods.

² On the cause of the secular trend towards an increased school year see my comments, *ibid.*, p. 103.

equally sophisticated about other non-working uses of time. For example, the cost of a service like the theatre or a good like meat is generally simply said to equal their market prices, yet everyone would agree that the theatre and even dining take time, just as schooling does, time that often could have been used productively. If so, the full costs of these activities would equal the sum of market prices and the forgone value of the time used up. In other words, indirect costs should be treated on the same footing when discussing all non-work uses of time, as they are now in discussions of schooling.

In the last few years a group of us at Columbia University have been occupied, perhaps initially independently but then increasingly less so, with introducing the cost of time systematically into decisions about non-work activities. J. Mincer has shown with several empirical examples how estimates of the income elasticity of demand for different commodities are biased when the cost of time is ignored;¹ J. Owen has analysed how the demand for leisure can be affected;² E. Dean has considered the allocation of time between subsistence work and market participation in some African economies;³ while, as already mentioned, I have been concerned with the use of time in education, training and other kinds of human capital. Here I attempt to develop a general treatment of the allocation of time in all other non-work activities. Although under my name alone, much of any credit it merits belongs to the stimulus received from Mincer, Owen, Dean and other past and present participants in the Labor Workshop at Columbia.⁴

The plan of the discussion is as follows. The first section sets out a basic theoretical analysis of choice that includes the cost of time on the same footing as the cost of market goods, while the remaining sections treat various empirical implications of the theory. These include a new approach to changes in hours of work and "leisure," the full integration of so-called "productive" consumption into economic analysis, a new analysis of the effect of income on the quantity and "quality" of commodities consumed, some suggestions on the measurement of productivity, an economic analysis of queues and a few others as well. Although I refer to relevant empirical

¹ See his "Market Prices, Opportunity Costs, and Income Effects," in *Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld* (Stanford University Press, 1963). In his well-known earlier study Mincer considered the allocation of married women between "housework" and labour force participation. (See his "Labor Force Participation of Married Women," in *Aspects of Labor Economics* (Princeton University Press, 1962).)

² See his *The Supply of Labor and the Demand for Recreation* (unpublished Ph.D. dissertation, Columbia University, 1964).

³ See his *Economic Analysis and African Response to Price* (unpublished Ph.D. dissertation, Columbia University, 1963).

⁴ Let me emphasise, however, that I alone am responsible for any errors.

I would also like to express my appreciation for the comments received when presenting these ideas to seminars at the Universities of California (Los Angeles), Chicago, Pittsburgh, Rochester and Yale, and to a session at the 1963 Meetings of the Econometric Society. Extremely helpful comments on an earlier draft were provided by Milton Friedman and by Gregory C. Chow; the latter also assisted in the mathematical formulation. Linda Kee provided useful research assistance. My research was partially supported by the IBM Corporation.

work that has come to my attention, little systematic testing of the theory has been attempted.

II. A REVISED THEORY OF CHOICE

According to traditional theory, households maximise utility functions of the form

$$U = U(y_1, y_2, \dots, y_n) \quad . \quad . \quad . \quad . \quad (1)$$

subject to the resource constraint

$$\sum p'_i y_i = I = W + V \quad . \quad . \quad . \quad . \quad (2)$$

where y_i are goods purchased on the market, p'_i are their prices, I is money income, W is earnings and V is other income. As the introduction suggests, the point of departure here is the systematic incorporation of non-working time. Households will be assumed to combine time and market goods to produce more basic commodities that directly enter their utility functions. One such commodity is the seeing of a play, which depends on the input of actors, script, theatre and the playgoer's time; another is sleeping, which depends on the input of a bed, house (pill?) and time. These commodities will be called Z_i and written as

$$Z_i = f_i(x_i, T_i) \quad . \quad . \quad . \quad . \quad (3)$$

where x_i is a vector of market goods and T_i a vector of time inputs used in producing the i th commodity.¹ Note that, when capital goods such as refrigerators or automobiles are used, x refers to the services yielded by the goods. Also note that T_i is a vector because, *e.g.*, the hours used during the day or on weekdays may be distinguished from those used at night or on week-ends. Each dimension of T_i refers to a different aspect of time. Generally, the partial derivatives of Z_i with respect to both x_i and T_i are non-negative.²

In this formulation households are both producing units and utility maximisers. They combine time and market goods via the "production functions" f_i to produce the basic commodities Z_i , and they choose the best combination of these commodities in the conventional way by maximising a utility function

$$U = U(Z_1, \dots, Z_m) \equiv U(f_1, \dots, f_m) \equiv U(x_1, \dots, x_m; T_1, \dots, T_m) \quad (4)$$

¹ There are several empirical as well as conceptual advantages in assuming that households combine goods and time to produce commodities instead of simply assuming that the amount of time used at an activity is a direct function of the amount of goods consumed. For example, a change in the cost of goods relative to time could cause a significant substitution away from the one rising in relative cost. This, as well as other applications, are treated in the following sections.

² If a good or time period was used in producing several commodities I assume that these "joint costs" could be fully and uniquely allocated among the commodities. The problems here are no different from those usually arising in the analysis of multi-product firms.

subject to a budget constraint

$$g(Z_i, \dots Z_m) = Z \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where g is an expenditure function of Z_i and Z is the bound on resources. The integration of production and consumption is at odds with the tendency for economists to separate them sharply, production occurring in firms and consumption in households. It should be pointed out, however, that in recent years economists increasingly recognise that a household is truly a "small factory":¹ it combines capital goods, raw materials and labour to clean, feed, procreate and otherwise produce useful commodities. Undoubtedly the fundamental reason for the traditional separation is that firms are usually given control over working time in exchange for market goods, while "discretionary" control over market goods and consumption time is retained by households as they create their own utility. If (presumably different) firms were also given control over market goods and consumption time in exchange for providing utility the separation would quickly fade away in analysis as well as in fact.

The basic goal of the analysis is to find measures of g and Z which facilitate the development of empirical implications. The most direct approach is to assume that the utility function in equation (4) is maximised subject to separate constraints on the expenditure of market goods and time, and to the production functions in equation (3). The goods constraint can be written as

$$\sum_1^m p_i x_i = I = V + T_w \bar{w} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where p_i is a vector giving the unit prices of x_i , T_w is a vector giving the hours spent at work and \bar{w} is a vector giving the earnings per unit of T_w . The time constraints can be written as

$$\sum_1^m T_i = T_c = T - T_w \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where T_c is a vector giving the total time spent at consumption and T is a vector giving the total time available. The production functions (3) can be written in the equivalent form

$$\left. \begin{aligned} T_i &\equiv t_i Z_i \\ x_i &\equiv b_i Z_i \end{aligned} \right\} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where t_i is a vector giving the input of time per unit of Z_i and b_i is a similar vector for market goods.

The problem would appear to be to maximise the utility function (4) subject to the multiple constraints (6) and (7) and to the production relations (8). There is, however, really only one basic constraint: (6) is not independent of (7) because time can be converted into goods by using less time

¹ See, e.g., A. K. Cairncross, "Economic Schizophrenia," *Scottish Journal of Political Economy* (February 1958).

at consumption and more at work. Thus, substituting for T_w in (6) its equivalent in (7) gives the single constraint ¹

$$\sum p_i x_i + \sum T_i \bar{w} = V + T\bar{w} \quad . \quad . \quad . \quad . \quad (9)$$

By using (8), (9) can be written as

$$\sum (p_i b_i + t_i \bar{w}) Z_i = V + T\bar{w} \quad . \quad . \quad . \quad . \quad (10)$$

with

$$\left. \begin{aligned} \pi_i &\equiv p_i b_i + t_i \bar{w} \\ S' &\equiv V + T\bar{w} \end{aligned} \right\} \quad . \quad . \quad . \quad . \quad (11)$$

The full price of a unit of Z_i (π_i) is the sum of the prices of the goods and of the time used per unit of Z_i . That is, the full price of consumption is the sum of direct and indirect prices in the same way that the full cost of investing in human capital is the sum of direct and indirect costs.² These direct and indirect prices are symmetrical determinants of total price, and there is no analytical reason to stress one rather than the other.

The resource constraint on the right side of equation (10), S' , is easy to interpret if \bar{w} were a constant, independent of the Z_i . For then S' gives the money income achieved if all the time available were devoted to work. This achievable income is "spent" on the commodities Z_i either directly through expenditures on goods, $\sum p_i b_i Z_i$, or indirectly through the forgoing of income, $\sum t_i \bar{w} Z_i$, i.e., by using time at consumption rather than at work. As long as \bar{w} were constant, and if there were constant returns in producing Z_i so that b_i and t_i were fixed for given p_i and \bar{w} the equilibrium condition resulting from maximising (4) subject to (10) takes a very simple form:

$$U_i = \frac{\partial U}{\partial Z_i} = \lambda \pi_i \quad i = 1, \dots, m \quad . \quad . \quad . \quad (12)$$

where λ is the marginal utility of money income. If \bar{w} were not constant the resource constraint in equation (10) would not have any particularly useful interpretation: $S' = V + T\bar{w}$ would overstate the money income achievable as long as marginal wage-rates were below average ones. Moreover, the equilibrium conditions would become more complicated than (12) because marginal would have to replace average prices.

The total resource constraint could be given the sensible interpretation of the maximum money income achievable only in the special and unlikely case when average earnings were constant. This suggests dropping the approach based on explicitly considering separate goods and time constraints and substituting one in which the total resource constraint necessarily equalled the maximum money income achievable, which will be simply called "full income."³ This income could in general be obtained by devoting all the

¹ The dependency among constraints distinguishes this problem from many other multiple-constraint situations in economic analysis, such as those arising in the usual theory of rationing (see J. Tobin, "A Survey of the Theory of Rationing," *Econometrica* (October, 1952)). Rationing would reduce to a formally identical single-constraint situation if rations were saleable and fully convertible into money income.

² See my *Human Capital*, *op. cit.*

³ This term emerged from a conversation with Milton Friedman.

time and other resources of a household to earning income, with no regard for consumption. Of course, all the time would not usually be spent "at" a job: sleep, food, even leisure are required for efficiency, and some time (and other resources) would have to be spent on these activities in order to maximise money income. The amount spent would, however, be determined solely by the effect on income and not by any effect on utility. Slaves, for example, might be permitted time "off" from work only in so far as that maximised their output, or free persons in poor environments might have to maximise money income simply to survive.¹

Households in richer countries do, however, forfeit money income in order to obtain additional utility, *i.e.*, they exchange money income for a greater amount of psychic income. For example, they might increase their leisure time, take a pleasant job in preference to a better-paying unpleasant one, employ unproductive nephews or eat more than is warranted by considerations of productivity. In these and other situations the amount of money income forfeited measures the cost of obtaining additional utility.

Thus the full income approach provides a meaningful resource constraint and one firmly based on the fact that goods and time can be combined into a single overall constraint because time can be converted into goods through money income. It also incorporates a unified treatment of all substitutions of non-pecuniary for pecuniary income, regardless of their nature or whether they occur on the job or in the household. The advantages of this will become clear as the analysis proceeds.

If full income is denoted by S , and if the total earnings forgone or "lost" by the interest in utility is denoted by L , the identity relating L to S and I is simply

$$L(Z_1, \dots, Z_m) \equiv S - I(Z_1, \dots, Z_m) \quad . \quad . \quad . \quad (13)$$

I and L are functions of the Z_i because how much is earned or forgone depends on the consumption set chosen; for example, up to a point, the less leisure chosen the larger the money income and the smaller the amount forgone.² Using equations (6) and (8), equation (13) can be written as

$$\sum p_i b_i Z_i + L(Z_1, \dots, Z_m) \equiv S \quad . \quad . \quad . \quad (14)$$

¹ Any utility received would only be an incidental by-product of the pursuit of money income. Perhaps this explains why utility analysis was not clearly formulated and accepted until economic development had raised incomes well above the subsistence level.

² Full income is achieved by maximising the earnings function

$$W = W(Z_1, \dots, Z_m) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1')$$

subject to the expenditure constraint in equation (6), to the inequality

$$\sum_1^m T_1 \leq T \quad . \quad . \quad . \quad . \quad . \quad . \quad (2')$$

and to the restrictions in (8). I assume for simplicity that the amount of each dimension of time used in producing commodities is less than the total available, so that (2') can be ignored; it is not

This basic resource constraint states that full income is spent either directly on market goods or indirectly through the forgoing of money income. Unfortunately, there is no simple expression for the average price of Z_i as there is in equation (10). However, marginal, not average, prices are relevant for behaviour, and these would be identical for the constraint in (10) only when average earnings, \bar{w} , was constant. But, if so, the expression for the loss function simplifies to

$$L = \bar{w}T_c = \bar{w}\sum t_i Z_i \quad . \quad . \quad . \quad . \quad . \quad (15)$$

and (14) reduces to (10). Moreover, even in the general case the total marginal prices resulting from (14) can always be divided into direct and indirect components: the equilibrium conditions resulting from maximising the utility function subject to (14)¹ are

$$U_i = T(p_i b_i + L_i), \quad i = 1, \dots, m \quad . \quad . \quad . \quad (16)$$

where $p_i b_i$ is the direct and L_i the indirect component of the total marginal price $p_i b_i + L_i$.²

Behind the division into direct and indirect costs is the allocation of time and goods between work-orientated and consumption-orientated activities. This suggests an alternative division of costs; namely, into those resulting from the allocation of goods and those resulting from the allocation of time. Write $L_i = \partial L / \partial Z_i$ as

$$L_i = \frac{\partial L}{\partial T_i} \frac{\partial T_i}{\partial Z_i} + \frac{\partial L}{\partial x_i} \frac{\partial x_i}{\partial Z_i} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

$$= l_i t_i + c_i b_i \quad . \quad . \quad . \quad . \quad . \quad (18)$$

where $l_i = \frac{\partial L}{\partial T_i}$ and $c_i = \frac{\partial L}{\partial x_i}$ are the marginal forgone earnings of using more time and goods respectively on Z_i . Equation (16) can then be written as

$$U_i = T[b_i(p_i + c_i) + t_i l_i] \quad . \quad . \quad . \quad . \quad (19)$$

The total marginal cost of Z_i is the sum of $b_i(p_i + c_i)$, the marginal cost of using goods in producing Z_i , and $t_i l_i$, the marginal cost of using time. This division would be equivalent to that between direct and indirect costs only if $c_i = 0$ or if there were no indirect costs of using goods.

difficult to incorporate this constraint. Maximising (1') subject to (6) and (8) yields the following conditions

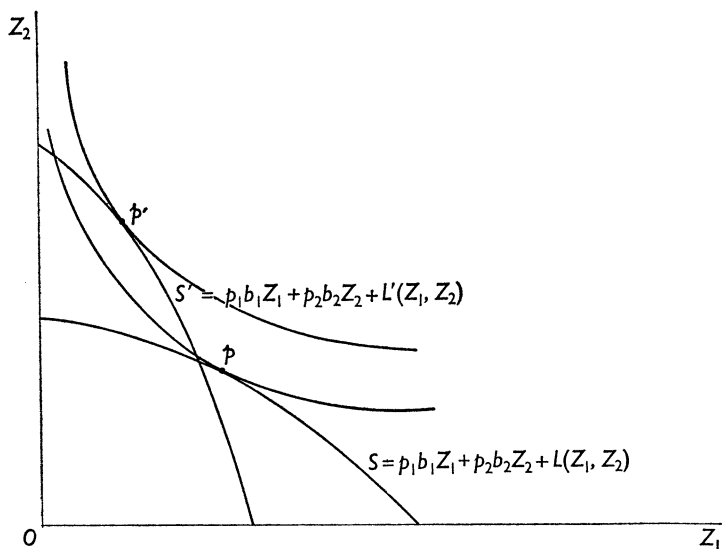
$$\frac{\partial W}{\partial Z_i} = \frac{p_i b_i \sigma}{1 + \sigma} \quad . \quad . \quad . \quad . \quad . \quad (3')$$

where σ is the marginal productivity of money income. Since the loss function $L = (S - V) - W$, the equilibrium conditions to minimise the loss is the same as (3') except for a change in sign.

¹ Households maximise their utility subject only to the single total resource constraint given by (14), for once the full income constraint is satisfied, there is no other restriction on the set of Z_i that can be chosen. By introducing the concept of full income the problem of maximising utility subject to the time and goods constraints is solved in two stages: first, full income is determined from the goods and time constraints, and then utility is maximised subject only to the constraint imposed by full income.

² It can easily be shown that the equilibrium conditions of (16) are in fact precisely the same as those following in general from equation (10).

The accompanying figure shows the equilibrium given by equation (16) for a two-commodity world. In equilibrium the slope of the full income



opportunity curve, which equals the ratio of marginal prices, would equal the slope of an indifference curve, which equals the ratio of marginal utilities. Equilibrium occurs at p and p' for the opportunity curves S and S' respectively.

The rest of the paper is concerned with developing numerous empirical implications of this theory, starting with determinants of hours worked and concluding with an economic interpretation of various queueing systems. To simplify the presentation, it is assumed that the distinction between direct and indirect costs is equivalent to that between goods and time costs; in other words, the marginal forgone cost of the use of goods, c_t , is set equal to zero. The discussion would not be much changed, but would be more cumbersome were this not assumed.¹ Finally, until Section IV goods and time are assumed to be used in fixed proportions in producing commodities; that is, the coefficients b_t and t_t in equation (8) are treated as constants.

III. APPLICATIONS

(a) *Hours of Work*

If the effects of various changes on the time used on consumption, T_c , could be determined their effects on hours worked, T_w , could be found residually from equation (7). This section considers, among other things, the effects of changes in income, earnings and market prices on T_c , and thus on T_w ,

¹ Elsewhere I have discussed some effects of the allocation of goods on productivity (see my "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy*, special supplement (October 1962), Section 2); essentially the same discussion can be found in *Human Capital*, *op. cit.*, Chapter II.

using as the major tool of analysis differences among commodities in the importance of forgone earnings.

The relative marginal importance of forgone earnings is defined as

$$\alpha_i = \frac{l_i t_i}{p_i b_i + l_i t_i} \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

The importance of forgone earnings would be greater the larger l_i and t_i , the forgone earnings per hour of time and the number of hours used per unit of Z_i respectively, while it would be smaller the larger p_i and b_i , the market price of goods and the number of goods used per unit of Z_i respectively. Similarly, the relative marginal importance of time is defined as

$$\gamma_i = \frac{t_i}{p_i b_i + l_i t_i} \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

If full income increased solely because of an increase in V (other money income) there would simply be a parallel shift of the opportunity curve to the right with no change in relative commodity prices. The consumption of most commodities would have to increase; if all did, hours worked would decrease, for the total time spent on consumption must increase if the output of all commodities did, and by equation (7) the time spent at work is inversely related to that spent on consumption. Hours worked could increase only if relatively time intensive commodities, those with large γ , were sufficiently inferior.¹

A uniform percentage increase in earnings for all allocations of time would increase the cost per hour used in consumption by the same percentage for all commodities.² The relative prices of different commodities would, however, change as long as forgone earnings were not equally important for all; in particular, the prices of commodities having relatively important forgone earnings would rise more. Now the fundamental theorem of

¹ The problem is: under what conditions would

$$\frac{-\partial T_w}{\partial V} = \frac{\partial T_c}{\partial V} = \sum t_i \frac{\partial Z_i}{\partial V} < 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1')$$

when

$$\sum (p_i b_i + l_i t_i) \frac{\partial Z_i}{\partial V} = 1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2')$$

If the analysis were limited to a two-commodity world where Z_1 was more time intensive, then it can easily be shown that (1') would hold if, and only if,

$$\frac{\partial Z_1}{\partial V} < \frac{-\gamma_2}{(\gamma_1 - \gamma_2)(p_1 b_1 + l_1 t_1)} < 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3')$$

² By a uniform change of β is meant

$$W_1 = (1 + \beta) W_0(Z_1, \dots, Z_n)$$

where W_0 represents the earnings function before the change and W_1 represents it afterwards. Since the loss function is defined as

$$\begin{aligned} L &= S - W - V \\ &= W(\hat{Z}) - W(Z), \end{aligned}$$

then

$$\begin{aligned} L_1 &= W_1(\hat{Z}) - W_1(Z) \\ &= (1 + \beta) [W_0(\hat{Z}) - W_0(Z)] = (1 + \beta) L_0 \end{aligned}$$

Consequently, all opportunities costs also change by β .

demand theory states that a compensated change in relative prices would induce households to consume less of commodities rising in price. The figure shows the effect of a rise in earnings fully compensated by a decline in other income: the opportunity curve would be rotated clockwise through the initial position p if Z_1 were the more earnings-intensive commodity. In the figure the new equilibrium p' must be to the left and above p , or less Z_1 and more Z_2 would be consumed.

Therefore a compensated uniform rise in earnings would lead to a shift away from earnings-intensive commodities and towards goods-intensive ones. Since earnings and time intensiveness tend to be positively correlated,¹ consumption would be shifted from time-intensive commodities. A shift away from such commodities would, however, result in a reduction in the total time spent in consumption, and thus an increase in the time spent at work.²

The effect of an uncompensated increase in earnings on hours worked would depend on the relative strength of the substitution and income effects. The former would increase hours, the latter reduce them; which dominates cannot be determined *a priori*.

The conclusion that a pure rise in earnings increases and a pure rise in income reduces hours of work must sound very familiar, for they are traditional results of the well-known labour-leisure analysis. What, then, is the relation between our analysis, which treats all commodities symmetrically and stresses only their differences in relative time and earning intensities, and the usual analysis, which distinguishes a commodity having special properties called "leisure" from other more commonplace commodities? It is easily shown that the usual labour-leisure analysis can be looked upon as a special case of ours in which the cost of the commodity called leisure consists entirely of forgone earnings and the cost of other commodities entirely of goods.³

¹ According to the definitions of earning and time intensity in equations (20) and (21), they would be positively correlated unless l_i and t_i were sufficiently negatively correlated. See the further discussion later on.

² Let it be stressed that this conclusion usually holds, even when households are irrational; sophisticated calculations about the value of time at work or in consumption, or substantial knowledge about the amount of time used by different commodities is not required. Changes in the hours of work, even of non-maximising, impulsive, habitual, etc., households would tend to be positively related to compensated changes in earnings because demand curves tend to be negatively inclined even for such households (see G. S. Becker, "Irrational Behavior and Economic Theory," *Journal of Political Economy* (February 1962)).

³ Suppose there were two commodities Z_1 and Z_2 , where the cost of Z_1 depended only on the cost of market goods, while the cost of Z_2 depended only on the cost of time. The goods-budget constraint would then simply be

$$p_1 b_1 Z_1 = I = V + T_w w$$

and the constraint on time would be

$$t_2 Z_2 = T - T_w$$

This is essentially the algebra of the analysis presented by Henderson and Quandt, and their treatment is representative. They call Z_2 "leisure," and Z_1 an average of different commodities. Their

As a description of reality such an approach, of course, is not tenable, since virtually all activities use both time and goods. Perhaps it would be defended either as an analytically necessary or extremely insightful approximation to reality. Yet the usual substitution and income effects of a change in resources on hours worked have easily been derived from a more general analysis which stresses only that the relative importance of time varies among commodities. The rest of the paper tries to go further and demonstrate that the traditional approach, with its stress on the demand for "leisure," apparently has seriously impeded the development of insights about the economy, since the more direct and general approach presented here naturally leads to a variety of implications never yet obtained.

The two determinants of the importance of forgone earnings are the amount of time used per dollar of goods and the cost per unit of time. Reading a book, taking a haircut or commuting use more time per dollar of goods than eating dinner, frequenting a night-club or sending children to private summer camps. Other things the same, forgone earnings would be more important for the former set of commodities than the latter.

The importance of forgone earnings would be determined solely by time intensity only if the cost of time was the same for all commodities. Presumably, however, it varies considerably among commodities and at different periods. For example, the cost of time is often less on week-ends and in the evenings because many firms are closed then,¹ which explains why a famous liner intentionally includes a week-end in each voyage between the United States and Europe.² The cost of time would also tend to be less for commodities that contribute to productive effort, traditionally called "productive consumption." A considerable amount of sleep, food and even "play" fall under this heading. The opportunity cost of the time is less because these commodities indirectly contribute to earnings. Productive consumption has had a long but bandit-like existence in economic thought; our analysis does systematically incorporate it into household decision-making.

Although the formal specification of leisure in economic models has ignored expenditures on goods, cannot one argue that a more correct specification would simply associate leisure with relatively important forgone earnings? Most conceptions of leisure do imply that it is time intensive and does not indirectly contribute to earnings,³ two of the important

equilibrium condition that the rate of substitution between goods and leisure equals the real wage-rate is just a special case of our equation (19) (see *Microeconomic Theory* (McGraw-Hill, 1958), p. 23).

¹ For workers receiving premium pay on the week-ends and in the evenings, however, the cost of time may be considerably greater then.

² See the advertisement by United States Lines in various issues of the *New Yorker* magazine: "The S.S. *United States* regularly includes a week-end in its 5 days to Europe, saving [economic] time for businessmen" (my insertion).

³ For example, *Webster's Collegiate Dictionary* defines leisurely as "characterized by leisure, taking abundant time" (my italics); or S. de Grazia, in his recent *Of Time, Work and Leisure*, says, "Leisure is a state of being in which activity is performed for its own sake or as its own end" (New York: The Twentieth Century Fund, 1962, p. 15).

characteristics of earnings-intensive commodities. On the other hand, not all of what are usually considered leisure activities do have relatively important forgone earnings: night-clubbing is generally considered leisure, and yet, at least in its more expensive forms, has a large expenditure component. Conversely, some activities have relatively large forgone earnings and are not considered leisure: haircuts or child care are examples. Consequently, the distinction between earnings-intensive and other commodities corresponds only partly to the usual distinction between leisure and other commodities. Since it has been shown that the relative importance of forgone earnings rather than any concept of leisure is more relevant for economic analysis, less attention should be paid to the latter. Indeed, although the social philosopher might have to define precisely the concept of leisure,¹ the economist can reach all his traditional results as well as many more without introducing it at all!

Not only is it difficult to distinguish leisure from other non-work² but also even work from non-work. Is commuting work, non-work or both? How about a business lunch, a good diet or relaxation? Indeed, the notion of productive consumption was introduced precisely to cover those commodities that contribute to work as well as to consumption. Cannot pure work then be considered simply as a limiting commodity of such joint commodities in which the contribution to consumption was nil? Similarly, pure consumption would be a limiting commodity in the opposite direction in which the contribution to work was nil, and intermediate commodities would contribute to both consumption and work. The more important the contribution to work relative to consumption, the smaller would tend to be the relative importance of forgone earnings. Consequently, the effects of changes in earnings, other income, etc., on hours worked then become assimilated to and essentially a special case of their effects on the consumption of less earnings-intensive commodities. For example, a pure rise in earnings would reduce the relative price, and thus increase the time spent on these commodities, *including the time spent at work*; similarly, for changes in income and other variables. The generalisation wrought by our approach is even greater than may have appeared at first.

Before concluding this section a few other relevant implications of our

¹ S. de Grazia has recently entertainingly shown the many difficulties in even reaching a reliable definition, and *a fortiori*, in quantitatively estimating the amount of leisure. See *ibid.*, Chapters III and IV; also see W. Moore, *Man, Time and Society* (New York: Wiley, 1963), Chapter II; J. N. Morgan, M. H. David, W. J. Cohen and H. E. Brazer, *Income and Welfare in the United States* (New York: McGraw-Hill, 1962), p. 322, and Owen, *op. cit.*, Chapter II.

² Sometimes true leisure is defined as the amount of discretionary time available (see Moore, *op. cit.*, p. 18). It is always difficult to attach a rigorous meaning to the word "discretionary" when referring to economic resources. One might say that in the short run consumption time is and working time is not discretionary, because the latter is partially subject to the authoritarian control of employers. (Even this distinction would vanish if households gave certain firms authoritarian control over their consumption time; see the discussion in Section II.) In the long run this definition of discretionary time is suspect too because the availability of alternative sources of employment would make working time also discretionary.

theory might be briefly mentioned. Just as a (compensated) rise in earnings would increase the prices of commodities with relatively large forgone earnings, induce a substitution away from them and increase the hours worked, so a (compensated) fall in market prices would also induce a substitution away from them and increase the hours worked: the effects of changes in direct and indirect costs are symmetrical. Indeed, Owen presents some evidence indicating that hours of work in the United States fell somewhat more in the first thirty years of this century than in the second thirty years, not because wages rose more during the first period, but because the market prices of recreation commodities fell more then.¹

A well-known result of the traditional labour-leisure approach is that a rise in the income tax induces at least a substitution effect away from work and towards "leisure." Our approach reaches the same result only via a substitution towards time-intensive consumption rather than leisure. A simple additional implication of our approach, however, is that if a rise in the income tax were combined with an appropriate excise on the goods used in time-intensive commodities or subsidy to the goods used in other commodities there need be no change in full relative prices, and thus no substitution away from work. The traditional approach has recently reached the same conclusion, although in a much more involved way.²

There is no exception in the traditional approach to the rule that a pure rise in earnings would not induce a decrease in hours worked. An exception does occur in ours, for if the time and earnings intensities (*i.e.*, $l_i t_i$ and t_i) were negatively correlated a pure rise in earnings would induce a substitution towards time-intensive commodities, and thus away from work.³ Although this exception does illustrate the greater power of our approach, there is no reason to believe that it is any more important empirically than the exception to the rule on income effects.

(b) *The Productivity of Time*

Most of the large secular increase in earnings, which stimulated the development of the labour-leisure analysis, resulted from an increase in the productivity of working time due to the growth in human and physical capital, technological progress and other factors. Since a rise in earnings resulting from an increase in productivity has both income and substitution

¹ See *op. cit.*, Chapter VIII. Recreation commodities presumably have relatively large forgone earnings.

² See W. J. Corbett and D. C. Hague, "Complementarity and the Excess Burden of Taxation," *Review of Economic Studies*, Vol. XXI (1953-54); also A. C. Harberger, "Taxation, Resource Allocation and Welfare," in the *Role of Direct and Indirect Taxes in the Federal Revenue System* (Princeton University Press, 1964).

³ The effect on earnings is more difficult to determine because, by assumption, time intensive commodities have smaller costs per unit time than other commodities. A shift towards the former would, therefore, raise hourly earnings, which would partially and perhaps more than entirely offset the reduction in hours worked. Incidentally, this illustrates how the productivity of hours worked is influenced by the consumption set chosen.

effects, the secular decline in hours worked appeared to be evidence that the income effect was sufficiently strong to swamp the substitution effect.

The secular growth in capital and technology also improved the productivity of consumption time: supermarkets, automobiles, sleeping pills, safety and electric razors, and telephones are a few familiar and important examples of such developments. An improvement in the productivity of consumption time would change relative commodity prices and increase full income, which in turn would produce substitution and income effects. The interesting point is that a very different interpretation of the observed decline in hours of work is suggested because these effects are precisely the opposite of those produced by improvements in the productivity of working time.

Assume a uniform increase only in the productivity of consumption time, which is taken to mean a decline in all t_i , time required to produce a unit of Z_i , by a common percentage. The relative prices of commodities with large forgone earnings would fall, and substitution would be induced towards these and away from other commodities, causing hours of work also to fall. Since the increase in productivity would also produce an income effect,¹ the demand for commodities would increase, which, in turn, would induce an increased demand for goods. But since the productivity of working time is assumed not to change, more goods could be obtained only by an increase in work. That is, the higher real income resulting from an advance in the productivity of consumption time would cause hours of work to *increase*.

Consequently, an emphasis on the secular increase in the productivity of consumption time would lead to a very different interpretation of the secular decline in hours worked. Instead of claiming that a powerful income effect swamped a weaker substitution effect, the claim would have to be that a powerful substitution effect swamped a weaker income effect.

Of course, the productivity of both working and consumption time increased secularly, and the true interpretation is somewhere between these extremes. If both increased at the same rate there would be no change in relative prices, and thus no substitution effect, because the rise in l_i induced by one would exactly offset the decline in t_i induced by the other, marginal forgone earnings (it_i) remaining unchanged. Although the income effects would tend to offset each other too, they would do so completely only if the income elasticity of demand for time-intensive commodities was equal to unity. Hours worked would decline if it was above and increase if it was below unity.² Since these commodities have probably on

¹ Full money income would be unaffected if it were achieved by using all time at pure work activities. If other uses of time were also required it would tend to increase. Even if full money income were unaffected, however, full real income would increase because prices of the Z_i would fall.

² So the "Knight" view that an increase in income would increase "leisure" is not necessarily true, even if leisure were a superior good and even aside from Robbins' emphasis on the substitution effect (see L. Robbins, "On the Elasticity of Demand for Income in Terms of Effort," *Economica* (June 1930)).

the whole been luxuries, such an increase in income would tend to reduce hours worked.

The productivity of working time has probably advanced more than that of consumption time, if only because of familiar reasons associated with the division of labour and economies of scale.¹ Consequently, there probably has been the traditional substitution effect towards and income effect away from work, as well as an income effect away from work because time-intensive commodities were luxuries. The secular decline in hours worked would only imply therefore that the combined income effects swamped the substitution effect, not that the income effect of an advance in the productivity of working time alone swamped its substitution effect.

Cross-sectionally, the hours worked of males have generally declined less as incomes increased than they have over time. Some of the difference between these relations is explained by the distinction between relevant and reported incomes, or by interdependencies among the hours worked by different employees;² some is probably also explained by the distinction between working and consumption productivity. There is a presumption that persons distinguished cross-sectionally by money incomes or earnings differ more in working than consumption productivity because they are essentially distinguished by the former. This argument does not apply to time series because persons are distinguished there by calendar time, which in principle is neutral between these productivities. Consequently, the traditional substitution effect towards work is apt to be greater cross-sectionally, which would help to explain why the relation between the income and hours worked of men is less negatively sloped there, and be additional evidence that the substitution effect for men is not weak.³

Productivity in the service sector in the United States appears to have advanced more slowly, at least since 1929, than productivity in the goods sector.⁴ Service industries like retailing, transportation, education and health, use a good deal of the time of households that never enter into input, output and price series, or therefore into measures of productivity. Incorporation of such time into the series and consideration of changes in its productivity would contribute, I believe, to an understanding of the apparent differences in productivity advance between these sectors.

An excellent example can be found in a recent study of productivity

¹ Wesley Mitchell's justly famous essay "The Backward Art of Spending Money" spells out some of these reasons (see the first essay in the collection, *The Backward Art of Spending Money and Other Essays* (New York: McGraw-Hill, 1932)).

² A. Finnegan does find steeper cross-sectional relations when the average incomes and hours of different occupations are used (see his "A Cross-Sectional Analysis of Hours of Work," *Journal of Political Economy* (October, 1962)).

³ Note that Mincer has found a very strong substitution effect for women (see his "Labor Force Participation of Married Women," *op. cit.*).

⁴ See the essay by Victor Fuchs, "Productivity Trends in the Goods and Service Sectors, 1929-61: A Preliminary Survey," N.B.E.R. Occasional Paper, October 1964.

trends in the barbering industry in the United States.¹ Conventional productivity measures show relatively little advance in barbers' shops since 1929, yet a revolution has occurred in the activities performed by these shops. In the 1920s shaves still accounted for an important part of their sales, but declined to a negligible part by the 1950s because of the spread of home safety and electric razors. Instead of travelling to a shop, waiting in line, receiving a shave and continuing to another destination, men now shave themselves at home, saving travelling, waiting and even some shaving time. This considerable advance in the productivity of shaving nowhere enters measures for barbers' shops. If, however, a productivity measure for general barbering activities, including shaving, was constructed, I suspect that it would show an advance since 1929 comparable to most goods.²

(c) *Income Elasticities*

Income elasticities of demand are often estimated cross-sectionally from the behaviour of families or other units with different incomes. When these units buy in the same market-place it is natural to assume that they face the same prices of goods. If, however, incomes differ because earnings do, and cross-sectional income differences are usually dominated by earnings differences, commodities prices would differ systematically. All commodities prices would be higher to higher-income units because their forgone earnings would be higher (which means, incidentally, that differences in real income would be less than those in money income), and the prices of earnings-intensive commodities would be unusually so.

Cross-sectional relations between consumption and income would not therefore measure the effect of income alone, because they would be affected by differences in relative prices as well as in incomes.³ The effect of income would be underestimated for earnings-intensive and overestimated for other commodities, because the higher relative prices of the former would cause a substitution away from them and towards the latter. Accordingly, the income elasticities of demand for "leisure," unproductive and time-intensive commodities would be under-stated, and for "work," productive and other goods-intensive commodities over-stated by cross-sectional estimates. Low apparent income elasticities of earnings-intensive commodities and high apparent elasticities of other commodities may simply be illusions resulting from substitution effects.⁴

¹ See J. Wilburn, "Productivity Trends in Barber and Beauty Shops," mimeographed report, N.B.E.R., September 1964.

² The movement of shaving from barbers' shops to households illustrates how and why even in urban areas households have become "small factories." Under the impetus of a general growth in the value of time they have been encouraged to find ways of saving on travelling and waiting time by performing more activities themselves.

³ More appropriate income elasticities for several commodities are estimated in Mincer, "Market Prices . . .," *op. cit.*

⁴ In this connection note that cross-sectional data are often preferred to time-series data in estimating income elasticities precisely because they are supposed to be largely free of co-linearity

Moreover, according to our theory demand depends also on the importance of earnings as a source of income. For if total income were held constant an increase in earnings would create only substitution effects: away from earnings-intensive and towards goods-intensive commodities. So one unusual implication of the analysis that can and should be tested with available budget data is that the source of income may have a significant effect on consumption patterns. An important special case is found in comparisons of the consumption of employed and unemployed workers. Unemployed workers not only have lower incomes but also lower forgone costs, and thus lower relative prices of time and other earnings-intensive commodities. The propensity of unemployed workers to go fishing, watch television, attend school and so on are simply vivid illustrations of the incentives they have to substitute such commodities for others.

One interesting application of the analysis is to the relation between family size and income.¹ The traditional view, based usually on simple correlations, has been that an increase in income leads to a reduction in the number of children per family. If, however, birth-control knowledge and other variables were held constant economic theory suggests a positive relation between family size and income, and therefore that the traditional negative correlation resulted from positive correlations between income, knowledge and some other variables. The data I put together supported this interpretation, as did those found in several subsequent studies.²

Although positive, the elasticity of family size with respect to income is apparently quite low, even when birth-control knowledge is held constant. Some persons have interpreted this (and other evidence) to indicate that family-size formation cannot usefully be fitted into traditional economic analysis.³ It was pointed out, however, that the small elasticity found for children is not so inconsistent with what is found for goods as soon as quantity and quality income elasticities are distinguished.⁴ Increased expenditures on many goods largely take the form of increased quality—expenditure per pound, per car, etc.—and the increase in quantity is modest. Similarly, increased expenditures on children largely take the form of increased expenditures per child, while the increase in number of children is very modest.

between prices and incomes (see, e.g., J. Tobin, "A Statistical Demand Function for Food in the U.S.A.," *Journal of the Royal Statistical Society*, Series A (1950)).

¹ Biases in cross-sectional estimates of the demand for work and leisure were considered in the last section.

² See G. S. Becker, "An Economic Analysis of Fertility," *Demographic and Economic Change in Developed Countries* (N.B.E.R. Conference Volume, 1960); R. A. Easterlin, "The American Baby Boom in Historical Perspective," *American Economic Review* (December 1961); I. Adelman, "An Econometric Analysis of Population Growth," *American Economic Review* (June 1963); R. Weintraub, "The Birth Rate and Economic Development: An Empirical Study," *Econometrica* (October 1962); Morris Silver, *Birth Rates, Marriages, and Business Cycles* (unpublished Ph.D. dissertation, Columbia University, 1964); and several other studies; for an apparent exception, see the note by D. Freedman, "The Relation of Economic Status to Fertility," *American Economic Review* (June 1963).

³ See, for example, Duesenberry's comment on Becker, *op. cit.*

⁴ See Becker, *op. cit.*

Nevertheless, the elasticity of demand for number of children does seem somewhat smaller than the quantity elasticities found for many goods. Perhaps the explanation is simply the shape of indifference curves; one other factor that may be more important, however, is the increase in forgone costs with income.¹ Child care would seem to be a time-intensive activity that is not "productive" (in terms of earnings) and uses many hours that could be used at work. Consequently, it would be an earnings-intensive activity, and our analysis predicts that its relative price would be higher to higher-income families.² There is already some evidence suggesting that the positive relation between forgone costs and income explains why the apparent quantity income elasticity of demand for children is relatively small. Mincer found that cross-sectional differences in the forgone price of children have an important effect on the number of children.³

(d) *Transportation*

Transportation is one of the few activities where the cost of time has been explicitly incorporated into economic discussions. In most benefit-cost evaluations of new transportation networks the value of the savings in transportation time has tended to overshadow other benefits.⁴ The importance of the value placed on time has encouraged experiment with different methods of determination: from the simple view that the value of an hour equals average hourly earnings to sophisticated considerations of the distinction between standard and overtime hours, the internal and external margins, etc.

The transport field offers considerable opportunity to estimate the marginal productivity or value of time from actual behaviour. One could, for example, relate the ratio of the number of persons travelling by aeroplane to those travelling by slower mediums to the distance travelled (and, of course, also to market prices and incomes). Since relatively more people use faster mediums for longer distances, presumably largely because of the greater importance of the saving in time, one should be able to estimate a marginal value of time from the relation between medium and distance travelled.⁵

¹ In *Ibid.*, p. 214 fn. 8, the relation between forgone costs and income was mentioned but not elaborated.

² Other arguments suggesting that higher-income families face a higher price of children have generally confused price with quality (see *ibid.*, pp. 214-15).

³ See Mincer, "Market Prices . . .," *op. cit.* He measures the price of children by the wife's potential wage-rate, and fits regressions to various cross-sectional data, where number of children is the dependent variable, and family income and the wife's potential wage-rate are among the independent variables.

⁴ See, for example, H. Mohring, "Land Values and the Measurement of Highway Benefits," *Journal of Political Economy* (June 1961).

⁵ The only quantitative estimate of the marginal value of time that I am familiar with uses the relation between the value of land and its commuting distance from employment (see *ibid.*). With many assumptions I have estimated the marginal value of time of those commuting at about 40% of their average hourly earnings. It is not clear whether this value is so low because of errors in these assumptions or because of severe kinks in the supply and demand functions for hours of work.

Another transportation problem extensively studied is the length and mode of commuting to work.¹ It is usually assumed that direct commuting costs, such as train fare, vary positively and that living costs, such as space, vary negatively with the distance commuted. These assumptions alone would imply that a rise in incomes would result in longer commutes as long as space ("housing") were a superior good.²

A rise in income resulting at least in part from a rise in earnings would, however, increase the cost of commuting a given distance because the forgone value of the time involved would increase. This increase in commuting costs would discourage commuting in the same way that the increased demand for space would encourage it. The outcome depends on the relative strengths of these conflicting forces: one can show with a few assumptions that the distance commuted would increase as income increased if, and only if, space had an income elasticity greater than unity.

For let Z_1 refer to the commuting commodity, Z_2 to other commodities, and let

$$Z_1 = f_1(x, t) \quad . \quad . \quad . \quad . \quad . \quad (22)$$

where t is the time spent commuting and x is the quantity of space used. Commuting costs are assumed to have the simple form $a + l_1 t$, where a is a constant and l_1 is the marginal forgone cost per hour spent commuting. In other words, the cost of time is the only variable commuting cost. The cost per unit of space is $p(t)$, where by assumption $p' < 0$. The problem is to maximise the utility function

$$U = U(x, t, Z_2) \quad . \quad . \quad . \quad . \quad . \quad (23)$$

subject to the resource constraint

$$a + l_1 t + px + h(Z_2) = S \quad . \quad . \quad . \quad . \quad . \quad (24)$$

If it were assumed that $U_t = 0$ —commuting was neither enjoyable nor irksome—the main equilibrium condition would reduce to

$$l_1 + p'x = 0^3 \quad . \quad . \quad . \quad . \quad . \quad (25)$$

which would be the equilibrium condition if households simply attempt to minimise the sum of transportation and space costs.⁴ If $l_1 = kS$, where k

¹ See L. N. Moses and H. F. Williamson, "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation," *Journal of Political Economy* (June 1963), R. Muth, "Economic Change and Rural-Urban Conversion," *Econometrica* (January 1961), and J. F. Kain, *Commuting and the Residential Decisions of Chicago and Detroit Central Business District Workers* (April 1963).

² See Muth, *op. cit.*

³ If $U_t \neq 0$, the main equilibrium condition would be

$$\frac{U_t}{U_x} = \frac{l_1 + p'x}{p}$$

Probably the most plausible assumption is that $U_t < 0$, which would imply that $l_1 + p'x < 0$.

⁴ See Kain, *op. cit.*, pp. 6-12.

is a constant, the effect of a change in full income on the time spent commuting can be found by differentiating equation (25) to be

$$\frac{\partial t}{\partial S} = \frac{k(\epsilon_x - 1)}{p''x} \quad . \quad . \quad . \quad . \quad . \quad (26)$$

where ϵ_x is the income elasticity of demand for space. Since stability requires that $p'' > 0$, an increase in income increases the time spent commuting if, and only if, $\epsilon_x > 1$.

In metropolitan areas of the United States higher-income families tend to live further from the central city,¹ which contradicts our analysis if one accepts the traditional view that the income elasticity of demand for housing is less than unity. In a definitive study of the demand for housing in the United States, however, Margaret Reid found income elasticities greater than unity.² Moreover, the analysis of distance commuted incorporates only a few dimensions of the demand for housing; principally the demand for outdoor space. The evidence on distances commuted would then only imply that outdoor space is a "luxury," which is rather plausible³ and not even inconsistent with the traditional view about the total elasticity of demand for housing.

(e) *The Division of Labour Within Families*

Space is too limited to do more than summarise the main implications of the theory concerning the division of labour among members of the same household. Instead of simply allocating time efficiently among commodities, multi-person households also allocate the time of different members. Members who are relatively more efficient at market activities would use less of their time at consumption activities than would other members. Moreover, an increase in the relative market efficiency of any member would effect a reallocation of the time of all other members towards consumption activities in order to permit the former to spend more time at market activities. In short, the allocation of the time of any member is greatly influenced by the opportunities open to other members.

IV. SUBSTITUTION BETWEEN TIME AND GOODS

Although time and goods have been assumed to be used in fixed proportions in producing commodities, substitution could take place because different commodities used them in different proportions. The assumption of fixed proportions is now dropped in order to include many additional implications of the theory.

It is well known from the theory of variable proportions that households

¹ For a discussion, including many qualifications, of this proposition see L. F. Schnore, "The Socio-Economic Status of Cities and Suburbs," *American Sociological Review* (February 1963).

² See her *Housing and Income* (University of Chicago Press, 1962), p. 6 and *passim*.

³ According to Reid, the elasticity of demand for indoor space is less than unity (*ibid.*, Chapter 12). If her total elasticity is accepted this suggests that outdoor space has an elasticity exceeding unity.

would minimise costs by setting the ratio of the marginal product of goods to that of time equal to the ratio of their marginal costs.¹ A rise in the cost of time relative to goods would induce a reduction in the amount of time and an increase in the amount of goods used per unit of each commodity. Thus, not only would a rise in earnings induce a substitution away from earnings-intensive commodities but also a substitution away from time and towards goods in the production of each commodity. Only the first is (implicitly) recognised in the labour-leisure analysis, although the second may well be of considerable importance. It increases one's confidence that the substitution effect of a rise in earnings is more important than is commonly believed.

The change in the input coefficients of time and goods resulting from a change in their relative costs is defined by the elasticity of substitution between them, which presumably varies from commodity to commodity. The only empirical study of this elasticity assumes that recreation goods and "leisure" time are used to produce a recreation commodity.² Definite evidence of substitution is found, since the ratio of leisure time to recreation goods is negatively related to the ratio of their prices. The elasticity of substitution appears to be less than unity, however, since the share of leisure in total factor costs is apparently positively related to its relative price.

The incentive to economise on time as its relative cost increases goes a long way towards explaining certain broad aspects of behaviour that have puzzled and often disturbed observers of contemporary life. Since hours worked have declined secularly in most advanced countries, and so-called "leisure" has presumably increased, a natural expectation has been that "free" time would become more abundant, and be used more "leisurely" and "luxuriously." Yet, if anything, time is used more carefully to-day than a century ago.³ If there was a secular increase in the productivity of working time relative to consumption time (see Section III (b)) there would be an increasing incentive to economise on the latter because of its greater expense (our theory emphatically cautions against calling such time "free"). Not surprisingly, therefore, it is now kept track of and used more carefully than in the past.

Americans are supposed to be much more wasteful of food and other

¹ The cost of producing a given amount of commodity Z_i would be minimised if

$$\frac{\partial f_i / \partial x_i}{\partial f_i / \partial T_i} = \frac{P_i}{\partial L / \partial T_i}$$

If utility were considered an indirect function of goods and time rather than simply a direct function of commodities the following conditions, among others, would be required to maximise utility:

$$\frac{\partial U / \partial x_i}{\partial U / \partial T_i} = \frac{\partial Z_i / \partial x_i}{\partial Z_i / \partial T_i} = \frac{p_i}{\partial L / \partial T_i}$$

which are exactly the same conditions as above. The ratio of the marginal utility of x_i to that of T_i depends only on f_i , x_i and T_i , and is thus independent of other production functions, goods and time. In other words, the indirect utility function is what has been called "weakly separable" (see R. Muth, "Household Production and Consumer Demand Functions," unpublished manuscript).

² See Owen, *op. cit.*, Chapter X.

³ See, for example, de Grazia, *op. cit.*, Chapter IV.

goods than persons in poorer countries, and much more conscious of time: they keep track of it continuously, make (and keep) appointments for specific minutes, rush about more, cook steaks and chops rather than time-consuming stews and so forth.¹ They are simultaneously supposed to be wasteful—of material goods—and overly economical—of immaterial time. Yet both allegations may be correct and not simply indicative of a strange American temperament because the market value of time is higher relative to the price of goods there than elsewhere. That is, the tendency to be economical about time and lavish about goods may be no paradox, but in part simply a reaction to a difference in relative costs.

The substitution towards goods induced by an increase in the relative cost of time would often include a substitution towards more expensive goods. For example, an increase in the value of a mother's time may induce her to enter the labour force and spend less time cooking by using pre-cooked foods and less time on child-care by using nurseries, camps or baby-sitters. Or barbers' shops in wealthier sections of town charge more and provide quicker service than those in poorer sections, because waiting by barbers is substituted for waiting by customers. These examples illustrate that a change in the quality of goods² resulting from a change in the relative cost of goods may simply reflect a change in the methods used to produce given commodities, and not any corresponding change in *their* quality.

Consequently, a rise in income due to a rise in earnings would increase the quality of goods purchased not only because of the effect of income on quality but also because of a substitution of goods for time; a rise in income due to a rise in property income would not cause any substitution, and should have less effect on the quality of goods. Put more dramatically, with total income held constant, a rise in earnings should increase while a rise in property income should decrease the quality chosen. Once again, the composition of income is important and provides testable implications of the theory.

One analytically interesting application of these conclusions is to the recent study by Margaret Reid of the substitution between store-bought and home-delivered milk.³ According to our approach, the cost of inputs into the commodity "milk consumption at home" is either the sum of the price of milk in the store and the forgone value of the time used to carry it home or simply the price of delivered milk. A reduction in the price of store relative to delivered milk, the value of time remaining constant, would reduce the cost of the first method relatively to the second, and shift production towards the first. For the same reason a reduction in the value of time, market prices

¹ For a comparison of the American concept of time with others see Edward T. Hall, *The Silent Language* (New York: Doubleday, 1959), Chapter 9.

² Quality is usually defined empirically by the amount spent per physical unit, such as pound of food, car or child. See especially S. J. Prais and H. Houthakker, *The Analysis of Family Budgets* (Cambridge, 1955); also my "An Economic Analysis of Fertility," *op. cit.*

³ See her "Consumer Response to the Relative Price of Store versus Delivered Milk," *Journal of Political Economy* (April 1963).

of milk remaining constant, would also shift production towards the first method.

Reid's finding of a very large negative relation between the ratio of store to delivered milk and the ratio of their prices, income and some other variables held constant, would be evidence both that milk costs are a large part of total production costs and that there is easy substitution between these alternative methods of production. The large, but not quite as large, negative relation with income simply confirms the easy substitution between methods, and indicates that the cost of time is less important than the cost of milk. In other words, instead of conveying separate information, her price and income elasticities both measure substitution between the two methods of producing the same commodity, and are consistent and plausible.

The importance of forgone earnings and the substitution between time and goods may be quite relevant in interpreting observed price elasticities. A given percentage increase in the price of goods would be less of an increase in commodity prices the more important forgone earnings are. Consequently, even if all commodities had the same true price elasticity, those having relatively important forgone earnings would show lower apparent elasticities in the typical analysis that relates quantities and prices of goods alone.

The importance of forgone earnings differs not only among commodities but also among households for a given commodity because of differences in income. Its importance would change in the same or opposite direction as income, depending on whether the elasticity of substitution between time and goods was less or greater than unity. Thus, even when the true price elasticity of a commodity did not vary with income, the observed price elasticity of goods would be negatively or positively related to income as the elasticity of substitution was less or greater than unity.

The importance of substitution between time and goods can be illustrated in a still different way. Suppose, for simplicity, that only good x and no time was initially required to produce commodity Z . A price ceiling is placed on x , it nominally becomes a free good, and the production of x is subsidised sufficiently to maintain the same output. The increased quantity of x and Z demanded due to the decline in the price of x has to be rationed because the output of x has not increased. Suppose that the system of rationing made the quantity obtained a positive function of the time and effort expended. For example, the quantity of price-controlled bread or medical attention obtained might depend on the time spent in a queue outside a bakery or in a physician's office. Or if an appointment system were used a literal queue would be replaced by a figurative one, in which the waiting was done at "home," as in the Broadway theatre, admissions to hospitals or air travel during peak seasons. Again, even in depressed times the likelihood of obtaining a job is positively related to the time put into job hunting.

Although x became nominally a free good, Z would not be free, because the time now required as an input into Z is not free. The demand for Z

would be greater than the supply (fixed by assumption) if the cost of this time was less than the equilibrium price of Z before the price control. The scrambling by households for the limited supply would increase the time required to get a unit of Z , and thus its cost. Both would continue to increase until the average cost of time tended to the equilibrium price before price control. At that point equilibrium would be achieved because the supply and demand for Z would be equal.

Equilibrium would take different forms depending on the method of rationing. With a literal "first come first served" system the size of the queue (say outside the bakery or in the doctor's office) would grow until the expected cost of standing in line discouraged any excess demand;¹ with the figurative queues of appointment systems, the "waiting" time (say to see a play) would grow until demand was sufficiently curtailed. If the system of rationing was less formal, as in the labour market during recessions, the expected time required to ferret out a scarce job would grow until the demand for jobs was curtailed to the limited supply.

Therefore, price control of x combined with a subsidy that kept its amount constant would not change the average private equilibrium price of Z ,² but would substitute indirect time costs for direct goods costs.³ Since, however, indirect costs are positively related to income, the price of Z would be raised to higher-income persons and reduced to lower-income ones, thereby redistributing consumption from the former to the latter. That is, women, the poor, children, the unemployed, etc., would be more willing to spend their time in a queue or otherwise ferreting out rationed goods than would high-earning males.

V. SUMMARY AND CONCLUSIONS

This paper has presented a theory of the allocation of time between different activities. At the heart of the theory is an assumption that households are producers as well as consumers; they produce commodities by combining inputs of goods and time according to the cost-minimisation rules of the traditional theory of the firm. Commodities are produced in quantities determined by maximising a utility function of the commodity set subject to prices and a constraint on resources. Resources are measured by what is called full income, which is the sum of money income and that forgone or "lost" by the use of time and goods to obtain utility, while commodity prices are measured by the sum of the costs of their goods and time inputs.

¹ In queueing language the cost of waiting in line is a "discouragement" factor that stabilises the queueing scheme (see, for example, D. R. Cox and W. L. Smith, *Queues* (New York: Wiley 1961)).

² The social price, on the other hand, would double, for it is the sum of private indirect costs and subsidised direct costs.

³ Time costs can be criticised from a Pareto optimality point of view because they often result in external diseconomies: e.g., a person joining a queue would impose costs on subsequent joiners. The diseconomies are real, not simply pecuniary, because time is a cost to demanders, but is not revenue to suppliers.

The effect of changes in earnings, other income, goods prices and the productivity of working and consumption time on the allocation of time and the commodity set produced has been analysed. For example, a rise in earnings, compensated by a decline in other income so that full income would be unchanged, would induce a decline in the amount of time used at consumption activities, because time would become more expensive. Partly goods would be substituted for the more expensive time in the production of each commodity, and partly goods-intensive commodities would be substituted for the more expensive time-intensive ones. Both substitutions require less time to be used at consumption, and permit more to be used at work. Since the reallocation of time involves simultaneously a reallocation of goods and commodities, all three decisions become intimately related.

The theory has many interesting and even novel interpretations of, and implications about, empirical phenomena. A few will be summarised here.

A traditional "economic" interpretation of the secular decline in hours worked has stressed the growth in productivity of working time and the resulting income and substitution effects, with the former supposedly dominating. Ours stresses that the substitution effects of the growth in productivity of working and consumption time tended to offset each other, and that hours worked declined secularly primarily because time-intensive commodities have been luxuries. A contributing influence has been the secular decline in the relative prices of goods used in time-intensive commodities.

Since an increase in income partly due to an increase in earnings would raise the relative cost of time and of time-intensive commodities, traditional cross-sectional estimates of income elasticities do not hold either factor or commodity prices constant. Consequently, they would, among other things, be biased downward for time-intensive commodities, and give a misleading impression of the effect of income on the quality of commodities consumed. The composition of income also affects demand, for an increase in earnings, total income held constant, would shift demand away from time-intensive commodities and input combinations.

Rough estimates suggest that forgone earnings are quantitatively important and therefore that full income is substantially above money income. Since forgone earnings are primarily determined by the use of time, considerably more attention should be paid to its efficiency and allocation. In particular, agencies that collect information on the expenditure of money income might simultaneously collect information on the "expenditure" of time. The resulting time budgets, which have not been seriously investigated in most countries, including the United States and Great Britain, should be integrated with the money budgets in order to give a more accurate picture of the size and allocation of full income.

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