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F. Thomas Juster; Frank P. Stafford

Journal of Economic Literature, Vol. 29, No. 2. (Jun., 1991), pp. 471-522.

Stable URL:
http://links.jstor.org/sici?sici=0022-0515%28199106%2929%3A2%3C471%3ATAOTEF%3E2.0.CO%3B2-B

Journal of Economic Literature is currently published by American Economic Association.

Journal of Economic Literature
Vol. XXIX (June 1991), pp. 471–522

The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement

By F. THOMAS JUSTER
The University of Michigan
and
FRANK P. STAFFORD
The University of Michigan

We would like to thank the following individuals for comments and suggestions: Charles Brown, W. Keith Bryant, Greg Duncan, Gunnar Eliasson, Daniel Hamermesh, James S. Jackson, Anders Klevmarken, Ken Lockridge, Thomas L. Markey, Eva Mueller, Susanne Oxenstierna, Hal Varian, and referees of the Journal of Economic Literature. *Anders Klevmarken additionally supplied us with special tabulations from the Swedish time use survey. Comments were also received from seminar participants at Arbetslivscentrum (Stockholm), Michigan State University, the Industrial Institute for Social and Economic Research (IUI, Stockholm), and the Research Institute of the Finnish Economy (Helsinki). Financial support for completion of the project was received by Frank Stafford from IUI and the Program in American Institutions at the University of Michigan.*

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 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, 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 a selection of what has been learned in a very broad and diffuse literature, to present the basic descriptive patterns of time use by men and women in a variety of countries differing in level of development and economic organization, and to indicate some of the directions for future work in the area.

We start by giving the reader a brief description of the origins and evolution of time allocation data. In Section II we present some recent descriptive data among countries and over time. A main finding is that there are very substantial differences among industrialized countries in time use patterns—differences that are often larger than those between particular industrialized and preindustrial economies.[2] In Section III we examine measurement issues, which appear to be of greater importance to this topic than to most other areas of economic inquiry. 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 time use data, and in Section VII we discuss the potential of these data for future research.

The first systematic collection of time allocation data originated in the USSR in 1924, and is associated with the Soviet academician, S. G. Strumilin (cited in German 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.,[3] 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., USSR, Hungary, FRG, GDR, Yugoslavia, Belgium, France, Peru, Poland, and Bulgaria. Some studies were of a single urban site

[1] The 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.

[2] In a world of growing economic integration, time use data can provide an important insight into the economic performance of countries and can be used to assess the impact of policy changes.

[3] For a review of the early work on time allocation, see Alexander Szalai (1966). Studies on the U.S. population include Pitirim Sorokin and Clarence Berger (1939), George Lundberg, Mira Komarowsky and Mary McInerny (1934), Kate Liepmann (1944), Robert Kleemeier (1961), Nelson Foote and Rolf Meyersohn (1959), and Kathryn Walker and Margaret Woods (1976).

and others of the urban population as a whole (Szalai 1972).

Since the 1960s 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 study, national sample studies conducted in the mid-1970s and the early 1980s by the Institute for Social Research at the University of Michigan, regional studies of special populations conducted in the 1960s by Cornell University and in the 1970s by the U.S. Dept. of Agriculture, and a national study done in the mid-1980s by the Survey Research Center at the University of Maryland.

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; much of the more recent work has been done in the U.S., some in conjunction with the regional studies at Cornell and the Dept. of Agriculture in the 1960s and 1970s, some as part of the national time use studies done at the University of Michigan in 1975–76 and 1981–82.

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 probability sample of all types of days and of the different 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 on time allocation data for inputs of nonmarket production time, and for inputs of leisure time. These systems are discussed in Section VI.

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., Susan Clark and Andrew Harvey 1976; Mohamed Abdel-Ghany and Sharon Nickols 1983; Sigmund Gronmo and Susan Lingsom 1982); the use of nommarket 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; Vassily Patrushev 1982).

More model-based studies have examined a set of household production activities involving shopping, cleaning, cooking, repairs and maintenance for housing, etc. (Barbara Seel 1988; Ann Chadeau and Caroline Roy 1986; Martha Hill 1985; T. P. Hill 1979; Karen Goebel and Charles Hennon 1983).

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 data on time allocation can be seen in Tables 1–3, where we show the allocation of time in a recent year for representative samples of men and women in six industrialized countries (Table 1), time use in two preindustrial countries (Table 2), and changes in time use over the last two decades for five industrial countries (Table 3). 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 they are 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 represent national population samples except in the USSR, where the city of Pskov is the comparison base, and in the two preindustrial societies. While there are obviously problems of comparability, we judge that the broad outlines of the data in these tables represent real differences and not differences in sample definition or in the classification of activities.

The taxonomy in the three tables is one used in a 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. We employ 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 these tables is available on request.

Even these basic descriptive data show a number of important and interesting differences among countries.

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 (for Tables 1–4): See Data Appendix, p. 514.

TABLE 2

TIME ALLOCATION IN AGRICULTURAL SOCIETIES
(HOURS PER WEEK)

	Men		Women	
Activity	Rural Botswana (1975)	Nepalese Villages (1981)	Rural Botswana (1975)	Nepalese Villages (1981)
Total work	47.8	52.6	59.4	75.6
Marketable work	38.8	40.7	23.2	32.3
Housework	9.0	11.9	36.2	43.3
Leisure	55.5	46.3	42.0	27.8
Other	4.7	13.2	6.6	8.5
Sleep*	60.0	56.0	60.0	56.0

* Assumed in study.

1. Total work time (defined as market plus nonmarket work) tends to be higher for men than for women only in countries with relatively high income levels. Specifically, total work time of men exceeds that of women in the U.S. and Sweden (Table 1), and in Norway (1980) and Denmark (Table 3). In contrast, women have substantially more total work time than men in Hungary and Finland (Table 1), in Botswana and Nepal (Table 2), and in the USSR and Japan in 1965 (Table 3).
2. Among men, work for pay in the market (which includes work on agricultural crops in rural societies, as well as commuting time) is substantially higher in the USSR, Japan, and Hungary than elsewhere. Market or marketable work of men is lowest in Denmark, Norway, Botswana, Sweden, and Nepal. Men in the U.S. (1981), and Finland (1977) have weekly market hours between these extremes.
3. Among women, market or marketable work is highest in the Soviet Union and Hungary, lowest in the U.S., Sweden, Norway, and Denmark.[4]
4. Time spent doing housework by men (defined to include routine chores, home projects, and child care) is roughly the same among all countries in these tables except for Norway and Sweden, which are substantially 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; Botswanian, Hungarian, and rural Nepalese women put in more housework hours than others, while by a small margin USSR women show the lowest weekly housework hours.

[4] A recent study (Oxenstierna 1990, p. 190) indicates that the participation rate of Soviet women has stabilized at about 90 percent since the 1970s. Combined with the diary data in Tables 1 and 3, which are for all adult women, the implied average workweek net of commuting time was just under 40 hours per week in 1985. Possibly the long market work hours of Russian women reflect administratively set hours, even over longer periods. Students of market economies tend to regard long run hours variations as arising from individual choice, and could be misled in the interpretation of market time in the Soviet Union.

TABLE 3

CHANGES IN TIME ALLOCATION IN FIVE SOCIETIES, 1965–1980s

(HOURS PER WEEK)

	USSR (Pskov)				Japan				U.S.			
	Men		Women		Men		Women		Men		Women	
Activity	1965	1985	1965	1985	1965	1985	1965	1985	1965	1981	1965	1981
Total work	64.4	65.7	75.3	66.3	60.5	55.5	64.7	55.6	63.1	57.8	60.9	54.4
Market work	54.6	53.8	43.8	39.3	57.7	52.0	33.2	24.6	51.6	44.0	18.9	23.9
Commuting	4.9	5.2	3.7	3.4	3.6	4.5	1.0	1.2	4.8	3.5	1.6	2.0
Housework	9.8	11.9	31.5	27.0	2.8	3.5	31.5	31.0	11.5	13.8	41.8	30.5
Leisure	36.9	34.6	26.1	32.0	34.4	40.3	32.7	40.3	36.7	41.8	35.4	41.9
Soc. inter.	8.6	7.8	8.9	9.6	5.9	8.0	5.5	7.0	13.4	14.9	13.7	17.6
Passive leis.	16.1	21.7	10.0	16.8	24.2	25.5	24.2	27.5	19.3	20.8	17.9	19.8
TV	5.6	14.5	3.9	11.2	16.8	17.3	19.4	21.4	11.8	12.7	9.3	11.5
Active leis.	6.0	4.1	2.2	3.0	3.4	5.3	1.8	3.6	2.8	5.6	3.2	4.2
Adult ed.	6.2	1.0	5.0	2.6	0.8	1.2	1.2	2.2	1.2	0.6	0.6	0.4
Personal care	66.6	67.8	66.4	69.8	73.0	72.4	70.6	72.1	68.2	68.2	71.9	71.6
Sleep & rest	56.0	56.9	55.5	58.2	63.8	60.0	59.6	57.0	58.7	57.9	59.9	58.9
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

	Norway				Denmark					
	Men		Women		Men			Women		
Activity	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

5. 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 USSR, and Hungary. Active leisure is higher by far in Sweden than for any other country for which such disaggregation is available, and otherwise follows roughly the same pattern as social interaction time.
6. Overall, leisure time is highest for men in Nepalese villages and Botswana, and for both men and women in Denmark, Norway, and the U.S. It is lowest in Hungary (for both men and women), and for women in Nepal.
7. Television viewing as a primary activity, that is, as an activity receiving the major attention of the individual rather than simply having the set "on," is substantially higher in Japan than elsewhere, especially for women. One interesting result is that some countries with low program variety (such as Sweden in 1984 before video rentals were widely available) still have close to two hours per day devoted to television as a primary activity.

The time allocation data in agricultural societies is of special interest. These data have been gathered by development economists using diaries in which entries are often made by observers rather than respondents. Otherwise, the data are designed to be comparable to those collected in industrial societies. From Table 2 in comparison with Tables 1 and 3, it can be seen that time use in these agricultural societies is not widely distinctive from time use patterns in industrialized economies: the striking feature is the similarities. For example, men in rural Botswana and Denmark have total work hours as well as a market and housework disaggregation that are quite close to one another.[5]

Even given limitations of measurement there appear to be some established patterns: men in low income societies do not work long hours, but instead appear to have large amounts of free time, and in the same societies total work time of women far exceeds that of men. Men's high leisure hours might be explained by substitution effects toward leisure at low wage levels: if so, such factors should also operate for women, but it appears that they do not. Other explanations might include culturally defined differences in work hours by sex, or a measurement problem—what is called leisure time for men may really include a planning and organizing activity, for example. Another possibility is that the "free time" of men serves the function of providing a contingency resource in societies where insurance for the village or extended family is not available. Perhaps the study of time use during village crises, such as a flood or crop failure, would show that under such conditions men's leisure time becomes a resource to draw on for the emergency.

A clear and consistently defined set of time uses is essential for the analysis of

[5] Anthropologists (Richard Lee and Irven DeVore 1976) have studied time use in hunter-gatherer societies such as Kalahari (not coincident with the Botswana villages in Table 3). In some cases, they have shown work hours that are not too different from those in high income industrialized societies. Among the Kade San men a "relatively small amount of effort and time (was) used in obtaining food (about 5 hours per day)" (Lee and Devore, p. 100). While the techniques include some diary-like procedures such as randomized spot observations of children (Lee and Devore, p. 205), a serious limitation is that the data are not coded into a set of predetermined categories nor is the sample well designed. This prevents comparisons of human activity across a wide range of social systems and environments. Perhaps future efforts by social scientists could be designed with objectives of comparison more in mind.

changes in time use through time. While the cross-sectional differences discussed above are interesting and provide some grist for modeling and social accounting efforts, equally simple repeated cross-section descriptions of change in time allocation are in some ways more interesting. Table 3 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 USSR, Japan, and the U.S. without access to the basic data tapes. From these data, 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 the mid-1960s and the 1980s; the decline was generally sharper for women than for men.[6]
2. The decline in total work hours for women shows very different patterns for the different countries. In the USSR, 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 by more than 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 USSR market hours hardly changed for men, and for Denmark there was a substantial rise in housework hours. The USSR 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.

An interesting feature of these data is the substantial decline in market work hours shown for the U.S. population as a whole, in the face of the widespread public impression that market work hours have increased. For women, of course, market work hours *have* increased substantially since the 1960s, but for men and for men and women combined, market work hours measured by the time diary clearly declined—substantially for men and moderately for men and women combined. The key to this anomaly lies in the measurement methods used in collecting the data. The Harris Poll data, which is the source of the public impression that work hours have increased, are based on an early (1973) survey that asked about "hours a week [on your] job," and a later 1980 survey that asked a totally different question: "hours a week [on your] job, [including] keeping house or going to school" (Richard Hamilton, forthcoming). The earlier question is ambiguous about whether the respondent should include nonmarket work or time in school, and the presumption is that some respondents included it and some did not. The later question is not ambiguous—nonmarket work and time spent in school are both included. But the measured change is, of course, an artifact of the question change.

[6] It 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 3, 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).

TABLE 4

TIME ALLOCATION AMONG SCHOOL-AGE CHILDREN, U.S. AND JAPAN (HOURS PER WEEK)

	U.S. (1981–82)			Japan (1986)			
Activity	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

The challenge for economic research is whether the differences in Tables 1–3 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 a model explain the parallel tendency in the U.S. and the USSR 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)?

More generally, how important are cultural factors in explaining individual choice and in the resulting differences that we observe? Can the modest hours of marketable work of men in agricultural villages as well as in high income industrialized societies be explained by the famous backward-bending supply curve of labor? And what of the application of that theory to women's hours of work? To some extent, income effects on labor supply seem to be operating, with market hours of men declining as real wage rates have grown in the U.S., Norway, Sweden, and Japan. But this leisure dividend of economic growth is far from apparent if one examines nondiary measures of market work, a topic we return to in the discussion of measurement issues.

As an interesting aside, we present some additional descriptive data in Table 4 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 4 are striking, and will not come as a surprise to students of achievement score diffferences among countries. They include:

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 larger difference (in relative terms) in the amount of time spent 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—they probably spend more time studying outside of class than do Japanese university students.
5. Students in both Japan and 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 4 is the total amount of time not accounted for by the categories shown in the table. In Tables 1, 2, and 3 the time was allocated completely, in that the total amount of available time was distributed into a set of consistent categories. In Table 4, 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 that are listed. American children show substantially greater amounts of "left-over" time than Japanese children in comparable ages and school grade. The presumption is 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 forces 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 USSR 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.[7]

The reason that diary measurements of time use tend to be valid,[8] 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 5 shows these comparisons.[9]

[7] These conclusions are documented in Erwin Scheuch (1972), John Robinson (1977, 1985), and Juster (1985, 1986).

[8] Time diaries clearly have limitations. An important one is the presence of multiple activities. If someone is loading clothes into a washer while watching television, what are they doing? In principle this could be easily solved by defining a new activity which is the joint activity, but the codes for possible diary activities would then explode in number. In practice what is commonly done is to indicate one activity as primary and the other as "secondary." In addition, spells of activity are also appended with information on who was present. This feature allows measurement of patterns of interaction and can be important in studying such topics as the development of children.

Another way to conceptualize secondary activities is to argue that there is really only one activity at any given time, but that there are frequent switches between activities—e.g., between television viewing and washing clothes. If the time grid were fine enough, the issue of secondary activities would then effectively disappear. Finally it seems plausible that the issue of multiple or joint activities is a key source of the major failure of alternative recall methods. Recall accuracy falls when respondents make primitive attempts to respond to questions about hours of an activity in the last week or month by engaging in a kind of temporal double-counting—adding in periods when the activity was secondary to periods when it was central.

[9] A 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).

TABLE 5

EXPERIMENTAL TESTS OF TIME-DIARY METHODOLOGIES
(HOURS/WEEK ALLOCATED TO ACTIVITY)

	Experiment 1 (Women)		Experiment 2		Experiment 3 (Women)		Experiment 3 (Men)	
Activity	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

Source: Adapted from Robinson (1985).

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.[10]
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 three times as much childcare as recorded in the diaries; perhaps it only seems so, or perhaps the stylized data include a good deal of child care that is really a secondary activity. In any event, stylized methods will yield a week with considerably more than 168 total hours of activity reported.

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 obtained by recall (Scheuch 1972; Robinson 1977).

Although stylized measures typically overestimate time use, there are some conspicuous exceptions where the opposite is true. For example, stylized estimates of time spent on home repairs and alterations "during the past 12 months" are only about half as large as the cumulative total of home repair and alteration time obtained from four time diaries covering the same 12-month period (M. Hill 1985). And Charles Cannell et al. (1965) report that hospital stays are seriously underreported (relative to administrative record data) for recall periods of six months or more.

These underreports from stylized questions are almost certainly due to the length of the retrospective time horizon: for the stylized/diary comparisons in Table 5, the recall periods are typically one week, not six months or one year. More-

[10] A similar result is reported in William Michelson and Suzanne 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.

over, the activities in Table 5 are typically ones that are done regularly, not ones that are relatively rare events, as would be true for home repairs and alterations or for hospital stays. Finally, the lengthy retrospective data are especially weak for activities that lack salience—e.g., small repairs involving virtually no materials cost and small amounts of time.

The home repairs and alterations data can also be used to illustrate another important characteristic of the time allocation data, which bears on our ability to model individual behavior with such data. While the total time reported on the diaries for repairs and maintenance was about twice as high as the time reported on the stylized question, it was also true that more than two-thirds of the total sample reported spending *some* time during the past 12 months on home repairs and alterations, while less than 30 percent recorded any repair time on the four daily time diaries.

The reason for this discrepancy is straightforward: The time diaries captured activities on only four days out of the 365 days in a year; home repairs and alterations are an episodic activity that involves relatively large amounts of time on a relatively small number of days. While diary methods will produce unbiased estimates of the *mean* amount of time spent in the population as a whole, they will produce a distribution among households that has far too many cases with a zero value and far too many with very large values (because the diary captured one of the infrequent but lengthy periods of repairs or alterations activity for that particular household).

Estimates reported in Graham Kalton (1985) of the reliability proportion (defined as the fraction of the observed variance among a sample of days that represents true variance) of time diaries for different activities range (for a sample of four weekdays) from 88 percent for market work to an estimated value of zero for home improvements and spectator events. The diary data obviously have high sampling variability for activities like home improvements. Thus from the perspective of micro level analysis, stylized estimates even over long retrospective time periods may represent a better variable to identify households with small or large amounts of home repair activity. On the other hand, since estimates of mean time allocation calculated from stylized measures are known to be biased compared to mean values computed from diary measures, the diary measures are clearly preferred for a social accounting system where aggregate or subgroup means are the desired statistic.

From the perspective of both augmented economic accounts and modeling of individual behavior, the reliability estimates of most household production activities are encouraging. For activities like cooking, childcare, and cleaning, the reliability proportion for time diary data obtained on four weekdays of the year are, respectively, 83 percent, 74 percent, and 72 percent; aside from home repairs and maintenance, the lowest home production activities in terms of reliability are shopping and administration (45 percent), and medical care (13 percent), again using the four-weekday reliability estimates (Kalton 1985).

One of the most surprising findings from these methodological studies is that a variable 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. data 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, while the time diary provides a measure 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, including Japan and Sweden. As we note below, the differences between time diary measures of labor supply and the conventional measures turn out to be quite important for analysis of a number of microeconomic 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; Lennart 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 focused primarily on issues of econometric estimation and error structure (Mark Killingsworth 1983). Analysis of time diary data permits the conceptualization of choices beyond labor-leisure; in principle, all nonmarket activities can be modeled explicitly. In this paper such models are referred to as household production models.

1. *Household Production and Labor Supply Models*

The earliest household production models were those of Jacob Mincer (1962) and Gary 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:

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

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

is the household production function for the commodity Z_i and $U(\cdot)$ is the utility of an individual or a family (social) welfare function.

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). Fur-

ther, 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.

Important restrictions in this model 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:

$$\sum_{i=i}^{n} P_i X_i = Y(Z_n) + A \qquad (3)$$

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 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 the outcome of 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 others modes across the range of consumer's time values.

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 market work or choice of activities outside the market. In addition, the utility function is defined over total goods consumption $(Y + A)$ and market 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

$$\begin{aligned} Et_{n\cdot w} = [(T - t_n)/T] \\ \{-1 + s_1[F_{M1}R_{L1} + F_{L1}R_{M1}] \\ + s_2[F_{M2}R_{L2} + F_{L2}R_{M2}] \\ + s_D[(R_{L1} - R_{L2})(F_{L1} - F_{M1})]\} \end{aligned} \qquad (4)$$

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), 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, p. 679).[11]

The elasticity of market work with respect to the wage rate is seen to be an increasing function of the weighted average for the (nonnegative) 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. Suppose the evolution of household technology has made it easier to substitute market goods for own time in the 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 for substitution of own time, we can predict from equation (4) an increased labor supply elasticity.[12]

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. (pp. 40–41)

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.

2. *Applications of the hpm Models*

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

$$Y = Y(t_n, Z_j) \tag{5}$$

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 (Alfred Marshall 1920; John Hicks 1932). Certain nonmarket activities contribute to market productivity and this leads to a modified labor supply model (Jeff Biddle and Hamermesh 1990). In that model the nonmarket activity that enhances job performance (e.g.,

[11] The results in (4) can be extended to the case of differing, nonunitary income elasticities.

[12] In this discussion we are assuming interior solutions.

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 Malcolm 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 (Robert Willis 1973) and the intrafamily allocation of time (Marilyn Manser and Murray Brown 1980; Marjorie McElroy and Marilyn Horney 1981) 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,

$$Z_c = C(X_c, t_c) \tag{6}$$

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 ($Y_f = \omega T + A$), the wage elasticity of childcare time can be shown to be

$$|Et_c \cdot \omega|_{y_f} = (1 - k)s_D(\beta_s - \beta_c) - (1 - \beta_c)s_c \tag{7}$$

where time intensity for childcare is $\beta_c = \omega t_c/\Pi_c z_c$, 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 childcare time per child (C. Russell 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.

3. *Intertemporal Time Use*

Cross-sectional observation via time diaries indicates that time use is strongly related to age. 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:

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

subject to

$$R_{m+1} = R_m + (T - t_{1m} - t_{2m})\alpha K_m - pX_m + rR_m \qquad (9)$$

and

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

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 α 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 (Gilbert Ghez and Becker 1975; Alan Blinder and Yoram Weiss 1976; Harl Ryder, Stafford and Paula Stephan 1976), and these predict a life-cycle pattern such that hours of market work will be greatest in an individual's 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 decline in later phases.

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 (αK) grows, the greater value of labor market activity should increase market 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).

It is worth noting that dynamic life cycle models suggest the possibility of large qualitative changes in the lifetime pattern of time allocation in response to relatively small changes in some of the parameters, including initial wealth. For example, it is theoretically possible to observe dramatic changes in career and nonmarket time use of the sort observed for women in industrialized societies as a consequence of small changes in the opportunity set. Similarly, optimizing life-cycle behavior is consistent with dramatic life style changes in response to modest changes in opportunities as an economy begins the transfer from agriculture to industry.

4. *Some Qualifications*

How essential is the household production model to understanding behavior? Our discussion has indicated some insights: to name several, the household production model can better illuminate travel mode choice since we can observe the time required for different modes explicitly; new household technologies can impact labor supply elasticities, and indeed we can express the labor supply elasticity as a function of preference and household technology parameters; variants of the household production model have been used to explain sleep as an endogenous variable.

On a more skeptical note one might be inclined to interpret many of the basic facts about labor supplied to the market from the perspective of the simpler traditional labor supply model. For example, as the consequence of income effects dominating substitution effects there has been a decline in men's market work hours as real wages have grown in Japan, the United States, and Scandinavia. Further, if one contemplates the labor supply elasticity in the hpm (4), the childcare elasticity expressions (7), or those derived in the dynamic models (8)–(10), it could be concluded 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 1985b, 1991). 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 Robert Pollak and Michael 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 that can be tested with diary data. Another direction (Pollak 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. Reuben 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 that 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 rates in Eastern Europe have (negative) income effects that dominate substitution effects and lead to greater market hours for men in the USSR and Hungary.

This view is supported by the practice of Russian pensioners returning to work (Oxenstierna 1990) and the generally low Russian wage rates. One study estimates that the wage rate in the USSR is less than half that in Western Europe and the U.S. (Keith Bush 1984), and that the

apparent rate of USSR wage growth in the 1980s was negligible or possibly negative. A caution here is that hours of work in the USSR are known to involve idle time arising from poor coordination of activities and intermediate goods supply in the workplace. If so, time at work may not measure effective labor supply but might include a type of on-the-job "leisure." Moreover, work hours are set by decree, with the last major change apparently that of March 1967 (Oxenstierna 1990).

Even if one postulates that hours fixed by decree are influenced by underlying worker preferences to some extent, a simple labor supply interpretation of intercountry differences will not hold up. For example, the data show that Japanese men, who have much higher wage rates, work about as many hours as do Russian or Hungarian men. A simple modification of a labor supply approach would be to argue that there are country-specific differences in preferences; allowing for these effects, the change in labor supply in repeated cross-sections could be explained by wage changes in each country.

Another approach to understanding market work differences of men in different countries would be to look at intrafamily division of labor between men and women in market and nonmarket activities. This is clearly an important phenomena: Japanese women specialize more in housework, performing 31.0 hours per week of housework in comparison to only 3.5 hours for men. It is the combined effect of market and nonmarket work differences which create approximately equal leisure time for Swedish and Japanese men: regardless of conceptual model (labor supply, hpm, or other), data from diaries are essential for observing the fact that men in both these high-income countries have about the same amount of work and leisure.

Even if we restrict our attention to market work, there are advantages to diary-based measures. For the United States the time-series data (from Current Population Survey (CPS) or establishment sources, which use nondiary measures of work hours) show a gradual decline of about 8–10 percent per decade in hours of market work for working men, as real wages rose, up until about 1960 (H. Gregg 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 (Chinhui Juhn, Kevin Murphy, and Brooks Pierce 1989; Robert Moffitt 1990; Thomas MaCurdy and Thomas Mroz 1989).

Suppose nondiary reports of weekly hours continue to be reported at some "normal hours," both from employers, who report hours paid for, and from respondents, who are asked for their hours of market work in the previous week. Specifically, these nondiary reports of market work continue to be overrepresented by numbers like "40" (Lewis 1957, p. 201) even when actual hours on the job continue to decline. Using the panel data from the 1975/76–1981/82 Time Use Survey, it was found that diary measures of market work hours showed a decline of an hour more than the market work hours reported by the same respondents (Hamermesh 1990). The trend toward shorter hours and rising hourly wages would be obscured if, as hours fell to 40 and then below 40 the measured hours continued to register as 40. And hourly wages (measured as wage income divided by hours) would also appear to grow at a slower rate. Data from the Japanese household survey shows a parallel pattern; there appears to be a tendency for men's market hours to persist at 50

when diary data (such as in Table 3) indicate a steady decline below 50.

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 3 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 work 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 (N. Sören Blomquist 1983). One study interprets the tax disincentives as so strong as to reduce not only market work but also tax revenue (Charles Stuart 1981). Starting in 1990, Swedish workers face substantially lowered marginal tax rates with a further reduction scheduled in 1991. This sequence of tax reductions will have dropped the highest marginal personal income tax rates from approximately 85 percent to about 65–70 percent in 1990 and then to about 50 percent in 1991.[13]

Diary data in Table 1 show that in 1984 Swedish men and also Norwegian men (in 1980, Table 3), who are subject to a similar tax system, had higher hours of housework than men in other economies. The hpm and the standard labor supply models would both predict a switch toward market work, but special forms of the hpm to be discussed below emphasize more explicitly the potential for a reduction in household production as distinct from leisure time. In contrast, sociological models that emphasize societal forces leading to less differentiated sex roles for men and women would predict no change or possibly a continuation of the time trends seen in Sweden and elsewhere, where diary-based measures show men doing an increasing amount and share of housework.

The changes in the Swedish tax law are designed to yield a balanced government budget and include reduced entitlements and increases in taxes on cigarettes, gasoline, and other items. As a rough approximation the Swedish tax law changes can be regarded as effecting an income-compensated rotation of the budget line: from the perspective of the basic labor supply model the only issue is how large will the increase in market work of men be?

More formal tests of static labor supply models using diary data are just beginning to appear. A 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 (John Pencavel 1986). Analysis of data on Swedish males' labor supply (Lennart Flood 1989) appears to offer modest confirmation of this: Those with

[13] Using a nationally representative sample of Swedish households (Klevmarken and Paul Olovsson 1989), the mean marginal tax rate was calculated to be 43 percent in 1984. The information is from personal communication with Anders Klevmarken. Presumably this average marginal rate will be falling, but if the response to the tax laws includes more market work hours and earnings, then the observed average marginal rate will not decline as much. It should also be noted that there is a sizable payroll tax in Sweden, almost 40 percent, which is not scheduled for reduction. Thus, the percentage reductions in the tax on market versus nonmarket production of such goods as home repairs may end up being far more modest than suggested by a decline in maximum tax rates on labor income from 85 to 50 percent. The income taxes are levied by both the national and the local governments. The new tax law stipulates that local governments may not raise their rates as the national rates are reduced.

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 that 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 a time-intensive commodity (Z_j) that 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 nonunion 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 during downturns employees keep on workers not needed for current production, particularly workers with firm-specific skills in technology-based companies (Mincer and Yoshi Higuchi 1988). This is done in expectation of eventual greater use of their services when demand recovers (Stephen 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 a caring for children or market work, tended to be rated more highly than activities that are solitary. The least preferred activity was household chores, typically the most solitary activity.[14] While some researchers are skeptical 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),[15] one can adapt many con-

[14] As 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, Paul Courant, and Greg Dow (1981) and Juster (1991) make the same point.

[15] Besides 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.

ventional models to deal with the presumption that market work provides inherent satisfaction as well as purchasing power.

In a labor-leisure model with work yielding high intrinsic satisfaction there are some specializations of the utility function that 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 leisure versus off-the-job leisure, and firms differ in their ability to offer packages with different on-the-job leisure 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 (Sherwin 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 recorded between men and women, with women placing more emphasis on coworkers' ratings and men placing more emphasis on learning opportunities (Juster 1985b). For students of labor supply, are longer market hours induced not just by the substitution effects of higher wages but also by the attractiveness of the working conditions (on-the-job leisure), particularly the social aspects of work? If long hours are induced by on-the-job leisure, what influences will this have on measuring productivity growth and "true" labor supply?

Evaluation of life-cycle models such as equations (8)–(10) has been largely independent of time diary data. Specifically, Ghez and Becker (1975) relied primarily on information on retirement from the labor force rather than on variations in market hours of workers to support their model's prediction of rising market work time as skills rise with age. Data from diary measures show a more pronounced age-dependency to market work even among labor market participants, and when the diary measures are modified to subtract nonwork time on-the-job this age dependency becomes even more apparent. Specifically, in 1976 U.S. men under age 25 worked an average of 24.5 hours per week as measured by the time diary, and those 45–54 averaged 31.2 hours. Nondiary measures for the same age groups show hours of 40.1 and 41.1 per week, respectively (Stafford and Duncan 1985).

Diary data can also be used to test the hypothesis that leisure is concentrated in early and later life-cycle periods when market earning power is smaller. This prediction is strongly supported by the fact that early life-cycle leisure is more in the form of active leisure (active sports, social entertainment), while later life-cycle leisure is more in the form of

passive leisure, particularly TV viewing. A radically different interpretation of life-cycle behavior is that clinical depression is most prevalent among young and old in the population (Ronald Kessler et al. 1990). Is it possible that high levels of leisure observed at certain points in the life cycle reflect stress rather than pleasurable activity?

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 (B. Peter Pashigian and Brian 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 3 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 price of own time relative to that of labor purchased through the market for repair or other household services. As well, the price of men's and women's time is far more equal after tax. Thus, it is not surprising to observe high levels of men's home production time and household division of labor more equal than in other economies.[16]

If we examine goods and time in home repair by men based on more detailed time use data than presented in Table 1, we can make much more precise comparisons of the U.S. and Sweden. Exact data on home improvement expenditures (X's) in the two countries are not easily obtained, but limited evidence suggests these do not differ much per capita. Hence, under the assumption of minimization of the full (time plus money) price of home repairs analogous to our discussion of equation (7) or Gronau's travel mode model, we expect differences in taxes to alter the input ratio toward more time in home improvement for Swedish men. A prediction is that home repair time relative to market-purchased inputs should decline in response to the current and pending reductions in marginal tax rates in Sweden. As it stands now, Swedish men are the clear leaders in home improvement time, averaging over 4 hours per week in 1984. In contrast, men in the U.S. averaged 2.8 hours, Japanese men less than 1 hour.

It should be noted that a detailed comparative analysis of Sweden, Japan, and U.S. home repair time would be best conducted by utilizing the actual micro

[16] Note that time diary data for the same country through time have the advantage that time invariant country specific effects should be controlled for. For this reason the availability of data of the type reported in Table 3 is particularly important if one believes that intercountry differences in institutions and preferences are so great as to preclude such multinational comparisons.

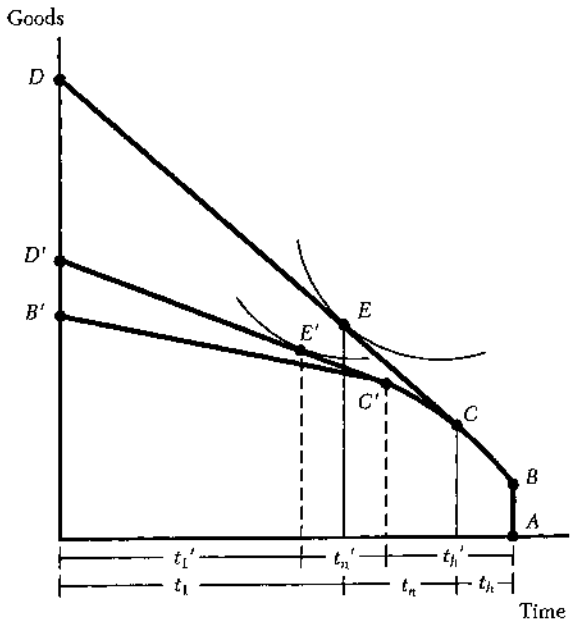

Figure 1. Taxes and Home Production

data from the countries. This would allow statistical controls for home ownership and could possibly illuminate the effects of other influences such as labor-market policy. For example, Sweden has a more comprehensive and flexible work-leave policy for both men and women (Marianne Sundström 1990). This may help to free up time for larger time projects.

Abstracting for a moment from such institutional factors, the value of even the simplest household production model to analyze choice among time uses can be illustrated from the Table 1 data for Sweden. If taxes have discouraged men's market work time in Sweden, it can be predicted that the result will be more production of home output but not necessarily more leisure. At the risk of oversimplification, consider the well-known one-person model (Figure 1) of household production in Gronau (1977). In this representation, AB is unearned income, BB' is a (diminishing returns) output function from home production time, CD is goods purchased with market earnings when the marginal tax rate is zero, and E indicates total goods consumption associated with the optimum choice of t_h home production time, t_n market work time and t_l leisure time. With the (high) Swedish marginal tax rate, $C'D'$ becomes goods purchased with market work, and the new equilibrium is E', with more home production (t_h'), less market work (t_n') and in Figure 1, less leisure.

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 (Jennifer Gerner and Cathleen Zick 1983). 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 (M. Hill and Juster 1985).

There is a strong positive correlation between each spouse's time spent in leisure activities such as time in organizations, TV viewing, and sports. These results suggest that spouses' time is substitutable for activities without inherent benefits (as with drudge work) but

TABLE 6

DECADE-TO-DECADE CHANGES IN DOMESTIC WORK FOR MEN AND WOMEN, SELECTED COUNTRIES (DIARY MINUTES PER DAY)

	Canada	Denmark	Holland	Japan	Norway	U.K.	U.S.
				A. Men			
60s to 70s	NA	+4	NA	+1	NA	−12	0
70s to 80s	+11	NA	−1	−0	+10	+20	+18
				B. Women			
60s to 70s	NA	−79	NA	+0	NA	−60	−43
70s to 80s	−45	NA	−2	−1	−64	−14	−19

Source: Adapted from Jonathan Gershuny and Robinson (1988). The entries are adjusted for changes in demographic composition in the countries and apply to all adults whether or not they are labor market participants.

is complementary for most leisure activities. This finding also highlights an important point about survey design: 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, as well as the Swedish 1984 data, are for such pairs, virtually all of the data sets 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 3, a finding that can be explained by a pattern of growing (aftertax) 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 (Siv 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 aftertax wage equality of men and women, and this should reduce incentives for specialization in market or nonmarket activities by men and women. The prediction of more equal housework time for men and women in Sweden is consistent with the time diary data in Table 1 and with a recent study (Flood 1990) showing a slightly higher marginal aftertax wage rate for women than for men in Sweden.[17]

Another perspective on this issue can be seen from Table 6. 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 (aftertax) 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. The U.S. also has joint taxation of income but the rates were lower than in European countries and were reduced when changes were made to diminish the "marriage tax." At the same time the market earnings potential of women was

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

growing, particularly during the late 1970s and 1980s (James Smith and Michael Ward 1984).

Time diary data have been used to study the effect of intrafamily bargaining power as influenced by the legal provisions of divorce laws of the different states in the U.S. There appears to be less leisure time and more housework by husbands in states where divorce settlements are more favorable to the wife (Paul Carlin 1991). This research also indicates that childcare time is influenced by divorce laws, with children receiving more quality care time from fathers in families residing in states with divorce settlements more favorable to the wife. These impacts of legal structure on the division of labor can be regarded as consistent with the observation of the housework time of Scandinavian men and women reported in Tables 1 and 3.

The influences of tax laws certainly must shape some of the differences in the household division of labor between Scandinavia and Japan, and could be analyzed in a nonbargaining framework. However, tax law provisions as well as other extensive programs improving the out-of-marriage utility state (such as public daycare, adult vocational education, and parental leave) should provide Scandinavian women an improved threat point within marriage. Thus, application of the well-known models of intrafamily bargaining (Manser and Brown 1980; McElroy and Horney 1981) could be useful in understanding some of the wide differences across societies in the housework and free time of men and women observed in Tables 1–3.

3. *Child Care and the Family*

From the simple theoretical model of childcare in Section II, the sign of the uncompensated wage elasticity of childcare time can be seen to depend on unobserved structural parameters. Analysis of time diaries shows more childcare time per child by higher wage mothers, a pattern consistent with a high-income elasticity of demand for child development, *and* with the presumption that it is difficult to substitute for own time in the care of children under age 3 (C. R. Hill and Stafford 1985). Moreover, research has shown a substantial nonmarket productivity connection: Diary and other measures of mother's care time per preschool child are positively related to subsequent school performance and earnings (Stafford 1987; Linda Datcher-Loury 1988).

Analysis of the production of jointly consumed family public goods, the production of private goods as well as the division of labor in home production, are important for understanding the economics of marriage: Successful marriages are those in which each of the marriage partners gains over alternative marriage states (a different spouse or living single). These marriage gains will be greater if spouses' time in leisure (sports, entertainment, socializing, childcare, and the like) is complementary, but where spouses' time in routine chores or what might be called drudge work is substitutable (M. Hill and Juster 1985). The need for diary data to test these marriage gain models and the resulting stability of marriage is apparent. To illustrate, a recent study based on time diaries for respondent pairs (Paul Kingston and Steven Nock 1987) shows that dual-earner couples have less opportunity for time together in domestic life and, as a consequence, have lower reported levels of a marital quality index.

4. *New Directions*

While some of the research findings on nonmarket time are consistent with conventional economic models, findings that suggest rethinking of these models

have also emerged; here we will highlight three.

Clues to nontraditional reasons for declining market work hours are available in the time diary studies: In both Japan and the United States the decline in diary estimates of market work hours of men coincided with a rise in television viewing as color TV and more diverse programming were introduced, presumably to target advertising to those with higher incomes. In the U.S. this programming appears to have its major impact by increasing the TV time of the more educated adult males between 1965 and the late 1970s. For both economies, as of the early 1980s the trends toward more TV and reduced market hours for men slowed (Juster 1985b; Naomichi Nakanishi and Yutaka Suzuki 1986). From the perspective of policy analysis, it is of great importance to realize that reduced market work of adult men in these industrialized societies was very possibly the consequence of a new household technology rather than tax rates or rising income, and that possibly a further changing television technology (e.g., video) could have additional major impacts on market activity.

Time diary data for children between the ages of 3 and 17 indicate definite age-dependent activity patterns that differ by sex, with the differences becoming larger as children mature. For example, while there is only a small difference between boys and girls aged 3–11 in time spent in market work and household work, there is a substantial difference between boys and girls aged 12–17: Older boys work about twice as much in the market on weekends as older girls, and girls do more than twice as much work in the household than boys on both weekdays and on weekends (Susan Timmer, Jacquelynne Eccles, and Kerth O'Brien 1985). These evolving differences imply that early socialization patterns for boys and girls may be part of the explanation for subsequent differences in labor market activity of adult men and women (Mary Corcoran and Courant 1990).

Finally, both the U.S. and Swedish time diary data sets indicate the potential importance of including intrinsic preferences for activities in the models. Both data sets indicate that the usual simplifying assumption of consumers' indifference to alternative time uses is not valid, and that properly specified models will have to include these preferences.

5. *Time Buffers, Sharing, and Time Insurance*

Time allocation data have been used to illuminate the use of what can be called time buffers. These and time sharing are substitutes for various types of insurance systems, possibly including insurance systems based solely on time as the denominator for both premiums and claims. Here we offer some fragmentary findings from both preindustrial and modern societies, and use these to illustrate potential research opportunities.

Recall our interpretation of the low working time of men found in studies of agricultural villages in Asia and Africa and of the Kalahari hunter-gatherers. The argument was that low working time was an adaptation to the need for a kind of time buffer to protect the population against swings in harvestable food supplies rather than being explained by strong substitution effects toward leisure as in the traditional economic interpretation of the association between low work hours and low wages.

If the population were built up to the limit by greater time allocated to work during good times, limited storability would lead to starvation during food crises. Such a system of low work time as both a buffer and a check on population could evolve into a pattern of male domination after the need for such time buff-

ers dwindled with the growth of storable crops, markets, or other mechanisms for limiting risk, such as insurance.

While the sample frame of these studies of agricultural villages implicitly excludes periods of village crises, data for developed countries include situations where there are stresses for individual families that cannot be dealt with by insurance. For example, research shows that more educated U.S. women with preschoolers present in the household increase their total work effort: market work is maintained at a high level, and childcare responsibilities require added housework time as well as childcare itself. At the same time men's time use in these households does not appear to change much. In the process both sleep and passive leisure (largely TV viewing) of the mothers are reduced below normal levels (C. R. Hill and Stafford 1985), and these women could be said to be subject to a "time squeeze." Why is there such a minor response of spouse's time to these conditions?

Sharing systems are found in the Kalahari society (John Yellen 1990). Here we will distinguish sharing from insurance by the degree of actuarial specificity of the terms of the arrangement, and it is natural for monetary or other quantifiable entries to support insurance since they promote such specificity. Another system feature could be differences in form of payment among participants, with some paying cash and others devoting time, some receiving services and some receiving cash or goods.[18] Most of the research has focused on sharing of goods. An interesting question is sharing of time services. What appears as sharing could be represented alternatively as an organized insurance system in both industrial or hunter-gatherer societies. For example, a time-based system of "babysitting" insurance appears to exist in the U.S.

Consider a time-based insurance system with a large set of parents. Almost every week a participant in the babysitting system can expect to help somebody for an hour or so. What they get in return is the ability to draw on the system for several hours if a crisis should arise. (Here a crisis is defined as something the usual babysitting arrangements will not cover.) The normal hour of help is the premium for claims which may occur for an "insured loss." Note that a market economy is not needed for such a system, and it could be organized as a system of gift exchange with much of the activity taking place within families. However, unless time is quantified as with clocks, the system will probably be one of sharing rather than of insurance.[19]

Cultural patterns of sharing or time-based insurance appear to be transmitted through generations. For example, as of 1980 an astounding 95 percent of a sample of poor rural blacks in the (Southern) U.S. reported having emergency help available in a form other than an emergency loan (Terry Adams and Duncan 1990). Specifically, this non-money help was in the form of "a lot of time helping out." In the parallel white sample, 79 percent report such help being available.[20] A concern is that there has been substantial erosion of this sharing system within the black family during the last decade. A recent study indicates the percent of blacks seeking informal help for serious personal problems declined from

[18] Note that insurance or sharing can apply to surpluses as well as to losses. In either case there is an increase in total (social) utility to be achieved by a form of redistribution.

[19] As well, such a system would be subject to usual limitations of insurance systems such as moral hazard and adverse selection into the insurance pool.

[20] Other studies also strongly support the notion of sharing within black families (Carol Stack 1974; Robert Taylor, Linda Chatters, and Vickie Mays 1988).

43.0 percent in 1980 to 28.4 percent in 1987 and the percent receiving neither formal or informal help rose from 8.7 to 24.5 percent over the same period (Jackson and Monica Wolford 1990, Table 3).

The lower percent for sharing of time among U.S. whites (Adams and Duncan 1990) could be explained by their European heritage, which emphasizes market and money denominated social insurance—a tradition that extends back to a time prior to the pre-Indo-European period. The intrusive Indo-European "Mafia" from the east (Antonio Gilman 1990) also came to accept market based institutions and other aspects of commercial activity from the indigenous pre-Indo-Europeans in Northern, Atlantic Europe (Markey 1990). An implication is that time sharing systems are less dominant in these European cultures, given the longstanding experience with market or money-based insurance systems.

Sharing and helping out with time is also common in the culture of Northern Finland, where variable fishing harvests combined with limited storability to motivate sharing and generosity. These traditions carried over to such settlers in the United States (Ida Stafford 1981). Cultural sharing patterns can also be copied: "Southern hospitality" is a term used by Northerners to describe the practices of richer Southern whites. Southern whites were in direct contact with Southern blacks since slaves (and later freed slaves) worked in their households. Someone who is hospitable makes you feel that you can count on them for (time and other) help and that as a guest you got more than just a meal!

One objection to the observed cultural transmission of sharing or time insurance (the survey measure does not make this clear) in the case of U.S. blacks is that many of those enslaved were from the lush areas of West Africa. However, it is not unusual to observe sharing when there is persistent abundance. Why not share when there is always more? A benefit is that you may gain esteem and personal power; that is the interpretation of sharing (potlach) among the Kwakiutl indians of the Pacific Northwest (Harold Driver 1969, p. 210).[21]

It is also claimed that such sharing systems in regions of abundance served to preempt conflict and physical violence over who would control the surplus, a problem faced by both affluent African and European nations. Similar patterns of warring arose in New Zealand when the Maori discovered the cultivation of storable sweet potatoes (kumara), creating a strategic potato reserve (William Oliver and Bridget Williams 1981). In other cultures harvest surpluses were dissipated in a happier manner. For the themes in this paper, is it the case that abundance sometimes led to income effects increasing the sharing of time as well?

With a predictable surplus a socially beneficial system could encourage donation of resources to others, and analysis of U.S. households indicates the importance of income, tax rates, and beliefs and attitudes in donation to philanthropic causes (Victor Thiessen 1968). Some mid-1970's U.S. studies indicate that donations are more common among rich families, and that both time and money are given (James Morgan, Richard Dye, and Judith Hybels 1979) rather than there being a major shift away from time and toward money among those with higher wage rates.

A simple economic model of giving could call for high wage people to give

[21] Those who gave more were bestowed with titles and fanciful names such as "about those whose property people talk," "giving wealth," and "throwing away property" (Driver, p. 210). Since giving takes socializing and other time and reduces work time, does this partly explain the income effect toward more leisure in wealthy societies?

relatively more in the form of money and low wage people to give more in the form of time in the production of a charity Z (see Section IV, equation (7) for a case where income effects can induce more time to activity on the part of those with higher wages). Yet one observes that givers tend to give more of both while other families give little of either time or money. While a more complete model of intrafamily charity "production" could prove effective in connecting volunteer time to wage rates of different family members, the work to date indicates a potential role for a culture-based or a sharing of time explanation of giving. For example, using a small U.S. sample of employed males age 60 and older, it was observed that those in occupations with higher wage rates were far more likely to have volunteered time (Susan Maizel Chambré 1987, p. 62).

VI. *Social Accounting Systems*

1. *Introduction*

Time allocation data have been used in three sorts of economic accounting systems.[22] The most common systems have used the data in expanding the conventional National Income Accounts structure to include nonmarket production, to accommodate much broader concepts of investment, and to refine measures of consumption. Thus estimates of the value of time inputs into household production, as well as time inputs into leisure, have been added to national accounting production totals derived from market measurements, and concepts of investment have been redefined to include household investments in durables and in human skills, government investments in infrastructure, business investments in R&D, and so forth. We discuss the treatment of nonmarket time use in a number of such systems, drawing heavily on recent work by Robert Eisner (1988, 1989).

We also note briefly two other types of social accounting systems that are designed in principle to use time allocation data. The first constitute accounting systems in which the social and demographic characteristics of populations (age, sex, labor force status, educational attainment, marital status) are the main features of the system (Philip Stone 1972b). Systems with similar characteristics, but with the demographic data integrated into conventional or expanded economic accounting systems, have been developed by Richard and Nancy Ruggles (1978, 1985). Extended accounting systems of this sort also characterize the United Nations System of National Accounts-SNA—where demographic characteristics are described in various satellite accounts attached to conventional economic accounting systems.

Finally, a comprehensive social accounting system that is driven entirely by time allocation concepts is contained in Juster, Courant, and Dow (1981a, 1981b). The basic ideas here are that total societal output is constrained by the available resources of capital and time: Time can be allocated to the market for the production of goods and services, to the household for the production of nonmarket goods and services, to leisure, and to personal care and biological maintenance. Altogether, these comprise a mutually exclusive set of the available uses of time among the entire population. The allocation of time among these uses is jointly determined by market wage

[22] Other macro systems based entirely on time allocation data have also been developed, mainly by sociologists. These are systems largely designed to measure quality of life, and to trace the evolution of "committed time" and "free time" in society. Some of the relevant literature in this area has a methodological as well as substantive focus. See Dagfinn As 1978, 1982; Zahari Staikov 1982; Rudolf Andorka and Istrán Harcsa 1986; Nakanishi 1982, and Robinson, Vladimir Andreyenkov and Patrushev 1989.

rates, the household production technology, and the preferences of household members about the way in which their time is used.

The final outputs in this system are the utilities or satisfactions derived from various uses of time, and the utilities derived directly from various capital stocks (national security capital, health status, etc.). In this system, all of the goods and services produced both in the market and in the home constitute an intermediate product in the utility-generating function, since they affect the flow of goods (X's) used in the activities and thereby utility from the activity.

All of these economic or social accounting systems recognize the crucial distinction between time used for home production and leisure time use—a distinction first made by Margaret Reid (1934), later emphasized by Oli Hawrylshyn (1976) and Gronau (1977). A household production activity is defined as one where a third party could be paid to produce the output, while a leisure time activity is defined as one in which third-party production is conceptually impossible—e.g., attending the theater, playing sports, watching television, or sleep. Another important distinction, which is consistently recognized in the accounting literature, is between time spent for personal and biological maintenance (sleeping, eating, personal care) and time spent in other activities.[23]

The basic concept that underlies much of the interest in augmented economic and social accounting systems is that measurement of the rate of growth of real output in the economy as a whole, and the degree of improvement in broad notions of economic well-being, should not be influenced simply by variation through time in the share of economic activity conducted through markets, or by other institutional characteristics of the society. For example, one would expect to find relatively small market sectors in less developed countries, much of the output being produced within the household economy and most of the input not being priced. As economic development proceeds, the organized market sector in such economies is likely to grow, while the informal household sector is likely to shrink. It is clearly wrong to measure the growth rate of overall output by the growth of output in the market sector, since part of what is taking place is that the higher productivity market sector is absorbing resources formerly used in the lower productivity household sector; the growth rate of total output should include changes in both sectors.

Different developments occur in highly developed economies, where some of the changes between market and household sectors take the reverse form—public transportation yields to private vehicles, commercial entertainment yields to TV and home videos, the local laundry yields to wash-and-wear clothing, hours of market work typically decline for men, and the market work hours of women sometimes decline and sometimes rise. In light of the diverse pattern of shifts between market and nonmarket activities, accurate assessments of intercountry growth rates in real output need to combine outputs produced in the formal (market and public) sectors with outputs produced in the household sector.

2. *Valuation Issues*

All macro systems of social accounts need to decide on the appropriate valuation of nonmarket time (and of nonmarket stocks of capital as well, in most such systems). The issues here are quite com-

[23] Much of the micro analysis discussed earlier, particularly the analysis of labor supply, is based on data that do not contain these nonmarket differences in time allocation: Thus the analysis simply lumps together all nonmarket time uses, treating them as a homogeneous input into the utility function.

plex, and system builders have opted for one or another method of valuation largely as a function of whether the system was production oriented or welfare oriented. Thus, for systems designed to augment GNP accounts by adding the value of nonmarket production to the market output covered by GNP, the appropriate concept is a cost-based one and should be reflected by what it would cost to purchase the equivalent service in the market (Martin Murphy 1978; Gronau 1986; Zick and Bryant 1983; Janice Peskin 1982). A variant on that method, which is somewhat more appropriate analytically, is to value the time inputs into household production by an estimate of the money saved by the household in undertaking a nonmarket production activity, and to calculate the wage rate by dividing money saved by hours worked (M. Hill 1985; Carmel Chiswick 1982).

While appropriate for accounting systems that are based on aggregating production costs, that evaluation method is not appropriate for a system designed to measure welfare. Rather, the value of household production should be calculated as the value of the foregone alternative—the opportunity cost of spending time on household production. Thus, if the household production activity is done by a person with a market wage rate, and if the market wage rate is equal to the marginal wage rate, the appropriate estimate of opportunity costs is the marginal wage rate multiplied by 1 minus the marginal tax rate.

It is widely recognized that this measure of opportunity cost is biased upward if the marginal wage rate for household members who do not work in the market is estimated by a conventional set of human capital characteristics: The fact that household members choose not to work for pay in the market contains information: The presumption is that, given a set of observable human capital characteristics, people who do not work in the market have a lower opportunity cost of market work than those who do (assuming equivalent preferences for market and nonmarket activities). In effect, using wage rates for market workers and imputing wages from human capital characteristics for nonworkers produces a biased estimate of the opportunity cost of market work for nonworkers, a bias that can be corrected with appropriate estimation techniques (James Heckman 1979).

It should be noted that this literature basically ignores several important aspects of valuation, simply because they are analytically or empirically intractable. For example, all existing estimates of opportunity costs ignore the preferences of household members for different activities, and there is well-documented evidence (see pp. 495–96 above) that household members differ substantially in the characteristics of their intrinsic preferences for various activities. This is actually quite a pervasive problem, and does not apply only to the valuation of nonmarket activities. The utility generated directly by engaging in productive activities is always ignored in valuation systems that are based on production cost concepts, as it should be. But that source of utility is also ignored in systems that are aimed at a welfare concept, and in principle it ought not to be.

Perhaps more importantly, systems for valuing nonmarket activity make extremely simple assumptions about the relation between market and nonmarket productivity, and about the productivity of own time in a nonmarket production activity compared to the cost of purchasing the equivalent service in the market. One of the characteristics of much household production activity is that it consists of highly differentiated tasks involving relatively brief periods of time: the cost of purchasing an exactly equivalent service in the market includes both trans-

portation costs and setup time, as well as the time required to describe to outside suppliers exactly what product is desired by the household. Market-provided services typically have minimum prices, they often require that someone be present to describe and direct the activity, and they can often be done simultaneously by some household member who is at the same time doing some other household task—i.e., installing a light switch while babysitting the children.

Although the available data on time allocation contain quite substantial detail on the specifics of household production activities that take place during the course of the day, they do not provide any information at all on the true cost of equivalent market services. The typical valuation systems that deal with production concepts ordinarily estimate the "market cost" equivalent as the hourly wage rate for market workers multiplied by the hours spent by household members—a procedure that clearly ignores the fixed-cost element of doing a particular household production activity as well as the short duration and the overlapping nature (simultaneous, to a first approximation) of many such activities. The basic difficulty here is that the data base needed to describe real world situations accurately is substantially more complex than any data base that currently exists.

3. *Extended Accounting Systems*

Here we discuss the assumptions, procedures and empirical findings for a number of the extended accounting systems that have been implemented for the U.S. We focus on William Nordhaus and James Tobin (1972), John Kendrick (1979), Eisner (1989), and Dale Jorgenson and Barbara Fraumeni (1989, 1990), since these systems all make extensive use of time allocation data to estimate nonmarket components of output.

In Nordhaus and Tobin's accounting system (1972) it is assumed that household work is a function of labor force status and sex. The number of hours of nonmarket household activity is assumed constant for each work status/sex subcategory for the entire period 1929 to 1965, and household production time is valued at the (pretax) wage rates of household members. For leisure, Nordhaus and Tobin assume that hours vary inversely with the number of hours in gainful employment, given employment status; thus they value the increased leisure time resulting from lower hours for employed workers at the going wage rate, and value the leisure time of the unemployed as if they were employed. That treatment produces curious results for periods of time like the Great Depression, where the estimated number of leisure hours and the imputed value of leisure time grew rapidly. Although the valuation problems are thorny, it seems more plausible to us to treat leisure time as being valuable if and only if it results from an interior solution to the utility maximization problem, rather than from the corner solution of involuntary unemployment; those facing rationed market hours will have a shadow value of home time below their market wage.

In Kendrick's accounting system (Kendrick 1976, 1979), somewhat similar procedures to those used by Nordhaus and Tobin are followed for household work—time use data are used to construct average weekly hours by household members in various types of families and/or households, and these weekly hours are assumed not to change over the entire period for which the accounts were constructed (1966–1973, with updates to 1985). Total household work hours would of course change if households' composition, labor force participation rates, etc., change over time. Household production time is valued at the wage rates of persons in household employment—i.e., do-

mestic workers. For leisure hours, Kendrick's earlier work did not make an imputation, but his more recent work assumes leisure hours as fixed per capita over the relevant time period, valued at the pretax market wage rate.

One further distinction between the Kendrick and Nordhaus and Tobin calculations is that the latter use a much earlier (and more fragmentary) time use survey for the benchmark numbers, while Kendrick uses data from the 1960s and 1970s—a somewhat better benchmark. But it is still the case that neither of these approaches allows for the variation in household work for men or women observed in Table 2 and Table 5, other than through changes in labor force status, age, and other relevant characteristics. The basic data discussed earlier in this paper suggest that a rigid assumption of this sort significantly fails to capture the actual movements over time in household work activity by men and women.

Estimates of household work time in Eisner's accounting system (1982, 1988) are much more closely linked to the available time allocation data bases than either Nordhaus and Tobin or Kendrick. Eisner uses estimates from the time use studies for the U.S. of 1965–66, 1975–76, and 1981–82 to calculate hours per week devoted to household work by people classified by employment status and sex, and he interpolates annual estimates from the three benchmark time periods for which survey data have actually been obtained. Like Kendrick, Eisner uses the wage rates of domestic workers to value household production time. Eisner does not value leisure time in his system, as do Nordhaus and Tobin, and (in his later work) Kendrick.

A variant that we believe is the best single measure for valuing the time inputs of family members in household production—the household's estimate of the money cost difference between buying the service in the market and producing it within the household—has been used only occasionally, partly because the relevant data are sparse. As noted above, the money costs saved by home production can be converted to a wage rate by dividing it by the number of hours worked to produce the product.

An interesting application of this principle, as well as an illustration of how time allocation data and methodology can be used to value an important home production output, is contained in an analysis of home repair and alteration activities by M. Hill (1985). Such activities were not only reported as part of the 24-hour time diaries, but a special segment of the survey asked respondents directly about time use and money expenditures for a wide range of home repair/alteration projects covering the preceding 12 months. Thus there were two alternative methods of estimating time inputs into home repairs and alterations (diaries and direct questions), as well as estimates of expenditure on material for do-it-yourself repairs and alterations. Data were also available from a different survey (the Panel Study of Income Dynamics), where respondents were asked how much money they saved by doing home repair or alteration tasks themselves, compared to purchasing equivalent services in the market.

From these data, estimates can be derived of a number of accounting totals that are of obvious relevance to the construction of accounting systems which are augmented to include unpaid household labor:

1. The total amounts of time reported directly by respondents as being spent on repair and alteration projects over the preceding 12 months.
2. A different estimate of the total amount of time spent on such projects for the same respondents, us-

ing data from the four time diaries obtained over the course of an approximate 12-month period.

3. Respondent estimates of the total amount of money spent on material relating to those home repair and alteration projects.
4. An estimate of the total value of unpaid time, computed either by using the market wage rate or the reservation wage rates of respondents doing the home repairs, or computed using the "money saved divided by hours spent" wage rate.

Estimates of the total value of home repairs and alterations done with unpaid household labor suggests that less than half of the appropriate total is included in conventional economic accounting systems, which include only purchases of material inputs. Given the large intercountry differences in home repair time (Section V.2) and other nonmarket time (Tables 1–3), allowance for such imputations could easily influence our view of economic performance and growth among nations. Comparing opportunity cost estimates of the value of time with the "money saved" basis for calculating wage rates, the opportunity cost numbers are about 25 percent too high, on average, across a wide range of repairs, home improvement, and other home maintenance activities. These estimates are broadly consistent with other calculations recorded in Eisner (1988), where it is noted that opportunity cost estimates of nonmarket wage rates are 30–40 percent higher than the wage rates paid in the market for equivalent services.

Finally, Jorgenson and Fraumeni (1989, 1990) have developed a set of extended accounts that differ greatly from any of the other systems we discuss. The major innovation is in the measurement of human capital investment, where a gross present value of future earnings concept produces very large numbers for gross saving and investment. The time allocation data enter the system in the consumption of nonmarket goods and services, where opportunity cost measures net of taxes are used as the valuation method.

These macro accounting systems have the potential for illuminating two types of economic problems. The first, which has been the principal focus of all of the existing systems implemented to date, is to create a better measure of long-term output trends than can be obtained by simply looking at output in the market sector alone. For that purpose, adding in household production is clearly crucial, and adding in leisure time is important if one wishes to have a welfare interpretation of long-term trends. A second possible purpose, which none of the existing systems has examined because the data are not adequate, would be to explore the cyclical sensitivity of output in the economy as a whole, examining changes in both market and nonmarket output to gauge cyclical sensitivity. Work by Ironmonger (1989) explores the argument that cyclical sensitivity is a good deal less than is commonly thought because part of the decline in market output during contractions is offset by a rise in nonmarket output, but there has been little or no specific quantification of this effect.

The existing augmented systems do show different real growth rates over extended time periods for the U.S. For example, Nordhaus and Tobin show substantially higher real growth pre-World War II, and lower growth post-World War II, in their "welfare" measure than in conventional real GNP, largely because of the inclusion of leisure time in their welfare measure; the extent of the difference varies with the assumption about an appropriate deflator for the value of leisure time. Kendrick and Eis-

ner generally show lower real post-World War II growth rates in comparison to GNP growth rates, and both show larger fractions of investment to GNP. And all such systems show the household sector as much more important than recorded in the official GNP accounts, as is necessarily the case. But these are all exploratory systems with significant room for improvement in both conception and execution.

VII. *Concluding Comments*

1. *Time Use Findings*

Time use data provide a unique research resource for examining important scientific and public policy questions, many of them involving cross-national differences. For example, in Holland and Japan the earnings of couples are subject to joint taxation at a single marginal tax rate; there has been little reallocation between men's and women's share of housework and market work over recent decades (Table 5). In Norway and Sweden the earnings of couples are taxed separately at their own marginal rates; there has been a much stronger tendency toward equalization of market work and housework by men and women. These comparisons suggest that joint taxation has been a cause of the weaker tendency toward equalization, an outcome consistent with predictions of the household production model. On the other hand, the U.S. has joint taxation and considerable equalization of work time, while in the USSR income taxation is not very important[24] and the tendency toward equalization is much like that in the U.S. Research based on the micro data for several countries should be able to provide better specification of the role of taxes and other influences on work allocation between the sexes.

In many countries in the developed West, the 1980s have seen substantial reductions in marginal tax rates, with other reductions scheduled. According to the models discussed in Section IV, these changes in tax rates should have a substantial impact on the allocation of time between market and nonmarket production, and on the allocation of market production time between men and women. Some recent and prospective changes that would be expected to have a substantial impact on time allocation are the cut from roughly 50 percent to a little over 25 percent during the decade of the 1980s in the top U.S. marginal tax rate, and the scheduled cut from about 88 percent to roughly 50 percent in 1990–91 in Sweden's marginal tax rate. In contrast, Norway's marginal tax rates have been maintained at very high levels throughout the 1980s and no change has yet been implemented. And finally, potentially dramatic changes in incentives for market and nonmarket work are in prospect for Eastern European countries that are in the process of transition from centrally planned economies with questionable economic incentives toward more market-oriented economies with substantially stronger market incentives. What differences will emerge between the U.S., Scandinavia, and Eastern Europe in time allocation? What will be the new patterns of regular market work, work on own agricultural plots for market consumption, and home production work in Eastern Europe? Time allocation data would be a powerful tool for these types of analyses.

It is clear to us that the best way to assess the kind of changes that are likely to take place, both in countries where tax rates have been changing and in countries where the basic incentive structure is undergoing change, is almost certainly

[24] The core of the USSR system for taxing households is a turnover tax levied on commodities. The effect on household work incentives is much like that of a flat rate (joint) income tax on families.

with a set of consistent data on time allocation. As we have noted earlier, conventional methods of measuring time spent in market activities, as well as time spent in nonmarket activities, appear to be seriously deficient and are likely to provide substantially biased estimates of labor supply responses.

Other areas in which time allocation data play a very important role are in tracking the evolution of paid and unpaid work in economies that are undergoing economic development, in understanding the production of cognitive and social skills in children as the inputs change from unpaid parental time to more formal daycare arrangements, and in modeling the role of paid and unpaid inputs in the provision of care for the elderly. In all of these cases, we are likely to see substantial change in the relative importance of services produced in the market and services produced in the household, and we know of no effective way of analyzing such changes in the absence of data on time allocation.

There is a set of issues associated with the measurement of output changes over time and changes in well-being over time that can best be tackled with time allocation data in conjunction with other relevant variables. For example, there is some reason to suppose that the cyclical response of the economy to changes in demand is overestimated if the measurements are restricted to changes in market-produced output, since part of the reduction in market output may be offset by increases in nonmarket output. Analyses of this sort are simply the cyclical representation of the same types of changes that need to be tracked in developing economies as the market sector grows and the household sector shrinks in terms of output shares.

The productive uses of leisure time are an important issue from the perspective of many social scientists and planners, as are the development of retirement policies designed to improve the economic conditions of the elderly. Of particular interest here is the phenomenon, observed both in the U.S. and in Sweden where the relevant data have been collected, of the very high levels of intrinsic satisfaction associated with working for pay, relative to the levels of intrinsic satisfaction associated with most leisure activities. The findings here, while not necessarily inconsistent with utility maximizing models of the sort typically specified by economists, do suggest that the allocation of time to market and nonmarket work may be driven as much by considerations on the supply side (the types of jobs offered by employers) as by considerations on the demand side.

Finally, there are substantial research opportunities present in the development of economic and social accounting systems that depend crucially on the availability of time allocation data. While a number of such systems have been developed, they have all been restricted by the sketchy nature of the available time allocation data base on which all such systems are partly based. And none of the available systems have pursued what seems to us the appropriate strategy with respect to the valuation of both nonmarket time and leisure—both crucial elements in determing the trajectories of total output and welfare implied by such systems. Although some of the valuation problems are inherently intractable (e.g., leisure time), substantially richer insights could be developed from such systems than is currently the case.

2. *Data Access and Data Needs*

In developing comparisons across countries or through time, there is a large stock of existing data that, via archiving, could be put to much better economic research use than has been the case so far. Some of the data are currently ar-

chived, and have been used by sociologists (see Gershuny and Robinson 1988; the current archive is located at the University of Bath in the U.K.). The incentives for such comparative work seem to us quite obvious given the dramatic differences in time use across countries and through time documented in Section II. More detailed analysis based on hypothesis testing with data merged from one or more countries has not been conducted by economists, but appears potentially very fruitful.

While there are problems of comparability in the time use data available for different countries, most of these problems can be resolved by the creation of a set of micro data files for the many countries for which time allocation have been collected. Our assessment of the data is that the major difficulty in doing cross-national or cross-time comparisons is simply the noncomparability of the published data, which is in turn due to different classification strategies. Most countries have similar or at least compatible time diary codes in the micro data, with the codes typically based on the original multinational codes developed for the Szalai project in the mid-1960s. Hence a top priority in future research on time allocation is the creation of a consistent set of micro data files from which common classifications can be developed and from which statistical models can be estimated.

A second important priority that would greatly enhance the analytic value of the data would be to improve the timeliness of the available measurements so that common changes that should affect an entire set of countries could be examined with data that are comparable in concept and timing. Most developed and many developing countries collect these data with some semblance of regular periodicity—often roughly every decade. From that perspective, it would be desirable but not essential to try to provide a consistent set of fully comparable multinational data, much like the 1965—66 multinational study, although the present periodicities provide something like that type of comparability without any formal coordination. There are important exceptions to the existence of periodic data collection programs, not the least of which is in the U.S., where no regular data collection program has ever been organized and where data collection has been left to the judgments of peer review groups for public or private sources of research support. In virtually all other countries, the collection of time allocation data is a function of more or less regular programs organized within central statistical bureaus.

3. *Illustrative Future Research Directions*

As a concluding comment, we offer several directions for future research, and research uses of existing data, that are not discussed in our review of the literature. To those who may have done these studies already, we apologize and will gratefully receive reprints.

Time Management in Households. The simplest models assume that the production technology or uses of time are well-known to household members. In fact, households face such a wide array of choices for individual activities that their effectiveness in decision making and organization is an open issue. Different individuals and households may differ widely in their ability to make such decisions. One framework which proceeds along these lines but has not been used for analysis of both diary based time and goods allocation data is that of Robert Michael (1973).

Analysis approaches could include the use of production frontiers to examine the relation between inputs and outputs. Care needs to be taken to concentrate

on outputs that do not have joint consumption benefits, as suggested by Pollack and Wachter. If time use in production has an intrinsic consumption benefit with person specific differences, then "extra" time by one person need not reflect inefficiency. Another approach could be to attempt more direct measures from time diary entries of "downtime" and unnecessary waiting that could have been reduced by better planning.

Time Management at the Workplace. This issue arises in many different contexts. For example, the continued long market work hours of Russian men (Table 2) could be the consequence of downtime at work. Downtime is argued to be largely the result of manager's incentives to underutilize labor, providing a buffer against future increases in output targets. Downtime is also seen as the result of ineffective coordination of intermediate goods flows from other enterprises. Industrial plants in Russia have been found to have 1.5 to 1.7 times greater manning levels than comparable plants in Western Europe (Philip Hanson 1981). Auto plants in the U.S. are claimed to have larger labor requirements than comparable plants in Japan (James Harbour 1985), and production frontier analysis shows slack in public enterprise as well (Edward Cavin and Stafford 1985).

Time diaries by respondents could be adapted to include information provided by observers from a sample of workplaces. Observer supplements to conventional diaries are needed because respondents tend not to disaggregate a work period into subcomponents of different activities and different work intensities. Several questions could be posed. What is the influence of tax laws and organizational characteristics on work intensity and time management at work? To what extent is work intensity a shared working condition among coworkers and to what extent is it a matter of individual choice? If repeated measures were available, how would rising income or business cycle patterns affect the general level of work activity while at work? Do firms facing more domestic or international competition respond by eliciting more work effort or creating a better workplace coordination with less downtime? Are private enterprises characterized by less downtime than public enterprise?

Time Delays in Travel and Other Activities. Over 9 hours per week is spent travelling to work and for other purposes by adults in the United States. Russians have very long travel times to work and commuting time has risen in Japan, despite an extensive public transit system.[25] Specialized diary studies of travel would be illuminating. What is the value of time spent in commuting? One answer would be that it is the marginal wage, on the assumption that the process benefits of work and travel are equal. A more interesting approach connects to the issues of time management discussed above and perhaps a common model could be applied. Consider the case not just of a long commute to work but one with high variance as well. If the conditional loss function is convex from below, trip time variance per se has an expected cost, and a mean-preserving reduction in trip time would have economic value to the commuter. The logic of the loss function convexity can be based on the idea that a small addition to the scheduled arrival time to work could impose some cost but long delays may seriously disrupt the effectiveness of the coworker team. Early arrival, on the other hand, may simply create dead time. Of course these costs would depend on the type of job. It is easier to arrive late to work if your first task is not presenting a lecture or attending a staff meeting!

[25] See the country sources to Tables 1 and 2 given in the appendix.

How could time use research illuminate this issue of travel time variance? One could use a Lancasterian (Kevin Lancaster 1966) model or extend the mode choice model (Gronau 1970) to include time variance as an additional characteristic of competing travel modes or routes (e.g., freeway versus tollway). As a consequence of different money costs which commuters would or would not be willing to pay, possibly depending on the type of work setting, one could establish a market value to travel time certainty. Such estimates would be useful for calculation of benefits of proposed investments in commuting networks.

Time Use and Mental Health. Another direction to research would be to study aberrant time use patterns. There is evidence that clinical depression is often characterized by excessive sleep; one estimate is that 15 percent of the U.S. population is subject to depression or other mood disorders at any given time (Francis Mondimore 1990). If so, excessive sleep could be an indicator of stress on certain populations, quite different from the interpretations of sleep hours in the current economics literature (Biddle and Hamermesh 1990; Stafford and Cohen 1974). A related conjecture is that older people who watch excessive TV, may do so partly out of loneliness or depression. If so, surveys of the health of older people could use time data to study the well-being of such populations. These studies could combine time diary and other measures of somatic function with affect measures to assess the factors influencing mental health. For such purposes, data on changes through time are argued to be very important (Kessler et al. 1990).

Data Appendix

Notes on Time Use Data Tables

Introduction

In looking over the extensive literature dealing with time allocation, we are struck by the importance of methodological issues, including both straightforward issues of measurement—validity and reliability, in the usual statistical sense—and analytic issues relating to classifications of the basic data.

The reason that methodological issues have such a substantial influence on this area of inquiry appears to be the different theoretical frameworks and research perspectives that one finds in a field where economists, sociologists, planners, and statisticians are all major players, and where the same methodology can be applied to market economies, centrally planned economies, and economies in all stages of economic development. It is this diversity of scientists and economic and social systems that probably account for the unsettled state of the methodology.

The simplest way to see the importance of methodological issues is to examine the methods and procedures used to assemble the data in Tables 1–3. These are nothing more than simple descriptive tables of analytically important activity categories for the populations of a number of countries. Yet none of the data in the table is fully consistent among countries. Although there are archives with micro data on time use available for a limited number of countries, we put together the data in Tables 1–3 from various published tabulations—accessing the micro data files and working from them would have been a major research project by itself. It turned out that the underlying methodologies were all somewhat different. For example:

1. Most data sources treat time spent in transit as a separate activity. Analytically, we preferred to treat it as instrumental—driving to the shopping center as part of time spent in shopping—rather than as an activity generating production or utility in and of itself. But no published tabulation treated the data in that way except for the U.S. data, and from what we can tell it is likely that at least some of the micro datasets do not enable that distinction to be made.
2. Virtually all published tabulations treat time spent in eating meals as part of personal care, along with sleep and biological functions. We prefer to treat time spent in eating out, either at restaurants or at friends' homes, as social interaction rather than biological maintenance. It is not clear whether the available micro data would permit that distinction to be made in other countries besides the U.S., although it is never made in any of the published tabulations.
3. The distribution of time allocated to various activities is clearly a function of the demographic characteristics of the population under investigation. Most published tabulations use an age range of something like 16–74, but much of the comparative data is based on the 1965–66 multinational study, which used an age range of 18 through 64, and excluded the population in nonurban areas. And although most analyses provide separate tabulations for employed and nonemployed women, that tends not to be true for men.

4. Many activities tend to be either simultaneous or closely overlapping—one can be reading while watching television, doing laundry while taking care of a child, cooking while talking with a spouse, etc. Many of the time use micro data bases contain reports of "secondary" activities, which represent activities that the respondent reports being done at the same time as the diary (primary) activity, although not all data distinguish between primary and secondary activities. In the Japanese data, for example, all activities are recorded even when they are being done simultaneously, with the result that the total amount of time allocated to different activities comes to more than a 24-hour day.

As a result of these and similar problems, the difficulty of putting together consistent data of the sort shown in Tables 1–3 are substantial; precise comparisons are really possible only with access to the basic data tapes. Information available from published sources for one country tends to be classified with some elements that are unique compared to data for other countries, and it takes a good deal of arbitrary reallocation of time uses to achieve a conceptually comparable set of numbers. Fortunately, the reallocations necessary to make the data internally consistent are relatively small in terms of the overall distributions of time use among major categories, although categories where the activities involve only small amounts of time tend to be importantly influenced by the reallocations.

Tables 1 and 3

The U.S. data are from Chapter 12 of Juster and Stafford (1985), and include men and women between the ages of 25 and 64. The 1981 data contain the appropriate proportion of rural households, although the 1965 data cover only urban households. Data in the top two panels of Table 12.1 have been combined, using sample sizes as weights, to obtain the information in Tables 1 and 3. Data on sleep are taken from unpublished tabulations.

The Swedish data generally match the U.S. classification, and were provided to us by Anders Klevmarken. The sources are Klevmarken and Olovsson (1989) and Klevmarken (1984). Even though the Swedish data were designed to match the U.S. classification scheme and were produced from the basic micro data file, some inconsistencies remained. The Swedish category of "gardening and pet care," which averaged over two hours a week for men and well over an hour for women, turned out to include both outdoor cleaning and yard maintenance (along with) other (decorative) gardening, as well as pet care. In the U.S. data, these outdoor activites were separated, with outdoor cleaning and yard maintenance being part of housework and gardening being part of active leisure. We distributed the Swedish data between these two categories in the same way as the U.S. data were distributed in 1981.

The USSR data come from Robinson, Andreyenkov, and Patrushev (1989), while the Japanese data come from Nakanishi and Suzuki (1986) and Masayuki Furukawa (1976). The major problem with the USSR and Japanese data is in the treatment of travel time. In the published tables for the time use of men and women in Japan, only "commuting" time is given, which includes both trips to work and all other household travel. The latter includes travel associated with child care, shopping for goods and services, meals eaten out of the home, attendance at organizational meetings, social interaction and entertainment, and both active and passive leisure. For the Soviet data, total time spent commuting to work is given, along with total time spent for all other types of travel, but the latter again include not just travel time associated with housework but also travel associated with meals, social interactions and entertainment, active and passive leisure, etc.

From looking at the details of the calculations contained in both the Japanese and Soviet data, we are able to make some rough adjustments to put travel into the appropriate categories. For example, we can divide travel between work-related and all other kinds of travel for the Japanese data, but then must allocate the nonwork travel to all the residual categories. For the Soviet data, nonwork travel is given, but no allocations are available in the published sources. In both cases, we have used arbitrary but reasonable allocations of travel time to all the other categories, since that not only makes them consistent with the U.S. data, but also represents what we regard as the best treatment of time spent by purpose and function.

Other minor adjustments had to be made to the Japanese data.

1. Active leisure is combined with adult education classes in the published Japanese tables, although the distinction between the two is available in some of the detailed calculations published for 1985. Similar details are not available for the 1965 data, and we have assumed that the 1965 allocations were roughly comparable to those for 1985.
2. Meals include both meals eaten at home and eaten out. We estimated meals eaten out as 10 percent of the total time spent in eating meals overall for women. For men, we estimated that 20 percent of the 1965 total for meals, and 30 percent of the 1985 total, consisted of meals eaten out. These estimates of time spent eating out were taken out of the personal care category and put into the social interaction category under leisure.
3. The Japanese data add up to substantially more than 24 hours, for both 1965 and 1985, and for both men and women. We have assumed that time spent sleeping and time spent at market work are not contaminated by the presence of other activities, while all other time use patterns are complicated by the presence of joint activities that are both reported in the primary data. We have therefore reduced most of the time categories for men and women in both 1965 and 1985 to make the total add up to 24 hours, keeping the total time reported for sleep and

for market work at their original value but reducing all other time uses proportionately.

For the USSR data, there are some minor errors that have been corrected (totals not adding up to components, with the components clearly being right given the overall total). Three other adjustments have been made in the basic data to ensure comparability with the U.S. data.

1. Time spent eating includes both meals eaten at home and meals eaten out, as was also true of the Japanese data. For both men and women, we have taken out 10 percent of the time spent eating, assumed it was eating out, and added it to social interaction time while subtracting it from meals eaten at home.
2. The Soviet data are for employed men, which makes them roughly comparable to the U.S. data for males aged 25–64. But separate tabulations are shown for employed and nonemployed women. We have combined the estimates for employed and nonemployed women, using weights proportional to the sample sizes recorded in the basic data.
3. Time spent in gardening activities is included as a housework activity in the Soviet data, but we have moved it to a market work activity. The category is technically gardening and pet care, and our assumption is that the great majority of the Soviet time spent in gardening and pet care is for growing of crops for home consumption by households.

Finally, it should be noted that even a common classification does not really provide functional equivalents. Perhaps the best illustrations of that problem are in the interpretation of two categories of activities. The first is the category of gardening and pet care, which is included under housework in the original data for all countries except Sweden. As already noted, we have moved this category into market work for the Soviet data, on the assumption that most of this category was gardening and that most of the gardening was associated with raising food either for own consumption or for subsequent resale. We left gardening and pet care in the housework category for other countries.

The second category is adult education, that tends to involve very large numbers of hours for the Soviet data in 1965, much smaller numbers of hours for other countries. Moreover, adult education hours decline sharply in the Soviet Union between 1965 and 1985, while it rises somewhat in the Japanese data and declines (from very low levels) in the U.S. data. It seems possible—even probable—to us that adult education in the 1960s in the Soviet Union was much more like a work activity than a leisure activity, and that between the 1960s and 1980s it shifted from being dominantly a work activity to being dominantly a leisure activity. Any proper classification would have to distinguish between work-related adult education activities, and leisure-related such activities. But the basic data do not permit that distinction to be made, and we have left adult education as a leisure activity in both years. Incidentally, shifting most of the adult education in the Soviet data into work in the 1960s, but not in the 1980s, would have the result of increasing leisure hours in the USSR between the mid-60s and the mid-80s: The data in Table 3 actually show a slight decrease in leisure hours, but that decrease would be more than offset by the very large decline in hours spent in adult education—most of which was probably work-related in the 1960s, with the much smaller amount in the 1980s probably being less work-related.

For Finland and Hungary, the basic data come from Andorka, Harcsa, and Iiris Niemi (1983). The published data do not have appropriate age/sex/work status groups for comparison with other countries. The basic data are either for all people between the ages of 15 and 64, or for active workers. For people aged 15–64, there is a substantial amount of time allocated to school, especially in Finland, and correspondingly smaller time allocations to work or housework. The data in Table 1 contain the following adjustments for both Finland and Hungary.

1. For men, we used active workers—that is a more or less similar group to the basic data for the U.S., assuming that virtually all men in the relevant age ranges are participating in the labor force.
2. For women, we used a combination of the data for all women aged 15–64 and the data for women who were active workers. The specific adjustments for women were:
   a. A substantial amount of time spent on education for the all-women table was removed from the education category and divided between work and housework. That adjustment approximates what would have been the case if the age range had been truncated at 21 rather than at 15.
   b. The adjusted data for all women and for active women workers were averaged.

The other adjustments for women, and the adjustments for men, consisted of the same kinds of problems discussed above for the Japanese and Soviet data.

1. Meals are all included in personal care, and we took an arbitrary percentage of eating time and reallocated it to social entertainment on the ground that it represented meals eaten out rather than meals eaten at home. The allocations were 20 percent for the Finnish data, 15 percent for the Hungarian data for men, and 10 percent for the Hungarian data for women.
2. Total commuting time was divided between work and nonwork time initially, then the nonwork time was split between adult education, social entertainment (including meals), housework, and active leisure. The work/nonwork allocations for men were roughly 3:2 in favor of nonwork travel for Finland, roughly 5:4 in favor of nonwork travel for Hungary. For women, the allocations were approximately 2:1 in favor

of nonwork travel for Finland, roughly 3:2 for Hungary. The allocations are consistent with data for other countries with similar labor force participation rates. The division between the nonwork categories is basically arbitrary, although relatively large fractions were put into housework and for travel associated with meals eaten out—itself an allocation.

Norway and Denmark

Basic data from Memorandum No. 127, *Tid sanvändningen i Severige 1984*, Lennart Flood and Anders Klevmarken, Nov. 1989, Göteborg University. We used the categories as they were provided in the basic data source, except for a reallocation of travel time. Travel time for 1980 in Norway is divided approximately 30:20:50 for men, 20:20:60 for women, between market work, household work, and leisure.

For Denmark, travel time for men in 1964 is divided approximately 40:10:50 for market work, housework, and leisure; for 1975 and 1987 the division is 30:20:50. For women, the division in all three years (1964, 1975, and 1987) is 20:20:60 for market work, housework, and leisure.

The data for Norway and Denmark are not quite comparable to data for the other countries in Tables 1 and 3, and cannot be adjusted because no detail is provided in the publication that we used as our source. In particular, time spent eating out is included in personal care time. As in other countries, we reallocated an estimated amount of time spent eating out to the social interaction category under leisure.

Table 2

Data for Botswana apply to adults age 15–59 and are derived from Tables 1 and 2 in Mueller (1984). Sleep was assumed to average 60 hours per week for both men and women. The data were also adjusted for season of the year as follows. In the Mueller text it was argued that men devote 60 percent more time to income-earning activities during the busy season. Since the period not covered by the study, February through April, falls into the busy season, men's marketable work was increased by 15 percent (.6 × .25). Women's marketable work was claimed to increase even more during the busy season, and a 20 percent adjustment was made. A proportionate reduction was made on all other waking activities to satisfy the time constraint of 108 waking hours per week.

Data for Nepal are for men and women age 16 and older and are derived from Appendix 1, Table 2 of Meena Acharya (1982). Marketable activities coincide with what was designated as "Labor Force Participation Activities," defined as animal husbandry, agriculture, manufacturing and market work. Housework was defined to include subsistence activities of hunting and gathering (only about an hour per week for men), fuel collection and house construction, as well as domestic chores and child care. Sleep was assumed to be 8 hours per day or 56 hours per week.

Table 4

The U.S. data are from Table 14.5 in Timmer et al. (1985). The Japanese data are from Nakanishi and Suzuki (1986, Fig. 11).

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