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Abstract

Although income inequality has been studied extensively, relatively little attention has been paid to the role of household production. Economic theory predicts that households with less money income will produce more goods at home. Thus extended income, which includes the value of household production, should be more equally distributed than money income. We find this to be true, but not for the reason predicted by theory. Virtually all of the decline in measured inequality when moving from money income to extended income is due to the addition of a large constant--the average value of household production--to money income. This result is robust to alternative assumptions that one might make when estimating the value of household production.

I. Introduction

Inequality of earnings and inequality of household income have increased over recent decades, both in the United States and to a lesser extent in other industrialized countries (see Gottschalk and Smeeding 1997 for a review). In response to these developments, there has been an outpouring of research describing and trying to explain these trends. Most of these studies concern inequality in money income, where data are more readily available. However, money income is not a complete measure of economic welfare. Recent studies have attempted to describe inequality along other dimensions--for example, inequality in consumption (Johnson and Shipp 1995, 1997, and 2005; Krueger and Perri 2002) and in total compensation including fringe benefits (Pierce 2001).

Another branch of the inequality literature has incorporated the value of household production--goods and services produced at home--into measures of income to arrive at what is referred to as "extended income."[1] This measure is sensible, because home production represents additional "income" that is available for consumption but is not included in money income. Models of household production (for example, Gronau 1986) predict that high-wage workers will spend less time on nonmarket work than low-wage workers (assuming that all individuals have identical preferences and are equally productive in nonmarket work). Extending this model to two-person households generates analogous predictions for married couples.[2] These predictions lead us to expect a negative correlation between money income and

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[1] The definition of extended income varies somewhat across studies. Our definition is similar to that used in Jenkins and O'Leary (1996).

[2] For more details, please see the Appendix, which presents the Gronau (1986) model, extends the model to two-person households, and discusses the assumptions that drive these results.

time spent in household production, which implies that extended income will be more equally distributed than money income.

Several studies have empirically compared inequality measures using extended income and money income, and all but one have found that, consistent with theory, extended income is more equally distributed than money income.[3] However, the data that have been available to examine this question are far from perfect, and it is possible that the procedures used to address the deficiencies may be driving the results.

The ideal data would include information on household production, as well as income, for every member of the household. However, time-use surveys, which are the main data source for household production, typically collect data for only one or two days, and many collect data for only one household member. This results in an incomplete picture of household production at both the individual and household level.

The most common approach to addressing this deficiency is to fill in the missing data using regression techniques to impute the time spent in household production (Bonke, 1992; Jenkins and O'Leary, 1996; and Wolff, Zacharias, and Caner, 2004). However, these imputation procedures smooth over the individual variation in the data and reduce measured inequality in household production. The Jenkins and O'Leary study perturbed estimated household production by adding a random term to the imputed values. A more recent study by Bonke, Deding, and Lausten (2004)--the only study to find that extended income is less equally distributed than money income--multiplied each respondent's average hours per day spent in household production by 365. This approach tends to magnify the individual variation, because

[3] Bonke (1992) found that when taxes are incorporated, extended income is less equally distributed than money income.

in addition to the household's average time spent in production it also includes day-to-day variation given that the data contain only one or two diaries per person.

Another drawback to using regression techniques to impute household production is that most time-use surveys have little or no income data. Imputed values of household production are matched to a second dataset that contains income using variables common to both datasets. This means that income cannot be used as a covariate in the imputation procedure, and that any relationship between income and time spent in household production may be lost.[4]

A study by Gottschalk and Mayer (2002) avoided both of these problems by using data from Panel Study of Income Dynamics (PSID), which contains information on earned and unearned income as well as a measure of the usual amount of time spent doing household work. The main drawback to this approach, as they acknowledge, is that the PSID measure of household production leaves much to be desired. The question does not define household production, which could result in biased estimates if there are systematic differences in how respondents report. And because the question asks about time usually spent doing housework, it may be subject to recall and social desirability biases.

In this paper, we use data for 2003 from the American Time Use Survey (ATUS) to construct measures of earnings inequality that include the value of household production and examine how this inclusion affects measured inequality. Although, as in previous studies, it is still necessary to impute the value of household production to fill in missing data, our imputations are an improvement over those in earlier studies because ATUS makes it possible to include earnings as a covariate in the imputation process. We also perform a number of

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[4] Bonke (1992) was able to use income data from the register of income taxation for the respondents in the time-use survey, but this alternative is usually not available to researchers.

sensitivity analyses to determine the extent to which these imputation procedures are likely to matter.

We show that the greater equality of extended income compared to money income is not caused by the procedures used to address data deficiencies. But nor is it due to the predicted negative relationship between money income and time spent doing household production. In fact, we find, as did Jenkins and O'Leary (1996), that the correlation between money income and household production is close to zero. Instead, the greater equality of extended income is almost entirely due to the addition of a large constant--the average value of household production--to money income.

II. Methods

Ideally, we would have a long-run measure of household production corresponding to the time period of our income measure (in this case, annual). In contrast to other time-use surveys, the ATUS can be directly linked to data on income. But like many other time-use surveys, the ATUS interviews only one person per household and collects only one diary per person. Thus, we can only estimate means of household production conditional on observable characteristics. We use a variation of Bonke's (1992) regression method of predicting household production. We regress the value of household production on the log of annual family income, the log of weekly earnings, the log of non-labor income, the log of the hourly wage, dummies for employment status (2 categories), education level (4 categories), age, and the number of children zero to 5, 6 to 12, and 13 to 17. We run separate regressions by marital status and sex. For married respondents, we also include the log of spouse's weekly earnings, log of the spouse's wage, and dummies for spouse's employment status, education level, and age.

Because of our interest in household production by income, we use a flexible specification for the log of family income. Specifically, we use Gallant's (1981) Fourier series expansion. Transforming the log of family income into the variable $Z \in (0,2\pi)$ and letting X denote the vector of regressors listed above, our Fourier specification is:

$$(1) \qquad f(Z,X) = a + bZ + cZ^2 + \sum_{j=1}^{J}(\beta_{1j}\cos(jZ) + \beta_{2j}\sin(jZ)) + X\beta,$$

A function's Fourier expansion has the property that the differences between the true value of a function *g* and the value of its Fourier expansion *f* and between the derivatives of *g* and the derivatives of *f* can be minimized to an arbitrary degree over the range of the function by choosing *J* to be sufficiently large. It thus provides a global approximation to the true function, rather than a local approximation (as in a Taylor series expansion). We selected *J* by cross-validation, minimizing the sum of the squared prediction errors $\sum(y_i - \hat{y}_{-i})^2$, where $\hat{y}_{-i}$ is the leave-one-out prediction generated by omitting observation *i* from the regression.[5]

Using the flexible functional form in (1), we estimate the following equation to impute household production:

$$(2) \qquad P_{it}^{d} = f(Z_i, X_i) + u_i^d \qquad (d = D,E),$$

where separate equations were estimated for weekdays (*D*) and weekends (*E*) for each sex × marital status cell (8 regressions total). For each cell, we combine the predicted values from the weekday and weekend equations to generate imputed weekly value of household production for person *i* as follows:

$$(3) \qquad \hat{P}_i = 5\hat{f}_D(Z_i, X_i) + 2\hat{f}_E(Z_i, X_i),$$

where *X* is appropriately defined. For married households, total household production is simply the sum of the husband's and wife's predicted values.

This imputation procedure eliminates deviations from the conditional mean of household production. Because, as we noted in the Introduction, the absence of these residuals could bias estimates of income inequality, we assess the potential bias by adding a random perturbation and recomputing the inequality measures. The first step is to derive an estimate of the upper bound for the variance of the long-term household production that was eliminated in the imputation procedure. It is useful to decompose the residual in (2) into two components as follows:

(4) $$P_{it}^{d} = f_d(Z_i, X_i) + (m_i^d + e_{it}^d) \qquad (d = D,E),$$

where the residual is equal to the sum of a person-specific fixed effect (m_i^d) and a term denoting day-to-day variation (e_{it}^d).[6] If the Var(m_i^d) = 0, the residual consists entirely of day-to-day variation in household production, and our imputation procedure will generate consistent estimates of long-run household production for each observation in the sample, which in turn will result in consistent estimates of inequality measures for extended income. However, if Var(m_i^d) > 0, our procedure will underestimate the variability of long-run household production across households, and usually generate downwardly biased inequality measures.

We can use the residuals from (2) to place an upper bound on the variance of long-run household production. Letting σ_d ($d = D,E$) denote the standard deviation of the residual in (2) for weekdays and weekends, the maximum possible variance for long-run weekly household production (i.e., assuming Var(e_{it}^d) = 0) is $M = (5\sigma_D + 2\sigma_E)^2$. Thus Var($m_i^d$) $\in$ [0,M]. We

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[5] Andrews (1991) shows this criterion is asymptotically optimal in the sense that the probability of choosing the *J* that minimizes the expected sum of squared errors converges to 1 as the sample size increases, even in the presence of heteroscedasticity.

[6] More precisely, m_i is the long-run average of P_{it} - $f(X_i, Z_i)$. We do not assume that the e_{it} are independent across time.

generate perturbed values of imputed household production for single-person households by using:

$$(5) \qquad P_i^S = 5\hat{f}_D(X_i) + 2\hat{f}_E(X_i) + ks_i,$$

where $0 < k \leq 1$ and s_i is drawn from $N(0, M)$.

For married-couple households, the maximum possible variance for long-run production across married couple households occurs when the residuals for spouses' production are perfectly positively correlated. Extending the definition of the maximum residual variance M to include spouses, we have: $M' = (5[\sigma_{Dw} + \sigma_{Dh}] + 2[\sigma_{Ew} + \sigma_{Eh}])^2$ where σ_{ds} is the standard deviation of the residuals from the married-couple versions of (2) and subscripts denote day of week ($d = D,E$) and spouse ($s = w,h$). Total production is

$$(6) \qquad P_i^M = 5\hat{f}_{Dw}(Z_i, X_i) + 2\hat{f}_{Ew}(Z_i, X_i) + 5\hat{f}_{Dh}(Z_i, X_i) + 2\hat{f}_{Eh}(Z_i, X_i) + ks_i',$$

where s_i' is drawn from $N(0, M')$. We recomputed our inequality measures assuming $k = 0.25$, $k = 0.50$, and $k = 1.0$ for both singles and married couples.

III. Data and Definitions

Our data come from the 2003 ATUS, which is a stratified random sample drawn from households that have completed their participation in the Current Population Survey (CPS) and is representative of the U.S. civilian population. The ATUS collects information on the amount of time spent in over 400 detailed activities. The ATUS time diary does not collect information about what else the respondent was doing at the time of each episode (secondary activities), but several summary questions asked at the end of the diary collect information about times and activities during which children under 13 were in their care.

ATUS also contains labor force information that is comparable to that in the CPS, including employment status, usual hours worked per week, and earnings on the main job.[7] For the respondent's spouse or unmarried partner, the ATUS collects basic labor force information--employment status (employed or not employed) and total hours usually worked per week. Earnings are available from the CPS if the spouse was employed at the time of the last CPS interview. ATUS does not collect any labor force information for other household members.

We divide the sample into single-adult and married-couple households. Our sample of single-adult households includes respondents age 25-64 who had no spouse or unmarried partner present. Our married-couple sample includes households where both spouses are between 25 and 64. We excluded households with other adult (18+) family members in order to avoid the need to estimate the contribution of the other adult to household production.

Finally, to obtain data on unearned income, we matched the ATUS data to the March supplement. Because of the sample rotation scheme used in CPS, only about one-third of respondents--those whose final CPS interviews were in March-June--were interviewed in March.[8] Family income and non-labor earnings variables for the remaining two-thirds of the sample are predicted by regression using variables common to both the ATUS and the March CPS. Households with allocated family income data were excluded from the sample, and family incomes below the 1st percentile were replaced with the 1st percentile value. Households where other (minor) family members contributed more than 10 percent of income were also excluded.

[7] The earnings data are carried over from the final CPS interview. The earnings questions are asked in ATUS if the respondent had a new job in ATUS (either changed jobs or made a nonemployment-to-employment transition) or earnings were allocated in the last CPS interview.
[8] Households are in the CPS for 4 consecutive months, out for 8, then back in for 4. Because of the lag between the final CPS interview and introduction into the ATUS, most of the ATUS respondents who were matched to March were interviewed for ATUS in June through September.

Our sample consists of 10,048 observations from the 2003 ATUS data that fit our sample inclusion criteria. Of these, 3,329 observations had income data available from the March supplement and 2,639 of these had unallocated earnings. Our first step was to use these 2,639 observations to estimate (2) for each of the sex × marital status × day cells, and determine the optimal value of *J* in (1).[9] Next, we reestimated (2) over the entire sample using the optimal value of J.[10] For these regressions, we imputed income for observations that could not be matched to March or had allocated income in March.[11] Coefficient estimates from these regressions were used to generate imputed values of household production in (3). Our extended income measure is computed for the 3,329 values matched to the March supplement as the sum of family income from March, including allocated values, and imputed household production.

As in previous studies, we classify activities as household production if the same result could be achieved by hiring a third person (Reid, 1934). We used two alternative definitions of nonmarket work. The first definition includes household activities (including purchasing goods and services) and care of household members done as a primary activity.[12] The second definition is the same, but adds child care done as a secondary activity. To avoid double counting in the second definition, we excluded secondary child care that was done at times when the respondent was engaged in household production as a primary activity.[13]

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[9] The number of observations for these regressions ranged from 180 (for single men on weekdays) to 468 (married women on weekends).
[10] For these regressions, the sample sizes ranged from 599 to 1,831.
[11] Family income was imputed using predicted values from a regression of income on covariates. As noted in Greene (2000, p. 363), including observations with imputed family income increases does not change the coefficient on family income, but it does increase the precision of the coefficients on the other variables.
[12] We exclude volunteer work and care of non-household members from all of our measures. These activities could legitimately be classified as nonmarket work, but they do not contribute directly to the household's income. In any case, the time spent in these activities is small, and their inclusion would have no effect on our results.
[13] The implicit assumption is that it is possible to hire someone to do household chores and look after household children. Alternatively, one could assume that it would be necessary to hire two people--one to do the housework

We use the replacement-cost approach to value household production. Under this approach, time spent in household production is valued at either a specialist wage that corresponds to the specific activity or a generalist wage. The specialist wages were generated using the Outgoing Rotation Group files from the CPS as follows. We computed the hours-weighted mean wage for each 3-digit occupation. The time spent in each nonmarket activity was valued at the wage for the occupation that most closely resembles the activity.[14] For the generalist wage, we used the average wage for Maids and Housekeepers. We made no adjustments to account for differences in productivity in household production across households, although the lower productivity of non-specialists is a primary justification for using a generalist wage.[15]

We considered using other approaches to valuing household production. The opportunity-cost approach, which uses the individual's market wage to value the time spent in household production, has some conceptual and practical difficulties associated with it. On a conceptual level, the implicit assumption that hours of paid work are freely variable at the margin may not hold; workers, at least in the short run, may have no choice in their working hours. Perhaps more importantly, the opportunity cost approach assumes that people who are highly productive in market work are just as productive doing household work. It is hard to imagine that a lawyer is 5 times more productive building a deck than a carpenter. On a practical level, it would be necessary to impute a wage for nonworkers. Another approach, taken by Gronau (1980), is to specify a functional form for the marginal product of nonmarket work,

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and one to look after the children. Given that individuals routinely perform these tasks simultaneously, the former assumption makes more sense.

[14] This crosswalk is available from the authors upon request.

[15] For example, Wolff et al. (2004) multiplied this wage by a performance index that depends on household-level characteristics as well as characteristics of household members.

estimate the parameters of the function using time-diary data, and integrate the function for each individual in the sample.[16] This approach has the advantage of being based in theory, but it is sensitive to the functional form of the production function.

Finally, because we are comparing extended income across households of different sizes, we adjusted extended income measures using two alternative equivalence scales. The first is the OECD equivalence scale (OECD, 2005), which is given by: $E = I/(1.0 + 0.7(A - 1) + 0.5C)$, where E is equivalent income, I is the income measure, A is the number of adults in the household (either one or two in our case) and C is the number of children less than 18. The second is: $E = I\big/\sqrt{A + C}$. We run separate regressions for each equivalence scale.

IV. Results

Table 1 shows person-weighted estimates of mean household earnings and household production for the four definitions of household production.[17] Under all measures, household production is a substantial fraction of household money earnings, from 31 percent (using the generalist wage and excluding secondary childcare) to 47 percent (specialist wages and including secondary childcare). Put differently, household production comprises 23-32 percent of combined labor earnings and household production. Married households do more household production than do single households, with household production comprising 32-49 percent of money income for married couples compared to 24-32 percent for singles.

Table 2 shows results for five inequality measures: the coefficient of variation, the Gini coefficient, and the ratios of the 90th to the 50th percentile, the 50th to the 10th percentile, and the

[16] Gronau points out that an alternative approach in the same vein is to specify a functional form for the home production function, and then solve for the marginal product function.
[17] All of our estimates are person weighted, rather than household weighted.

90th to the 10th. As expected, moving from money income to extended income (that is, from row 1 to row 2 for each measure) substantially reduces measured inequality. Both the coefficient of variation and the Gini coefficient fall by about one-quarter regardless of whether the OECD or the square root scale is used. The effect on the 50/10 and 90/10 ratios are also quite dramatic, with the ratios falling by about one-third and one-half, respectively, under both scales. The effect on the 90/50 ratio is somewhat smaller, with the ratio falling by about one-fifth under both scales. (All of these differences are statistically significant at the 1 percent level.) The larger effects on the 50/10 and 90/10 ratios compared with the 90/50 ratio are not surprising, because we would expect household production to be a larger fraction of extended income for those lower in the money income distribution.

Relative inequality measures such as the Gini coefficient will always fall if a positive constant is added to the income of all members of the population. Jenkins and O'Leary (1996) pointed out that inequality of extended income is positively related to the variance of household production and the correlation between money income and household production. In our data, this correlation ranges from -0.10 to 0.20 across extended income measures and equivalence scales. Using specialist wages increases the correlation, while including secondary child care reduces the correlation. Gottschalk and Mayer (2002) also found a weak relationship between money income and household production, with high-money-income households spending more time in household production. This would seem to imply that including household production should increase measured inequality. But the value of household production is a larger fraction of money income for low-income households than for high-income households, and this effect dwarfs differences in the amount of time spent in household production by income level.

We investigated this further by adding the mean household production (normalized across households by the equivalence scale), rather than imputed household production, to household money income (row 3 of Table 2). Adding mean household production accounts for by far the greatest portion of the effect of household production on inequality measures. There are only two instances (both using the 90/50 ratio) where the predicted-household-production extended income (row 2) inequality measure is less than the corresponding mean-household-production measure (row 3) by a statistically significant amount. In most cases point estimates for the mean-household-production measure are less than the predicted-household-production estimates, in many cases by a statistically significant amount.

Rows 4-6 of Table 2 show the effect of adding random disturbances to predicted household production as in (5) and (6). The results in row 6, which were generated assuming the maximum variance for the disturbance, are upper bounds on the effect of the perturbations. Hence, we will focus on the results in rows 4 and 5 ($k = 0.25$ and $k = 0.50$), which were generated under more realistic assumptions. Adding the disturbances increases the variance of household production but reduces the magnitude of the correlation with money income, so the direction of the effect is ambiguous if the correlation is negative. In almost all cases adding the disturbance increases the inequality of extended income, frequently to the extent that the inequality measures in rows 4-6 are statistically significantly greater than the constant-household-production measure in row 3. However, the differences for rows 4 and 5 are rather small and are not economically significant.

The inclusion of secondary childcare and to a lesser extent the use of specialist rather than generalist wages both tend to reduce measured inequality. In both cases this is mostly due to greater mean levels of household production. For most comparisons, it makes little difference whether the square root or OECD equivalence scale is used. The most notable exception is the 50/10 ratio when secondary childcare is included (both using generalist and specialist wages). The decline in inequality is larger when using the OECD scale than when using the square root scale. And the difference between the predicted-household-production and the mean-household-production measures is smaller for the OECD scale.

Thus far we have shown that the lower measured inequality of extended income, compared to money income, is due to the addition of mean household production, rather than to the substitution of household production for market work. Given the small correlation between the value of household production and money income, it is natural to wonder by how much measured inequality would change if the correlation were large in magnitude.

For convenience, we confine ourselves to the coefficient of variation (CV). Note that

$$CV^2 = \frac{\sigma_E^2}{\overline{E}^2} = \frac{\sigma_Y^2 + 2\sigma_{YP} + \sigma_P^2}{\overline{E}^2} = \frac{\sigma_Y^2(1+2\beta) + \sigma_P^2}{\overline{E}^2}$$

where $\overline{E}$ is the mean of extended income; the subscripts on the variance and covariance terms denote money income (Y), household production (*P*), and extended income (*E*); and $\beta \equiv \sigma_{YP} / \sigma_Y^2$ is the coefficient on money income in a simple regression of household production on money income.

The coefficient β is a convenient measure of the relationship between household production and market goods, as it represents the amount by which household production increases or decreases for a dollar increase in money income. It varies from -0.018 to 0.011 across the various combinations of measures of household production and equivalence scales. The minimum occurs when using the OECD equivalence scale, the generalist wage, and including secondary care, while the maximum occurs when using the square root equivalence scale, the specialist wage, and excluding secondary care.

Table 3 shows how the CV varies across values of β and σ_P^2 using the specification that produces the minimum value of β (–0.018) as a reference point. The values of σ_P^2 considered correspond to those in Table 2, with $\sigma_{\hat{P}}^2$ corresponding to the variance of predicted household production (row 2 in Table 2).

Note that even fairly large negative values of β produce only moderate differences in the CV compared to including the mean value of household production in the income measure. (Also note that, as shown in the last column of Table 3, the possible values of β are limited by σ_P^2, as large magnitudes of β violate the Cauchy-Schwarz inequality.) For example, using the variance of household production equal to that in row 5 of Table 2 and increasing the magnitude of β from −0.018 to −0.1 (i.e., increasing the magnitude of the correlation from −0.10 to −0.58) decreases the CV from .689 to .626. The implied elasticity of the CV with respect to β is very small--about 0.05. Thus changes in β over time, unless they are very large, should have negligible effects on measured inequality.

V. Conclusion

In this study, we used data from the ATUS to further examine how measures of inequality of earnings are affected by using extended income, which includes household production, instead of money income. The ATUS has the advantage over other time-use surveys of having data on income, but, like many time-use surveys, it covers one day for one household member. We extended previous authors' imputation procedures to take advantage of the income data in ATUS using a flexible functional form.

Consistent with our expectations and with most of the previous literature, we found that adding household production to money income reduces measured income inequality significantly. But little of this effect comes from variation in household production across households--virtually all of it is due to the addition of mean household production to earnings. Perturbing imputed values of household production to restore variation in household production across households causes inequality to increase only slightly. It makes virtually no difference whether generalist or the specialist wages are used or which equivalence scale is used, although the inclusion of child care as a secondary activity matters--but only to the extent that mean household production is greater when secondary childcare is included. We also found that measured inequality is not very sensitive to the relationship between money income and the value of household production. Thus, we conclude that measures of extended income inequality are robust to alternative assumptions one could make when estimating the value of household production.

The practical implication of these results is that one can simply use the mean value of household production when estimating trends in extended income, and that there are virtually no gains to using more sophisticated imputation techniques. Any changes in the variance of household production across households or in the relationship between money income and the value of household production will have such a small effect on measured trends that they can safely be ignored.

Appendix

In order to analyze how the inclusion of household production in income would be expected to affect measures of inequality, we present the Gronau (1986) model of household production, extend it to two-person households, and discuss its implications.

We begin with a single-person household. Using Gronau's nomenclature, the utility function is given as:

$$U = U(X,L,H,N),$$

where X is the quantity of goods and services purchased in the market plus those produced at home, L is time spent in leisure, H is time spent in nonmarket production, and N is time spent working for pay. The individual maximizes utility subject to the following constraints:

$$X = X_M + f(H) = W \cdot N + V + f(H)$$

$$T = L + H + N,$$

where X_M represents goods and services purchased in the market, W is the individual's market wage, V is unearned income, and $f(H)$ is the home production function ($f_H > 0$ and $f_{HH} < 0$).

There are several features of this model that are worth pointing out. First, as is evident from the first constraint, home-produced goods are perfect substitutes for market goods. This may seem unrealistic, because households clearly do not produce most of the goods that they consume. An alternative way to specify the model would be to allow goods and services to enter into the production function separately, and to assume that home production is a perfect substitute only for services. Under this specification, the qualitative results are the same, so we opted for the simpler specification. Second, the time spent in market and nonmarket work enters directly into the utility function. This allows individuals to obtain utility or disutility from these activities. We assume that, at the margin, that the marginal utility of time spent in these activities is negative, and that the disutility of work is concave ($U_H, U_N, U_{HH}, U_{NN} < 0$). Third, market goods do not enter into the production function. This is consistent with our notion that home production mostly is a substitute for services, but abstracts somewhat from reality in that much of this production would involve the use of household capital (vacuum cleaners, stoves, dishwashers, etc.).

Solving the above maximization problem yields the following equilibrium conditions:

$$(1)\ W = \frac{U_L - U_N}{U_X}$$

$$(2)\ W = f_H + \frac{U_H - U_N}{U_X},$$

for individuals who are employed. For nonemployed individuals, the condition is:

$$(3)\ \frac{U_L}{U_X} = f_H + \frac{U_H}{U_X}$$

Differentiating equations (1) and (2) and simplifying the expressions obtains the following comparative static results:

$$(4)\ \frac{dN}{dW} = \frac{U_X^2}{(U_{LN} - U_{NN})U_X - (U_L - U_N)U_{XN}}$$

$$(5)\ \frac{dH}{dW} = \frac{U_X^2}{U_X f_{HH} + (U_{HH} - U_{NH})U_X - (U_H - U_N)U_{XH}}$$

$$(6)\ \frac{dL}{dW} = \frac{U_X^2}{(U_{LL} - U_{NL})U_X - (U_L - U_N)U_{XL}}$$

To sign equations (4) and (5), it is sufficient to assume that the utility function takes the following form: $U = U(X,L,H,N) = U(X,L) - C(H,N)$, where $C(H,N) = C(\alpha H) + C(\beta N)$ or $C(H,N) = C(H+N)$. Under these assumptions, the derivatives in equations (4) and (5) will be positive ($dN/dW, dH/dW > 0$). The derivative in equation (6) is negative if, in addition, $U_{XL} > 0$ (or is not too negative). Equations (4) - (6) give the standard result that an increase in the wage will result in an increase in the amount of time spent in market work and decreases in time spent in nonmarket work and time spent in leisure.

It is straightforward to extend Gronau's model to examine two-person households. Assuming that both household members share a common utility function, the maximization problem faced by the two-person household is:

$$\text{Max } U = U(X,L_H,L_W,H_H,H_W,N_H,N_W) \text{ s.t.}$$

$$X= W_H{\cdot}N_H + W_H{\cdot}N_H + V + f(H_H,H_W)$$

$$T_H = L_H + H_H + N_H$$

$$T_W = L_W + H_W + N_W,$$

where the subscripts indicate the husband (H) and wife (W). To derive comparative static results for changes in L_i, H_i, and N_i with respect to own wage, W_i, the equilibrium conditions in (1) and (2) apply so that the expressions for the derivatives are the same as in the single-person household case. At first blush, it might seem that the solution is no different than putting two single-person households together. But the common consumption of X results in interactions between time use and spouse's wage. Thus, although the derivatives are the same, the actual values they take on will differ from the single-person case. Combining equation (1) for $i,j = H,W$ yields:

$$(7)\ \frac{W_i}{W_j} = \frac{U_{L_i} - U_{N_i}}{U_{L_j} - U_{N_j}},$$

and combining equation (2) for $i,j = H,W$ yields:

$$(8)\ \frac{W_i}{W_j} = \frac{U_X f_{H_i} + (U_{H_i} - U_{N_i})}{U_X f_{H_j} + (U_{H_j} - U_{N_j})},$$

for households in which both spouses work. Differentiating these conditions and arranging terms yields the following comparative static results:

$$(9)\ \frac{dH_i}{dW_j} =$$

$$\frac{[R_j]^2}{W_j\{[(U_{XH_i} f_{H_i} + U_X f_{H_iH_i}) + (U_{H_iH_i} - U_{N_iH_i})][R_j] - [(U_{XH_i} f_{H_j} + U_X f_{H_jH_i}) + (U_{H_jH_i} - U_{N_jH_i})][R_i]\}}$$

$$(10)\ \frac{dN_i}{dW_j} = \frac{[R_j]^2}{W_j\{[U_{XN_i} f_{H_i} + (U_{H_iN_i} - U_{N_iN_i})][R_j] - [U_{XN_i} f_{H_i} + (U_{H_jN_i} - U_{N_jN_i})][R_i]\}}$$

where $R_i = U_X f_{H_i} + (U_{H_i} - U_{N_i})$. If we maintain the assumptions above, and make the additional assumptions that the household utility function is separable in husband's and wife's disutility of work and that additional time spent in household production by one spouse does not reduce the marginal product of the oher spouse ($f_{H_iH_j} \geq 0$), these derivatives have the expected signs ($dH_i/dW_j, dN_i/dW_j < 0$). Under the same assumptions, the derivative of own leisure with respect to spouse's wage has the expected positive sign:

$$(11)\ \frac{dL_i}{dW_j} = -\frac{(U_{L_i} - U_{N_i})}{(U_{L_iL_i} - U_{N_iL_i}) \cdot W_j - (U_{L_jL_i} - U_{N_jL_i}) \cdot W_i} > 0$$

To derive comparative static results for the case where one spouse does not work, we combine the condition in equation (2) (for the working spouse) with the following equilibrium condition:

$$f' = \frac{U_L - U_H}{U_X}$$

Differentiating and arranging terms yields the following:

$$(12)\ \frac{dH_j}{dW_i} =$$

$$\frac{(U_{L_j} - U_{H_j})^2}{\{[(U_{H_iH_j} - U_{N_iH_j}) \cdot f_{H_j} + (U_{H_i} - U_{N_j}) \cdot f_{H_jH_j}](U_{L_j} - U_{H_j}) - (U_{L_jH_j} - U_{H_jH_j})(U_{H_i} - U_{N_i}) \cdot f_{H_i} + (U_{H_i} - U_{N_i})^2 \cdot f_{H_jH_j}\}} < 0$$

$$(13)\ \frac{dL_j}{dW_i} = \frac{(U_{L_j} - U_{H_j})^2}{(U_{H_iL_j} - U_{N_iL_j}) \cdot f_{H_j} \cdot (U_{L_j} - U_{H_j}) - (U_{L_jL_j} - U_{H_jL_j})(U_{H_i} - U_{N_i}) \cdot f_{H_j}} > 0$$

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Table 1: Mean Annual Household Earnings and Household Production for Different Production Measures

		Household Production			
		Generalist Wage		Specialist Wage	
	Household Money Earnings	Secondary Childcare Excluded	Secondary Childcare Included	Secondary Childcare Excluded	Secondary Childcare Included
All Households	70,553	21,542	31,517	23,385	32,969
Single-person Households	38,689	9,220	11,600	10,155	12,440
Married-couple Households	81,863	25,915	38,587	28,080	40,256

Note: Household production estimated using the OECD equivalence scale. The square-root equivalence scale gives similar results. Data are from the 2003 ATUS.

Table 2: Inequality Measures for Different Measures of Household Income

	Generalist Wage				Specialist Wage			
	Secondary Childcare Excluded		Secondary Childcare Included		Secondary Childcare Excluded		Secondary Childcare Included	
	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence
Coefficient of Variation								
(1) Family income	0.942**	0.917**	0.942**	0.917**	0.942**	0.917**	0.942**	0.917**
(2) = (1) + Pred. HH production	0.741	0.720	0.679	0.663	0.730	0.710	0.671	0.655
(3) = (1) + Mean HH prod.	0.738	0.714	0.684	0.657	0.723	0.700	0.673	0.647
(4) = (2) + .25 S	0.745	0.725	0.684	0.669*	0.735	0.716	0.677	0.662*
(5) = (2) + .5 S	0.749	0.729**	0.689	0.674**	0.740	0.721*	0.683	0.668**
(6) = (2) + S	0.758**	0.740**	0.706**	0.696**	0.751*	0.735**	0.701**	0.692**
Gini								
(1) Family income	0.416**	0.409**	0.416**	0.409**	0.416**	0.409**	0.416**	0.409**
(2) = (1) + Pred. HH production	0.328	0.324**	0.299	0.301**	0.324**	0.320**	0.297	0.298**
(3) = (1) + Mean HH prod.	0.325	0.318	0.302	0.293	0.319	0.312	0.297	0.288
(4) = (2) + .25 S	0.329*	0.325**	0.301	0.302**	0.326**	0.321**	0.299	0.300**
(5) = (2) + .5 S	0.332**	0.328**	0.305	0.306**	0.330**	0.326**	0.304**	0.305**
(6) = (2) + S	0.340**	0.336**	0.317**	0.318**	0.339**	0.336**	0.317**	0.318**
90^{th} percentile/50^{th} percentile								
(1) Family income	2.416**	2.355**	2.416**	2.355**	2.416**	2.355**	2.416**	2.355**
(2) = (1) + Pred. HH production	2.029	1.978	1.905*	1.879	2.002	1.956	1.894*	1.854
(3) = (1) + Mean HH prod.	2.046	1.998	1.955	1.904	2.021	1.975	1.938	1.889
(4) = (2) + .25 S	2.042	1.997	1.913*	1.881	2.014	1.980	1.900*	1.859
(5) = (2) + .5 S	2.041	2.007	1.913*	1.883	2.018	1.990	1.904	1.870
(6) = (2) + S	2.042	2.014	1.928	1.911	2.029	2.007	1.923	1.910
50^{th} percentile/10^{th} percentile								
(1) Family income	3.231**	3.216**	3.231**	3.216**	3.231**	3.216**	3.231**	3.216**
(2) = (1) + Pred. HH production	2.039	2.041	1.880	2.031**	2.027	2.024	1.877	2.019**
(3) = (1) + Mean HH prod.	2.040	2.030	1.871	1.851	1.992	1.983	1.843	1.824
(4) = (2) + .25 S	2.063	2.083	1.880	2.044**	2.065	2.077	1.884	2.042**
(5) = (2) + .5 S	2.110*	2.156**	1.943**	2.094**	2.132**	2.167**	1.955**	2.100**
(6) = (2) + S	2.269**	2.319**	2.139**	2.255**	2.310**	2.346**	2.175**	2.284**

Table 2: Inequality Measures for Different Measures of Household Income (continued)

	Generalist Wage				Specialist Wage			
	Secondary Childcare Excluded		Secondary Childcare Included		Secondary Childcare Excluded		Secondary Childcare Included	
	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence	OECD Equivalence	Sq. Root Equivalence
90th percentile/10th percentile								
(1) Family income	7.807**	7.573**	7.807**	7.573**	7.807**	7.573**	7.807**	7.573**
(2) = (1) + Pred. HH production	4.138	4.037	4.058	3.960**	4.058	3.960	3.555	3.743**
(3) = (1) + Mean HH prod.	4.174	4.055	4.027	3.916	4.027	3.916	3.570	3.446
(4) = (2) + .25 S	4.213	4.159	4.161	4.111**	4.161*	4.111	3.580	3.796**
(5) = (2) + .5 S	4.307*	4.327	4.302	4.311**	4.302**	4.311**	3.723**	3.926**
(6) = (2) + S	4.631**	4.669	4.686**	4.706**	4.686**	4.706**	4.182**	4.362**

Data are from the 2003 ATUS.

* Significantly different from Row (3) at 5 percent level.

** Significantly different from Row (3) at 1 percent level.

Table 3: Coefficient of Variation For Differing Values of the Regression Coefficient of Household Production on Money Income and the Variance of Household Production

β		Actual (-0.018)	-0.01	-0.02	-0.05	-0.1	-0.2
$\sigma_P = \sigma_{\hat{P}}$	CV	0.679	0.684	0.677	0.656	0.620	--
	Corr.	-0.124	-0.069	-0.137	-0.344	-0.687	< -1
$\sigma_P = \sigma_{\hat{P}} + .25S$	CV	0.684	0.685	0.678	0.657	0.621	--
	Corr.	-0.119	-0.065	-0.131	-0.327	-0.655	< -1
$\sigma_P = \sigma_{\hat{P}} + .5S$	CV	0.689	0.690	0.683	0.662	0.626	--
	Corr.	-0.105	-0.058	-0.116	-0.290	-0.580	< -1
$\sigma_P = \sigma_{\hat{P}} + S$	CV	0.706	0.696	0.689	0.669	0.633	0.554
	Corr.	-0.077	-0.042	-0.085	-0.212	-0.424	-0.849

Note: Household production measured using the OECD equivalence scale, the generalist wage, and including secondary childcare. Data are from the 2003 ATUS.