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ABSTRACT

The American Time Use Survey 2003-15, the French *Enquête Emploi du Temps*, 2009-10, and the German *Zeitverwendungserhebung*, 2012-13, have sufficient observations to allow examining the theory of household production in much more detail than ever before. We identify income effects on time use by non-workers, showing that relatively time-intensive commodities—sleep and TV-watching—are inferior. For workers we identify income and substitution effects separately, with both in the same direction on these commodities as the income effects among non-workers. We rationalize the results by generalizing Becker's (1965) "commodity production" model, allowing both substitution between time and goods in household production and substitution among commodities in utility functions. We then use the evidence of price discrimination in product markets against minorities in the U.S. and immigrants in France to motivate an extension of the model that predicts how household production differs between members of these groups and the majority. We find the predicted results—minorities engage in more time-intensive activities, sleep and TV-watching, than otherwise identical majority-group members.

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I. Introduction—Economic Variables in Time Use

The literature on time use is immense; but due to the paucity of available data allowing identification of income and price effects, few attempts have been made to take Becker's (1965) "commodity production" model seriously as a guide to empirical work, in the sense of deriving and testing the implications of an explicitly specified model (Kooreman and Kapteyn, 1987; Biddle and Hamermesh, 1990; and recently Blundell *et al*., 2018). With the recent accumulation in several countries of very large collections of time diaries, this problem can now be vitiated. These data reveal strong empirical regularities in the relationship between household income and quantitatively important categories of time use. We show that a straightforward generalization of Becker's model provides a simple rationalization of these regularities.

The data also allow testing an implication of the theory of time use about how behavior is affected by discrimination. Literatures measuring the extent of discrimination along such dimensions as race, ethnicity and gender are immense; and there are burgeoning literatures measuring the amount of discrimination by sexual orientation, disability status, appearance and other characteristics.[1] With the exception of the fairly large literature on racial differences in consumption/saving behavior, consideration of how discrimination affects the behavior of the agents who are discriminated against is rare.[2] Even the few studies that examine these effects concentrate only on how agents' behavior in market(s) where they are discriminated against is altered by the discrimination that they face in those markets. Missing completely is any research on how discrimination in one market affects the behavior of disadvantaged agents in a different market or area of activity— how discrimination spills over across markets. Within the context of the theory of household production we examine one spillover, namely how racial/ethnic differences in the allocation of time are affected by racially discriminatory pricing in product markets.

[1]On race, see, e.g., Charles and Guryan (2008); on ethnicity Leal and Trejo (2011); on gender, Blau and Kahn (2017); on sexual orientation Valfort (2017); on disability Beegle and Stock (2003); on appearance Hamermesh (2011).

[2]Among the few studies that make this at least part of their analyses is Parsons *et al.* (2011).

We begin by discussing the sets of time diaries used in this study, those for the U.S., France and Germany. With these data we present broad-based evidence of a negative relationship between income and two quantitatively important uses of time: sleep and television watching, both of which are "time-intensive" commodities. One obvious explanation for this relationship was provided by Becker (1965): rising worker productivity would increase the opportunity cost of time, thus raising the relative prices of time- to goods-intensive commodities, inducing substitution away from the former and towards the latter. In most models using this framework, however, all time uses except market work are "normal", so that there is an income effect that works against this substitution effect, even for time-intensive commodities. Also, the explanation does not account for the possible existence of this pattern among non-workers, for whom income differences cannot result from wage differences.

In Section III we use samples of workers to estimate separately the income and substitution effects on time spent sleeping and television watching, along with effects on two activities that are likely to be goods-intensive—eating away from home, and attending museums, sporting events and concerts. In Section IV we explain the empirical results by developing a model that allows substitution between goods and time in the production of commodities and between commodities in agents' utility functions. The model identifies a broad range of circumstances under which non-workers will respond to higher incomes, and workers to higher wages, by substituting more goods-intensive commodities for more time-intensive commodities in consumption and using more goods-intensive technologies of household production, in keeping with the empirical results presented in Sections II and III. The model also suggests a hypothesis regarding racial/ethnic differences in time use, and Section V develops and tests this hypothesis using the American and French data.

II. Data Sets and Estimates of Income Effects

With the creation of the ongoing American Time Use Survey (ATUS) in 2003, we now have over 170,000 one-day diaries of people's short-term recollections of how they spend their time.[3] With a sampling

[3]See Hamermesh *et al*. (2005) for a discussion of the characteristics of this data set.

frame based on previous respondents to the Current Population Survey, the ATUS also provides information on a wide array of demographic characteristics and on family incomes. Minorities account for around 25 percent of the U.S. population. Thus this sample is also sufficiently large to allow the examination of racial/ethnic differences in time use. For that purpose, we divide the sample into the following three mutually exclusive groups: African-Americans, white Hispanics, and white non-Hispanics.[4]

In 2009-10 France fielded its fourth roughly decennial national time-diary study, the *Enquête Emploi du Temps 2009-2010* (INSÉÉ, 2014). This survey collected nearly 28,000 diaries containing large amounts of demographic and other information on people ages 10 or over throughout France, located in roughly 12,000 households. Unlike the ATUS each person in the *Enquête* was asked to complete two one-day diaries, filling each out for 10-minute intervals from Midnight through 11:59PM on the previous day.[5] There is no information on race/ethnicity in this data set; but respondents are categorized by immigrant status, and nearly 8 percent were immigrants. We analogize this demographic characteristic to race/ethnicity in the U.S.

In its third roughly decennial time-diary study the German Statistical Office fielded the *Zeitverwendungserhebung* over five quarters in 2012 and 2013. The survey asked respondents to complete diaries on three separate days, with slightly heavier sampling of weekends than weekdays. As with the French survey, respondents were asked to provide their activities in fixed intervals of time, and nearly 25,000 time diaries were collected (Statistiches Bundesamt, 2015). We present detailed descriptions of the construction of the aggregates of time use in this and the other two data sets in the Data Appendix.[6]

[4]African-American is defined as anyone who reports being of a single race, African-American, or who lists two races, with African-American being one of them. White Hispanic is anyone who is not African-American and who lists his/her ethnicity as Hispanic. White non-Hispanic is any else who lists his/her sole racial affiliation as white. We exclude Asian-Americans and the other very small racial groups.

[5]This contrasts with the ATUS, in which respondents were asked to note the exact time that they began each new activity and to describe its nature so that it could be coded into one of the over 400 categories describing time use.

[6]This data set and the ATUS present daily totals of time spent in each individual activity. The *Enquête* presents the activity undertaken in each ten-minute interval of the day, which we then aggregate across the diary day.

Our focus is on the economic measures in these surveys, wages and incomes, so we need to be clear about how these are measured. In the ATUS, as in the CPS currently, household income is listed in 16 brackets. We assign mid-points to the closed intervals and assign 1.5 times the top-coded amount to the highest, open interval. We compute the hourly wage rate (available only for those currently employed) as usual weekly earnings divided by usual weekly hours and exclude workers with computed hourly wages below $5 or above $150. The French income data are continuous measures with no top-coding, and can thus be used as presented. We compute the hourly wage as monthly earnings divided by 4.33 times weekly hours, using the same disqualifiers (in euros) as with the U.S. data. The German data set presents household incomes and monthly earnings in only five brackets, creating a very high positive correlation between them across individuals. For that reason, and also because its sample of immigrants is small, we only include the German data in the examination of income effects among non-workers. In each data set, when we examine workers' behavior, we include the hourly wage measure and define non-labor income as the household's income less the worker's earnings.

A frequent division of time use is into four categories: Paid work, home production, personal time and leisure. Sleep predominates in personal care, and television-watching is the predominant leisure activity. Sleep and television watching are both relatively time-intensive (Gronau and Hamermesh, 2007), so that their responses to income and price differences may make them non-aggregable with other personal and leisure activities. Thus, in each of the three data sets we divide personal care into sleep and other personal care, and leisure into TV-watching and other leisure activities.

Table 1 lists statistics describing the six categories of time use for each of two samples in each of the three data sets: All diaries for which the respondent reported no usual hours of work, no work on the diary day and no usual earnings (non-workers); and all diaries for which the respondent reported usually working and working on the day of the diary (workers). The statistics and estimates throughout are calculated using the sampling weights. The means in Table 1 accord with what is generally known about time use and its differences across countries. On workdays work time (of workers) and sleep time are about equal in all three countries. Workers sleep less on workdays than do non-workers, and watch much less

television. In all categories Americans watch more television than the Europeans, especially among non-workers. Averaging across all households in the samples, household incomes track the national averages quite closely.

For each of the three samples of non-workers we estimate equations describing the responses of each of the five non-work aggregates of time use to changes in household income. Large vectors of demographic controls are included in each equation. While they necessarily differ across the three samples because of differences in the available information, in all cases they include indicators of gender and marital (coupled) status and their interaction, a quadratic in age, indicators of the numbers and ages of young children, and vectors of indicators of educational attainment, and the year, month and day of the week for which the diary was kept. They also include state in the U.S., and region in France.

Table 2 presents estimates of the impact of a $10,000 (€10,000) increase in annual income, far less than one standard deviation in each case, on the minutes of time spent in each activity on a representative day. These are pure income effects, since the samples are restricted to respondents who report no usual work hours, do not work on the diary day and have no earnings. Because of the adding-up requirement, for each country the five estimated income effects sum to zero.

While there are some variations across the three countries, there are remarkable similarities: 1) Sleep and television-watching are uniformly inferior; and in each data set TV-watching is the most relatively inferior commodity. The impacts of income on sleep are very close in the three data sets; 2) Other leisure activities are uniformly superior and constitute the most relatively superior aggregate in each sample; 3) The estimated impacts of increased income on the other two aggregates, home production and other personal activities, are not uniformly positive or negative.

If we re-estimate these equations excluding any variable that might possibly be considered endogenous, leaving only the respondent's age and the year, month and day of the diary, in the U.S. all the estimated income effects become larger in absolute value; most are also larger in the French data, but in the German data the changes are mixed. Another alternative is to estimate this model separately for married

individuals, including their spouse's age and education (the same coding as for the respondent's demographic characteristics). This re-specification hardly changes the estimates.[7]

One might be concerned that non-workers' choices are constrained by the activities of other family members' working and perhaps even by the time allocations of non-family members (Goux *et al.*, 2017). Because of the size of the ATUS sample, we can get some insight into this potential problem by examining time allocation on public holidays by both non-workers and workers who do not work on the holiday (even in the U.S., most workers). The second part of the upper panel in Table 2 presents the same equations as before, but estimated over the reduced sample of 2,050 people who are not working on the holiday for which they recorded a time diary. The estimates are remarkably similar to those for the entire sample of non-workers; and they differ little if we restrict the sample still further to include only those of non-workers who kept diaries on holidays.

In much of the following we focus on the two activities, sleeping and TV-watching. These are hardly ever considered in the economics literature, no doubt because information on them is only available in time-diary surveys. Yet, at least in the three countries examined here, they are the primary activities that are the first and third-most important among the hundreds of ways that the data sets classify time use; and together the average person in each country spends over ten hours per day engaged in these two activities.

We simulate income effects on these two uniformly inferior activities by calculating changes in time spent in response to increases in family incomes from one standard deviation below the mean to one standard deviation above. In the U.S. this increase would reduce the non-worker's sleep time by 20 minutes per night (4 percent), and his/her TV-watching time by 28 minutes (12 percent). In France it would reduce

[7]Another possible concern is that some of the respondents may be more willing and available to complete a diary and may do so differently from others. We do not have information on the difficulty of obtaining an ATUS respondent's diary; but we do know how difficult it was to contact them in their eighth month in the CPS. Dividing the sample by this measure and re-estimating the equations for the U.S. in Table 2 yielded no significant differences among the three sub-samples. Yet another concern might be that, despite restricting the samples to respondents who stated that their usual work hours are zero and that they did no work on the diary day, perhaps they are still attached to the labor force. To circumvent this potential difficulty, we re-estimate the equations for sleep and TV-watching on those non-workers who are at least at the age of eligibility for a public pension. In all three countries the parameter estimates remain statistically significant and negative, with the main change being that the difference in the impact of additional unearned income in the U.S. on sleep time becomes even smaller relative to that on TV-watching.

non-workers' sleeping by 12 minutes (2 percent) and TV-watching by 28 minutes (17 percent). In Germany the analogous decreases are 12 minutes (2 percent) of sleeping and 20 minutes (12 percent) of TV-watching. While both commodities are inferior, in all three data sets TV-watching is markedly more income elastic than sleep. Physical limitations make it difficult to switch away from sleeping when incomes rise, although some switching is apparently possible. No such limitations exist to choosing to watch less television when more goods can be purchased; and people do substitute strongly against this activity in response to pure increases in income.

III. Wage and Income Effects on Workers' Time Use

To estimate income and wage effects for workers, we re-specify the equations estimated in Table 2, adding the hourly wage rate and replacing household income by household income minus the worker's earnings.[8] Because of the long history of focus in the labor-supply literature on women's labor supply, we estimate the models of time use separately by gender. Other than that, the control variables are the same as those included in the equations underlying Table 2. The sample consists of all days reported by workers who indicate that they engaged in some market work in the week preceding the diary day and in some work on the diary day. We restrict the estimation to married (in France, coupled) to avoid including workers whose income is nearly entirely their own earnings.

The upper panel of Table 3 shows estimates of the impacts of increases in other household income (again in $10,000 units) and the worker's hourly earnings (in $10 units, slightly less than one standard deviation) on time spent in the two time-intensive activities, sleep and TV-watching, in the ATUS.[9] Both activities respond negatively to increases in the price of the worker's time. In these specifications the pure

[8]We treat all other income the same rather than separating out partners' earnings from unearned income. Because the ATUS only collects one diary per household, we cannot examine cross-wage effects on time use within partnered couples, so that a further disaggregation of household incomes would not be fruitful.

[9]Estimates of the effects of these variables on time spent in the other four major uses of time are presented in the Appendix for the U.S. and France. For purposes of comparison to other studies, the implied elasticities of labor supply (at the intensive margin) are +0.02 for men, +0.06 for women.

income effects are much below those for non-workers in Table 2, and, except for women's TV-watching, not significantly nonzero.[10]

A large literature has demonstrated the inelasticity of men's labor supply and the decreasing elasticity of women's in the U.S. as well (Heim, 2007). While paid work time is obviously endogenous, treating it as fixed in estimating these equations is not a large departure given its relative wage inelasticity, especially in the literature examining the intensive margin. The bottom panel of Table 3 thus estimates the demand equations for sleep and TV-watching holding work time constant. Except for women's sleep time the estimated effects of increases in hourly earnings change little from the upper panel. All the income effects, however, become negative, with three of them becoming statistically significant; but their magnitudes are still quite small, especially compared to the wage effects.

The estimates include all workers, of whom slightly more than half are paid hourly, and thus have a specified hourly wage, and of whom the other half are salaried and whose hourly wage we calculated as the ratio of usual weekly earnings to usual weekly hours. Excluding salaried workers from the estimates might increase the reliability of the results (at the expense of cutting the sample in half) by removing possible division-bias in the wage variable. Re-estimating the models summarized in Table 3 without salaried workers, however, produces only minor changes in the parameter estimates.

We present estimates of the same equations for France in Table 4, again for all those who report some paid work during the week and who work on the diary day. With sub-samples less than one-sixth the sizes of the American sub-samples, we cannot expect the same significance of the parameter estimates. Nonetheless, whether we hold paid work time constant or not, we do find substantial negative income effects among workers, especially on time spent watching television. None of the wage effects is statistically significant, but the largest are positive. The estimated wage effects contrast with those for the U.S., which tended to be significant. A general conclusion from these tables is that pure income effects on workers' time spent sleeping and TV-watching are negative.

[10]Some indirect corroborative evidence on these effects is provided by Aguiar *et al*. (2013), who use the implied cuts in wages and incomes during the Great Recession to examine time spent in sleep and TV-watching.

As with the results for non-workers in Table 2, here too we re-estimate the models first with only age and the year, month and day indicators, and with the two monetary measures included. The changes are similar to those when we re-specified the models estimated in Table 2: The absolute values of the effects, of both wages and incomes, generally become larger. Also, as in Table 2, when we include the spouse's demographic characteristics, the essential results change only slightly.

We know that health is correlated with income, so that income or earnings may proxy for poor health. And people in worse health may find the production of some commodities more difficult than others. The ATUS has a measure of self-rated health for six of the years in our sample, and the *Enquête* has a similar measure, with both on a 5 to 1 scale, from excellent in the ATUS (very good in the *Enquête*) to poor (very bad). Those in worse self-rated health do spend more time both sleeping and eating in both samples. Adding these indicators to the estimated equations does reduce the absolute values of the income effects in the U.S. equations in Table 2, and of the wage and income effects in Table 3, but never by more than 25 percent. In the French data in Table 2, and in the results in Table 4, there are almost no changes.

With the impacts on what we believe are the relatively time-intensive activities, sleep and TV-watching, being generally negative, estimating similar equations describing variations in activities that we might believe are relatively goods-intensive should give the opposite results. To examine this possibility, we define the two activities, time spent eating away from home, and time spent attending sporting events, museums, concerts, etc. (the latter only for the U.S., as the French data have very few observations with positive amounts of time spent in such activities). Because neither of these activities is undertaken by more than half the samples' respondents, we estimate both a probit describing the incidence of the activity on the diary day(s) and a conditional regression describing its intensity among those who spend any time on it.

Table 5 presents the estimates of income effects in these equations, specified to include the same controls as in Tables 2, 3 and 4. Income has a positive effect on the likelihood that an individual engages in both these activities in the U.S., and in eating out in France. Income also has a positive effect on time spent eating out for those who do report eating out in the U.S. The other two estimated effects of income on the intensity of the activity are tiny, negative and statistically insignificant

IV. Income and Substitution Effects in Household Production

A. Background

In this section we explore the extent to which the empirical regularities that we have demonstrated for the time-intensive commodities of sleep and TV-watching are consistent with the Becker (1965) model. A primary consideration is the nature of the income and substitution effects on various categories of time use in such a model. From Becker (1965) to Gronau's (1980) study and his survey (Gronau, 1986), one finds occasional analyses of the impact of changes in wages and in non-labor income on various uses of time; but the discussions are characterized by a lack of shared definitions and take place in the context of models that assume fixed proportions for combining goods and time in household production. With fixed-coefficient commodity production functions the effect of an increase in non-labor income on all the time uses will generally be positive, while a compensated wage increase leads to a shift away from earnings-intensive commodities and toward goods-intensive ones, where earnings intensity is measured by the share of the total cost of a commodity represented by foregone earnings.

There are a number of other relevant results in the literature, but none applies to non-workers. Gronau (1986) asserts that for non-workers, or when work time is exogenous, "time scarcity depends upon the individual's income and his non-labor time. The higher his income and the smaller his non-labor time, the greater the time scarcity and the shadow price of time. An increase in the shadow price of time should raise the relative price of time-intensive commodities (i.e., commodities where t_i/x_i is high) and result in a substitution of goods for time", with t_i/x_i being the ratio of the marginal input requirements of time and goods for commodity i.[11]

The negative effect of the wage on both sleep and TV-watching found here is consistent with Becker's result concerning the negative substitution effects on time-intensive commodities, and the

[11]A final relevant result is due to Deardorff and Stafford (1976), who show that with a homothetic utility function defined over two commodities and linearly homogenous commodity production functions, the wage elasticity of labor supply will be an increasing function of a weighted average of the elasticities of substitution of the production functions and the utility function. If this weighted average is greater than one, the wage elasticity of labor supply will be positive. Versions of this result have appeared in more recent papers proposing explanations of aggregate trends in time use, including Kopecky (2011) and Aguiar and Hurst (2007).

negative effect of income on these activities for non-workers supports Gronau's conjecture. In the absence of an *ad hoc* assumption about the utility of sleep versus TV-watching, however, the model with fixed coefficients cannot explain the finding that both the income and wage elasticities are larger in absolute value for TV-watching than for sleep, as both activities are similarly time-intensive. For this reason, we introduce, as a possible means of explaining the results, a generalization that allows for substitution between goods and time in the production of commodities—abandoning fixed-coefficients production.

B. Model

As in Becker (1965) ours is a one-period model in which individuals maximize utility defined over m commodities Z_1 ,..., Z_m. Each commodity is produced by combining time and goods according to a production function $Z_i = f_i(X_i, T_i)$, where X_i is the expenditure on goods (and/or the service flow from durable goods) used in the production of Z_i, and T_i is time spent in producing Z_i. For simplicity we assume that "goods" is a Hicksian composite with price fixed at one and the same for all consumers, although we relax this assumption in Section V below. We rule out joint production. Individuals can also devote time to market work, receiving a wage rate w per unit of time. Market work does not directly affect utility or contribute to the production of any of the commodities.

In order to concentrate on the relationship between patterns of time allocation and the characteristics of the commodity production functions, we specify a simple utility function:

$$U = \sum (Z_i/\gamma)^{\gamma} , \gamma < 1.$$

Each commodity is produced according to a commodity-specific CES production function $Z_i = [\delta_i X_i^{\rho(i)} + (1-\delta_i)T_i^{\rho(i)}]^{1/\rho(i)}$, where $\sigma_i = 1/(1-\rho_i)$ is the elasticity of substitution between time and goods in the production of commodity i. This set-up embodies three intuitively appealing properties: 1) Diminishing marginal productivity and utility of money expenditure on each commodity; 2) Diminishing marginal productivity and utility of time spent in each commodity; and 3) Decreasing returns to scale in utility for each commodity.

The assumption of no joint production leads to the standard budget constraint:

$$I + w(T^* - \sum T_i) = \sum X_i,$$

with I being non-labor income, T^* total time available, and $(T^* - \sum T_i)$ time devoted to market work. The first-order conditions for the individual's maximization problem take the form:

$$\gamma\delta_i\rho_i X_i^{\rho(i)-1}[\delta_i X_i^{\rho(i)} + (1-\delta_i)T_i^{\rho(i)}]^{((\gamma-\rho(i))/\gamma)} = \lambda \text{ for all i;} \quad (1a)$$

$$\gamma(1-\delta_i)\rho_i T_i^{\rho(i)-1}[\delta_i X_i^{\rho(i)} + (1-\delta_i)T_i^{\rho(i)}]^{((\gamma-\rho(i))/\gamma)} \geq \lambda w \text{ for all i,} \quad (1b)$$

where λ is the Lagrangian multiplier on the goods budget constraint. Note that we assume that (1a) always holds with equality, but that it is possible for the marginal utility of time to be greater than the marginal utility of the wage rate, so that the individual chooses not to engage in market work. In that case, the problem takes a different form, with maximization subject to two separate constraints: $(T^* - \sum T_i) = 0$ and $I = \sum X_i$. The first-order conditions become:

$$\gamma\delta_i\rho_i X_i^{\rho(i)-1}[\delta_i X_i^{\rho(i)} + (1-\delta_i)T_i^{\rho(i)}]^{((\gamma-\rho(i))/\gamma)} =$$

$$\gamma\delta_k\rho_k X_k^{\rho(k)-1}[\delta_k X_k^{\rho(k)} + (1-\delta_k)T_k^{\rho(k)}]^{((\gamma-\rho(k))/\gamma)} \text{ for all i and k;} \quad (2a)$$

$$\gamma(1-\delta_i)\rho_i T_i^{\rho(i)-1}[\delta_i X_i^{\rho(i)} + (1-\delta_i)T_i^{\rho(i)}]^{((\gamma-\rho(i))/\gamma)} =$$

$$\gamma(1-\delta_k)\rho_k T_k^{\rho(k)-1}[\delta_k X_k^{\rho(k)} + (1-\delta_k)T_k^{\rho(k)}]^{((\gamma-\rho(k))/\gamma)} \text{ for all i and k.} \quad (2b)$$

C. *Wage and Income Effects on the Time Allocation of Workers*

Conditions (1a) and (1b) place restrictions on the expenditure per unit of time on each commodity:

$$(\delta_i/(1-\delta_i))(X_i/T_i)^{\rho(i)-1} = (1/w) \quad (3)$$

Equating the left-hand side of (1b) for commodity i to its counterpart for an arbitrarily chosen commodity k, then using (3) to substitute for X_i and X_k in that expression, provides an equation in T_i and T_k:

$$(1-\delta_i)T_i^{(\gamma-1)}[\delta_i\,(\delta_i/(1-\delta_i))^{\rho(i)/(1-\rho(i))}w^{\,\rho(i)/(\rho(i)-1)} + (1-\delta_i)]^{(\gamma-\rho(i))/\rho(i)} =$$

$$(1-\delta_k)T_k^{(\gamma-1)}[\delta_k\,(\delta_k/(1-\delta_k))^{\rho(k)/(1-\rho(k))}w^{\,\rho(k)/(\rho(k)-1)} + (1-\delta_k)]^{(\gamma-\rho(k))/\rho(k)} \quad (4)$$

Logarithmically differentiating (4) we obtain an expression that shows the relationship between the wage and income elasticities of the time inputs into any pair of commodities i and k:

$dlnT_i = dlnT_k + Q^k_i * dlnw$, where:

$$Q^k_i = [a_i(\sigma_u - \sigma_i) - a_k(\sigma_u - \sigma_k)] = [(a_i - a_k)\sigma_u - a_i\sigma_i + a_k\sigma_k], \quad (5)$$

where $a_i = X_i/(X_i + wT_i)$ is the share of money expenditures on commodity i in the total (opportunity) cost of commodity i, and σ_u is the elasticity of substitution between commodities in the utility function. An

immediate implication of (5) is that all uses of time have the same elasticity with respect to non-labor income (i.e., $(d\ln T_i/d\ln I) = (d\ln T_k/d\ln I)$. Whether the wage elasticity of one commodity is more or less positive than that of another depends on the sign of Q, the determinants of which we discuss below.

To obtain an expression for the wage elasticity of time spent on a commodity, logarithmically differentiate the budget constraint, after using (3) to substitute out the X_i terms, then use (5) to replace the $d\ln T_i$ terms. This leads to

$$d\ln T_k/d\ln I = \theta_I/(1+ (1-\theta_I)T_w); \quad (6a)$$

$$d\ln T_k/d\ln w = \{(1-\theta_I) - \sum[s_i + (1-\theta_I)r_i]Q^k_i - \sum s_i\sigma_i\}/(1+ (1-\theta_I)T_w), \quad (6b)$$

where θ_I is the share of non-labor income in total money income, s_i is the share of expenditure on commodity i in total expenditures, and $r_i = (T_i/T_w)$ is the ratio of time spent on commodity i to time in market work.

Equation (6a) shows the elasticity of time allocated to a commodity with respect to non-labor income, which is positive and identical for all time uses. Equation (6b) is the wage elasticity. The first term in its numerator is due to the income effect. The final term is a weighted average of the elasticities of substitution for the various commodities and exerts the same negative influence on the wage elasticity for all time uses. The middle term is different for each commodity, as it involves Q^k_i which may be positive or negative.

Inspection of (5) and (6b) reveals four useful results:

(1) If $\sigma_u > \sigma_k$ (substitution away from commodity k in consumption is easy relative to substitution away from time in its production), $d\ln T_k/d\ln w$ is more positive for more goods-intensive commodities (those with higher a_k values), and more negative for time-intensive commodities.[12]

(2) If $\sigma_u < \sigma_k$, $d\ln T_k/d\ln w$ is more negative for more-time intensive commodities, and more positive for goods-intensive commodities.

[12]In Becker's (1965) model $\sigma_k = 0$, so this result is consistent with Becker's result that that a compensated wage increase will lead to a substitution of goods-intensive for time-intensive commodities. The value of a_k is proportional to the elasticity of output of Z_k with respect to X_k, so that one could also describe the phenomenon as substituting toward activities in which the marginal productivity of goods expenditure is higher.

(3) Higher values of σ_u (easier substitution in consumption), make $d\ln T_k/d\ln w$ more negative for relatively time-intensive commodities, and more positive for relatively goods-intensive commodities

(4) Higher values of σ_k (easier time-goods substitution in the production of commodity k) make $d\ln T_k/d\ln w$ more negative.

A crucial distinction in the model is that between substitution in the production of the Z's and substitution in their consumption, which ultimately depends on how the commodities are defined. In empirical work, however, the definitions adopted by researchers are often arbitrarily determined by the nature of the available data. As time use and expenditure data grow in quantity and quality, it will increasingly be possible and worthwhile to maintain the distinction between substitution within and substitution across commodities, and to think in terms of the relative values of σ_u and the σ_i and their differing impacts on time allocation.[13]

D. *Income Effects on the Time Allocation of Non-Workers*

The optimal allocations of time and expenditure to commodities by non-workers, and by those who cannot vary their hours of work, are described by (2a) and (2b). For the former group, changes in the market wage are not relevant to the time-allocation decision, provided that these changes are not sufficiently large to induce entry into the labor force. For the latter group the elasticity of time spent on a commodity with respect to a change in the wage is proportional to the elasticity with respect to a change in non-labor income. Unlike the case for workers analyzed above, it is not possible for the income effect on time use to be positive for all commodities. Unless the income elasticities of all uses of time are zero, there must be both positive and negative elasticities.

Deriving the elasticity of time use with respect to income from (2a) and (2b) leads to a complicated expression from which little insight can be gleaned. In a two-commodity version of the model, however,

[13]For example, in an analysis of changes over time in how Americans have fed themselves, we could define an activity "eating", and discuss changing possibilities for substituting money for time within that activity by eating less at home and more at fast-service restaurants.

the sign of the income elasticity of time use in commodity 1 is the sign of $[a_1(\sigma_u - \sigma_1) - a_2(\sigma_u - \sigma_2)]$.[14] This expression is similar to Q^k_i in the expression describing the time elasticities for workers, indicating that the effect of a pure income change on the time allocation of non-workers resembles the substitution effect of a wage change for workers. The reason for the resemblance is that a change in income for non-workers causes a change in the relative opportunity costs of the activities, as is readily apparent in a version of the model with fixed-coefficient production.[15] The same argument applies, *mutatis mutandis*, when the production functions are CES. If the elasticity of substitution between commodities is greater than the elasticity of substitution within commodities, a higher goods-intensity contributes to a more positive income elasticity. If both commodities are equally goods-intensive, rising incomes will lead to a fall in time devoted to the commodity with a higher elasticity of substitution in production.[16]

E. Explaining the Results on Sleep and TV-Watching

The preceding analysis suggests explanations of the results for sleep and TV-watching reported in Tables 2-4. Consider a three-commodity version of the model, with sleep, TV-watching and a composite commodity. The first two are very time-intensive (low values of a_i relative to the composite commodity), which leads to more negative income effects for non-workers, and more negative wage effects for workers. A high elasticity of substitution between commodities would amplify this effect, and these two factors would explain the consistently negative and significant income effects for non-workers in Table 2 for both sleep and TV-watching, as well as the predominance of negative wage effects for these activities for American workers in Table 3. A plausible explanation for fact that the negative elasticities associated with

[14]The derivation is available from the second author.

[15]Letting b_i represent the required goods input for a unit of Z_i, and t_i the required time input, the (utility) cost to the non-worker of a unit of Z_i relative to a unit of Z_k is $(\lambda b_i + \mu t_i)/(\lambda b_k + \mu t_k)$. An increase in income lowers λ, which lowers the relative cost of Z_i if $b_i/t_i > b_k/t_k$, that is, if Z_i is more goods intensive than Z_k. In contrast, the relative prices of the activities for workers $(b_i + wt_i)/(b_k + wt_k)$ are determined in the market and are thus unaffected by changes in non-labor income.

[16]Simulations of the three-commodity version of the model confirm the indications of the two-commodity version. In particular, with two very time-intensive commodities (say sleep and TV-watching), one commodity evenly balanced between time and goods, and σ_i values that are small relative to σ_u and nearly equal to each other, rising incomes lead to substitution away from the two time-intensive commodities and toward the goods-intensive commodity.

TV-watching are larger in absolute value than those associated with sleep is that the elasticity of substitution in the production of TV-watching, that is, the ability to enhance the utility of the activity by increasing expenditure per unit of time, is greater for TV-watching than for sleep.

An additional assumption is required to rationalize the coefficients on non-labor income in Tables 3 and 4, as they are predominantly negative and occasionally significant, and no configuration of parameters in our model leads to negative income effects for workers. If we assume, however, that an appreciable number of the workers are temporarily or permanently constrained in their choices of work hours, then negative income effects on workers become possible (and are consistent with the results in the bottom panels of the two tables). The responses of workers who are hours-constrained, at least in the short-run, will be the same as the responses predicted by the model for non-workers to increases in income: If substitution between activities is easy, higher wages and higher incomes will cause hours-constrained workers to decrease the time spent in time-intensive activities like TV-watching and sleep. Finally, the positive income effects on eating out in Table 5 would follow from the relative goods intensity of the commodity and the likely high elasticity of substitution between eating out and eating at home.

F. Additional Evidence on the Model

In both production and consumption, the responses to changes in income will diminish in absolute value as income rises, due to the shapes of the utility and household production functions, so long as the latter are not characterized by fixed coefficients. To examine this, we add quadratic terms in income to the equations estimated for the U.S. and France for which Table 2 presented the results. In both countries, and for both sleep and TV-watching, the quadratic terms in income are positive and statistically significant, as implied by the assumptions underlying the model.

The alternating signs of the derivatives in the arguments of the utility and production functions also suggest that the impacts of marginal changes in incomes or wages will be greater if the amounts consumed/produced are less. Some evidence that these responses are reflected in the data is provided by comparing income elasticities in the estimates in Table 2 for the U.S. and France, distinguishing between women and men. In the data for these non-workers, men slept slightly more than women (9 minutes per

day in the U.S. 3 minutes in France), and the income elasticities differed little by gender. American men however, watched over 1 hour more TV per day than women, French men 10 minutes more per day. In both countries TV-watching is significantly less income elastic among non-working men than among non-working women.

The model implicitly assumes that the supply of different amenities (television shows, restaurants, sporting activities and museums, etc.) is the same for all individuals, so that the prices of these goods are identical for all decision makers. Similarly, we assume preferences are independent of other people's choices about how to spend time. We can examine whether these assumptions are correct, but not distinguish between them, by including in the equations for the U.S. the average amount of time spent in the activity in the metropolitan area where the respondent lives. We do this for all the U.S. estimates in Tables 2, 4 and 5, using all individuals in whose metropolitan area at least 100 other individuals were ATUS respondents.[17]

In no case did these considerations produce any but the tiniest changes in the estimated impacts of an individual's income or earnings on the outcomes. In all cases except sleep, however, the time that an individual spent in the activity was positively related to the average time spent in that activity in his/her metropolitan area. The data do not allow us to infer the cause(s) of this relationship; but in no way does it alter our conclusions about the effects of income and prices on individuals' use of time.

V. Racial/Ethnic Discrimination in Goods Markets, and Its Spillovers

A. Product Market Discrimination and Majority/Minority Differences in Time Use

Assume that a group is discriminated against in the product market, so that while the price faced by members of the majority group for goods inputs is p, the price facing minorities is p[1 + d] with d being the discriminatory goods price premium. The impact of this discrimination on the time-allocation decisions of workers is seen by noting that the left-hand side of (3) becomes p/w for members of the majority group, and p[1 + d]/w for minorities. Logarithmically differentiating the minorities' version of (4) at d=0 leads to

[17]This restriction to individuals living in larger consolidated metropolitan areas (46 in this sample) reduced sample sizes by around 2/3.

$d\ln T_i/d\ln(1+d) = d\ln T_k/d\ln(1+d) - Q^k_i$, so that price discrimination in a product market affects time allocation the same way as a lower wage.

The case for non-workers is similar. If minorities face a product-market discrimination coefficient d, the budget constraint becomes $I/[p(1 + d)] - \sum X_i = 0$, and d affects time allocation only thorough its impact on real income $I/[p(1 + d)]$. Increasing discrimination in a product market acts on time allocation in the same way as a decrease in I, raising the relative price of goods-intensive activities. Under the circumstances posited above to explain the results in Tables 2-4 (substitution between commodities relatively easier than substitution within commodities) price discrimination will lead minorities to spend more time in time-intensive activities than otherwise similar (including same incomes) members of the majority group. This will be the case for both workers and non-workers.

Several studies have attempted to measure the extent to which minorities pay more than majority citizens for equal-quality goods and services. Many of these are audit studies (with Ayres and Siegelman, 1995, apparently the first in this literature), in which racially different but otherwise identical individuals seek price quotes on some well-defined product or service. Munnell *et al.* (1996) examined discrimination in the treatment of applications for mortgage loans, showing higher denial rates to otherwise identical minority applicants. More recent work in this vein is exemplified by Zussman (2013). Another still smaller vein of the literature is exemplified by field studies such as List (2004).

Some of the more recent literature (e.g., Antecol and Cobb-Clark, 2008; Brewster, 2012) has used respondents' subjective views of their treatment in various retail contexts to analyze differences in outcomes by race. Myers (2004) used data from the American Housing Survey to examine racial differences in purchase and rental prices of housing with narrow geographic clusters; Bayer *et al*. (2017) looked at the same question using detailed data on housing sales. Related to this, Edelman *et al.* (2017) demonstrate that minority applicants for rentals with AirBnB are less likely than majority applicants to have their bids accepted, other things equal. All these studies suggest the existence of price discrimination against minority purchasers. It is nearly impossible to use this literature to answer how much more the average minority

purchaser pays for a typical market basket of goods and services than a majority purchaser. The literature is, however, sufficiently conclusive to allow us to assume that $d > 0$ in the United States.

This line of research has spread to other countries, with most of the recent research also relying on audit studies and focusing on housing markets. Thus Acolin *et al.* (2016) examined how a variety of immigrant groups were treated when they responded to advertisements for rental housing in France. Drydakis (2011) did a similar study in Greece, focusing on the treatment of Albanian immigrants. The results are similar to those for racial minorities in the U.S.

This literature implies that the goods prices faced by minorities will exceed those facing majority consumers. All else equal, including incomes and wages, discrimination in goods markets will raise the relative prices of commodities that are relatively goods-intensive. Thus, we expect to observe minorities spending less time producing/consuming goods-intensive commodities and more in time-intensive commodities than members of the majority. With sleep and TV-watching being particularly time-intensive commodities, we should expect minorities to be more heavily engaged in these activities than otherwise identical majority-group members.

B. Evidence on the Impacts of Product-Market Discrimination on Time Use

Using both the American and French samples, we examine majority-minority differences in sleep and TV-watching, the two clearly inferior activities, with minorities designated as explained in Section II. While we have identified TV-watching as more inferior than sleeping, there is a language problem in testing the model of spillovers of consumer discrimination to TV-watching: Majority-minority differences in time spent watching television are likely to be confounded by language issues in the cases of white Hispanics in the U.S. and immigrants in France. The only American groups whose television-watching we therefore consider are white Non-Hispanics and African-Americans.

The upper panel of Table 6 lists the estimates of the impacts of race or ethnicity on time spent sleeping in the U.S., and in TV-watching. Each equation includes all the controls that underlay the estimates presented in Tables 2 and 3. The sample includes both workers and non-workers; because of that the only

monetary measure that we include is the household's total income.[18] African-American women and men sleep more than otherwise identical white non-Hispanics; they also watch more television.[19] As with the pure income effects, the differences are larger for TV-watching than for sleep, suggesting that the discriminatory price effects on consumer goods are working along the same margin of choice in these time-intensive activities as the results in Tables 2 and 3 implied about the effects of decreases in household incomes. White Hispanics also sleep more than otherwise identical white non-Hispanics, a difference that on average is about the same as among African-Americans.[20]

The bottom panel of Table 6 presents the estimates of the same equations as in Tables 2 and 4, but with workers and non-workers pooled, and including household income as the only economic variable. These results for France are weaker than those in the U.S.; with sub-sample sizes that are only one-sixth as large, their relative weakness is not surprising. The impact on the sleep time of immigrants in France compared to that of similar natives, however, is about the same as the difference between African-American and white non-Hispanic males. That between female immigrants and natives in France is positive, but much smaller than in the U.S. Overall the French results corroborate the more secure findings in Table 6 based on the larger U.S. samples.[21]

We have argued that these racial/ethnic differences in time use arise because the measured incomes of minorities overstate their true incomes due to discrimination in product markets. Assuming that $d \leq 0.25$,

[18]Separate estimates for samples of non-workers and workers in each country, using the same control variables as in Tables 2-4, yield essentially similar results: Greater sleep time among otherwise identical minorities, whether or not they are workers.

[19]One might be concerned that annual incomes understate the difference in annual spending ability between whites and African-Americans because the latter may expect fewer and smaller inheritances. Perhaps so, although most inheritances are fairly small (Hurd and Smith, 2001). More important, with the average African-American in our sample expecting to live four fewer years than the average white, if anything annual incomes overstate racial differences in annual spending ability, so that our results understate the racial difference in sleep time arising from discrimination in incentives to purchase goods.

[20]These effects are not due to differences in the concentration of minorities in particular inner cities. Interacting the indicators of state of residence with those of metropolitan status barely alters the parameter estimates describing the racial/ethnic differences in sleep and TV-watching.

[21]Except for the estimate for black males in describing sleep, the parameter estimates change only slightly when the respondent's time spent working on the diary day is added to the specification.

and using the estimated income effects reported in Table 2, we can adjust incomes to reflect the price differences and simulate the impacts on time use of the implicit reduction in real incomes, thus placing an upper bound on the racial/ethnic differences attributable to product-market discrimination.

Among African-Americans this simulation suggests that, if the excess sleep arose solely from responses to discrimination in product-pricing, we would observe differences in sleep time equaling 1/7 to 1/3 of those measured in Table 6, and in TV-watching time of 1/3 of those listed in the table. Among Hispanics the explanation can account for only ¼ of their extra sleep, while among French immigrants the simulation explains 1/6 to ½ of the extra sleep that we observe. Minorities do devote more time to these time-intensive activities than majority citizens; but at least half of this extra time cannot be explained by a model relying on spillovers from discrimination in product markets. Numerous explanations for the discrepancy are possible, including racial/ethnic differences in access to transportation, minority fears of non-price discriminatory responses while shopping or attending events outside the home, and no doubt others. We leave distinguishing among these possibilities to future research.

VI. Conclusion

We have documented a significant negative relationship between household income and time spent in two time-intensive activities, sleep and television-watching, which together with market work are two of the three activities that account for nearly two-thirds of time spent in Western economies. The relationship exists among non-workers in time-dairy data from the United States, France, and Germany, and among workers in the former two countries. Among workers, it results mainly from a negative wage effect, although there is also evidence for a smaller negative effect of non-labor income in the French sample. For both the U.S. and France we demonstrate a significant minority/majority difference in time use: Minorities engage in more time-intensive activities than otherwise similar members of the majority group.

These results can be rationalized by a generalized model of time allocation, which allows both substitution between time and goods in the production of commodities and substitution between commodities in a representative individual's utility function. The analysis demonstrates that the effect of a change in income on non-workers' time use will generally resemble the substitution effect of a wage change

on workers' time allocations. It produces the observed negative relation between income and time spent in time-intensive activities, provided that the elasticity of substitution between commodities is sufficiently large relative to the average elasticity of substitution between goods and time in the production of each commodity. This combination of circumstances also leads to the observed minority/majority differences in time use if, as other evidence shows, minorities experience discrimination in goods markets. This extension of the theory and its demonstrated use in explaining the novel findings suggest that it might usefully be applied to policy propositions that affect how people spend time.

While we have not focused on responses of work time to prices and incomes, the results here and the expanded household production model are relevant for studying labor supply. The implicit non-aggregability of various components of non-market time suggests that treating the labor-supply decision as a choice between working or not is incorrect: Changes in economic incentives affect different non-work uses of time differently, so that the failure to account for the changing mix of non-market time use as wages or other incomes change will bias estimates of labor supply responses to these parameters.

These theoretical and empirical results have at least two implications for future research. First, the results on minority/majority differences in time use are examples of how discrimination in one market can affect behavior outside the market where discrimination is practiced. There are undoubtedly many other examples of this kind of spillover that could be investigated. Second, the rising quantity and quality of time-diary data available from several nations should lead to a wide array of interesting empirical results. Our generalized model of time allocation can be used both to help make sense of the patterns observed in such data and to suggest what patterns of time use to look for.

REFERENCES

Arthur Acolin, Raphael Bostic and Gary Painter, "A Field study of Rental Market discrimination across Origins in France," *Journal of Urban Economics*, 95 (2016): 49-63.

Mark Aguiar, Erik Hurst, and Loukas Karabarbounis, "Time Use During the Great Recession," *American Economic Review*, 103 (Aug. 2013): 1664-96.

Mark Aguiar and Erik Hurst. "Measuring Trends in Leisure: The Allocation of Time over Five Decades," *Quarterly Journal of Economics*, 122 (Aug. 2007): 969-1006.

Heather Antecol and Deborah Cobb-Clark, "Racial and Ethnic Discrimination in Local Consumer Markets: Exploiting the Army's Procedures for Matching Personnel to Duty Locations," *Journal of Urban Economics*, 64 (Sept. 2008): 4960509.

Ian Ayres and Peter Siegelman, "Race and Gender Discrimination in Bargaining for a New Car," *American Economic Review*, 85 (June 1995): 304-21.

Patrick Bayer, Marcus Casey, Fernando Ferreira and Robert McMillan, "Racial and Ethnic Price Differences in the Housing Market," *Journal of Urban Economics*, 102 (Nov. 2017): 91-105.

Gary Becker, "A Theory of the Allocation of Time," *Economic Journal*, 75 (Sept. 1965): 493-517.

Kathleen Beegle and Wendy Stock, "The Labor Market Effects of Disability Discrimination Laws," *Journal of Human Resources*, 38 (Fall 2003): 806-59.

Jeff Biddle and Daniel Hamermesh, "Sleep and the Allocation of Time," *Journal of Political Economy*, 98 (October 1990): 922-43.

Francine Blau and Lawrence Kahn, "The Gender Wage Gap: Extent, Trends, and Explanations," *Journal of Economic Literature*, 55 (Sept. 2017): 789-865.

Richard Blundell, Luigi Pistaferri and Itay Saporta-Eksten, "Children, Time Allocation, and Consumption Insurance," *Journal of Political Economy*, 126 (October 2018): S73-115.

Zachary Brewster, "Racialized Customer Service in Restaurants: A Quantitative Assessment of the Statistical Discrimination Explanatory Framework," *Sociological Inquiry*, 82 (Feb. 2012): 3-28.

Kerwin Charles and Jonathan Guryan, "Prejudice and Wages: An Empirical Assessment of Becker's The Economics of Discrimination," *Journal of Political Economy*, 116 (Oct. 2008): 773-809.

Alan Deardorff and Frank Stafford. "Compensation of Cooperative Factors," *Econometrica*, 44 (July 1976): 671-684

Nick Drydakis, "Ethnic Discrimination in the Greek Housing Market," *Journal of Population Economics*, 24 (2011): 1235-55.

Benjamin Edelman, Michael Luca and Dan Svirsky, "Racial Discrimination in the Sharing Economy: Evidence from a Field Experiment" *American Economic Journal: Applied Economics*, 9 (April 2017): 1-22.

Dominique Goux, Simon George-Kot and Eric Maurin, "Following the Crowd: Leisure Complementarities Beyond the Household," *Journal of Labor Economics*, 35 (October 2017): 1061-88.

Reuben Gronau, "Leisure, Home Production, and Work--the Theory of the Allocation of Time Revisited," *Journal of Political Economy*, 85 (Dec. 1977): 1099-1123.

----------, "Home Production—A Forgotten Industry," *Review of Economics and Statistics*, 62 (Aug. 1980): 408-16.

---------- and Daniel Hamermesh, "Time vs. Goods: The Value of Measuring Household Production Technologies," *Review of Income and Wealth*," 52 (March 2006): 1-16.

Daniel Hamermesh, *Beauty Pays*. Princeton, NJ: Princeton University Press, 2011.

----------, Harley Frazis and Jay Stewart, "Data Watch: The American Time Use Survey," *Journal of Economic Perspectives*, 19 (Winter 2005): 221-32.

Bradley Heim, "The Incredible Shrinking Elasticities: Married Female Labor Supply, 1978-2002," *Journal of Human Resources* (Fall 2007): 881-918.

Michael Hurd and James Smith, "Anticipated and Actual Bequests," in David Wise, ed., *Themes in the Economics of Aging*. Chicago: University of Chicago Press, 2001.

Institut National de la Statistique et des Études Économiques, *Enquête Emploi du Temps, 2009-2010*. Paris: Inséé, 2014. https://www.insee.fr/fr/metadonnees/source/s1224#caracteristique-technique

Peter Kooreman and Arie Kapteyn, "A Disaggregated Analysis of the Allocation of Time within the Household," *Journal of Political Economy*, 95 (April 1987): 223-49.

Karen Kopecky, "The Trend in Retirement," *International Economic Review*, 52 (May 2011): 287–316.

David Leal and Stephen Trejo, *Latinos and the Economy*. New York: Springer, 2011.

John List, "The Nature and Extent of Discrimination in the Marketplace: Evidence from the Field," *Quarterly Journal of Economics*, 119 (Feb. 2004): 49-89.

Alicia Munnell, Geoffrey Tootell, Lynn Brown and James McEneany, "Mortgage Lending in Boston: Interpreting HMDA Data," *American Economic Review* 86 (March 1996): 25-53.

Caitlin Knowles Myers, "Discrimination and Neighborhood Effects: Understanding Racial Differentials in US Housing Prices," *Journal of Urban Economics*, 56 (2004): 279-302.

Christopher Parsons, Johan Suleyman, Michael Yates and Daniel Hamermesh, "Strike Three: Discrimination, Incentives and Evaluation," *American Economic Review*, 101 (June 2011): 1410-35.

Statistiches Bundesamt, *Datenbeschreibung: Erhebung zur Zeitverwending*. Wiesbaden: Statistiches Bundesamt, 2015.

Marie-Anne Valfort, "LGBTI in OECD Countries: A Review," Social, Employment and Migration Working Papers, No. 198, 2017.

Asaf Zussman, "Ethnic Discrimination: Lessons from the Israeli Online Market for Used Cars," *Economic Journal*, 133 (Nov. 2013): F433-68.

Table 1. Descriptive Statistics, Time Use in the U.S., 2003-15; France, 2009-10; Germany, 2012-13

	Work	Home Production	Sleep	Other Personal	TV-watching	Other Leisure
ATUS:						
Non-workers	-----	249	557	124	236	274
(N = 51,997)		(0.90)	(0.62)	(0.44)	(0.89)	(0.95)
Family Income:	$49,383					
(annual)	(210)					
Workers	497	124	473	115	104	127
(N = 52,383)	(0.85)	(0.56)	(0.48)	(0.28)	(0.45)	(0.60)
Family Income:	$61,434	Earnings	$20.59			
(annual)	(301)	(hourly)	(0.08)			
Enquête:						
Non-workers	------	257	532	210	167	274
(N = 5,854)		(2.26)	(1.50)	(1.39)	(1.73)	(2.26)
Family Income:	€28,005					
(annual)	(259)					
Workers	499	119	458	170	86	109
(N = 4,287)	(2.58)	(1.72)	(1.45)	(1.19)	(1.24)	(1.70)
Family Income:	€39,972	Earnings	€11.71			
(annual)	(369)	(hourly)	(0.15)			
Zeitverwendungserhebung:						
Non-workers	------	265	526	183	164	302
(N = 1,993)		(3.51)	(2.00)	(1.68)	(2.65)	(3.85)
Family Income:	€28,683					
(annual)	(397)					
Workers	476	127	455	130	94	158
(N = 8,173)	(2.06)	(1.31)	(1.06)	(0.62)	(0.92)	(1.51)
Family Income:	€41,892					
(annual)	(223)					

*Standard errors of means in parentheses.

Table 2. Income Effects on Time Use (Minutes/Day in Response to +10,000 ($ or €) Annual Income): Non-workers U.S., 2003-15; France, 2009-10; Germany, 2012-13*

	Home Production	Sleep	Other Personal	TV-watching	Other Leisure
ATUS:**					
All Nonworkers					
(N = 51,997)	2.19	-2.05	1.10	-2.95	1.71
	(0.18)	(0.14)	(0.10)	(0.20)	(0.22)
Adj. R^2	0.260	0.078	0.035	0.121	0.065
Not working on holidays					
(N = 2,050)	1.96	-2.07	1.00	-2.05	1.16
	(0.83)	(0.62)	(0.45)	(0.92)	(1.06)
Adj. R^2	0.260	0.079	0.031	0.104	0.087
Enquête:**					
(N = 5,439)	-0.63	-3.00	3.19	-7.07	7.52
	(1.74)	(1.22)	(1.53)	(1.49)	(2.03)
Adj. R^2	0.324	0.122	0.068	0.101	0.208
Zeitverwendungserhebung:**					
(N = 1,993)	0.82	-3.35	-4.10	-5.68	12.31
	(2.18)	(1.49)	(1.19)	(1.81)	(2.70)
Adj. R^2	0.221	0.068	0.053	0.080	0.102

*Standard errors in parentheses below the parameter estimates. Those in the French and German equations are clustered on the individuals.

**The equations also include a quadratic in age; indicators and numbers of children in several age groups; gender, marital status and their interaction; a vector of indicators of educational attainment; and vectors of indicators of state of residence, metropolitan status, year, month and diary day.

***The equations also include a quadratic in age; a vector of indicators of educational attainment; indicators and numbers of children in several age groups; gender, coupled status and their interaction; and vectors of indicators of the month, diary day and region.

****The equations also include a quadratic in age; indicators of number of children under age 10; gender, marital status and their interaction; and, vectors of indicators of quarter, diary day, educational attainment and East Germany.

Table 3. Parameter Estimates, Sleep and TV-watching (Minutes/Day in Response to +$10 Hourly Earnings, +$10,000 Other Annual Income): Married Workers, ATUS 2003-15*

	Sleep		TV-watching	
	Male	**Female**	**Male**	**Female**
Ind. Var.:				
Annual Other Income	0.061	-0.205	-0.229	-0743
	(0.220)	(0.162)	(0.263)	(0.183)
Hourly Earnings	-1.153	-0.711	-2.212	-3.305
	(0.558)	(0.651)	(0.668)	(0.687)
Adj. R^2	0.122	0.117	0.113	0.073
Ind. Var.:				
Annual Other Income	-0.238	-0.567	-0.507	-1.008
	(0.202)	(0.162)	(0.250)	(0.177)
Hourly Earnings	-1.064	0.207	-2.130	-2.633
	(0.512)	(0.608)	(0.635)	(0.666)
Work Time	-0.186	-0.170	-0.173	-0.124
	(0.003)	(0.003)	(0.004)	(0.003)
Adj. R^2	0.260	0.232	0.198	0.131
N =	18,122	19,526	18,122	19,526

*All equations also include a quadratic in age; indicators and numbers of children in several age groups; a vector of indicators of educational attainment; and vectors of indicators of state of residence, metropolitan status, year, month and diary day.

Table 4. Parameter Estimates, Sleep and TV-watching (Minutes/Day in Response to +€10 Hourly Earnings, +€10,000 Other Annual Income: Partnered Workers, *Enquête Emploi du Temps*, 2009-10*

	Sleep (minutes/day)		TV-watching (minutes/day)	
	Male	**Female**	**Male**	**Female**
Ind. Var.:				
Annual Other Income	-0.07 (0.202)	-0.08 (0.17)	-0.38 (0.15)	-0.32 (0.10)
Hourly Earnings	2.08 (3.00)	1.32 (5.60)	-3.44 (2.35)	7.65 (5.87)
Adj. R^2	0.111	0.156	0.090	0.098
Ind. Var.:				
Annual Other) Income	-0.091 (0.195)	-0.09 (0.11)	-0.39 (0.15)	-0.397 (0.114)
Hourly Earnings	3.16 (2.47)	-1.08 (4.49)	-2.83 (0.252)	6.39 (5.21)
Work Time	-0.17 (0.02)	-0.14 (0.01)	-0.10 (0.01)	-0.08 (0.01)
Adj. R^2	0.216	0.250	0.131	0.137
N =	2,775	2,635	2,775	2,635

*Standard errors below the parameter estimates, clustered on individuals. The regressions also include a quadratic in age; a vector of indicators of educational attainment; indicators and numbers of children in several age groups and vectors of indicators of the month, diary day and region.

Table 5. Income Effects on Time Use (Minutes/Day in Response to +10,000 ($ or €) Other Annual Income): Non-workers U.S., 2003-15; France, 2009-10*

	U.S.**				France***	
	Eating Out		Sports/Arts		Eating Out	
Determinants of:	**Prob.**	**Cond. Mean**	**Prob.**	**Cond. Mean**	**Prob.**	**Cond. Mean**
	0.028	0.462	0.028	-0.556	0.058	-16.71
	(0.002)	(0.091)	(0.002)	(0.423)	(0.017)	(18.78)
Pseudo-R^2 or Adj. R^2	0.037	0.026	0.071	0.026	0.094	0.168
N =	51,997	8,834	51,997	2,408	5,407	1,154

*Standard errors in parentheses below the parameter estimates. Those in the French equations are clustered on the individuals.

**The equations also include a quadratic in age; indicators and numbers of children in several age groups; gender, marital status and their interaction; a vector of indicators of educational attainment; and vectors of indicators of state of residence, metropolitan status, year, month and diary day.

***The equations also include a quadratic in age; a vector of indicators of educational attainment; indicators and numbers of children in several age groups; gender, coupled status and their interaction; and vectors of indicators of the month, diary day and region.

Table 6. Effect of Minority Status on Minutes of Sleep and TV-watching (Minutes/Day): U.S. Minorities/Immigrants, 2003-15; French Immigrants, 2009-10*

	Sleep		TV-watching	
		U.S.		
Ind. Var.:	**Male**	**Female**	**Male**	**Female**
African-American	7.22	14.88	37.56	25.21
	(1.72)	(1.42)	(2.23)	(1.68)
White Hispanic	10.69	11.54	------	------
	(1.67)	(1.48)		
.				
Adj. R^2	0.099	0.091	0.154	0.126
N	64,766	83,229	55,640	72,112
		France		
Immigrant	12.23	4.78		
	(6.17)	(6.53)		
Adj. R^2	0.141	0.110		
N	10,517	12,169		

*Each equation includes the variables listed and all the variables included for each country in the estimates presented in Tables 3 and 4. The French estimates are clustered on the individual respondents.

DATA APPENDIX: Definitions of Time-Use Aggregates

ATUS:
Work—*bls_work* (+ *bls_educ* if *age*<=25)
Home production—*bls_carehh* + *bls_hhact_*+ *bls_purch*
Sleep—*bls_pcare_sleep*
Other personal care—*bls-pcare* + *bls_food – sleep*
TV-watching—*bls_leis_tv*
Other leisure—*bls_comm* + *bls_social* + *bls_carenhh* + *bls_leis – bls_leis_tv* (+ *bls_educ* if *age*>25)
Eating out—*bls_food* (not at home or workplace)
Sports and arts—*bls_leis_arts* + *bls_leis_atts*

Enquête Emploi du Temps:
Work— $\Sigma_i[act_i>210$ and $act_i<252$ or $act_i=811] + (\Sigma_i[act_i>260$ and $act_i<300]$ if *age*<=25), i = 1,…,144
Home production— $\Sigma_i[act_i>299$ and $act_i<435] + \Sigma_i[act_i=813]$, i = 1,…,144
Sleep— $\Sigma_i[act_i=111]$, i = 1,…,144
Other personal care— $\Sigma_i[act_i>111$ and $act_i<200]$, i = 1,…,144
TV-watching— $\Sigma_i[act_i>633$ and $act_i<637]$, i = 1,…,144
Other leisure— $\Sigma_i[act_i>434$ and $act_i<700] + \Sigma_i[act_i=810$ or =812 or =819] – *tvwatching* (+ $\Sigma_i[act_i>260$ and $act_i<300]$ if *age*>25), i = 1,…,144
Eating out—$\Sigma_i[act_i=143$ or $act_i=146]$, i = 1,…,144

***Zeitverwendungserhebung*:**
Work— *hainklweg_2* + (*hainklweg_3* if *age*<=25)
Home production—*hainklweg_4*
Sleep—*ha_11*
Other personal care—*hainklweg_1 – sleep*
TV-watching—*ha_82*
Other leisure— *hainklweg_5+hainklweg_6+hainklweg_7+hainklweg_8 - tvwatching + (hainklweg_3* if *age*>25)

Appendix Table 1. Effects on Work Time, Household Production, Non-Sleep Personal Time, and Non-TV Leisure Time (Minutes/Day in Response to +$10 $ or € Hourly Earnings, +10,000 $ or € Other Annual Income): U.S. 2003-15; France 2009-10*

A. U.S., 2003-15

	Male	Female	Male	Female
Ind. Var.	**Paid Work**		**Home Production**	
Annual Other Income	-2.91	-3.36	1.40	2.33
	(0.83.)	(0.55)	(0.55)	(0.42)
Hourly Earnings	3.59	11.72	7.82	-3.88
	(2.96)	(2.83)	(1.94)	(2.15)
Adj. R^2	0.303	0.260	0.086	0.130
	Non-Sleep Personal		**Non-TV Leisure**	
Annual Other Income	0.25	0.66	0.08	0.80
	(0.15)	(0.13)	(0.33)	(0.26)
Hourly Earnings	1.55	1.49	0.40	-1.44
	(0.37)	(0.48)	(0.84)	(0.99)
Adj. R^2	0.018	0.021	0.116	0.117

B. France, 2009-10

	Male	Female	Male	Female
Ind. Var.:	**Paid Work**		**Home Production**	
Annual Other Income	-0.23	-1.07	-3.39	1.95
	(3.51)	(3.94)	(3.70)	(2.71)
Hourly Earnings	6.36	-16.47	-5.28	-1.00
	(5.46)	(10.48)	(2.69)	(4.66)
Adj. R^2	0.412	0.287	0.143	0.151
	Non-Sleep Personal		**Non-TV Leisure**	
Annual Other Income	-1.15	2.09	1.64	1.88
	(1.29)	(1.27)	(2.45)	(2.76)
Hourly Earnings	-0.10	1.17	-1.52	7.33
	(2.43)	(2.16)	(3.58)	(4.06)
Adj. R^2	0.092	0.107	0.257	0.218

*The equations include the same other regressors as in Tables 3 and 4, and the same numbers of observations.`