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Modelling domestic work time

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Abstract. What variables should be used as regressors in models of the length of time which people spend doing unpaid domestic work? To most economists, the answer would be straightforward: use the variables which are implied by a theoretical model of household time allocation (e.g. Becker's). This paper shows that this strategy has not been followed, explores why this is so, and makes some recommendations about variable specification and the treatment of paid market work time in particular. The arguments are illustrated using regressions based on UK time budget data for the mid-1980s.

1. Introduction

What variables should be used as regressors in models of unpaid domestic work (cooking, cleaning, child care, shopping, etc.)? To most economists, the answer would be straightforward: use the variables which are implied by a theoretical model of time allocation (e.g. Becker's). This paper shows that this strategy has not been followed in a significant number of cases, explores why this is so, and makes some recommendations about variable specification and the treatment of paid market work time in particular.

Our initial conjecture was that there would be a high degree of consensus about regression specification[1] since most applied economists work within much

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Table 1. Research reporting domestic work time regressions (a selection)

'Market (paid) work time' included as a regressor	'Market (paid) work time' not included as a regressor
Apps (1994)	Graham and Green (1984)
Flood and Klevmarken (1993)	Gronau (1977)
Fuchs (1986)[a]	Gronau (1980)
Gershuny and Robinson (1988)	Kooreman and Kapteyn (1987)
Gershuny, Jones and Godwin (1988)[a]	
Gershuny and Halpin (1993)	
Gustafsson and Kjulin (1994)[b]	
Manchester and Stapleton (1991)	

[a] Market work time measured using participation dummy variables.
[b] Regressor refers to spouse of respondent

the same paradigm. In fact our reading of the literature suggested a lack of consensus, and about one aspect in particular – whether the regressor list included measures of (paid) 'market work time', or not. Table 1 lists a selection of research classified on this basis.

As budding domestic work time modellers, we were puzzled by the different practices, and we suspect that other researchers may be too. Moreover we have found little explicit discussion of this specification issue in the literature. Thus the aim of this paper is to go some way towards filling this gap: its goal is to clarify the issues and to identify the correct rationâle for different empirical specifications.

Our first thoughts were that paid market work time should *not* be included amongst the regressors, since this is the conclusion implied by a standard behavioural model of household time allocation. We elaborate this argument in Sect. 2. In Sect. 3 we argue that different regression specifications might be justified if the goals are other than behavioural modelling. The arguments are illustrated in Sect. 4 using regressions based on UK time budget data for the mid-1980s.

2. Behavioural time use models and regression specification

The model of household time allocation we use to illustrate our arguments is a simplified version of the one underlying Kooreman and Kapteyn's (1987) empirical work.

Consider a two-adult couple household and assume there is a single household utility function summarising preferences, and a combined household budget constraint (and thus complete income and expenditure pooling).[2] Also suppose a static model (and hence no saving or borrowing), and that wage rates are expressed net of taxes.

Let

x_m, x_f = consumption of market goods by the man and woman, respectively, at per unit price p;
h_m, h_f = paid market work times for the man and woman;

w_m, w_f = the corresponding net wage rates;
c_m, c_f = domestic work time for the man and woman (cooking, cleaning, child care, shopping, etc.); and
l_m, l_f = leisure time for the man and woman (pure leisure + personal maintenance time, etc.).

Let household utility be represented by the function

$$u = U(x_m, x_f, c_m, c_f, l_m, l_f) \ . \tag{1}$$

Following Kooreman and Kapteyn (1987), interpret this as a reduced form representing the combined influence of both preferences and the technology of household production. Household constraints are of both time and money:

$$l_m + c_m + h_m = T_m \tag{2}$$

$$l_f + c_f + h_f = T_f \tag{3}$$

$$p(x_m + x_f) = w_m \cdot h_m + w_f \cdot h_f + v \tag{4}$$

where T_m and T_f are the fixed time endowments and v is non-labour income such as capital income and cash transfers (assumed exogenous). The constraints can be combined into a single full income constraint if we make the standard assumption about perfect substitutability of time between activities:

$$p \cdot (x_m + x_f) + w_m \cdot (l_m + c_m) + w_f \cdot (l_f + c_f) = w_m \cdot T_m + w_f \cdot T_f + v \equiv Y \ . \tag{5}$$

Solving the constrained maximisation problem yields solutions for $x, c_m, c_f, l_m, l_f, h_m, h_f$ as functions of the exogenous elements of full income $Y(w_m, w_f, T_m, T_f, v)$ and the exogenous parameters characterising the utility function (α, say). Where the utility function allows a closed form solution we have:[3]

$$q_k = f_k(w_m, w_f, T_m, T_f, v, \alpha) \tag{6}$$

where

$$q_k \subseteq \{x_m, x_f, c_m, c_f, l_m, l_f, h_m, h_f\} \ . \tag{7}$$

Observe that market hours are endogenous – solutions for any two time activities of each person imply, given the time constraint, the solution for the third activity.

In sum, the regressors in the regression equation for domestic work time should comprise the various exogenous variables only. In this model there is no rationâle for using market work hours as an explanatory variable in a domestic work time regression.

Why then do some analysts do so? A response we have heard is that it increases R^2 substantially (we confirm this in Sect. 4). In Sect. 3 we consider whether this unabashedly empiricist justification has a sure foundation. First, however, let us consider whether changing the theoretical model might provide a justification. Flood and Klevmarken (1993) have argued that it does:

> We . . . explicitly introduce another type of interdependence between activities, based on an assumption about separability in the utility function between goods purchased in the market on the one side and goods produced at home and benefits derived from doing leisure activities on the other. From this assumption it follows that people first decide about the time allocation between market work and non-market work, and then in a second step decide about the allocation of the resulting income on consumption goods and allocation of the remaining time on household and leisure activities. The total time for nonmarket work will thus determine the number of hours allocated to each nonmarket activity (cf. the budgeting behavior which follows from the assumption of a separable utility function in conventional demand theory). Because total nonmarket time is just a constant minus hours of work, we can equally well use hours of market work to explain nonmarket activities. This model will thus permit us to obtain direct estimates of the trade off between market work and other activities. The obtained estimates will, however, only be consistent if this assumption about a sequential behavior is at least approximately true. If people actually make joint decisions about market work, cooking, cleaning, sporting, watching TV, etc. then we cannot condition on market work when the model is estimated for nonmarket activities (1993, p. 9).

However separability of the type assumed by Flood and Klevmarken does not have the consequences they claim, and hence does not rationalise the inclusion of market hours as they suggest.

To show this, let us modify the specification of the household utility function to correspond with Flood and Klevmarken's separability assumption:

$$u = U[V_1(x_m, x_f), V_2(c_m, c_f, l_m, l_f)] \ . \tag{8}$$

In effect we have a utility tree with two branches, represented by the subutility function V_1 for market goods, and the sub-utility function V_2 for household services, and this second branch comprises several twigs corresponding to household production services (leisure and domestic work).

Standard results about utility trees, separability and two-stage budgeting can now be applied. Deaton and Muellbauer's (1980, Chap. 5) arguments show that with a specification of the utility function like this, optimal expenditure demands for the man's and woman's market goods can be written as a function of total expenditure on market goods and their prices (assumed equal in this case), but not other prices (the wage rates in this case). Similarly, optimal domestic work and leisure allocations for the man and woman cut be written as a function of total expenditure on non-market time (aggregated using the appropriate wage rates) and their shadow prices (the wages). Total expenditure on each branch depends on total household income which, in this household production context, is full income $Y \equiv w_m \cdot T_m + w_f \cdot T_f + v$.

The overall conclusion is that a first-stage decision about the optimal split between market and non-market *hours* does not 'follow' from Flood and Klevmarken's separability assumption. The assumption implies an allocation of full income between market goods and home production services. It is total expenditure on non-market production services which 'thus determine' the allocation of time to the various domestic work and leisure activities, not total non-market

time. (Full income depends on time endowments in total, not only their non-market time components.)

Perhaps the most straightforward way of rationalising the market work time as a regressor is simply to suppose that people are restricted to supplying a fixed amount of hours to the market. In this case we have:

$$h_m = \bar{h}_m \ , \quad h_f = \bar{h}_f \tag{9}$$

and so full income will equal

$$\bar{Y} = w_m \cdot (T_m - \bar{h}_m) + w_f \cdot (T_f - \bar{h}_f) + v \ . \tag{10}$$

The demand functions will thus become conditioned on the market hours constraints:

$$\bar{q}_k = f_k(w_m, w_f, T_m, T_f, v, \alpha, \bar{h}_m, \bar{h}_f) \ . \tag{11}$$

This expression provides a rationâle for using paid market work hours as a regressor variable.

Market hours restrictions are not the only rationâle for conditioning the q_k in this way. Another possibility is a different household utility-maximising strategy from that described so far: suppose that decision-making is genuinely sequential (rather than metaphorically as in the 'two stage' sense referred to earlier). However it is difficult to think why it might be thus: why should we focus specifically on market hours rather than some other aspect of household time allocation e.g. leisure? Perhaps only if there are constraints, in which case we return to the situation discussed in the previous paragraph.

The arguments so far suggest that the case for using paid work time as a regressor is not strong unless market hours are constrained in some way. This conclusion is predicted, however, on an implicit assumption that the goal of the regression analysis is to fit a behavioural model of household time allocation. Are the different empirical specifications which we observe justified by different underlying goals?

3. Regression specification and the goals of regression fitting

Let us therefore classify empirical papers according to the purposes of their regression analyses. We discern three different goals and have reclassified the papers in Table 1 accordingly: see Table 2. The first category covers pure 'behavioural' modelling, as already discussed. The second class of papers uses regressions for data matching. Their ultimate aim is analysis of distributions of 'extended income' = money income + a valuation of unpaid domestic work time.[4] However income surveys typically do not contain detailed time use data, and so regression estimates derived from time use surveys are used to impute values of unpaid domestic work time to respondents to the income survey utilising the variables common to both surveys.[5] The third category comprises papers with more diverse aims, but their main goal is to explain secular trends in the patterns of unpaid work time allocations. Regressions are fitted for each of two or

Table 2. Research reporting domestic work time regressions, by purpose

Purpose	Research
Behavioural modelling	Flood and Klevmarken (1993) Graham and Green (1984)[a] Gronau (1977)[a] Gronau (1980)[a] Gustafsson and Kjulin (1994) Kooreman and Kapteyn (1987)[a]
Data matching	Apps (1994) Fuchs (1986) Gershuny and Halpin (1993) Manchester and Stapleton (1991)[b]
Explaining trends in unpaid household work	Gershuny and Robinson (1988) Gershuny, Jones and Godwin (1988) Manchester and Stapleton (1991)[b]

[a] Paid market work not used as a regressor.
[b] Trends models used to comment on Fuchs's data matching.

more time periods, and secular trends in domestic work time are then decomposed into changes in the regression coefficients and changes in the composition of the sample.

Let us consider in more detail what explanatory variables should appear in a domestic work time regression for data matching. First it will be necessary to explain the matching procedure *per se*.

The ultimate aim is to study the personal distribution of extended income e, where extended income is the sum of money income and a valuation of domestic work time. If domestic work time is valued using the market wage rate w, then

$$e \equiv (w'h + v) + w'c = y + w'c \ . \tag{12}$$

The need for data matching arises because data sets with measures of money income and time budget allocations together with personal characteristics z are very rare. Income data sets typically contain information about the joint distribution

$$F(y, h, z) \ , \tag{13}$$

time budget surveys provide information about the joint distribution

$$G(c, h, z) \ , \tag{14}$$

whereas what one requires to construct and analyse e is a joint distribution

$$K(y, c, z) \ . \tag{14}$$

Data matching by linear regression typically comprises, first, the fitting of an equation to the time budget survey data of the form

$$\hat{c}_{\mathrm{TBS}} = \hat{\beta}'_{\mathrm{TBS}} \cdot z_{\mathrm{TBS}} + \hat{\gamma}_{\mathrm{TBS}} \cdot h_{\mathrm{TBS}} \ , \tag{15}$$

followed, second, by imputation of time use to each income survey respondent according to[6]

$$\hat{c}_{IS} = \hat{\beta}'_{TBS} \cdot z_{IS} + \hat{\gamma}_{TBS} \cdot h_{IS} \ . \tag{16}$$

Thus in place of the unobserved joint distribution $K(y, c, z)$, analysts use

$$M(y_{IS}, \hat{c}_{IS}, z_{IS}) \ . \tag{17}$$

There has been much debate about the validity of this matching procedure. Sceptics like Sims (1972) have emphasised that $M(.)$ can be guaranteed to match $K(.)$ well only if income and time use are conditionally independent for given z (and h, if also used in the matching).[7] Others, including us, demur from this nihilistic view. In defence of matching, they recognise that in practice conditional independence may not hold exactly, but maintain that it may be a satisfactory empirical approximation, especially given the lack of alternative data. Okner, for example, refers to 'being close enough for all practical purposes' (1972, p. 361). He, and others, emphasise the foregone benefits for policy and other analysis of *not* doing matching. Our purpose in this paper is not to revive this old debate *per se*; rather we recognise that there are some reasonable grounds for doing regression matching and hence it is indeed meaningful to raise the issue of what variables should be used to do the regression matching. In particular, should h or a related variable appear on the right hand side of (15)?

Our first point is that, in the matching context, regression is simply a method for *succinct statistical description* of multiple correlations. That is, there need not be a direct link between the specification estimated here and a behavioural model of domestic work time. Thus data matching provides the analyst with greater freedom about the specification of regressors.

But what more specific practical guidance can be given? Is 'maximisation of R^2' a helpful guide? Should all the variables common to two matching data sets be used as regressors? In particular, what about paid work time? It is difficult to provide general rules, but we offer the following observations.

Parsimony in specification is important and worth trading for the increasingly marginal increases in 'explanatory power' or R^2 which come from adding extra regressors. This trade off arises in all applied regression analysis, of course, but there are additional dimensions in the data matching context. Using a parsimonious specification reduces the number of variables for which one has to ensure that the variable definitions in the regression data set and the one matched into correspond.

Some theoretical analysis has also provided a case against over-fitting. Wolff (1974) addresses the problem posed by Sims (1972, p. 355): given 'observations on X, Y from one sample and on X, Z from another sample, when will it be true that by matching observations according to X, an artificial Y, Z sample will result whose distribution is the true joint Y, Z distribution.' Wolff examines the goodness of match by analysing how close the correlation between Y and the imputed Z is to the true correlation between Y and Z. Although the latter correlation is of course unobserved one can, with various simplifying assumptions, put bounds on it and use this range for the assessment. Wolff concludes that increasing the number of variables forming the X vector beyond a relatively small number (five in his illustration) leads to minimal improvements in the goodness of match. His in-

vestigations also demonstrated that 'considerable gains in the accuracy of the match can be achieved by choosing X variables that are uncorrelated or even negatively correlated' and 'X variables should be chosen that are highly correlated with either the Y or Z variable' (Wolff, p. 17).

Although we have been arguing the case for parsimony, there may well be scope for increasing the list of candidate regressors beyond those which have been used in most data matching regressions to date. In particular, there seems no particular reason why, for married couple respondents, one cannot use variables based on information about a respondent's spouse.[8]

The most contentious judgement – and the focus of this paper – concerns whether paid market work time should be included as a regressor in matching regressions. In favour there have been arguments that explanatory power can be increased significantly. E.g. Apps justifies her use of the number of market hours per week as a regressor saying that 'it is fundamental in explaining domestic hours of work: women who work longer hours in the market place typically work fewer hours at home' (1994, p. 147).

Against is the argument that paid market work time is an endogenous variable and so matching equation parameter inferences will be subject to 'simultaneous equations bias' (recall the discussion of 'behavioural' models). Or in other words, even if R^2 is increased, the estimated parameters, used later for the matching, will be inconsistent. Is the endogeneity argument decisive in the descriptive modelling context too?

It is, we believe, if the market work time instrument used as the regressor is sensitive to marginal changes in time use. Respondent's total market work time is a prime example of such an instrument.[9]

However this conclusion does not imply that *no* labour market variable can ever be used as a regressor in matching models. It is well-known that labour force attachment is one of the principal characteristics defining a person's position in the socio-economic structure. E.g. a leading UK sociology text emphasises that:

> Work is central in our culture. When someone asks us 'What do you do?', they really mean 'What work do you do?' When a woman is asked 'Do you work?', what is meant is 'Are you doing a paid job?' ... Paid work is also crucially important socially, because so much else-people's life chances, their lifestyles, their world views – all tend to be related to occupation (Brown 1987, p. 273, 275).

Thus a regressor summarising participation – perhaps also distinguishing part- and full-time work – summarises a major socio-economic difference between households (and thereby raises model fit).[10]

A similar argument has been made in the literature about modelling time use trends (category 3 in Table 2), where the distinction between regression as 'explanation' (as in the first category) and regression as 'description' is also not clear-cut. Gershuny and Robinson (1988), summarising trends in time use with employment status, family composition and educational level as regressors, commented that

> Taking the long view, all structure is behaviour. Having or not having a paid job (or a child) are actions, however chosen or constrained. There is nevertheless some point in identifying some such attributes as relatively stable structures on which the explanation of other aspects of behaviour may be

based. Table 2 shows that in fact a large part of the variance in the time spent in domestic tasks may be explained by employment status and the presence of dependent children in the household.

Of course, using these particular variables as 'independent' for these purposes does not mean that they are taken as causally prior. . . . We know on a priori grounds, however, that having a job or a child shows less short-term instability – varies less from week to week – than does housework or shopping time. Therefore it seems sensible to organise the data by using these as the structural variables (1988, p. 542).

We agree with Gershuny and Robinson that using labour force participation variables as regressors is legitimate for category 2 and 3 models. However we disagree with Gershuny and Halpin's (1993) and Flood and Klevmarken's (1993) inclusion of total paid work time.

A further practical argument against using total paid work time as a regressor in regression matching models is that the survey instrument for paid work time in time budget data is (mostly) derived from time diaries kept for several days, whereas in income surveys the instrument is typically a self-reported count of the usual or actual hours worked last week or month etc. The distributions derived from these two sources are rather different, especially at the tails of the distribution.[11] Hence even if it were thought legitimate to use total work time as a regressor in the domestic work time regression, errors would be introduced when the parameter estimates were used at the matching stage.

4. Empirical illustration using UK time use data

Let us now consider the empirical relevance of our clarificatory points. With an application to data matching, we examine the impact on model fit of varying the regressor specification, giving particular attention to paid market work variables.

Our data are derived from the Time Budget extension to the 1987 UK ESRC Social Change and Economic Life (SCEL) household survey of six UK travel-to-work areas.[12] Seven day time diaries were completed by survey respondents and their spouses, and the returns averaged to provide estimates of time use on a 'minutes per day' basis. The sub-sample we work with comprises persons aged 20–59 years who are either the 'central adult' in one-adult households, or the husband or wife of a 'central spouse pair' in multi-adult households.[13] The definition of 'domestic' work time used in the SCEL survey is a relatively standard one. Our data refers to a respondent's principal activity, and covers food preparation, housework, odd jobs about the house (including do-it-yourself activities), gardening, shopping, child care, plus some domestic travel associated with these activities.[14]

Our 'basic set' of regressors comprises variables which are available in both the SCEL survey and the income survey into which we shall be imputing domestic work time values (in other current research). These variables summarise differences in the age of respondent and the composition of the household in which they live: the total number of children and the presence of a child aged under four years. As it happens, age and household composition are variables used in many previous studies as well; perhaps the most obvious omission is information about education and wage rates.[15]

Table 3 presents the domestic work time regression results for four sample subgroups partitioned by marital status. Although a partition by gender alone is more common, we have also partitioned by marital status as this provided a generally better fit.[16] In the first four columns the regressors are just the basic set; in the second four, paid work participation dummy variables are added, and in the final two columns a spouse labour force participation variable for married people is added as well.

On average females do about twice as much domestic work as males, and married people at least 25% more than single people. For married women the average is about five hours, for single men it is about two. The coefficient estimates are 'sensible'. They suggest that domestic work time increases with age *ceteris paribus*, though the sharpest distinction is whether the respondent is over or under 40 years of age. Unsurprisingly, the more children there are in the household the more domestic work there is. The presence of a child under five is also associated with more domestic work, except for single males for whom the association is not statistically significant.

What about equation fit overall? In general, when measured by R^2 it is higher for females than males, regardless of marital status, but for each gender group, R^2 is higher for single people than married people. By conventional standards the goodness of fit for females in particular is good. The smaller extent of unexplained variation in domestic work time amongst females than amongst males might be explained by greater perpetuation of traditional home-making rôles amongst women ('new men' increase the variance!).

When paid work participation dummy variables are added to the regressors, there is a marked impact: see columns 5–8 of Table 3. The R^2s increase by about 60% in each case. Participating in market work is associated with significantly lower amounts of domestic work, with the exception of single men for whom full-time work participation is associated with more domestic work (are these the 'new men'?). The final two columns add in spouse's paid work participation status, and it turns out that the variable is not statistically significant for either married men or married women.

Now consider what happens if we also use total paid work time as a regressor: see Table 4. In all columns, the coefficient on paid work is negative (and statistically significant), i.e. more paid work is associated with less domestic work, even when one controls for paid work participation *per se*.

Perhaps what catches the eye the most is the further large increase in R^2 compared to Table 3 for married men and women. This finding might be used to support a case for using the paid market work variable in matching regressions. However, because of the endogeneity issues discussed earlier, we are rather suspicious of the results. They may well simply reflect the adding-up constraint of the time budget. Notice too that for married men the coefficients on the paid work participation variables are no longer statistically significant, and that for married women they are the 'wrong' sign.[17]

So which sets of estimates do we prefer given our data matching goals? Given the need to balance parsimony, goodness of fit, and summary of significant differences in social structural position, while at the same time minimising endogeneity problems, our choices are the estimates in columns 5–8 of Table 1.

Table 3. OLS regressions for domestic work time, by marital status and gender

	Single		Married		Single		Married		Married	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Constant		126.30	120.89	239.99	149.05	239.40	204.14	329.82	204.77	324.55
	(12.17)	(15.30)	(15.24)	(14.97)	(17.94)	(21.49)	(19.55)	(15.91)	(20.12)	(17.62)
Aged 30 – 39 years	48.32	69.50	−2.62	−0.82	46.89	68.65	7.49	6.28	7.54	6.62
	(20.46)	(23.13)	(16.36)	(16.09)	(18.76)	(21.29)	(15.75)	(14.44)	(15.77)	(14.46)
Aged 40 – 49 years	96.80	137.59	19.34	44.34	98.25	113.07	24.80	38.53	24.82	38.72
	(32.02)	(27.32)	(17.72)	(17.35)	(29.35)	(24.30)	(16.99)	(15.65)	(17.01)	(15.66)
Aged 50 – 59 years	88.74	171.56	49.34	73.84	65.88	102.12	28.03	37.05	27.85	39.48
	(24.84)	(25.71)	(17.51)	(18.38)	(23.33)	625.03)	(17.10)	(16.84)	(17.17)	(17.21)
Number of children in household	19.10	51.32	21.05	32.34	14.88	28.85	15.91	19.00	15.84	19.29
	(15.55)	(13.44)	(5.88)	(6.71)	(14.28)	(12.13)	(5.69)	(6.19)	(5.72)	(6.21)
Youngest child aged 0 – 4	−26.33	117.33	29.00	124.39	−53.41	79.99	29.84	80.35	29.35	79.67
	(58.18)	(28.61)	(13.89)	(14.75)	(53.67)	(26.31)	(13.30)	(13.98)	(13.78)	(14.02)
Is in full-time paid work					86.02	−134.46	−90.52	−138.26	−90.15	−138.70
					(17.81)	(20.12)	(14.15)	(12.69)	(14.42)	(12.71)
Is in part-time paid work						−94.42		−60.96		−62.05
						(24.41)		(11.59)		(11.70)
Spouse is in paid work									−1.39	7.22
									(10.19)	(10.37)
R^2	0.184	0.431	0.061	0.253	0.321	0.577	0.141	0.403	0.141	0.403
Adjusted R^2	0.144	0.410	0.051	0.245	0.281	0.555	0.129	0.394	0.127	0.393
No. observations	107	146	449	481	107	146	449	481	449	481
Mean of dependent variable (min/day)	124.69	245.71	166.71	329.49	124.69	245.71	166.71	329.49	166.71	329.49

Standard errors in parentheses. Data from 1987 UK SCEL survey.

Table 4. OLS regressions for domestic work time with paid work time as a regressor, by marital status and gender

	Single		Married			
	Males	Females	Males	Females	Males	Females
Constant	159.12	255.93	227.55	353.97	205.54	306.45
	(17.77)	(21.41)	(15.83)	(13.86)	(17.47)	(15.99)
Aged 30–39 years	42.37	58.07	5.29	12.28	2.48	7.07
	(18.26)	(20.86)	(12.69)	(12.47)	(12.94)	(12.33)
Aged 40–49 years	92.26	98.27	13.75	29.16	8.66	18.90
	(28.54)	(23.95)	(13.71)	(13.53)	(14.14)	(13.49)
Aged 50–59 years	70.88	82.88	20.25	24.81	28.34	33.53
	(22.69)	(24.95)	(13.79)	(14.57)	(14.41)	(15.06)
Number of children in household	9.81	26.17	11.03	16.20	13.79	19.77
	(13.97)	(11.77)	(4.59)	(5.34)	(5.07)	(5.34)
Youngest child aged 0–4	−36.44	69.34	33.72	63.32	51.94	48.77
	(52.40)	(25.67)	(10.72)	(12.13)	(11.56)	(12.02)
Is in full-time paid work	−37.54	−62.99	60.93	0.14	50.84	−11.95
	(23.26)	(29.51)	(15.03)	(15.40)	(16.22)	(15.49)
In in part-time paid work		−52.88		9.28		4.02
		(26.91)		(11.41)		(11.47)
Paid work time (min/day)	−0.14	−0.24	−0.44	−0.50	−0.44	−0.50
	(0.05)	(0.08)	(0.03)	(0.04)	(0.03)	(0.04)
Spouse's paid work time (min/day)					0.13	0.15
					(0.03)	(0.02)
R^2	0.369	0.606	0.443	0.556	0.474	0.616
Adjusted R^2	0.324	0.583	0.435	0.549	0.463	0.606
No. observations	107	146	449	481	385	382
Mean of dependent variable (min/day)	124.69	245.71	166.71	329.49	162.60	327.35

Standard errors in parentheses. Data from 1987 UK SCEL survey.

5. Concluding comments

Existing empirical models of domestic work are not consistent in their choice of regressor variables, especially in their treatment of paid market work. The aim of this paper has been to clarify why empirical practice differs and to provide recommendations about specification.

We have argued that the main justification for differing strategies is differing modelling goals: we distinguish regressions for behavioural modelling, for data matching, and for explaining secular trends. With diverse goals there will be different views about the appropriate trade off between including market work regressors of various kinds versus potential endogeneity problems. For data-matching purposes a suitable compromise is to use paid work participation variables but not total market work time.

Appendix Table. OLS regressions for domestic work time, by gender

	Males	Females	Males	Females	Males	Females
Constant	105.86	209.58	188.78	278.90	211.52	339.84
	(12.48)	(12.34)	(16.16)	(12.94)	(13.80)	(11.83)
Marital status is single	−4.48	−46.36	−21.92	−38.59	−27.54	−48.18
	(12.51)	(11.11)	(12.13)	(10.20)	(10.30)	(8.77)
Aged 30−39 years	15.48	25.51	21.43	20.09	18.43	23.15
	(13.00)	(13.25)	(12.40)	(12.14)	(10.53)	(10.42)
Aged 40−49 years	38.65	77.66	41.06	56.24	32.20	45.68
	(14.69)	(14.36)	(14.00)	(13.29)	(11.89)	(11.42)
Aged 50−59 years	65.50	110.26	42.30	65.24	38.43	39.77
	(14.19)	(14.94)	(13.85)	(14.28)	(11.76)	(12.37)
Number of children in household	19.67	35.81	14.89	20.94	10.48	17.80
	(5.39)	(5.99)	(5.18)	(5.64)	(4.40)	(4.85)
Youngest child aged 0−4	32.76	131.37	32.02	100.23	37.80	65.72
	(12.96)	(13.03)	(12.35)	(12.26)	(10.48)	(10.77)
Is in full-time paid work			−86.92	−107.62	36.34	−11.47
			(11.48)	(9.79)	(12.88)	(10.59)
Paid work time (diary, min/day)					−0.37	−0.45
					(0.03)	(0.03)
R^2	0.093	0.330	0.179	0.439	0.410	0.588
Adjusted R^2	0.084	0.323	0.169	0.433	0.402	0.582
No. observations	556	627	556	627	556	627
Mean of dependent variable (min/day)	158.63	309.98	158.63	309.98	158.63	309.98

Standard errors in parentheses. Data from 1987 UK SCEL survey.

Endnotes

[1] Subject of course to inevitable differences in the availability of variables *per se* in data sets, an issue which we do not address here.

[2] The model for a one-adult household is a special case of this.

[3] As in Kooreman and Kapteyn (1987) who use an indirect translog representation of $U(.)$.

[4] Extended income is closely related to Becker's (1965) concept of 'full income' and Garfinkel and Haveman's (1977) concept of 'earnings capacity'. See Jenkins and O'Leary (1994).

[5] For example, in our own case, we have good income surveys (UK *Family Expenditure Survey* micro-data for 1976 and 1986) but these include no time-use data (apart from self-reported market work hours). We are using the detailed time use data from the 1974/75 *BBC* and 1987 *SCEL* surveys to impute personal household work times to *FES* respondents. The results for the 1980s are discussed by Jenkins and O'Leary (1994).

[6] Of course only variables common to both income and time budget surveys appear in the characteristics vector z used for matching. In order to preserve time use variances as well as averages, imputations often equal the expression given in (16) plus a random draw from a zero mean normal distribution with the variance equal to the estimated error variance from (15): see e.g. Garfinkel and Haveman (1977).

[7] For discussions of matching, see *inter alia* the symposia in the 1972 and 1974 *Annals of Economic and Social Measurement*, and Rodgers (1984). One referee sympathetic to Sims's position pointed out that some conditional means might nonetheless be estimable using Two Sample estimation

methods (Angrist and Kreuger 1992, and Arrellano and Meghir 1992), if suitable variables were available.

[8] Observe how behavioural models of household time use often use both respondent's and spouse's wage: see e.g. Kooreman and Kapteyn (1987).

[9] Moreover, suitable instrumenting variables are almost never available in the data sets data matchers have to work with.

[10] A referee has commented that participation dummy variables are simply a 'poor proxy' of work hours h and 'it is well known that this sort of grouping does not alleviate asymptotic bias'. *Per contra* we argue that the participation variables are in fact proxies for something altogether different – related to position in the social structure.

[11] See e.g. Juster and Stafford (1991) and Robinson and Gershuny (1994).

[12] See Gershuny et al. (1988) for a detailed discussion of response rates and representativeness etc., and Gershuny and Halpin (1993) for different data matching regressions using the same data set. Travel-to-work areas are officially-defined regions of the UK, with each covering a local labour market and the surrounding area from which its workers commute.

[13] Multi-adult households without a central spouse pair are excluded from the analysis. However we do use information for a person belonging to a central spouse pair even if their spouse did not complete their diary. This is why the number of married men in our regressions does not equal the number of married women.

[14] For further details, see Gershuny et al. (1988, Appendix 1).

[15] There is hardly any information about wages and income in the SCEL survey and what there is of relatively poor quality.

[16] The Appendix Table shows the regression results for males and females without the further split by marital status. Our domestic work time variable is sufficiently broad so that virtually all respondents do some work. The OLS results reported here did not yield distinctly different conclusions from our exploratory Tobit regressions.

[17] The coefficients on spouse's paid work time are significant now however: higher levels of paid work by a spouse are associated with higher levels of domestic work by a respondent.

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