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**THE ALLOCATION OF TIME: Empirical
Findings, Behavioral Models, and Problems of
Measurement**

by

F. Thomas Juster and Frank P. Stafford

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THE ALLOCATION OF TIME:
EMPIRICAL FINDINGS, BEHAVIORAL MODELS, AND PROBLEMS OF MEASUREMENT

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I. Introduction

It can be argued that the fundamental scarce resource in the economy is the availability of human time, and that the allocation of time to various activities will ultimately determine the relative prices of goods and services, the growth path of real output, and the distribution of income. While the importance of time allocation as an analytic construct is close to being self-evident, the use of data on time allocation either to model economic behavior or to understand the dynamics of economic change over time has only recently begun to attract the interest and attention of economists.

Over the past several decades, a substantial and greatly heterogeneous literature has grown up on the subject. In the U.S., economists have been the major contributors to this literature, with concerns centered on the role of time inputs in social accounting systems, the role of time in behavioral models of market and nonmarket activities, and the methodological issues involved in the measurement of time use. In Europe and in developing countries, in contrast, much of the work has involved the documentation of differences among societal groups or between countries in time allocation, and is more likely to have been produced by sociologists, planners, and statisticians with an

interest in national income accounts.¹ Of the work outside the U.S. that has some basis in behavior modeling rather than accounting or description, most has been concerned with the use of time within the household to produce nonmarket goods and services--meals, childcare, housing services, etc. Curiously enough, lines of inquiry that have been followed in the U.S. have had remarkably little influence on work in other countries, and vice versa, due in part to the heterogeneous nature of the research approaches, disciplinary backgrounds, and publication outlets.

It is the purpose of this essay to familiarize economists with what has been learned from analysis of time allocation data, to explore the nature of the models that have been used, and to provide an assessment of the research potential of this relatively new field of inquiry. We focus mainly on work done by economists and on formal models or accounting systems, but note lines of inquiry by researchers in other disciplines.

We start by giving the reader a brief description of the origins and evolution of time allocation data, the measurement issues, and the types of analyses contained in the literature. In Section II we present some recent descriptive data among countries and over time, and in Section III we examine measurement issues in greater detail. Sections IV and V examine some of the behavioral models that use time allocation data and summarize some of the principal findings. In Section VI we look at social accounting systems that place substantial reliance on

¹The professional association organized by the time use research community is the International Association for Time-Use Research, which is part of the World Congress of Sociology.

such data, and in Section VII we discuss the potential of time allocation data for future research.

The first systematic collection of time allocation data originated in the U.S.S.R. in 1924, and is associated with the Soviet academician, S. G. Strumilin (Cited in G. A. Prudenskii, 1961). Scattered bits and pieces of similar data were obtained from special-purpose populations (often cities) with a focus on specific topics (leisure time, commuting time) over the next several decades in a number of both Western and Eastern European countries and in the U.S.,² but it was not until the middle 1960s that a systematic attempt was made to collect methodologically comparable data for a large number of countries. The mid-1960s effort was organized by Alexander Szalai, the Hungarian sociologist, and included studies for the U.S., U.S.S.R., Hungary, FRG, GDR, Yugoslavia, Belgium, France, Peru, Poland, and Bulgaria. Some studies were of a single urban site and others of the urban population as a whole (Szalai, 1972).

Since the 1960's multinational study, data on time allocation have been obtained in most European countries and in the U.S., Canada, and Japan, as well as in a number of developing countries, with periodicities that range from five to ten years. The available U.S. data include the 1960's multinational study, studies conducted in the mid-1970s and the early 1980s by the Institute for Social Research at the University of Michigan, and a study done in the mid-1980s by the Survey Research Center at the University of Maryland.

²For a review of the early work on time allocation, see Szalai (1966). Studies on the U.S. population include Sorokin and Berger (1939), Lundberg, Komarowsky and McInerny (1934), Liepmann (1944), Kleemeier (1961), and Foote and Meyersohn (1959).

One of the characteristics of data on the allocation of time among the population is that valid measurements are both difficult and costly to obtain. Most of the early methodological research on measurement was undertaken in conjunction with the 1960's multinational study; the more recent work has been done largely in the U.S., much of it in conjunction with the 1975-76 and 1981-82 studies at the University of Michigan. The methodology for collecting time allocation data has been well developed at this point, and the main characteristics of optimum methodology are not in dispute.

The only way in which reliable data on time allocation have been obtained is by the use of time diaries, administered to a sample of individuals in a population and organized in such a way as to provide a representation of all types of days and seasons of the year. The time diaries are usually retrospective--they ask respondents for a detailed chronology of the previous 24 hours, with responses coded according to a standard list of activities such as that developed for the 1965-66 multinational study. In some studies the standard codes are elaborated to provide more detail on topics of particular interest, but in virtually all time allocation studies the categories can be reduced to a common set of functional activities with common definitions. Thus, the basic data on time allocation come from a sample of days collected from a sample of the population of interest.

Time allocation data have served two main research purposes. At a macro level, they have been used in the construction of augmented economic and social accounting systems. Conventional economic accounting systems have always provided analysts with detailed descriptions of market activity, both in terms of output and input. But

much productive activity takes place outside the market, and the most readily available measure of this activity is clearly the time inputs represented by the use of nonmarket time among the population. In addition, leisure activities play an important role in the production of economic welfare. Thus a number of accounting systems have been developed that rely heavily on time allocation data for inputs of nonmarket production time, and for inputs of leisure time. These systems are discussed in Section VI of the paper.

At the micro level, the data have been used to describe and model household behavior. Descriptive studies have focused on the division of responsibility for nonmarket activity by sex (e.g., Clark and Harvey, 1976; Gronmo and Lingsom, 1982); the use of nonmarket time in childcare and in care for the elderly (e.g., Lingsom, 1975), and in analysis of leisure time activities (e.g., Harvey and Gronmo, 1986; Patrushev, 1982). More model-based studies have examined a set of household production activities involving shopping, cleaning, cooking, repairs and maintenance for housing, etc. (Seel, 1988; Chadeau and Roy, 1986; M. Hill, 1985; T. P. Hill, 1979).

There is an extensive micro literature in which constrained optimization models are used to analyze household production choices; much of that literature is from the U.S., although there are also Scandinavian, French, and West German studies. Topics have included analysis of transportation mode, labor supply, leisure activities, household production, and sleep. In the labor supply area, statistical models that use time allocation data from time diaries often show surprising differences from models that use conventional survey data on work hours. These labor supply and household production models are

summarized below in Section IV, and the behavioral findings from the models are discussed in Section V.

II. Descriptive Patterns of Time Allocation among Countries

The basic structure of some of the more recent data on time allocation is shown below in Table 1, where we show the allocation of time for representative samples of men and women in six countries. The data are not fully comparable, since we have used published tabulations for the most part rather than the basic microdata files. For example, the data for men are usually for active workers, although in some countries it is for all men between the ages of 25 and 64. The data for women are for all women in some countries, but are weighted averages of employed women and homemakers in others. Substantial modification and adjustment, some of it basically arbitrary, had to be made to the published tables to achieve approximate comparability in the time allocation classifications. All of the data are for national population samples except in the U.S.S.R., where the city of Pskov is the comparison base. While there are obviously problems of comparability, we judge that the broad outlines of the data in Table 1 represent real differences and not differences in sample definition or in the classification of activities.

The taxonomy in the table is one used in a 1985 monograph describing a set of results for the U.S. (Juster and Stafford, 1985). Time is divided into work time, in turn subdivided into market work and household work; into personal care (dominantly sleep and rest); and into a number of leisure activities. The table employs a number of conventions that depart in some respects from those familiar to economists. For example, the category labeled "market work" includes a

number of activities that are not conventionally included in measures of hours--commuting time (shown separately), time spent at second jobs, and unpaid time spent at the workplace before or after work as well as time spent in job search. We have adopted the convention that travel time should be associated with the activity that motivates the travel. Thus time spent in traveling to and from restaurants is included with social interaction time, since eating out is one of the subcategories of social interaction. A complete description of the subcategories contained in the distributions shown in Table 1 is available on request.

Even a table as simple and straightforward as Table 1 shows a number of interesting differences among countries. For example:

1. Total work time (paid work plus work in the home) tends to be higher for women than for men in all countries except the U.S. (Other exceptions exist that are not shown in Table 1, e.g., Denmark.)
2. Among men, work for pay in the market (including commuting time) is substantially higher in the U.S.S.R. and Japan than elsewhere, and is lowest for Sweden. Among women, work for pay is highest in the Soviet Union and Hungary, lowest in the U.S.
3. Time spent doing housework by men is roughly the same among the countries in the table except for Sweden, which is higher than the rest, and for Japan, which is strikingly lower than any other country. The differences in housework time among women are much smaller than among men; Hungarian women put in more housework hours than others while by a small margin the U.S.S.R. shows the lowest weekly housework hours for women.

Table 1
Time Allocation Across Countries
(hours per week)

Activity	Men						Women					
	U.S. 1981	Japan 1985	USSR 1985 (Pskov)	Finland 1979	Hungary 1977	Sweden 1984	U.S. 1981	Japan 1985	USSR 1985 (Pskov)	Finland 1979	Hungary 1977	Sweden 1984
Total Work	57.8	55.5	65.7	57.8	63.7	57.9	54.4	55.6	66.3	61.1	68.9	55.5
Market Work	44.0	52.0	53.8	44.0	50.8	39.8	23.9	24.6	39.3	32.5	35.1	23.7
Commuting	3.5	4.5	5.2	3.0	4.0	3.8	2.0	1.2	3.4	2.5	2.6	2.1
Housework	13.8	3.5	11.9	13.8	12.9	18.1	30.5	31.0	27.0	28.6	33.8	31.8
Personal Care	68.2	72.4	67.8	72.5	74.0	70.9	71.6	72.1	69.8	72.7	73.6	73.8
Sleep	57.9	60.0	56.9	60.2	59.4	55.3	59.9	57.0	58.2	60.9	60.4	56.9
Leisure	41.8	40.3	34.6	38.1	30.4	39.0	41.9	40.3	32.0	33.6	25.3	38.5
Adult Ed.	0.6	1.2	1.0	0.9	1.9	1.0	0.4	2.2	2.6	1.2	1.3	1.0
Soc. Inter.	14.9	8.0	7.8	12.1	7.1	9.6	17.6	7.0	9.6	10.2	4.6	11.2
Active Leis.	5.6	5.3	4.1	4.3	2.4	7.2	4.2	3.6	3.0	2.7	1.8	8.4
Passive Leis.	20.8	25.5	21.7	20.8	19.0	21.2	19.8	27.5	16.8	19.5	17.6	17.9
TV	12.7	17.3	14.5	9.7	10.2	13.4	11.5	21.4	11.2	7.7	9.2	10.8
Total	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0

Sources: Data Appendix.

4. Time spent in social interaction (visiting friends and neighbors, eating out either at restaurants or at friends' home, movies, plays, etc.) is substantially higher in the U.S. than in any other country. Social interaction time is next highest in Sweden and Finland, and is quite low in Japan, the U.S.S.R., and Hungary. Active leisure is highest by far in Sweden, and otherwise follows roughly the same pattern as social interaction time.
5. Overall, leisure time is highest for the U.S. and lowest in Hungary (although it is a good deal higher in both Denmark and Norway than in any of the countries shown in Table 1).
6. Television viewing time is substantially higher in Japan than elsewhere, and seems to be next highest in the U.S.S.R. and the U.S.

While these intercountry differences are interesting and provide some grist for modeling efforts, equally simple repeated cross-section descriptions of change in time allocation are even more interesting. Table 2, which has the same data comparability problems as Table 1, shows changes in time allocation between the 1960s and the 1980s for a selection of countries where the relevant data are available. The table has two slightly different classifications, since the data for Norway and Denmark cannot be made comparable to the data for the U.S.S.R., Japan, and the U.S. without access to the basic data tapes. From Table 2, it appears that:

1. In Japan, Norway, and the U.S., total work time (household plus market) for both men and women declined substantially between

Table 2 (continued)

Activity	Norway				Denmark					
	Men		Women		Men			Women		
	1971	1980	1971	1980	1964	1975	1987	1964	1975	1987
Total Work	53.2	51.0	54.6	50.6	45.4	43.0	46.2	43.4	41.8	43.9
Market Work	37.8	34.2	13.3	17.6	41.7	33.9	33.4	13.3	15.8	20.8
Household Work	15.4	16.8	41.3	33.0	3.7	9.1	12.8	30.1	26.0	23.1
Leisure	42.0	45.5	39.2	45.2	53.8	53.1	54.3	51.7	51.2	53.7
Personal Care	72.8	71.4	74.2	72.1	68.8	72.0	67.2	72.8	75.0	70.4
Total	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0

Sources: Data Appendix.

the mid-1960s and the 1980s; the decline was generally sharper for women than for men.³

2. The decline in total work hours for women shows very different patterns for the different countries. In the U.S.S.R., both market work and housework hours for women declined substantially from very high initial levels; in Japan, market work hours declined substantially while housework hours hardly changed; and for the U.S., Norway, and Denmark, housework hours declined sharply and market work hours increased.
3. While total work hours for men declined substantially in Japan, the U.S., and Norway, that was typically a consequence of a modest increase in housework hours offset by a larger decline in hours spent at market work. In contrast, for the U.S.S.R. market hours hardly changed for men, and for Denmark there was a substantial rise in housework hours. The U.S.S.R. data are probably misleading in part, since the very substantial decline in adult education hours between the mid-1960s and the mid-1980s almost certainly reflected a decline in adult education activity directly tied to market work.

The challenge for economic research is whether these differences across countries and over time can be explained by a common model of economic behavior in which differences in wages, prices, income taxation or other forces lead to differences in the allocation of time. Can such

³It is often asserted, both in the popular press and in research studies, that leisure time has been decreasing (or not increasing) for U.S. women. The basis for this finding, which is clearly at variance with the data in Table 2, is that nondiary measures of market work hours show much larger increases than the diary data. As we discuss below, the nondiary measures are biased upwards, and the bias is substantial (see Stafford and Duncan, 1985).

a model explain the parallel tendency in the U.S. and the U.S.S.R. for large declines in housework for women (down from 31.5 hours in Pskov in 1965 to 27.0 hours in 1986, and down from 41.8 hours in the U.S. in 1966 to 30.5 hours in 1981), and modest rises in the housework time of men (up from 9.8 hours in Pskov in 1965 to 11.9 hours in 1986 and from 11.5 hours in the U.S. in 1966 to 13.8 hours in 1986)? Can the same model explain the declining diary measures of the work week for adult men in Japan and the United States between 1965 and 1981 (Stafford and Duncan, 1985)?

Finally, we present some additional descriptive data in Table 3, where the focus is on time allocation by school-age children. The only data to which we have access describe the U.S. and Japan. For the Japanese data, we can compare time spent by children all the way from primary school through university or college schooling, while for the U.S., we have comparable data for primary school through senior high school.

The differences shown in Table 3 are striking, and will not come as a surprise to students of achievement score differences among countries. Relevant generalizations from the data are:

1. U.S. children, even at very young ages, spend substantially more time at market work than do Japanese children, although the absolute amount of time is quite small.
2. Children in both societies spend about the same amount of time at household work in both countries, and more time is allocated to household work than market work.
3. There is a large difference between the amount of time spent in classroom settings in Japan compared to the U.S., and a far

Table 3

Time Allocation among School-Age Children,
U.S. and Japan (hours per week)

Activity	U.S. (1981-82)			Japan (1986)			
	Primary School	Junior H.S.	Senior H.S.	Primary School	Junior H.S.	Senior H.S.	College & Univ.
Household Work	2.7	4.6	4.8	3.0	3.3	4.1	5.8
Market Work	1.2	2.1	3.9	0.1	0.2	2.4	10.3
School Work	27.0	31.9	30.0	46.5	62.8	60.4	41.2
In school	25.2	28.7	26.2	38.2	46.6	41.5	32.4
Studying	1.8	3.2	3.8	8.3	16.2	19.0	8.8
Playing games and sports	15.0	8.3	7.0	11.4	3.4	0.7	1.1
Reading	0.9	1.2	1.6	2.8	2.6	3.3	6.4
TV	15.6	17.5	14.2	15.0	15.4	17.7	14.9
Sleep	68.2	59.6	60.3	64.4	56.5	53.0	47.6
Eating	9.0	8.0	7.8	10.6	9.8	9.6	10.0
Personal Care	5.2	6.7	6.7	7.1	7.6	8.1	8.4
Subtotal	144.8	150.4	136.3	160.9	161.6	159.3	145.7
Not Allocated	23.2	27.6	31.7	7.1	6.4	8.7	22.3
Total	168.0	168.0	168.0	168.0	168.0	168.0	168.0

Source: Data Appendix.

larger difference (in relative terms) in the amount of time spent in studying outside of school. Japanese children spend almost 50 percent more time in school than do American children, and their time spent studying outside of school exceeds that of American children by a factor of 4 or 5.

4. Curiously enough, Japanese children spend substantially more time studying in junior high school and in senior high school than they do while attending colleges or universities. We would guess that the opposite is true of American college and university students, and that they probably spend more time studying outside of class than do Japanese university students.
5. Students in both Japan and the U.S. spend just about the same amount of time in television viewing--a surprising finding in light of the large difference in time spent in school or studying.
6. American children spend a good deal more time playing games and sports than Japanese children, especially during the later teen years.
7. American children spend substantially more time sleeping than Japanese children.

A final interesting feature of the data in Table 3 is the total amount of time not accounted for by the categories shown in the table. In Tables 1 and 2, the time was allocated completely, in that the total amount of available time was distributed into a set of consistent categories. In Table 3, the comparable data that we have accounts for the activities shown in the table, and there is a substantial amount of time left over--not accounted for by any of the activities shown in the

table. American children show substantially greater amounts of left-over time than Japanese children in comparable ages and school grades, with a presumption that much of that difference is in time spent "socializing."

This brief description of across-country and across-time differences in time allocation has at least three important implications: (1) there is a great deal of variation in time allocation to be explained; (2) economic models appear to have an important role to play even in explaining differences among countries with very different institutional structures (e.g., the U.S., and U.S.S.R. and Sweden); and (3) cultural and social forces are likely to matter quite a lot in explaining some of the observed differences (e.g., between Japan, the U.S., and the Scandinavian countries).

III. Measurement Issues Involving Time Use

A substantial amount of attention has been paid to measurement issues involving time use. The major study that initiated systematic examination of time use--the multinational study conducted in 1965-66--devoted a good deal of effort to methodological issues, and a number of subsequent studies done both in the U.S. and abroad have also examined measurement issues. The conclusion from these studies is that some form of diary instrument that records the chronology of various time uses over the day is the only valid measurement of time use, and less expensive substitutes are of substantially lower quality and have systematic biases of a major sort.⁴

⁴These conclusions are documented in Scheuch (1972), Robinson (1977, 1985), and Juster (1985, 1986).

The reason that diary measurements of time use tend to be valid, and alternative estimates biased, is easy to understand once the problem is specified. Many of the activities that people do during the course of a day (and certainly the durations of spells in each activity) are not memorable, are not repetitive day by day, and do not necessarily leave traces in terms of market measurements that might be used as a proxy. Thus it should not be surprising that survey questions of the form, "How much time did you spend doing X last week or month," typically prove wide of the mark except for activities like labor supply, and even there valid responses are likely only when daily work patterns have regular schedules. For ordinary household tasks-- childcare, travel and entertainment, socializing, TV viewing, reading, etc.--it is apparently not possible to get valid estimates of actual time use from relatively simple survey questions about typical time use over some past period of time. The major bias is overestimation-- respondents appear to recollect days when the activity asked about was especially prominent, and treat that as an average day. As a result of these findings, time diaries are the preferred method of data collection on time use.

The best tests of validity for time diaries consist of several experiments conducted during the 1975-76 U.S. study. In one experiment, subjects were asked to carry an electronic paging device programmed to emit a signal at random intervals, and were instructed to record their activity on an attached notepad when the signal went off. Subjects were interviewed the next day, using a conventional 24-hour recall diary. In another experiment, subjects who had already provided a conventional 24-hour recall diary were asked to provide a very detailed description of

their activities during a randomly selected one-hour slice of that time. In still a third experiment, data were collected for a 24-hour time diary, and subjects were also asked about "average time use" for a number of activities during the previous week ("stylized" time use). Table 4 shows these comparisons.⁵

Even though these are very small samples, the message is clear:

1. Comparing the paging device with the diary, activities outside the home (where subjects tended not to carry the pager, such as work, shopping, and social entertainment) are all higher on the diaries. All other activities are lower (as they must be, on average). Correcting for the bias from activities outside the home, the amounts of time are very close on the pager and the diary.
2. Comparing the random hour with the diary, the amounts of time allocated to different activities are all quite close except for telephone conversations, which are much higher in the random-hour data.⁶
3. Comparing the stylized time use questions with the diaries, the stylized questions are (with one exception) all higher than the diaries, some substantially higher. For example, women report

⁵A fourth natural experiment compared the frequency of activities where a respondent reported that a spouse was present, and the spouse independently reported the same event, with frequencies where dissimilar reports were obtained from respondents and spouses. The incidence of mismatches on these independent reports was relatively small. (See Juster, 1986).

⁶A similar result is reported in Michelson and Ziegler (1982), where direct observation was compared with a time diary. The mean values for time allocated to different activities were very close, and the correlations quite high.

Table 4

Experimental Tests of Time-Diary Methodologies
(Hours/Week Allocated to Activity)

Activity	Experiment 1 (Women)		Experiment 2		Experiment 3 (Women)		Experiment 3 (Men)	
	Paging Device	Time Diary	Random Hour	Time Diary	"Stylized" Time Use	Time Diary	"Stylized" Time Use	Time Diary
Work for Pay	9.3	14.4	22.2	23.9	14.9	12.8	36.1	34.8
Housework	21.4	18.5	10.6	13.9	20.9	16.6	2.7	2.7
Childcare	8.6	7.1	2.7	3.6	16.6	5.5	3.8	1.7
Shopping	4.3	6.6	7.5	6.8	2.9	2.6	1.3	1.1
Social Entertainment	3.7	5.7	7.4	9.1	9.6	10.6	7.2	6.6
Active Leisure	5.8	4.0	3.4	2.8	5.0	3.6	3.0	2.5
Passive Leisure	23.6	20.4	20.5	12.8	-	-	-	-
Talking on phone	4.3	3.6	10.2	2.6	-	-	-	-
TV	-	-	-	-	18.3	11.4	15.2	11.2
Reading	-	-	-	-	7.6	2.7	6.8	5.3

Sources: Adapted from Robinson (1985).

three times as much childcare as recorded in the diaries;
perhaps it only seems so!

The overall conclusion is that the diary method dominates, with the only serious bias being an underreporting of telephone conversation time. The pager will underreport activities taking place outside the home, the stylized method will overreport virtually everything, although differentially, and the random hour is just as good as the diary-- probably better--but is much more costly. With an unlimited budget, one would pick the random-hour method; budget limitations argue for the diary.

Given the evidence suggesting that the basic diary method produces valid measures of time use while other methods are unsatisfactory, it also has been shown that minor variations in the way diaries are obtained do not make a great deal of difference to the estimates. For example, it has been shown that telephone surveys (which are a good deal less costly than personal interview surveys) yield diary estimates that are comparable to personal interview surveys; it has been shown that the recall bias in time diaries (for up to a seven-day recall period) is negligible for estimates of time use on weekend days, but tends to become noticeable for weekday estimates if the recall period is more than 24 hours (Juster, 1986); and it has been shown that diaries that are left behind for respondents to fill out have about the same characteristics as diaries that are obtained by recall (Scheuch, 1972; Robinson, 1977). Work by Kalton (1985) shows the extent of day-to-day variability in diary estimates of different time use components.

One of the most surprising findings from these methodological studies is that a variable which most economists would presume to be

well measured by conventional survey techniques--labor supply hours--turns out to be quite poorly measured in conventional studies, and appears to be much better measured in time diary studies. Not only do the time diaries suggest that the distribution of labor hours has a good deal more variance than is shown by conventional studies (which have very sharp peaks at conventional weekly hours numbers like 40 or 35), but it also appears that conventional respondent reports of labor supply seriously overstate the amount of hours actually supplied to the market. And not only is it true that weekly hours are overstated in conventional survey measures of hours, but the extent of the bias in the U.S. was substantially greater in 1975 than it appears to have been in 1965. Specifically, market work of adult males in the U.S. shows a modest 2.7 percent decline between 1965 and 1981 in the Current Population Survey. In Table 2 the decline in market work net of commuting time is 13.5 percent for adult men.

What seems to happen in the measurement of labor supply is that respondents give conventional numbers of hours when asked about weekly hours supplied to the market, and a time diary gives a measurement that is sensitive to the difference between scheduled hours and actual hours. Biases of this sort show up not only for the U.S. but also for other countries where similar comparisons have been made. As we note below, the differences between time diary measures of labor supply and the conventional measures turns out to be quite important for analysis of a number of micro economic problems--the effect of life cycle on hours supplied, the effect of young children on the labor supply of both men and women, etc. (Stafford and Duncan, 1985, 1987; Flood, 1989).

IV. Behavioral Models

Most research on time use by economists is on labor supply as measured by respondent or employer reports of market hours rather than from time diaries. In this research, the familiar labor-leisure model and its variants, including intertemporal models and nonlinear budget sets, are used as the theoretical framework. More recent work has been focused primarily on issues of econometric estimation and error structure (Killingsworth, 1983). Analysis of time diary data requires the conceptualization of choices beyond labor-leisure; all nonmarket activities need to be modeled explicitly. In this paper such models are referred to as household production models.

The earliest household production models were those of Mincer (1962) and Becker (1965). Their framework was general, static, and emphasized responses of individuals to market prices, time prices, incomes, and technologies that would influence the "production function" for home goods. Subsequently, research by economists has become more involved in the empirical assessment of more specialized forms of the original time use theories and has begun to offer revisions in the theory to account for some of the recent findings. Time use models and findings have emerged emphasizing feedbacks, joint production, intertemporal time use, and intertemporal time use with feedbacks.

The static household production model (hpm) is of the form:

$$\text{Maximize } U = U(Z_1, \dots, Z_n) \quad (1)$$

$$\text{where } Z_i = Z_i(X_i, t_i) \quad (2)$$

is the household production function for the commodity Z_i . Important restrictions are that each t_j and X_j is specific to the production of a

given Z_j , and that households are indifferent to the allocation of time apart from its role as an input into production of the Z's. While these assumptions expedite the development and analysis of the model, they will be seen to create issues of estimation and interpretation.

The budget constraint is:

$$\sum_{i=1}^n p_i X_i = Y(Z_n) + A \quad (3)$$

where p_i is the price of market input X_i , $Y(Z_n)$ is income from the market work activity Z_n , and A is exogenous income.

The Z's represent "more basic commodities" (Becker, 1965) than conventional goods (the X's). The argument is that utility is derived from consuming the Z's (e.g., a prepared meal) rather than from the X's, which are intermediate market inputs (e.g., groceries and flows of services from household capital). Further, since there are intermediate time inputs, which in most cases can be substituted for by market inputs, people with differing time values will choose different production strategies for the Z's.

The role of the theory in highlighting these nonmarket production choices can be seen in a specialization of the production technology side of the hpm offered by Gronau, who characterized alternative travel mode choices as having fixed time and money requirements per trip and predicted mode choice (such as rail, car, and public transport) as a decision to minimize overall (time plus money) cost per trip. Gronau (1970) offered empirical evidence in support of his model: Those with higher time values took "time-saving" modes, and the disappearance of railroads from U.S. intercity travel could be explained by the rising

full (time plus money) price of railroads compared to other modes for people in all ranges of time value.

In conventional static labor supply models, market work activity is usually just a time decision; i.e., $Z_n \equiv t_n$ and $Y \equiv t_n w$, where w is the wage rate per unit time, assumed to be independent of hours of work or choice of nonwork activities. In addition, the utility function is defined over total goods consumption ($Y+A$) and work time, $U = U(Y+A, t_n)$ with increases in t_n assumed to decrease utility. In contrast, the hpm is more ambitious in that the market work decision can be connected to the technology of home production (the Z function), as well as to the utility function. The model implies that the demand for the X 's and t 's is related to the p 's, w , and A and, of course, to the form of the $U(\cdot)$ and $Z(\cdot)$ functions. The form of the implied demand functions is usually difficult if not impossible to determine even with simple expressions for $U(\cdot)$ and $Z(\cdot)$. However, for certain specializations comparative static results can be obtained.

To illustrate this, consider the supply function for hours of market work in the case in which there are only two commodities, Z_1 and Z_2 , two conventional goods, X_1 and X_2 , and two time inputs, t_1 and t_2 . The utility function $U(Z_1, Z_2)$ is assumed homothetic (so income elasticities of demand are unitary) and each production function, $Z_1(X_1, t_1)$ and $Z_2(X_2, t_2)$, is linearly homogeneous. Market work is $T = t_1 + t_2 = t_n$ and total time available is T . Under these assumptions, the allocation problem described in equations (1), (2), and (3), yields a labor supply function with the property that the elasticity of labor supply with respect to the wage rate takes the special form of

$$Et_{n \cdot w} = \left(\frac{T-t_n}{T} \right) \{-1 + s_1[F_{M1}R_{L1} + F_{L1}R_{M1}] + s_2[F_{M2}R_{M2} + F_{L2}R_{M2}] + s_D[(R_{L1} - R_{L2})(F_{L1} - F_{M1})]\} \quad (4)$$

Here s_1 and s_2 are the elasticities of substitution between each good and time in the production functions, s_D is the elasticity of substitution between Z_1 and Z_2 in the utility function (1), and where F is the fraction of nonmarket time and goods allocated to each activity and R denotes the shares of these inputs in the costs of the activities (Deardorff and Stafford, 1976).⁷

The elasticity of market work with respect to the wage rate is seen to be an increasing function of the weighted average for the (non-negative) substitution elasticities in production (s_1 and s_2) as well as the substitution elasticity in the utility function, s_D . These weighted averages in comparison to -1 tell us whether the market work elasticity is positive or negative.

From this specialization one can see an illustration of the connection between changing household technology and labor supply decisions. Perhaps the evolution of household technology has made it easier to substitute market goods for own time in household production of Z 's (a rise in s_1 and s_2), causing a secular shift toward a greater responsiveness of female labor supply to wage rates. This interpretation of labor supply of women is related to that originally offered by Mincer (1962). To illustrate, if new methods for market-provided childcare become available, and these increase the opportunity

⁷The results in (4) can be extended to the case of differing, non-unitary income elasticities.

for substitution of own time, we can predict from equation (4) an increased labor supply elasticity.*

It is interesting to contrast our discussion of the hpm and labor supply with that of Killingsworth (1983), who claims that "its (the hpm model) value for analysis of labor supply--market production is less obvious.... The main difference is that in the conventional model one can consider only the composite leisure, whereas in the time allocation model one can also consider allocation of this composite to the different activities (Z's). However, most propositions about the individual's labor supply that are implied by the time allocation approach will also be found in the conventional approach."

While it is common for economists to assume stable preferences, it is less common to assume stationary technology. From our perspective, technology is subject to change just as readily in the household sector as in the industrial sector. From equation (4) it is obvious that one can derive sensible expectations about how changing home technology could influence labor supply decisions. As Killingsworth conjectures, "improved 'household technology' has led to improved 'household productivity' and thus, presumably, to changes in labor supply" (p. 43, footnote). It is our view that the hpm can be used to represent this type of change quite explicitly, subject to the proposition that simplification is required to make the model tractable. Although one can object to the specific choice of simplification, it is hard to think of any economic model that does not require some specialization for the sake of tractability if refutable implications are to emerge.

*In this discussion we are assuming interior solutions.

Another direction to modeling household labor supply is to alter labor income, $Y(\cdot)$, to be of the form

$$Y = Y(t_n, Z_j) \quad (5)$$

where Z_j is a vector of nonmarket commodities. In this framework there is a type of "productive consumption" commonly discussed in the historic labor supply literature (Marshall, 1920; Hicks, 1930). Certain nonmarket activities contribute to market productivity and this leads to a modified labor supply model (Biddle and Hamermesh, 1989). In their model the nonmarket activity which enhances job performance (e.g., sleep, at home!) has a unit time cost which is reduced by the effect of extra sleep on market productivity. In another model (Stafford and Cohen, 1974) leisure breaks and consumption while at work are seen as producing such benefits, hence there are predicted to be heterogeneous episodes of both hard work and "goofing off" while at work. On-the-job consumption can be timed to provide benefits later in the work period and work pace can be varied to achieve an optimal plan of breaks and effort at work.

Models from economic demography (Willis, 1973) and the intrafamily allocation of time (Manser and Brown, 1980; McElroy and Horney, 1980) have been important for time use research. One of the major family activities is childcare, and childcare requires diversion of time from other activities over extended periods of time and possibly a reassessment of the household division of labor (Stafford, 1987). Consider a simplified, one (long) period case of a one-parent family or a two-adult family with a "social welfare function." If in (1) "child services," Z_c , are produced with time and market inputs,

$$Z_c = C(X_c, t_c) \quad (6)$$

and a second good, Z_s , or standard of living, is produced with time and goods as well, then the effects of changing income and prices on childcare time, t_c , can be modeled as a straightforward elaboration of (1) - (3). Holding constant full income, Y_f , the amount that could be earned in the market if the household's only goal were money income maximization ($Y_f = wT+A$), the wage elasticity of childcare time can be shown to be

$$|E_{t_c \cdot w}|_{Y_f} = - (1 - \beta_c) s_c + (1 - k) S_D(\beta_s - \beta_c) \quad (7)$$

where time intensity for childcare is $\beta_c = wt_c/\Pi_c Z_c$, β_s is similarly defined for Z_s , s_c is the elasticity of substitution between t_c and X_c in the production of Z_c , $k = \Pi_c Z_c/Y_f$, and S_D is the elasticity of substitution in consumption between Z_c and Z_s . The full (money plus time) price of childcare is $\Pi_c = p_c \hat{x}_c + \hat{t}_c w$, where $\hat{x}_c = \partial X_c / \partial Z_c$ and $\hat{t}_c = \partial t_c / \partial Z_c$ are the marginal inputs of goods and time in the production of childcare.

From (7) we can see that if childcare is more time-intensive, $\beta_c > \beta_s$, and the compensated wage elasticity of childcare time will be negative. However, an increasing wage rate has income effects, increasing the demand for both commodities if they are normal goods and increasing the demand for all inputs, assuming no inferior factors. The diary-based observation of more child care time per child (Hill and Stafford, 1985) for higher wage mothers (and often more total childcare time) is consistent with a presumed high-income elasticity of demand for Z_c combined with limited opportunities to substitute market inputs for own time (low s_c), particularly for preschoolers. Again, although the

model is quite specialized, its value can be in providing a heuristic, even though there is little basis for knowing the specifics of home production technology.

Cross-sectional observation of time use via diaries indicates age-dependencies. Market work of men peaks in the middle years (age 25-44) and leisure is high for younger and older men (M. Hill, 1985). Time in education declines monotonically with age. Can these patterns be explained by a simple dynamic theory which synthesizes the market work and training (education) decision with choice of nonmarket time?

The modeling direction pursued in this literature is drastic simplification of the production structure and an emphasis on intertemporal links through the accumulation of marketable skills. That is, time is allocated among current market work, leisure, and time spent accumulating skills. Each hour spent in today's skill acquisition costs lost wages and lost utility from leisure. On the other hand, such skill acquisition raises future wages and thereby produces greater future consumption opportunities.

Specifically, if $Z_1=t_1$ and $Z_2=X$, then the decision problem is to choose "leisure" (t_1), training time (t_2), and market goods expenditures (X) in each period to maximize the present value of discounted utility:

$$\sum_{m=0}^M U(t_{1m}, X_m)/(1+r)^m \quad (8)$$

subject to

$$R_{m+1} = R_m + (T-t_{1m}-t_{2m}) aK_m - pX_m + rR_m \quad (9)$$

and

$$K_{m+1} = K_m + g(K_m, t_{2m}) - \delta K_m \quad (10)$$

where $T-t_1-t_2$ is market work time, M is the planning horizon, and financial assets are R with a discount rate of r . The stock of market skills, K , produces earnings at a rate a for added market time and depreciates at the rate δ . The production function for skills, $g(\cdot)$, can be thought of as part of the hpm approach, in that time, skill, and (in some specifications) market goods are used to produce increments to the stock of skills. Various discrete and continuous time specializations of (8) - (10) have been analyzed (Ghez and Becker, 1975; Blinder and Weiss, 1976; Ryder, Stafford and Stephan, 1976), and these predict a life-cycle pattern such that hours of market work will be greatest in an individuals' middle years.

Time intensive commodities including those associated with leisure, ($Z_1 = t_1$), are predicted to be concentrated in early and late years of the life cycle; goods-intensive activities ($Z_2 = X$) are predicted to be concentrated in the peak earnings years; and training, particularly schooling and on-the-job training, is predicted to be highest in the early phase of the life cycle with a declines in later stages.

The intuition for the training time predictions is that the initial skill endowment starts out below its sustainable level and that with a finite horizon (M), training benefits in terms of the present value of the additional earnings from added skill declines later in the life cycle, reducing training incentives. When earnings capacity (aK) grows, the greater value of labor market activity should increase work hours and lead to greater relative use of market-intensive commodities (X). An important theoretical point is that, because of the additional margin for reallocation over time, life-cycle maximization implies a more

pronounced relation between contemporaneous market work time and earnings capacity than implied by a corresponding static model with a similar utility function (Ryder, Stafford and Stephan, 1976, p. 670).

How essential is the labor-leisure model or the added structure of household production models to understanding behavior? Our discussion has indicated some insights: to name several, the secular growth of wages can be postulated to create income effects of sufficient strength to offset substitution effects and lead to reduced market work (a pattern illuminated by the diary data in Table 2); production choice can better illuminate travel mode choice; and new home technologies could impact labor supply decisions even with stable preferences and wage distributions (the General Electric effect?).

On a more skeptical note one might be inclined to contemplate the labor supply wage-elasticity in the hpm (4), the childcare elasticity (7) expressions or those derived in the dynamic models (8) - (10), and conclude that empirical implementation of the framework to recover production and preference parameters will be close to impossible because of overwhelming data requirements. Specifically, in (4) and (7) one needs information on both the time and goods allocation to different Z's; the burden on the respondent of collecting either reliable time allocation or expenditure data is very large, and collecting both from the same respondent (as well as the specific joint uses) stretches the limits on cooperation.

There is the further problem in the hpm of defining the Z's and the inputs (X's and t's) themselves. Is a trip itself the Z or is the trip just another intermediate product into the real Z, which might be a visit? Is a prepared meal the Z or is eating the meal the Z, while

prepared food is more like an X with a shadow price? Does playing sports with a child produce an active leisure Z, a health Z, and a child development Z, or only the latter two for any adult who dislikes playing sports? Is the trip to the theatre an input into a leisure Z or a Z itself? Does that depend on whether it's a family trip or whether the subject enjoys driving per se? How is the stock of household capital to be allocated to the production of various Z's? And so on.

More emphasis on modeling the joint production of outputs to be consumed at a later time, as well as the direct benefits of time use in an activity, is clearly needed. Some housework appears to be valued primarily for the output achieved (clean house, clean clothes), whereas other activities not only produce valued outputs (Z's) but intrinsic satisfactions as well--the time devoted to production is itself regarded as enjoyable (childcare, some home projects). That is, utility is a function of both the "process benefits" of using time, t_j , and the outcome, Z_j (Juster, 1985, 1989). These process benefits from the use of time in different nonmarket activities create joint products which are ruled out of the basic hpm in (2).

A well-known criticism of the hpm is that of Pollack and Wachter (1975). They point out that constant returns to scale and absence of joint production are strong but required assumptions in the hpm. Otherwise the "prices" (such as π_c in (7)) become endogenous functions of household preferences. One rejoinder is that there are plenty of cases outside of the hpm where such endogeneity arises. In the simple labor supply model, for example, if workers can earn "overtime" wage premiums, the wage rate becomes endogenous and a function of

preferences. Of course, one would not want to add such a complication to the model unless it was regarded as important for predicting choices.

If one believes that joint production is a salient aspect of household choice or that there are not constant returns, one reaction might be to assess the hpm as irrelevant. Our view is different: If joint production, for example, is an important aspect of the problem (and evidence noted below indicates that it is because the process benefits of time use vary greatly with the activity), then future modeling efforts should be devoted to simplified variants of the hpm which do include joint production. The usefulness of such efforts would be in their ability to produce empirically refutable propositions which can be tested with diary data. Another direction (Pollack and Wachter, 1975, p. 275) is to focus on the household's allocation of goods and time among activities as a function of goods prices and the wage rate.

To summarize, as we have emphasized above, most applications of the hpm require a further specialization or a different specialization of Becker's original model. It is doubtful that researchers would independently reach the same conclusions on operationalizing the hpm for the many diverse empirical studies of household production. Yet the broad outlines of the theory are observable in the data. Market work and higher wages are strongly associated with meals out. It seems clear that a good deal of the evolution of household technology has been to allow the substitution of goods for own time (meals out and prepared foods at the grocery), and that this development coincides with the rising share of total female work time in the labor market observed in Section II. Gronau's insight on travel mode can extend to other commodities. If we postulate a homothetic production function, then

cost minimization implies that the ratio of own time to goods will be a function of the price of time relative to the price of goods, a result observed in several empirical studies noted below (e.g., shopping "modes").

In the next section, we examine the role of the time allocation theory in interpreting the data on the use of time, with special attention to time allocation data collected via time diaries.

V. Behavioral Analysis of Time Use Patterns

In this section we present a selection of empirical findings that bear on the different relationships and predictions outlined above. The evidence ranges from formal statistical tests of hypotheses to descriptive patterns which appear consistent or at odds with different models. The discussion is divided into results that pertain primarily to market labor supply and results that apply primarily to nonmarket activities.

1. Labor Supply

In Tables 1 and 2 one can interpret the higher levels of market work in Eastern Europe compared to other industrialized countries in a simple labor supply framework ($Z_n \equiv t_n$ and $Y \equiv t_n w$). Assuming worker preferences shape decisions in both market and planned economies, an explanation would be that the lower wage rate has (negative) income effects which dominate substitution effects and lead to greater market hours for men in the U.S.S.R. and Hungary. Such a simple explanation is not universally applicable because Japanese men, who have much higher wage rates, work about as many hours as do Russian or Hungarian men. A difference, of course, is the more extensive division of labor in

Japanese society with women specializing more in housework at 31.0 hours per week in comparison to only 3.5 hours for men. This sort of "explanation" is much more complex since an intrafamily choice model is implied, and there may be as well an important role for cultural differences which shape preferences across societies.

Another look at labor supply is to consider market work through time in a given country. For the United States the time-series data (from Current Population Survey (CPS) data or establishment data, which use nondiary measures of work hours) show a gradual decline of about 8-10 percent per decade in hours of market work for men, as real wages rose, up until about 1960 (Lewis, 1957). During the 1960s, market hours of men remained largely unchanged even though real wages continued to rise. From the 1970s on, men's wages in the U.S. have exhibited no real rise; if anything, there has been a wage decline and increased dispersion of wages (Juhn, Murphy and Pierce, 1989; Moffitt, 1990; MaCurdy and Mroz, 1989).

One possibility is that nondiary reports of weekly hours continue to be overrepresented by numbers like "40" (Lewis, 1957, p. 201) even when actual hours on the job continue to decline. As noted earlier, CPS data show a 2.7 percent decline in hours for men aged 20-65 from 1965 to 1981, while the hours (net of commuting time) from the time diary data in Table 2 show a decline of 13.5 percent over the same time period. If the diary data are correct, there has been a simultaneous understatement of both the rise in real wages and the decline in hours because hourly wages are typically computed by dividing annual or weekly earnings by an increasingly overstated work hours figure. It thus seems possible that measurement problems have obscured a continuation of the historic

pattern of U.S. male labor supply declines described by Lewis. We can note as well that productivity growth would be misestimated using the reported hours of work series.

Sweden's high taxes on labor income have been well documented (Bloomquist, 1983). One study interprets the tax disincentives as so strong as to reduce not only market work but also tax revenue (Stuart, 1981). Starting in 1990, Swedish workers face substantially lowered marginal tax rates with a further reduction scheduled in 1991. This sequence of reductions will drop typical marginal tax rates from the 85 percent range to the 50 percent range. Diary data (Tables 1 and 2) show that in 1984 Swedish men (and also Norwegian men, who are subject to a similar tax system) had comparatively low hours of market work, while Swedish men had the highest hours of housework of any country. The hpm would predict that Swedish men will shift their time allocation from household work to market work, given the tax rate changes. In contrast, sociological models that emphasize societal forces leading to less differentiated sex roles for men and women would predict the reverse.

More formal tests of static labor supply models using diary data are just beginning to appear. A fairly consistently observed pattern of male labor supply in the U.S. is that the presence of preschoolers or other dependents is related to greater labor supply (Pencavel, 1986). Analysis of data on Swedish males' labor supply (Flood, 1989) appears to offer modest confirmation of this: Those with a child under three worked slightly more in the labor market when hours were measured by respondent reports of average working hours per week. In contrast, time diary measures for the same individuals in the Swedish data indicate

that the presence of a child under three reduced market time by almost five hours.

Our interpretation of the diary-based results is that young children actually do reduce market hours but in an unscheduled way. When respondents are asked for average weekly hours, the cumulative impact of childcare on market work time is difficult to net out. These results suggest that parameter estimates of variables which influence labor supply are apt to be seriously misestimated using respondent reports of market hours. To conjecture a bit further, if men commonly report hours to be 40 per week, regardless of actual hours, then one result would be an apparent lack of responsiveness to wage and income changes.

Feedback models of labor supply as characterized by equation (5) have been estimated using diary data. Using cross-national data and U.S. micro data, Biddle and Hamermesh found that higher wages are associated with reduced sleep and more market work. One interpretation is that sleep is both a consumption good, the demand for which falls as a net consequence of income and substitution effects of higher wages, and is a time-intensive commodity (Z_j), which feeds back to enhance market productivity. The net effect is a decline in sleep as wages rise: Substitution effects offset both positive income effects and indirect effects of sleep on productivity.

A direction for future research could be to obtain better measures of the intensity and productivity of market work time. Perhaps these measures would show a clearer relation of work effort to various Z_j 's (including sleep). Some research shows substantial differences in work intensity between union and non-union workers as well as differences in

formal and informal breaks while on the job (Duncan and Stafford, 1980). One interesting application of work-intensity measures to supplement time diaries would be to examine the hypothesis of labor-hoarding--the thesis that employers keep on extra workers during downturns in expectation of eventual greater utilization of their services when demand recovers (Nickell, 1986). The prediction would be that actual time working while at the workplace would exhibit stronger covariation with output.

In an effort to understand time use choices, both the U.S. and Swedish time use data included respondent scaling of inherent satisfaction with different kinds of time use. The patterns across the two countries were very similar: Activities which normally occur in an interactive context, such as caring for children or market work, tended to be rated more highly than activities which are solitary. The least preferred activity was household chores, typically the most solitary activity.⁹ While there is some reason for skepticism about the interpretation of the high intrinsic satisfaction rating for market work (it is actually higher than almost all leisure activities in both U.S. and Swedish data),¹⁰ one can adapt many conventional models to deal with the presumption that market work provides inherent satisfaction as well as purchasing power.

⁹As Pollak and Wachter (1975, p. 271) note: "Household time spent cooking or cleaning is a direct source of utility or disutility to the household." Consequently, household decisions about the allocation of time reflect not only production considerations but also direct household preferences as to the uses of time. Juster, Courant, and Dow (1981) and Juster (1989) make the same point.

¹⁰Besides the skepticism among economists about subjective data generally, it could be argued that consumers would have difficulty in distinguishing between extrinsic and intrinsic rewards. We address that issue below.

In a labor-leisure model with work yielding high intrinsic satisfaction there are some specializations which lead to the same predictions as the standard labor supply model (e.g., an hour of work produces a unit of purchasing power and a unit of consumption in some fixed proportion), and some specializations that have different implications. An illustration of the latter would be a model where work time itself is divided between actual work and on-the-job leisure (in the form of socializing or relaxing from the stress of family life). Individuals differ in the extent to which they want on-the-job Z's versus off-the-job Z's, and firms differ in their ability to offer packages with different on-the-job Z's versus income. In such a setting labor supply is part of a process by which employers offering certain job characteristics are matched with employees desiring certain job characteristics; the solution can be represented by a hedonic or market matching equilibrium (Rosen, 1974).

Analysis shows that among a set of job characteristics used to explain the intrinsic satisfaction scores, pay was not very important; although respondents who were dissatisfied with their pay did offer lower average evaluations of intrinsic satisfaction from work, respondents who reported that they were well paid did not rate their job satisfaction higher than average. We infer that respondents were not simply confusing intrinsic and extrinsic rewards in reporting high satisfaction for time at work. More importantly, the strongest job characteristics predicting job satisfaction ratings were social interaction (ratings of coworkers), responsibility (including negative scores for too much responsibility), and traditional human capital attributes (learning opportunity). Substantial differences were

2. Nonmarket Activities

Consider a simple case of homothetic production technology so that cost minimization implies that the ratio of inputs in production is a function of relative input prices and not the scale of production. Suppose further that market inputs can be purchased by everyone at the same price. Then as a function of time price (as measured by the wage) we will expect a greater relative use of market inputs for those with higher wage rates. Does this approach receive empirical support? We have already seen the approach to have power in predicting travel mode choice.

Other studies indirectly support this prediction of cost minimization. For example, one study (Pashigian and Bowen, 1989) shows a rise over time in the purchase of branded shirts. Here there is a choice of shopping modes. A "good shirt" can be produced by more careful comparisons of different shirts, which requires more time, or by purchasing a well-known brand, which requires more money. Diary data show that women spend more time shopping than men (M. Hill, 1985), and their rising wages are used to explain the rising share of branded shirts.

A more ambitious task is that of explaining the very high household production levels of Swedish men. From Tables 1 and 2 we can see that Swedish (and Norwegian) men spend the most time in housework. A simple interpretation is that while market wages are not that different among European countries and the U.S., the Swedish tax laws lower the time price, since the marginal tax of about 85 percent sets in quite early in the schedule (Bloomquist, 1983). Thus, the ratio of own time to market

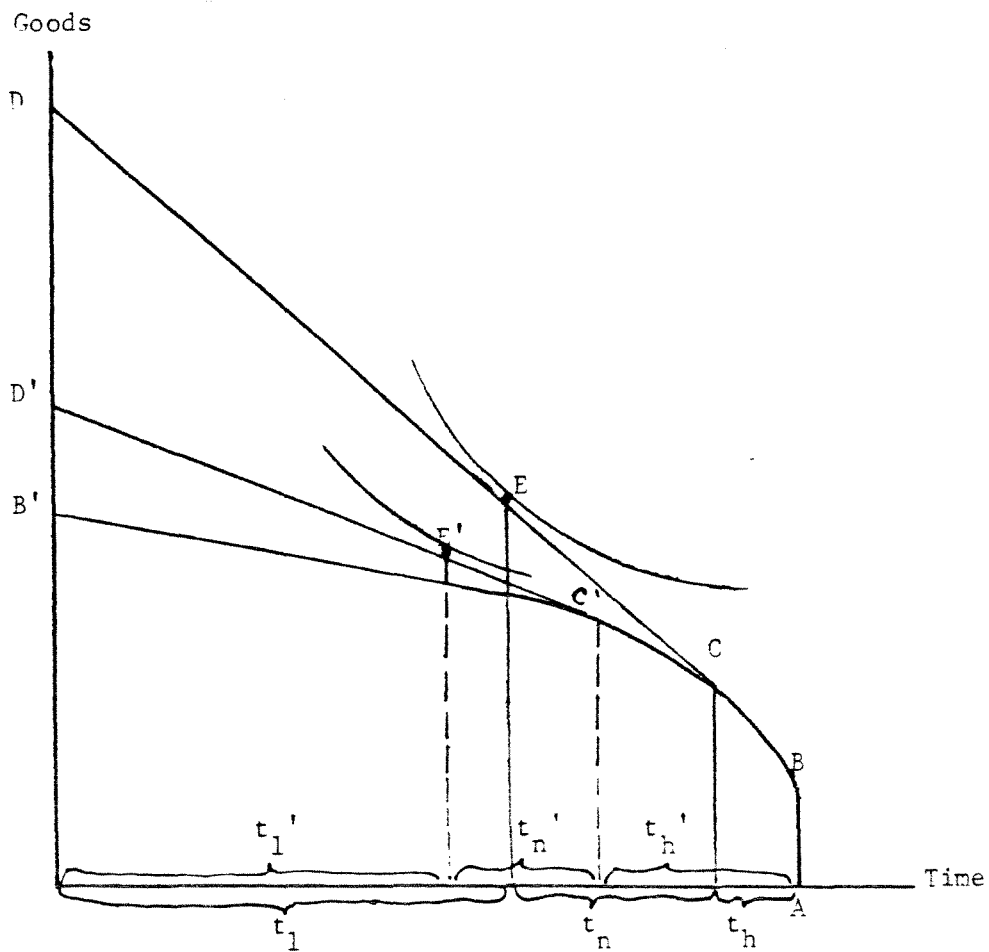


Figure 1

Taxes and Home Production

Thus, by reducing the marginal wage rate, the Swedish tax system extends the time devoted to home production and, in this illustration, reduces both market work and leisure time. The data in Table 1 show that Swedish men, compared to U.S. men, have less market work time, more home production time, and less leisure time.

Other predictions relate to who will do various chores in the household. Consider an activity which is valued primarily for its output rather than its inherent satisfaction or its value as a joint activity for a married couple. A good candidate is "drudge" work such as laundry, washing dishes, and cleaning house. Here research shows that relative wages of the couple appear to matter some, but that much of the division of labor is independent of wages and depends on the identity of the husband and wife. Specifically, in a model predicting drudge work time, a higher value of own wage reduces own time and increases spouse's time. When sex of respondent is added to the equation, the wage effects persist but are of much smaller magnitude.

There is a strong positive correlation between each spouse's time spent in leisure activities such as time in organizations, TV viewing, and sports (Hill and Juster, 1985). These results suggests that spouses' time is substitutable for activities without inherent benefits (as with drudge work) but is complementary for most leisure activities. This finding also highlights an important point about survey design in this area: To study many of the nonmarket time allocation issues, one needs information from respondent and spouse pairs. While the 1975/76 and 1981/82 U.S. data are for such pairs, virtually all of the datasets in other countries are not designed this way.

Time series analyses of several market economies provides additional evidence on the issue of organizing housework. A moderate convergence toward equality in market and nonmarket time of men and women characterizes the countries in Table 2. This can be explained by a pattern of growing (after tax) wage equality between men and women. In Sweden men and women are taxed separately; a husband's marginal tax rate would commonly have been about 85 percent in 1984. If the wife were not working, her tax rate would be zero on the first crown of earnings (Gustafsson, 1987). As well, the structure of wage bargaining in Sweden has led to reduced pre-tax wage rate differences. The overall policy consequence is to lead to greater after-tax wage equality of men and women, and this should reduce incentives for specialization in market or nonmarket activities by men and women. This prediction seems consistent with the fact that, among the countries we studied, the ratio of market work to housework is most similar between Swedish men and women.¹¹

Another perspective on this issue can be seen from Table 5. In five of seven countries examined there has been an increase in men's housework and a decline in women's housework. This general trend toward equality is consistent with a trend toward equal (after-tax) wages. In Holland and Japan, where joint taxation of income continues throughout the 1970s and 1980s, we see no real change toward equality of housework time.

From the simple theoretical model of childcare in Section II, the sign of the uncompensated wage elasticity of childcare time can be seen

¹¹Norwegian men and women are subject to a similar tax structure and have a similar division of labor.