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ABSTRACT

Sleep must be considered subject to choice and affected by the same economic variables that affect other uses of time. Using aggregated data for 12 countries, a cross-section of microeconomic data, and a panel of households, we demonstrate that increases in time spent in the labor market reduce sleep time. Each additional hour of market work reduces sleep by roughly 10 minutes (and waking nonmarket time by 50 minutes). The total time available for work and leisure is thus itself subject to choice. Interestingly too, otherwise identical women sleep significantly less than men (even though the average woman sleeps slightly more).

We develop a theory of the demand for sleep that differs from standard models by its assumption that sleep affects wages through its impact on labor-market productivity. Estimates of a system of demand equations demonstrate that higher wage rates reduce sleep time among men, an effect that is entirely offset by their positive effect on waking nonmarket time. Among women the wage effect on waking nonmarket time is negative and small, but the effect on sleep is negative and quite large. These results, and the model they are based on, allow a more subtle interpretation of standard results in the labor supply literature.

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The study of sleep is a wonder. (Burgess, 1983)

I. Introduction

Time is scarce; and, more than any other single activity in which people engage, sleeping occupies that scarce time. Economists, and labor economists especially, have devoted immense effort to studying how consumers allocate time, but we have almost entirely ignored the empirical study of choices about time spent sleeping.[1] For example, in a detailed analysis of time allocation Kooreman-Kapteyn (1987) estimate a demand system involving seven categories of leisure time use. However, sleep is mentioned only once in this study, when it is noted that time spent sleeping is to be grouped with various waking activities in a "personal <u>needs</u> and care [italics ours]" category. Stafford-Duncan (1980) noted a negative correlation between wages and sleep time, but dismissed it as resulting from unmeasured individual differences. We have essentially banished from our analysis of scarcity the consideration of roughly one-third of humankind's available allotment of time.

The failure to consider sleep is widespread in other social sciences. A monumental compilation of studies of time use in a number of countries (Szalai, 1972) reports briefly on time spent sleeping but devotes none of its massive analytical effort to studying this use of time. Similarly, a recent comprehensive study of time use in the United States (Juster-Stafford, 1985) examined a variety of quantitatively less important uses of time but never considered sleep time.

Only a very naive view of what determines the amount of time a person spends sleeping can justify the neglect of sleep in an economic model of time allocation. One could assume that sleep time is essentially fixed for reasons unrelated to any of the variables in the economic model.

For example, one could assume that the need for sleep is biologically determined. This would leave each person with an endowment of waking time T_i^* to divide between work and various consumption activities. Even if endowments differed across individuals, aggregation across a population would generate a total endowment of non-sleep time that was independent of economic shocks. Many studies of labor supply implicitly assume that the representative consumer has a fixed amount of time to allocate between work and waking leisure. This assumption is explicit in Michael (1973, p. 325), and Heckman-MaCurdy (1980, p. 59)).

It seems more plausible to assume that the amount of time at an individual's disposal is variable, because the amount slept changes from week to week and year to year. More important, some of the variation in time spent sleeping may result from conscious individual choice in response to changing economic incentives. These may operate directly, as the price of time and the utility from sleep vary; or indirectly, as the other factors that affect the demand for non-sleep leisure change. Clearly, some of the variation in sleep time is beyond the individual's control; but some may respond to variations in labor-leisure choices and to variations in the value of time. If so --- if decisions about sleep are not separable from decisions about labor supply --- the vast literature on labor supply, by ignoring this related area, contains a difficulty that could have important consequences for understanding the allocation of time between the home and the market.

In this study we use several sets of data to explore these possibilities. In broad terms, we look at whether variations in time spent sleeping represent an important part of people's shifting patterns of time allocation. A more specific question is whether the amount of time spent sleeping is under the individual's control and thus related to the economic variables that affect other decisions about time allocation. In pursuing this question we are in essence examining whether an individual's weekly endowment of waking hours is endogenous, a task analogous to the study of the endogeneity of length of life through suicide in Hamermesh-Soss (1974). In Section II we examine what little evidence exists on the distribution and socioeconomic correlates of sleep time, and establish the existence of a relationship between sleep time and time spent working in the market. In Section III we construct a simple model of time allocation that includes sleep as a choice variable, and in Section IV we present estimates of the demand equation for sleep that is implied by this model. Section V draws conclusions about the economic implications of our findings.

II. What Do We Know About Sleep, and Is Sleep Economically Important?

The most striking fact that biopsychologists have demonstrated about sleep is its diversity. Numerous early studies, summarized in Kleitman (1963), demonstrate the very wide range of sleep duration among adults. Authenticated examples of nonpathological short sleepers have been found (Meddis, 1977, Chapter 3). Though 7-1/2 hours may be the average, "there is no more a 'normal' duration of sleep, for either children or adults, than there is a normal heart rate, or height, or weight." (Kleitman, 1963). Clearly, sleep is a major expenditure of time that exhibits substantial variation within every population whose sleep has been studied.

There is apparently remarkably little evidence on the determinants of individual differences in sleep duration. There is some evidence that women sleep more than men (cited in Kleitman, 1963), and still weaker indications that sleep duration declines with age among adults (Morgan, 1985). (The decline with age before maturity is well-known.) Beyond this evidence and the existence of substantial unexplained individual variation, previous studies offer few guidelines about how to begin an empirical examination of sleep duration. One basic indicator of its importance as an economic variable might, however, be its relationship to another, extensively studied use of time, namely time supplied to the labor market. As the first step in determining whether sleep is an economic variable, we thus examine whether sleep duration is related to time spent working in the market. As a by-product of this part of the study we also provide the first comprehensive set of demographic correlates of sleep duration.

A. *Evidence from International Surveys*

One source of evidence on the sleep-work relationship is the data in Szalai (1972, p. 618), who reports average sleep duration from time diaries collected at fifteen different sites or sets of sites in twelve countries in the mid-1960s.[2] In each set of data average sleep duration is reported by employment and marital status, presence of children, sex, and whether the diary is kept for a weekday or a weekend. Varying numbers of respondents were included in the surveys, but underlying each usable cell were time diaries of at least ten people.

In column (1) of Table 1 we present the means of the variables included in a regression of minutes per day sleeping on minutes per day spent working in the market and on control variables.[3] The means are unweighted, while the regression coefficients reported in column (2) are based on weights that are inversely proportional to the square root of the number of people in each cell. The average sleep duration is nearly

TABLE 1

SLEEP (MINUTES PER DAY) AND EMPLOYMENT STATUS, 15 STUDIES[a]

	Means and Standard Deviations	Parameter Estimates
Sleep	503	
	(47)	
Minutes Worked	511	-.109
(by workers, on weekdays)	(21)	(.01)
Children	.35	-11.18
	(.48)	(4.15)
Male	.35	17.84
	(.48)	(2.66)
Married	.71	-8.52
	(.46)	(5.83)
Workday	.53	-30.28
	(.50)	(5.37)
$\bar{R}^2$		.70

-[a]Based on data in Szalai (1972). The means and standard deviations are unweighted. The estimates are from regressions that use the numbers of persons in each cell as weights. Standard errors of the regression parameters are in parentheses here and in Tables 3-5 and 7.

8-1/2 hours per day, somewhat above the mean durations reported in the clinical studies discussed above. While this discrepancy is not easily explicable, there is no reason to assume that whatever produced it biases the estimated effect of work time on sleep duration.

Webb (1985) has used these same data to examine differences in mean sleep time within several pairs of demographic categories and shown that people sleep less on workdays, and that women sleep less than men on weekends. The regression estimates presented here are mostly consistent with these comparisons and with casual observation (though there is no previous multivariate evidence on sex differences in sleep behavior). Thus the presence of children reduces sleep duration, and people sleep less on workdays than on weekends. The only inconsistency with the clinical results is the significantly longer sleep duration among men. Since we have controlled for time spent working and the presence of children, this difference must reflect either an inherent biological distinction or differing allocations of time in household production.

Holding other factors constant, each additional hour of work reduces time spent sleeping by about 7 minutes.[4] Alternatively, employed people sleep roughly one hour less per day on work days than those who do not work in the market. At the very least this aggregate evidence suggests that changes in work-leisure choices are related to changes in the amount of time individuals have available for sleep.

B. Evidence from the 1975-76 Time Use Study

The 1975-76 Time Use Study obtained data from four days of time diaries kept by members of 1519 households. The days were at three-month intervals, with two being weekdays, one a Saturday and the fourth a Sunday. The data on time use are combined into "synthetic weeks," and it is these that we use in estimating the relation between sleep duration and hours of work. Of the 1519 respondents, 421 were excluded because they were above age 65 or below age 23, or because they did not have complete information on main sleep time in each of the interview waves. Others were disqualified if data on one of the control variables of interest was missing, or if there were severe inconsistencies in the data.[5] This left a usable sample of 706 individuals, of whom 400 were men.

Among the 86 activities into which time use was categorized in the 1975-76 time diaries were: Night (or main) sleep; naps and resting; and miscellaneous personal activities. This last category does not include washing or dressing, but presumably includes such things as time spent in sexual activities and affection. Since we believe there is some scope for people to include sleep in any one of these categories, our analysis is conducted on increasingly broad definitions of sleep time that add the last two categories successively to main sleep time. In the regressions we measure work time as minutes spent in normal work (excluding on-the-job leisure) plus work at a second job.[6]

Table 2 shows the descriptive statistics for the three definitions of sleep time and for minutes of market work in the sample and two subsamples. The mean weekly sleep durations imply an average daily main sleep of around 7-3/4 hours, more consistent with clinical reports than was the mean in Part A. Adding rest and naps raises the daily average to slightly over 8 hours, while adding miscellaneous personal activities increases the total to nearly 8-1/4 hours. Moreover, the amount of sleep time varies strikingly. The standard deviation is large; 12 percent of

TABLE 2

SLEEP AND WORK TIME (MINUTES PER WEEK), 1975-76 TIME USE STUDY, MEANS AND STANDARD DEVIATIONS

	Sleep	Sleep and Naps	Sleep, Naps, and Personal	Work
All Respondents	3266	3383	3438	2122
	(444)	(499)	(520)	(947)
Men	3252	3360	3409	2435
	(435)	(492)	(505)	(848)
Women	3285	3413	3476	1715
	(456)	(507)	(539)	(916)

the sample sleeps more than 9 hours per night, and 10 percent sleeps less than 6-1/2 hours per night on average.

For the average respondent sleep clearly occupies a larger fraction of the total time endowment than does work time. What is more striking is that this is true for a huge majority of the people in the sample: Only 67 of the 400 men report working more than their main sleep time, and only 20 of the 306 women do so.[7] If one compares main sleep reported in the time diaries to the individual's response to a question about normal weekly work time, even smaller fractions in each sample report working more than sleeping. If our sample had not been restricted to exclude very young adults or likely retirees, the comparisons would have been even more striking. The data show that main sleep is the largest single use of time by most people. That simple fact alone makes it a worthwhile subject for economic analysis.

Let us examine some of the estimated effects of the several variables we use as controls in the regressions before we consider the relationship between sleep time and work time in this sample. To save space these are presented only for the regressions describing time spent sleeping and napping (resting). The dummy variable, health status, is coded as one if the individual's self-reported health status is excellent or good. The other variables are self-explanatory.

The results on the effects of age are mixed. The evidence suggests an inverse U-shaped sleep-age profile among men (with a peak at age 46), but a U-shaped sleep-age profile among women (with a minimum at age 36). For both men and women a linear term in age yields insignificant, but positive effects when included without the quadratic term. This runs counter to the sparse clinical evidence, and may

TABLE 3

PARAMETER ESTIMATES, OTHER VARIABLES, SLEEP AND NAPS EQUATIONS[a]

	All Respondents	Men	Women
Married	16.04	-43.15	92.50
	(57.27)	(82.71)	(82.20)
Years Married	-2.59	2.43	-7.62
	(2.31)	(3.13)	(3.49)
Age	1.86	24.52	-24.81
	(12.80)	(16.20)	(21.17)
Age^2	.02	-.26	.35
	(.15)	(.19)	(.25)
Years of Schooling	-14.30	-18.28	-9.09
	(6.71)	(8.55)	(10.83)
Male	99.42	-----	-----
	(39.07)		
Health Status	-94.16	-123.79	-59.66
	(59.16)	(80.75)	(89.05)
Children < 3 Years Old	-35.42	39.03	-153.00
	(56.44)	(67.72)	(102.60)
Protestant	86.15	90.87	93.97
	(37.45)	(47.99)	(60.04)
Black	-69.17	-110.65	-43.95
	(80.62)	(114.41)	(115.63)
$\bar{R}^2$	.141	.176	.108

-[a]Also included in the regressions are constant terms and the measures of time spent working, the coefficient estimates for which are shown in the middle column of Table 5.

perhaps be due to our multivariate analysis that controls for time spent in the labor market. More interesting, increased educational attainment reduces sleep duration. It is difficult to imagine that greater schooling reduces the taste for sleep; rather, we interpret this as operating through wages and thus as reflecting a price effect. (See Section IV.) Finally, given their market work time, Protestants sleep more than adherents of other faiths (in this sample, mostly Roman Catholics).

Table 3 shows that, as in the estimates in Part A, men sleep more than women. While mean sleep time is less among men (see Table 2), the difference is more than accounted for by differences in characteristics, particularly employment status and work hours, between the sexes. Also noteworthy are the various effects on parents' sleep time of having young children in the household.[8] Men's sleep duration is essentially unaffected, but young mothers' sleep is substantially reduced by the care devoted to young children.

The striking contrast between the mean sleep durations for men and women in Table 2 and the significant positive coefficients on the dummy variables for men in Tables 1 and 3 merits further analysis. To examine this reversal we present in the first row of Table 4 the percentage differences between the mean sleep durations of women and men for each of the three definitions of sleep. In row (2) these differences are adjusted using coefficients from equations like that in column (2) of Table 3 along with the mean values of the independent variables in the sample of women. Row (3) adjusts the ratio using the coefficients from equations like that in column (3) of Table 3 along with the mean values of the independent variables among the men. Both adjustments ask what

TABLE 4

SEX DIFFERENCES IN SLEEP TIME, 1975-76 TIME USE DATA

Percentage Female-Male Differences	Sleep	Sleep and Naps	Sleep, Naps and Personal
	Dependent Variable		
Unadjusted:	0.99	1.56	1.94
Adjusted Using			
Male Coefficients:	-4.01	-4.74	-5.04
Female Coefficients:	-3.03	-4.13	-4.26

the ratio of women's to men's sleep duration would be if the observable characteristics of the sexes were identical.

The results are clear-cut. While women do sleep more, an otherwise identical women sleeps between 3 to 5 percent less than her male counterpart, a difference of around 20 minutes per night. (This is, interestingly, remarkably close to the coefficient on the male dummy variable in Table 1.) There is some evidence that women who are in the labor market work more hours in total (in the home and the market together) than men (Cain, 1984). Our adjustments indicate that part of the cushion for this sex difference in hours worked is provided by reductions in hours of sleep. We cannot determine from our data whether this represents discrimination due to male dominance in household decision-making, or optimal responses to the differing capacities of men and women to reduce sleep without reducing household and market productivity.

Table 5 presents the central results of this section, the estimates of the relationship between sleep time and work time. The coefficients suggest that each hour of additional work time reduces sleep duration by roughly ten minutes. The effects on total sleep and nap time are slightly greater, and those on all possibly sleep-related time are greater still. None of these coefficients is changed appreciably if we base them on a bivariate regression of minutes sleeping on minutes of market work.[9]

The estimated effect of additional work time on sleep duration is 50 percent larger than what we inferred from the cross-section international averages in Part A. This discrepancy is not explicable by differences in average working hours. It may be due to discrepancies in

TABLE 5

PARAMETER ESTIMATES,
SLEEP TIME AND WORK TIME,
1975-76[a]

	Dependent Variable: Sleep	Sleep and Naps	Sleep, Naps and Personal
All Respondents	-.164 (.018)	-.199 (.020)	-.214 (.021)
$\bar{R}^2$	.116	.141	.147
Men	-.184 (.025)	-.219 (.028)	-.239 (.028)
$\bar{R}^2$	.146	.176	.190
Women	-.134 (.028)	-.169 (.031)	-.179 (.033)
$\bar{R}^2$	.082	.108	.101

[a]Includes all the variables listed in Table 3.

the instructions to the respondents about keeping their diaries, or to the presence of greater measurement error in the one-day diaries in the international samples than in the sum of time in the four-day diaries in the 1975-76 Time Use Study. One might also surmise that the aggregation over individuals that produced the cell means used to generate the estimates in Table 1 removed the correlated extreme values of both the sleep time and work time variables, so that the estimate of their partial correlation was reduced.

C. Evidence from Panel Data

We have shown that there is a significant negative partial correlation between sleep time and work time, and that this correlation is robust to the location where the sampling occurs and to the characteristics of the workers sampled. It does not, however, demonstrate a causal relationship. Consider a situation in which sleep has no effect on productivity or utility, provided that the individual satisfies a biologically required need for sleep. Suppose also that this need varies among individuals. Then economic theory predicts that (under most circumstances) individuals requiring less sleep would divide the extra waking time between work and leisure. This would lead to a negative correlation between work and sleep in cross-section data, even though sleep time would be irrelevant to changes in time allocation.

This extreme example illustrates that the estimates in Tables 1 and 5 may be subject to an individual-effect bias. Consider the equation:

(1) $T_{sit} = \alpha T_{wit} + \beta X_{it} + \nu_i + \epsilon_{it},$

where T_{sit} is the time spent sleeping by individual i in period t, T_{wit} is the time spent working, X is a vector of control variables, α and β

are parameter vectors, ν is an unobserved individual-specific effect that is time-invariant, and ϵ is a random term that varies across individuals and time. If we interpret ν_i as an individual-specific "need for sleep," then it will be positively correlated with T_{sit} and negatively correlated with T_{wit}. Cross-section estimates of α from equations like (1), for example, those in Tables 1 and 5, will be negatively biased. In short, despite the remarkable consistency of our estimates, we may only have shown that there some people who are innately sleepless workaholics.

To examine this possibility, difference (1) over time:

$$(2) \quad \Delta T_{si} = \alpha \Delta T_{wi} + \beta \Delta X_i + \Delta \epsilon_i \ ,$$

where Δ denotes a change between times t-k and t. Estimating (2) using a panel of observations on the same people eliminates possible biases in $\hat{\alpha}$ that may be caused by unobserved individual effects that are correlated with both T_w and T_s. Fortunately a 1981 follow-up study to the 1975-76 Time Use study allows us to obtain these estimates. The 1975-81 Time Use Longitudinal Panel Study collected data similar to those collected in the 1975-76 study, so that we take six-year differences in (2). Time diaries were kept for four days (again, at three-month intervals) by 620 of the households included in the 1975-76 survey. The same age disqualifier used in Part B reduced the sample to 507 observations. Missing data on the variables of interest reduced it to 278 respondents, while inconsistencies between reported incomes and earnings in 1974 or 1980 reduced it to a final size of 239 people, of whom 95 are women.

The 1981 categorization of time use allowed for 223 separate uses, including: Night sleep (main sleep of the day); naps and resting; sex, making out; personal, private; and affection. The first two categories are the same as those in the 1975-76 cross section; the last three can be viewed as subcategories of the group miscellaneous personal time that was used in the 1975-76 cross section. We therefore formed the same three dependent variables from the 1981 wave that we used in the cross-section analysis. The individuals in this subsample from the Panel Study did not differ significantly in their sleep or work times from the the sample from the 1975-76 cross section.[10] That there is potentially interesting variation in the panel data is shown by noting that only 93 of the sample participants changed their average main sleep time between the two synthetic weeks by less than 30 minutes, while 81 changed it by more than one hour. Whether this is simply measurement error should be apparent from comparisons of the results based on panel data to those shown in Table 5.

The estimates of α from (2) are shown in Table 6. In estimating (2) we are using a "within" estimator (Judge et al, 1980) to produce consistent estimates on the panel data. Included as control variables are all the measures for which $\Delta X \neq 0$ for some observations: Health status, presence of young children, marital status, years of schooling, and age.[11] These "within" estimates of α are remarkably similar to the cross-section estimates shown in Table 5. Neither for the sample as a whole nor for men and women separately does the estimate of α differ significantly from the cross-section estimates on the large 1975-76 sample.[12] Again we find that $\partial T_s/\partial T_w$ increases in absolute value the more broadly we define sleep time.

This replication of the cross-section results on panel data suggests that part of any change in time spent in market work is taken from non-market work and leisure, while the remainder is taken out of

TABLE 6

PARAMETER ESTIMATES, SLEEP TIME AND WORK TIME, 1975-76--1981, WITHIN ESTIMATES[a]

	Sleep	Sleep and Naps	Sleep, Naps and Personal
All Respondents	-.175 (.031)	-.224 (.037)	-.234 (.037)
$\bar{R}^2$	.108	.123	.133
Men	-.154 (.039)	-.229 (.045)	-.237 (.045)
$\bar{R}^2$	.090	.129	.138
Women	-.210 (.053)	-.224 (.064)	-.233 (.065)
$\bar{R}^2$	.115	.092	.105

-[a]Includes variables measuring age and change in: Health status, presence of young children, educational attainment, and marital status.

sleep time. Indeed, for the entire sample the panel results imply that each one-hour increase in work time results in a thirteen-minute reduction in sleep duration, and a forty-seven minute decline in waking nonmarket time. In elasticity terms, the sleep--market work elasticity is -.14, while the waking nonmarket time--market work elasticity is -.36. It is certainly not the case that there is a fixed amount of non-sleep time that individuals divide among other uses. It is also clear that the greater part of any increase in market work is met by a reduction in waking nonmarket time, though sleep time is also reduced significantly.

The estimates in Table 6 confirm that variations in people's sleep behavior are accompanied by variations in their labor supply. We still have not strictly established the direction of causation. It may be that variations in individuals' sleep time are beyond their control, and that their labor supply changes in response to these variations. For this explanation to be plausible, exogenous changes in sleep would have to be both predictable and persistent enough to engender a labor supply response. It seems reasonable, however, to believe that the correlation between sleep time and work time reflects in part people's ability to alter the time spent sleeping in response to the same economic factors that affect labor supply. Indeed, certain results of this section, particularly our findings of differences in sleeping on workdays and weekends, and of the effect of young children on parents' sleep behavior, imply that people are able to adjust their sleep behavior to changing circumstances.

The totality of our results suggests that, at the least, time spent sleeping will be changed by the indirect impacts of economic and demographic factors on decisions about work and leisure. We have already seen that education affects sleep duration independently of the amount of time spent working in the market, which may be interpreted as reflecting the direct effect of wages on sleep. This finding and the strength of the indirect effects justifies constructing and testing a utility-based model in which sleep is a choice variable.

III. The Demand for Sleep: A Theoretical Model

Fitting sleep into a model of consumer choice can proceed at the simplest level if we assume that individuals derive no utility from sleep and that it has no impact on their market or household productivity. In that case the consumer's choice is simple: Sleep duration will equal the biological minimum, T^*_{si}; it will be unaffected by other choices about time allocation and by changes in exogenous factors that affect consumer demand. At a more complex level we can assume that sleep is a completely time-intensive commodity that has no effect on productivity, and that its consumption yields utility just like other commodities. In that case it can be analyzed in the same way that we study the demand for any other commodity. Under that assumption sleep is the obverse of work: It takes no goods, only time, and its consumption reduces by one hour the amount of time available for producing other commodities or earning a wage.

At the most complex level we can assume that sleep adds to an individual's productivity. This view is consistent with Becker's (1965, p. 498) argument that some sleep is necessary for efficiency and required even if the goal is to maximize money income. The idea that sleep and productivity or job performance are related is supported by evidence from sleep researchers. Experiemental studies have long indicated that severe sleep deprivation leads to lapses in efficiency, especially in non-trivial but repetitious tasks (Meddis, 1977, pp. 58-59;

Wilkinson, 1965). A committee of the Association of Professional Sleep Societies (Mitler et al, 1988) surveyed studies of performance failures in actual work settings and concluded that, "inadequate sleep, even as little as one or two hours less than usual sleep, can greatly exaggerate the tendency for error," during certain times of the day, especially late afternoon. Other sleep researchers have placed at $50 billion the annual reduction in manufacturing productivity as a result of "sleep problems," including irregular work schedules and inadequate rest.[13]

We can model the worker's demand for sleep to allow for the possibility that sleep enhances both productivity and utility. Let the worker's market wage W_m be:

(3) $$W_m = W_1 + W_2T_s ,$$

where we have dropped the i subscript, and W_1 and W_2 are positive parameters. Assume the individual's utility is defined over T_s and a commodity Z:

(4) $$U = U(Z, T_s), U_1 > 0, U_{11} < 0 ,$$

and that the worker's endowment of time is divided as:

$$T^* = T_z + T_s + T_w ,$$

where $T_z = bZ$ is time spent producing commodity Z, and T_w is time spent working. Production of Z also requires the input of goods X such that X=aZ.[14] The price of X is P. Thus the individual's goods constraint is the standard:

$$PX = W_mT_w + I,$$

where I is nonlabor income. Combining this constraint with the individual's time constraint and the technology for producing Z yields:

(5) $$[W_1 + W_2T_s][T^* - T_s - T_z] + I = aPZ .$$

The individual maximizes (4) subject to (5), which yields:

$$(6) \quad \frac{U_1}{U_2} = \frac{aP + bW_m}{W_1 + W_2[T_s - T_w]} .$$

Equation (6) states simply that the ratio of the marginal utilities of consumption and sleep must equal the ratio of their prices. The price of a unit of Z reflects the cost of the goods required to produce it and the shadow price of the time needed for production. The price of a unit of sleep is the wage rate minus any addition to labor income that occurs as a result of the effect of extra sleep on productivity.

A comparative static analysis of how the choice variables Z and T_s respond to changes in the parameters I, W_1 and W_2 yields the various conditions describing the demand for sleep. The effect of a change in nonlabor income on sleep is given by:

$$(7) \quad \frac{\partial T_s}{\partial I} = \{U_{11}[W_1 + W_2(T_s-T_w)] - U_{12}[aP + bW_m] + bU_1W_2\}D^{-1} ,$$

where $D < 0$. The first two terms in the expression are standard; and if sleep enhances the utility of consumption, as one might expect, both terms exert a positive influence on the effect of income on sleep. The third term, which is present only if sleep raises productivity, works in the opposite direction. The counter-intuitive sign of this term results from the complementarity of market goods and waking leisure in the production of Z. The market goods that can be purchased with an addition to income can only enhance utility if they are accompanied by an increase in T_z. The increase in T_z, combined with the tendency for T_s to increase in response to the added income, implies a reduction in T_w. From (6) one can see that, if sleep is productive, a fall in T_w raises the price of sleep. Thus the third term in (7) can be viewed as a second-order substitution effect working against the pure income effect captured by the first two terms.

The demand for sleep is also affected by changes in the parameters of the wage function in (3):

$$\text{(8a)} \quad \frac{\partial T_s}{\partial W_1} = \{[U_1 - bU_2][aP + bW_m]\}D^{-1} + T_w \frac{\partial T_s}{\partial I} \ .$$

and

$$\text{(8b)} \quad \frac{\partial T_s}{\partial W_2} = T_s \frac{\partial T_s}{\partial W_1} - [aP + bW_m]U_1T_wD^{-1} \ .$$

Equation (8a) is the Slutzky equation describing the demand for sleep. The first term differs from the usual substitution effect in the presence of $-bU_2$. This appears because a change in the wage also changes the price of T_s; one can show, though, that $[U_1 - bU_2]$ is always negative. An analogous expression for $\frac{\partial T_z}{\partial W_1}$ can be derived, and it is interesting to note that in it the substitution effect of a change in W_1 on waking leisure is positive. This results from the complementarity of T_z and X in producing Z. If W_1 increases, the goods purchased with the extra income can only be enjoyed if T_z increases as well. However, the substitution effect of a change in W_1 on total nonmarket time, $T_s + T_z$, is negative, just as in the standard labor supply model. Equation (8b) shows the effect on the demand for sleep of a change in the productivity of sleep. As one would expect, an increase in W_2 has a less negative (more positive) impact on sleep than does an increase in W_1.

Note from the solution (6) that the demand for sleep may be affected by changes in any other exogenous factors that could be included as affecting tastes for sleep or the composite commodity Z. This means that, in general, any exogenous factor that shifts the demand for commodities will affect the demand for sleep and the (residual) supply of labor. Given a fixed total time endowment, T^*, this consideration suggests that it is likely, though not certain, that we will observe a negative relation within each pair among T_s, T_z and T_w, as we demonstrably have between T_s and T_w, and (implicitly) between T_z and T_w. Whether estimating separate wage effects for T_s and T_z provides different implications for the wage elasticity of the demand for leisure, T_l (= $T_s + T_z$), compared to what has been produced in the standard work that does not make the distinction between sleep and waking leisure, is an empirical question.

IV. The Demand for Sleep

A. Estimation of a Complete Model

The theoretical model implies a demand equation for sleep that is analogous to the commodity demand and labor supply equations typically estimated in the literature. The demand for sleep is a function of the individual's wage rate and nonlabor income. We estimate such a demand equation using the subsample of consumers we have extracted from the 1975-76 Time Use Study. Along with it we estimate a similar demand equation for waking nonmarket time T_z (= $T^* - T_s - T_w$). Market work is the commodity deleted from the system of demand equations. The estimating equations are analogues of equations that have become standard in the literature on labor supply:

(9) $$T_j = \gamma_{1j} + \gamma_{2j}W_m + \gamma_{3j}I + \beta_j X + \mu_j,$$

where j = s, the sleep equation, or j = z, the nonmarket waking time equation; the γ_{ij} are parameters to be estimated; W_m is the logarithm of the wage rate; I is the logarithm of the respondent's household's other income; and μ is an i.i.d. error term. Except for its exclusion of years of schooling, which we assume affected the results in Table 3 only through its effect on wages, X is the same vector of demographic variables whose coefficients were presented in Table 3.

We measure W_m as the logarithm of the respondent's self-reported monthly earnings divided by 4.3 times his or her self-reported weekly hours. This hours measure is a response to a question and is not part of the time diaries that yield the measures of T_s and T_z. This procedure has the admitted difficulty of inducing possible biases because of measurement errors in reported hours, but the lack of other data precludes using an alternative measure. Any bias induced by this measure is removed by the use of instrumental variables. Other income I is measured as the logarithm of the difference between the respondent's reported 1974 household income and 12 times his or her monthly earnings.

To estimate (9) we need to circumvent the standard problem that the market wage rate is not observed for nonworkers (174 of the 706 sample members). We do this by first estimating a probit over the entire sample of 706 observations, relating the probability of labor force participation to a number of variables that might affect it: Age and its quadratic; religious preference; health status; sex; marital status; and the presence of young children.[15] The inverse Mills' ratio, $\frac{f(-J)}{[1-F(-J)]}$, where J is the predicted ordinate of the unit normal distribution for an observation, was then entered into a second-round equation describing the logarithm of wages in the sample of 532 workers.

As is quite common in the labor-supply literature, the inverse Mills' ratio added little to the wage equation. We abandoned this approach and estimated (9) using the prediction of the logarithm of hourly earnings from wage equations that excluded this ratio. The estimates of these wage equations for the entire sample, and for men and women separately, are shown in Appendix Table A.1. The coefficients for them in this little-used set of data are quite comparable to those generated using some of the better-known sets of microeconomic data. By using instrumental variables for W_m, we are implicitly viewing the equations for T_s and T_z as part of a simultaneous system, due to the possible impact of both T_s and T_z on the wage rate. The time-use equations are identified by their exclusion of education, union status, large SMSA and region, and of the occupation and industry dummy variables.[16]

The estimates of γ_{2j} and γ_{3j} for demand equations describing T_s, sleep and nap time, and T_z, waking nonmarket time, are shown in Table 7. The results are presented for the entire sample, and separately for equations estimated for men and women. Before discussing the estimates, it is worth noting that the responses of T_s and T_z to wages are not really very different from each other. For the entire sample a test of the hypothesis that $\hat{\gamma}_{2s} = \hat{\gamma}_{2z}$ yields the statistic $\chi^2(1) = 1.38$. For the samples of men and women the corresponding χ^2-values are 1.46 and .61. Except for the hypothesis that the entire vectors of coefficents (including the control variables) in the two equations are equal, none of the hypotheses that impose equal responses of T_z and T_s to the independent variables can be rejected at conventional significance levels. However, the directions of the differences in the parameter estimates; the two χ^2-statistics that exceed unity; and the significant negative $\hat{\rho}$, the contemporaneous correlation of μ_s and μ_z, indicate that this approach to disaggregating nonwork time can be profitable.

While the $\hat{\gamma}_{2j}$ and $\hat{\gamma}_{3j}$ do not differ significantly across the two equations within each pair, the results are nonetheless fascinating. Holding the respondent's other household income constant, people with higher predicted wages sleep less.[17] In the sleep and naps equation for

TABLE 7

WAGE AND INCOME EFFECTS, DEMAND SYSTEMS, 1975-76 TIME USE DATA[a]

Dependent Variable:	Wage	Income	$\bar{R}^2$	$\hat{\rho}$
		All Respondents		
Sleep and Naps	-141.44	-1.78	.024	
	(77.35)	(4.80)		-.24
Waking Nonmarket Time	132.18	-1.71	.162	
	(129.37)	(8.09)		
		Men		
Sleep and Naps	-181.68	-2.88	.040	
	(120.88)	(5.77)		-.23
Waking Nonmarket Time	233.34	-6.69	.050	
	(193.67)	(9.30)		
		Women		
Sleep and Naps	-64.30	1.55	.018	
	(93.44)	(8.43)		-.27
Waking Nonmarket Time	-262.42	14.44	.053	
	(166.99)	(14.80)		

[a]Each equation also includes all the variables listed in Table 3. The standard errors are adjusted using the correction of Murphy-Topel (1985).

the entire sample $\hat{\gamma}_{2s}$ is significantly negative at the 95 percent level of confidence. (The sleep-wage elasticity is -.042.) Individuals whose time is more valuable substitute away from the relatively time-intensive commodity sleep, a commodity that yields utility but no direct income. While our results do suggest the existence of this most basic of economic effects on the demand for sleep, they are not overwhelming. We believe they are strong enough, though, to demonstrate that time spent sleeping is scarce and may be directly subject to variations produced by the same economic factors that affect other choices about allocating time.[18]

Among women an increase in the price of time leads to substitution toward market work (the activity left out of the demand systems) and away from nonmarket work, with little effect on sleep time. The wage effect on sleep is especially large for men, and it is close to opposite in size of the wage effect on waking nonmarket time. The amount of time that men spend in the market is unaffected by an increase in the wage rate, but that increase induces men to switch time from sleeping to leisure and nonmarket production. This could be a reflection of the complementarity between waking leisure and consumption that we highlighted in Section III. That sleep is a more important margin of choice among men than among women should not be surprising. We have already shown that otherwise identical women sleep less than men. This may make it physically more difficult for women to substitute away from sleep when the value of time increases than it is for men.

Taken together, the results of estimating this demand system are consistent with the mass of prior research that indicates that men's supply of work to the market is much less sensitive to wage rates than is that of women. The implied labor-supply elasticity for men is -.021, essentially zero, while for women it is +.191, positive but not very large (in this sample in which an unusually large fraction of women are in the labor force).

The standard errors of the estimated income effects $\hat{\gamma}_{3j}$ are too large to permit reliable inferences about their signs, but the effect of income on sleep appears to be economically insignificant. This could be caused by the nonsuperiority of sleep that is induced by the second-order substitution term in (7), or it could merely stem from problems in our measurement of other income. In any case, together with the evidence (summarized by Killingsworth, 1983) that income effects on the supply of hours of work are very small, these findings suggest that the receipt of additional unearned income does not affect T_s. Implicitly, the entire impact of extra nonlabor income is to shift the typical consumer to the production of relatively more goods-intensive commodities through purchasing more goods, not through reducing the total time spent producing those commodities.

B. Evidence on the Income Effect on the Demand for Sleep

We failed to find any evidence of income effects in the estimates of the demand system. Contemplating this issue, though, leads to two interesting extensions. First, while an increase in full income through an increased endowment of T^* is obviously impossible, it might be worth examining how people respond to the hypothetical offer of additional time.[19] In three of its monthly polls (in 1978, 1983 and 1988) the Roper Organization asked respondents to list two or three acitivities that they would engage in if they had an additional four hours each day. Sleeping was the seventh most frequently mentioned activity by the 776 people in the samples. Moreover, assuming each activity mentioned occupies the same share of the additional time, the implied estimate of $dT_s/dT^* = +.045$. While this is not strong evidence, based as it is on responses to hypothetical questions rather than on behavior, it does at least suggest that the demand for sleep is not inferior.

The second extension involves examining the impact of economic development on the demand for sleep. There is a general notion that, as the price of time increases and incomes rise, the demand for sleep will fall.[20] This ignores the possibility that sleep yields utility and that the higher incomes produced by rising wages can overcome the pure price effects. This possibility does not seem consistent with the results from the demand system; yet, since its obverse is the best way to reconcile cross-section and time-series estimates of variations in labor supply, the argument is surely not outlandish.

We do not have time series on sleep duration. We can, though, use measures of living standards along with the demographic variables in the international data set on which the estimates in Table 1 were based to estimate a reduced-form Engel curve for sleep over a diverse sample of economies. Using GNP per capita in 1966 in that equation, and dropping minutes of work, produces only minor (less than 10 percent) changes in the coefficient estimates in Table 1. Higher per-capita GNP is, though, associated with significantly longer sleep duration.[21] The effect is small, with an increase in income over the entire range producing only 21 extra minutes per day of sleep time for the average household (and an increase of two standard deviations producing only 14 extra minutes of sleep). Nonetheless, this contradicts the notion that economic development must be associated with less time spent sleeping, and it may provide some evidence for the existence of income effects in the demand for sleep.

V. Conclusions and Implications

People spend close to one-third of their time sleeping, but it is wrong to view these unconscious hours as a predetermined deduction from their scarce allotment of time. We have shown that at least part of sleep time is a reserve on which people can draw when economic circumstances make other uses of time more attractive. Our results suggest that it is not unusual for people's average daily sleep time to differ by as much as one hour at different times in their adult lives. Such variations are economically important, for they respond to economic incentives: The time spent sleeping is inversely related to both the wage and the amount of time spent in the labor market. In short, sleep is subject to consumer choice and is affected by the same economic variables that affect choices about other uses of time.

This fact has not been recognized in empirical studies of labor supply and commodity demand. To what extent does this oversight affect the validity of those studies? If sleep does not influence productivity, then estimates of labor supply equations and "complete" systems of labor supply and commodity demand (e.g., Abbott-Ashenfelter, 1976) that ignore sleep will yield unbiased estimates of income and substitution parameters. The labor supply equation proxies the complement of the demand for all non-market time (sleeping and waking); since the price of that time is the wage rate, estimating labor supply equations in standard ways is a legitimate application of the composite commodity theorem. The realization that sleep is a choice variable does lead to a subtle reinterpretation of estimated labor supply elasticities, in that they can no longer be viewed as the negative of elasticities of demand for leisure. For example, a substitution effect on labor supply that is nearly zero may reflect the combination of a positive price effect on waking leisure and a negative effect on the demand for sleep. Indeed, that is what our results suggest is the case for men.

If, as the evidence from other fields strongly suggests, sleep does affect productivity, the issue becomes more complex. The marginal price of sleep differs from the marginal price of other uses of time. The impact of sleep on the wage rate makes the wage endogenous in the labor supply function. Demand systems that are derived from parameterizations of the direct or indirect utility function without accounting for the role of sleep will produce biased estimates of the structural parameters. This relationship clearly merits further investigation by economists.

The conceptualization of sleep that we present suggests other interesting areas for study. The relation between sleep and per-capita GNP in the international data points to the possibility of a relationship between sleep and the level of economic development, and time spent sleeping may be related to other cultural factors as well. Thus a study of cross-cultural differences in sleep habits from an economic perspective would prove fruitful. Similarly, it would be useful to study historical changes in sleep behavior. Our model suggests that, in addition to changes in the value of time and income, secular changes in the technology of combining goods and waking leisure will also affect the development of the demand for sleep.

REFERENCES

Michael Abbott and Orley Ashenfelter, "Labour Supply, Commodity Demand and the Allocation of Time," Review of Economic Studies, 43 (1976): 389-412.

Gary Becker, "A Theory of the Allocation of Time," Economic Journal, 75 (1965): 492-517.

Theodore Bergstrom, "Toward a Deeper Economics of Sleeping," Journal of Political Economy, 84 (1976): 411-412.

Anthony Burgess, On Going To Bed. London, André Deutsch, 1982.

Glen Cain, "Women and Work: Trends in Time Spent in Housework," University of Wisconsin, Institute for Research on Poverty, Discussion Paper No. 747-84, April 1984.

Mohamed El-Hodiri, "The Economics of Sleeping," Manifold, 17 (1975): 13.

Daniel Hamermesh, "Shirking or Productive Schmoozing: The Allocation of Time at Work," National Bureau of Economic Research, Working Paper No. 2800, December 1988.

---------------- and Neal Soss, "An Economic Theory of Suicide," Journal of Political Economy, 82 (1974): 83-98.

James Heckman and Thomas MaCurdy, "A Life Cycle Model of Female Labour Supply," Review of Economic Studies, 47 (1980): 47-74.

Emily Hoffman, "The Deeper Economics of Sleeping," Journal of Political Economy, 85 (1977): 647-649.

George Judge, William Griffiths, R. Carter Hill, and Tsoung-Chao Lee, The Theory and Practice of Econometrics. New York: John Wiley and Sons, 1980.

F. Thomas Juster and Frank Stafford, Time, Goods, and Well-Being. Ann Arbor, MI, Institute for Social Research, 1985.

Mark Killingsworth, Labor Supply. Cambridge, England, Cambridge University Press, 1983.

Nathaniel Kleitman, Sleep and Wakefulness. Chicago, University of Chicago Press, 1963 edition.

Peter Kooreman and Arie Kapteyn, "A Disaggregated Analysis of the Allocation of Time within a Household," Journal of Political Economy, 95 (1987): 223-249.

Staffan Linder, The Harried Leisure Class. New York, Columbia University Press, 1970.

Ray Meddis, The Sleep Instinct. London, Routledge and Kegan Paul, 1977.

Robert Michael, "Education in Nonmarket Production," Journal of Political Economy, 81 (1973): 306-327.

Merrill Mitler, Mary Carskadon, Charles Czeisler, William Dement, David Dinges and R. Curtis Graeber, " Catastrophes, Sleep and Public Policy: Consensus Report," Sleep 11 (1988): 100-109.

Kevin Morgan, Sleep and Aging. Baltimore, Johns Hopkins University Press, 1987.

Kevin Murphy and Robert Topel, "Estimation and Inference in Two-Step Econometric Models," Journal of Business and Economic Statistics, 3 (October 1985): 370-379.

Frank Stafford and Greg J. Duncan, "The Use of Time and Technology by Households in the United States," Research in Labor Economics, 3 (1980): 335-375.

Alexander Szalai, The Use of Time. The Hague, Mouton, 1972.

Wilse B. Webb, "Sleep in Industrialized Settings in the Northern Hemisphere," Psychological Reports, 57 (1985): 591-598.

Robert Wilkinson, "Sleep Deprivation," in O. G. Edholm and A. L. Bacharach, eds., The Physiology of Human Survival. New York: Academic Press, 1965.

NOTES

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1. Three semi- (totally?) humorous notes, El-Hodiri (1975), Bergstrom (1976) and Hoffmann (1977), did examine sleep from one economic perspective without, however, developing or testing any predictions.

2. The studies included Belgium, Bulgaria, Czechoslovakia, France, two from the Federal Republic of Germany, the German Democratic Republic, Hungary, Peru, Poland, two from the USA, the USSR, and two from Yugoslavia.

3. Minutes of work per day are an average for all workers on workdays in the particular country study, not the average for each sex-marital status cell. These latter data were not available. The results were qualitatively the same when a dummy variable measuring employment status, which contains less information, was used instead.

4. In these data market work includes all work-related time, categorized in the four headings normal work, second job, other time at work and travel to work. This very broad definition thus means that we have slightly biased the calculation of the coefficient on work time toward zero.

5. 32 individuals were excluded who reported earnings in 1974 that exceeded their reported family income.

6. Hamermesh (1988) shows that on-the-job leisure is less than ten percent of total time spent at the job, and that its effects on wages are very small. This suggests it makes sense to exclude it from time spent working and to include it instead in waking nonmarket time.

7. Only 58 of the men worked more than their reported combined time sleeping and resting, and only 55 worked more than their reported aggregate of sleep, rest and miscellaneous personal time. The comparable figures among the 306 women are 17 and 17.

8. In the data a child is coded as being less than three years old if he or she was at most two years old. (Respondents who stated their child was 2-1/2 were not coded as having a young child.)

9. Tests of sex differences in the response of the sleep measure to additional minutes of market work yield t-statistics of 1.39, 1.33 and 1.50 for the three variables that measure sleep. The responses are significantly different at low levels of confidence.

10. The means in 1975-76 for the three sleep classifications and for work time were 3246, 3370, 3410 and 2184 minutes for the entire sample of 239 people. Among women they were 3278, 3410, 3458 and 1750,

while among men they were 3225, 3343, 3378 and 2470. Comparing these to the statistics in Table 2, one can conclude that, at least along these dimensions of time use, the individuals in the longitudinal data were remarkably similar to the people included in the sample from the 1975-76 Time Use Study.

11. Since a quadratic in age is included in equation (1), a linear term belongs in equation (2).

12. The estimates of α from (2) on the smaller sample from the Longitudinal Panel Study are also very similar to cross-section estimates of α based on this same smaller sample. For example, for sleep and naps, $\hat{\alpha}$ estimated over the 239 people in this panel and based on (1) for 1975-76 is -.212. Estimating the same equation for these people using 1981 data produces $\hat{\alpha} = -.100$. Among men the analogous estimates are -.242 and -.129; among women, they are -.185 and -.065. With the exception of the estimate for the (small) subsample of women in 1981, all of these estimates differ significantly from zero.

13. Wall Street Journal, July 7, 1988, p. 25.

14. We adopt a fixed-coefficients specification of the household production technology for expositional convenience, and also to highlight the fact that consumption activity requires waking as opposed to sleeping leisure. Indeed, this is one important reason for treating the two types of leisure as distinct categories. In the text we discuss certain implications of the perfect complementarity of market goods and waking leisure embodied in the specification. These results should be seen as extreme expressions of tendencies present when there is any complementarity between X and T_z. The basic results are not affected if our assumption that the enjoyment of sleep requires no expenditure on market goods is replaced with the more realistic assumption that it requires some fixed expenditure on goods (e.g., a bed).

15. This model is basically an extension of what Killingsworth (1983) has called "second-generation" models of labor supply.

16. We explored the possibility that sleep affects productivity by estimating a wage equation that included a measure of sleep. Our model suggests that to do this properly, sleep, waking nonmarket leisure (or hours of work) and wages would have to be treated as endogenous. Unfortunately, our data are not sufficient to allow us to identify convincingly such a wage equation --- there are not enough variables that are strongly correlated with sleep time and work time that can be excluded from the wage equation.

17. Qualitatively similar results on W_m are obtained when the equation systems are reestimated using either sleep, or sleep, naps and rest and personal time, as one of the three uses of time.

18. Kooreman-Kapteyn (1987), who use the 1975-76 Time Use Study to estimate their time allocation model, report (p. 241) that, "women substantially reduce the amount of time spent on personal care if their wage rate goes up." This result, with its conter-intuitive implication that highly-paid women are less attentive to their health and

appearance, makes more sense when one recognizes the importance of sleep in their personal care category. (Our broadest measure of sleep makes up 80 percent of their category.) The decreased time devoted to "personal care" is recognizable as the wage effect on the demand for sleep that we have found.

19. We thank Sender Hoffmann of the Roper Organization for providing the underlying data.

20. Linder (1970, p. 47) argues that, "...many people regard sleep as a waste of time. The greater the demand for time, the more people come to accept this view."

21. The GNP data were constructed from materials in the United Nations Statistical Yearbook and the International Financial Statistics. The coefficient on GNP per capita, measured in thousands of 1966 U.S. dollars, was 6.14; its standard error was 1.87. The range of GNP per capita in this sample was $356 to $3842, with a mean of $1609 and a standard deviation of $1110.

22. Estimated demand systems that ignore labor supply will produce biased parameter estimates if sleep is not weakly separable from goods in the utility function, just as they would if waking leisure time were not weakly separable.

TABLE A.1

WAGE EQUATIONS, 1975-76 TIME USE DATA-[a]

	All Respondents	Men	Women
Years of Schooling	.045 (.011)	.044 (.015)	.036 (.018)
Experience	.032 (.007)	.044 (.010)	.022 (.010)
$Experience^2$	-.0005 (.0001)	-.0007 (.0002)	-.0005 (.0002)
Married	.028 (.059)	.047 (.091)	-.021 (.078)
Male	.465 (.052)	-----	-----
Health Status	-.095 (.072)	.030 (.098)	-.275 (.106)
Union Member	.108 (.055)	.113 (.070)	.105 (.088)
Large Metropolitan Area	.183 (.048)	.130 (.064)	.242 (.072)
Black	-.017 (.102)	-.152 (.165)	-.019 (.134)
South	.010 (.057)	-.066 (.080)	.103 (.084)
$\bar{R}^2$	.370	.183	.281
N =	532	293	239

-[a]Also included in the equations are constant terms and vectors of dummy variables for one-digit occupation and industry.