HOUSEHOLD PRODUCTION, LEISURE AND LIVING STANDARDS

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Abstract

Household production is an important non-market activity and the empirical literature has come up with three main methods towards valuing household production. We follow the literature spawned by Becker (1965), Lancaster (1966) and develop a model of the household as producer and consumer that provides a theoretical justification for the two main approaches towards valuing labour in household production that are used in practice and we show how they can be combined. We also develop a cost-of-living index for full consumption and we show how real measures of full household income can be derived.

Introduction

Households are economic units that act both as consumers and producers of goods and services. The System of National Accounts (SNA) records mainly those acts of consumption and production that are subject to monetary transactions, leaving out of the picture consumption and production that households undertake on their own account or for other economic units but without a monetary market transaction. In particular, the non-market production of services by households such as cooking or childcare (but not dwelling services provided by owner-occupiers of houses) is outside the SNA production boundary. There are good reasons why not all services produced by households are inside the SNA production boundary but there are equally good reasons to assess their value and evolution in satellite accounts or in particular studies. Note, however, that the exclusion of household production from the SNA production measures is by convention rather than for conceptual reasons.

The theory of household production was first fully articulated by Becker (1965). He postulates that households combine time and market goods to produce more basic commodities that directly enter their utility functions. Becker makes no distinction between acts of non-market production, leisure or personal care – he considers all of these as acts of production of commodities that households value: “One such commodity is the seeing of a play, which depends on the input of actors, script, theatre and the playgoer's time; another is sleeping, which depends on the input of a bed, house (pills?) and time.” (Becker 1965, p. 495). In his formulation, households are both producing units and utility maximisers who combine time and market products via household production functions.

Apart from the fact that certain activities of non-market production are outside the SNA production boundary, there is also a difference between consumption and consumption expenditures.
Hill (forthcoming) explains this as follows: “Household final consumption is a particular type of economic activity in which members of households use goods or services to satisfy their personal needs, wants or desires. By definition, a final consumption good or service provides utility to the person or household that consumes it. [...] Household consumption expenditures may be defined as expenditures incurred by households to acquire goods and services that they intend to use for purposes of final consumption.” (Hill, p.5). The distinction between consumption expenditure and final consumption goes back to the work by Becker (1965) and Lancaster (1966) who distinguish between ‘goods’ that the household purchases on the market and then combines with time in a household production function to produce ‘commodities’.

Hill’s point was also made by Landefeld and McCulla (2000) and is directly linked to the first issue, the unmeasured value of household production. One part of consumption expenditures will be used for the acquisition of intermediate inputs which are then used in the household’s own production process. Household consumption expenditures also include expenditures on durables. The capital services derived from these durables constitute another input into household production. The third input is labour, in form of the time that persons spend in their own-account production activities.

But households spend time on other activities as well, the most important being paid work, personal care and leisure. There is thus an issue of time allocation and time valuation. Valuing paid work would appear relatively straightforward by observing the market wage that household fetches for its services on the labour market. Valuing labour input for non-market production of households and attaching a value to leisure is more difficult and several options have been proposed in the literature. The first contribution of this paper is to distinguish between two types of households – those that are active and unconstrained on labour markets, and those that do not supply labour on formal markets. We show that the valuation of household work and of leisure varies between the two groups. In particular, we derive a theoretical justification for two methodological variants that have been present in the literature: valuing household labour with a market wage rate (the ‘opportunity cost approach’) and valuing household labour with a wage rate for a household work (the ‘replacement approach’).

(Current price) valuation of non-market activities is a useful undertaking but at least as much interest lies in investigating how accounting for non-market operations affects measures of living standards. The evolution of living standards or its comparison across countries is intimately related to the construction of price indices that reflect a cost-of-living concept. The second contribution of this paper is to tackle the question of how to deflate the values obtained under a broader definition of consumption and income than in the national accounts. We develop a cost-of-living index to derive measures of real full income and volume measures of full consumption. Finally, the concepts are illustrated with empirical measures from a recent OECD study.

Model

Households that are active on labour markets

Our discussion starts with a household that is unconstrained in its allocation of consumer expenditure and in its allocation of time. The household consumes the following types of ‘commodities’: (i) a final consumption product \( q_1 \) that is purchased on the market at price \( p_1 \) and directly serves to satisfy consumer needs such as ice cream or a haircut. The product undergoes no transformation by the consumer; (ii) a service \( Q_N \) that the household produces itself. The own-account production process of this service is captured by the production function

\[
Q_N = f_N(t_N + q_N, q_2)
\]
where $t_N$ stands for the time the household spends on producing the service. We assume that instead of spending time on production, the household can also hire labour $q_N$ that is perfectly substitutable to $t_N$ as in input. $q_2$ is the quantity of intermediate inputs and/or capital services from consumer durables used in production. $f_N$ will be taken to be an increasing, concave and linearly homogenous function of $t_N + q_N$ and $q_2$ over suitable domains of definition; (iii) in addition to serving as input into own-account production, the household also ‘consumes’ $t_N$ directly. For example, time spent with a child not only constitutes an input to the service ‘child care’ but may be valued as such by households; (iv) along a similar vein, the household ‘consumes’ leisure – that is the time not spent on paid work, on household work and on personal care.

Turning to the household’s time constraint, we let $T$ be the total time per period available to the household, after accounting for matters of personal care. $T$ can then be either spent on $t_L$ hours of work in the labour market, $t_N$ hours of work in own-account production or $t_F$ hours of leisure so that

$$T = t_L + t_N + t_F.$$  

Let the household’s utility function be $U(q_1, Q_N, t_L, t_F, t_N)$. $U$ contains the items that the household ‘consumes’ and values positively or negatively. In particular, $U$ will be taken as a concave function, that is increasing in $q_1$, $Q_N$, and $t_F$, of unknown sign in $t_N$, and decreasing in $t_L$. Explicit appearance of the time variable in the utility function allows for situations where households are not indifferent between spending time on household work, market work or leisure above and beyond the fact that they generate consumption possibilities. This point had already been made by Pollak and Wachter (1975) who argue in favour of keeping separate time variables in the utility function

“In particular, we object to the implied but crucial assumption that time spent cooking and time spent cleaning are ‘neutral’ from the standpoint of the household and that only the ‘outputs’ of these production processes enter the household’s utility function. A more plausible assumption is that the household is not indifferent among all situations which involve the same output of home cooked meals and clean houses but involve different amounts of hired labor and household labor. Instead, we suggest that household time spent cooking or cleaning is a direct source of utility or disutility to the household.” (Pollak and Wachter, 1975, p. 270).

Before going further note that, for the sake of clarity, we have made two shortcuts in the present formulation. The first shortcut consists in the use of scalars for each type of commodity. Obviously, in reality we shall be dealing with vectors of final consumption products, and several types of own-account produced services. An extension from scalars to vectors is fairly straightforward but comes at the expense of more complicated notation which we want to avoid at this stage. The second shortcut is empirically motivated and lies in our labelling of $Q_N$ as a service. In practice, households produce not only services but also goods for their own account. The empirical difference is that own-account produced goods are included in countries’ national accounts whereas own-account produced services (with the exception of own-produced dwelling services) are outside the national accounts production boundary and so do not figure in data on private consumption expenditure. As all conceptual considerations regarding own-account production of services that will follow carry over directly to own-account produced goods we chose to restrict ourselves to the discussion of services because they are both produced on own account and outside the conventional measurement boundary. This is without consequences for the theoretical exposition.

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1 We shall, however, assume monotonicity so that the derivative is non-decreasing or non-increasing everywhere over the domains of interest.
Having dealt with consumption commodities and own-account production, we now come to consumption expenditure, monetary transactions and income. The household’s consumption expenditure (in the sense of Hill – see above) consists of (i) final consumption goods $q_1$, purchased at price $p_1$; (ii) intermediate products $q_2$, purchases at price $p_2$; (iii) labour services $q_N$, purchased at price $w_N$; (iv) consumer durables. Consumer durables are capital goods that deliver capital service above and beyond the period during which they are purchased. Although the national accounts, in principle, recognise the capital character of consumer durables, by convention, they are treated as final goods, that is, as if they were consumed during the period of purchase. This convention cannot be sustained in a model of household production, and for empirical purposes, we shall construct a stock of consumer durables that delivers capital services to household production. The formal model can easily capture capital services as a particular version of $q_2$. Also, in the special case where all consumer durables are rented, the capital services become intermediate inputs. Our conceptual considerations will therefore be limited to $q_1$, $q_2$, and $q_N$.

Next, we state the monetary budget constraint that the household faces. Let $w$ be the household’s wage rate on the labour market, so that wage income is given by $w_L$. Let $Y$ stand for all other forms of money revenues (for instance property income), and abstract from net lending (or suppose that this is also captured by $Y$), then the monetary budget constraint faced by the household (and pictured in the national accounts) is:

$$ w_L + Y = p_1 q_1 + p_2 q_2 + w_N q_N. $$

Substituting the time constraint into the monetary budget constraint one obtains the following extended budget constraint

$$ w(T-t_F)+Y = p_1 q_1 + p_2 q_2 + w_N q_N + w_L + w_F $$

The left-hand side of (5) now shows a nominal measure of full income $F_IN = wT + Y$. The first term in this full income expression is total time available to the household, $T$, which has been valued with the labour market wage rate $w$, thus giving an opportunity cost valuation to time spent on non-market production and to leisure. Becker (1965) reasons as follows:

"Households in richer countries do, however, forfeit money income in order to obtain additional utility, i.e., they exchange money income for a greater amount of psychic income. For example, they might increase their leisure time, take a pleasant job in preference to a better-paying unpleasant one, employ unproductive nephews or eat more than is warranted by considerations of productivity. In these and other situations the amount of money income forfeited measures the cost of obtaining additional utility. Thus the full income approach provides a meaningful resource constraint and one firmly based on the fact that goods and time can be combined into a single overall constraint because time can be converted into goods through money income. It also incorporates a unified treatment of all substitutions of non-pecuniary for pecuniary income, regardless of their nature or whether they occur on the job or in the household." (Becker 1965, p. 498)

The right-hand side of (5) shows a measure of consumption of the consumer-producer household. In what follows, we shall refer to the sum of direct consumption, the value of intermediate products, work at home, hired labour services and leisure as full consumption $FC = p_1 q_1 + p_2 q_2 + w_N q_N + w_L + w_F$.

We use the time constraint to eliminate $t_L$ from the utility function and define the reduced form utility function $f$ as
(6) \[ f(q_1, Q_N, t_F, t_N) \equiv U(q_1, Q_N, t_F, t_N, T-t_N-t_F). \]

The household’s maximisation problem is then

(7) \[ \max_{q_1, q_2, Q_N, t_F, t_N} \{ f : p_1q_1 + p_2q_2 + w_Nq_N + wt_F + wt_N \leq F_N; Q_N = f_N(t_N + q_N, q_2) \}. \]

Assume that \( q_1^*, q_2^*, Q_N^*, t_F^* \) and \( t_N^* \) are positive and solve (7). With a monotonicity condition on the utility function \( f \), the budget constraint will hold with an equality so one has \( p_1q_1^* + p_2q_2^* + w_Nq_N^* + wt_N^* + wt_F^* = F_N \). The first order conditions for a utility maximum are

(8) \[ \lambda^* p_1 = \frac{\partial f^*}{\partial q_1}; \]
(9) \[ \lambda^* p_2 = [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial q_2}]; \]
(10) \[ \lambda^* w = [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial t_N}] + \frac{\partial f^*}{\partial t_N}; \]
(11) \[ \lambda^* w = [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial q_N}]; \]
(12) \[ \lambda^* w = \frac{\partial f^*}{\partial t_F}; \]

where \( f_N^* \) and \( f^* \) denote functions evaluated at the utility-maximising variables and \( \lambda^* \) is the corresponding marginal utility of income. From (12) it is clear that in the case of a household that is not constrained in its supply of hours on the labour market, the price of leisure is the hourly market wage rate \( w \). Now consider (10) and (11). As \( t_N^* \) and \( q_N^* \) are perfect substitutes, it must be true that \( [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial t_N}] = [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial q_N}] \). The two equations can then be combined as follows:

(13) \[ \lambda^* (w-w_N) = \frac{\partial f^*}{\partial t_N}. \]

This expression determines the allocation of time worked at home. If there is negative marginal utility to housework\(^2\) so that \( \frac{\partial f^*}{\partial t_N} < 0 \), a necessary condition for an interior solution, i.e., a positive supply of \( t_N \), is \( w-w_N < 0 \): it implies that the opportunity cost of housework is less than the cost of hiring someone to provide household labour services. If \( w \) were larger than \( w_N \), no time would be spent on household work. Conversely, if the marginal utility from household work is positive \( \left( \frac{\partial f^*}{\partial t_N} > 0 \right) \) a necessary condition for an interior solution is that \( w \) exceeds \( w_N \). Thus, the household will increase time worked at home even if the market wage is higher than the costs of hiring some-one as long as the difference between \( w \) and \( w_N \) (in utility terms) is smaller than the direct utility derived from working at home. For example, a person may be willing to take care of a child even if the wage foregone on the labour market exceeds the costs of hiring a nanny. Again, one can think of corner solutions where either no or a maximum amount of \( t_N \) is supplied. But there is no need to dwell on them here.

Note an additional point from expression (13): the total shadow price of time spent in household work is the market wage \( w \), as can be seen from (10). Because \( t_N \) is a joint product that is present both as an input into household production and as a ‘commodity’ in itself (it constitutes an argument in the utility function), this total shadow price of \( t_N \) can be broken into two components. The first component is the shadow price of the ‘commodity’ \( t_N \) and the second component is the shadow price of \( t_N \) as an input into household production. (13) tells us the former is \( (w-w_N) \), and consequently, the latter is \( w_N \). This is also readily apparent after inserting (13) into (10):

(14) \[ \lambda^* w_N = [\frac{\partial f^*}{\partial Q_N}][\frac{\partial f_N^*}{\partial t_N}]. \]

\(^2\) Note that this is actually a combined measure that comprises (i) the direct extra utility or disutility from adding an hour of housework and (ii) the reduced disutility from market labour by one hour. The combined effect arose from replacing the utility function \( U \) by the reduced form \( f \).
This provides a theoretical justification for the common practice of valuing household work as an input into household production by the wage rate of a comparable household employee. Note, however, that this remains a partial approach – when all aspects of $t_N$ are to be valued, the correct price for an unconstrained household is $w$.

We are now ready to take a closer look at the household’s own account production function (1). Define the cost function that is dual to this production function as follows:

$$C_N(Q_N,w_N,p_2) = \min_{q_2, t_N, q_N} \{ w_N(t_N+q_N)+p_2q_2 : f_N(t_N+q_N, q_2) \geq Q_N \}$$

$$= Q_NC_N(1,w_N, p_2)$$

$$= Q_NP_N. \tag{15}$$

In the first line of (15), we have made use of (14) to establish the input price of $t_N$. The second equation follows from the linear homogeneity of $f_N$; that is, total cost is equal to total output times unit costs $C_N(1,w_N, p_2)$, where the latter are independent of the level of production/consumption $Q_N$. For the third equation, the quasi-price of own account production has been defined as its unit cost: $P_N \equiv C_N(1,w_N, p_2)$. For utility-maximising levels of household production, $Q_N^*$, one gets

$$C_N(Q_N^*,w_N, p_2) = Q_N^*C_N(1,w_N, p_2) = w(t_N^*+q_N^*)+p_2q_2^*. \tag{16}$$

Multiplication of both sides of (9) by $q_2^*$, of both sides of (11) by $q_N^*$ and of both sides of (14) by $t_N^*$ gives

$$\lambda^*p_2q_2^* + \lambda^*w_N(t_N^*+q_N^*) = (\partial f_N^*/\partial q_2)q_2^*+ (\partial f_N^*/\partial t_N)(t_N^*+q_N^*)$$

$$= (\partial f^*/\partial Q_N)Q_N^*$$

using the linear homogeneity of $f_N$.

Next, combine (17) and (16):

$$\lambda^*[p_2q_2^* + w_N(t_N^*+q_N^*)] = \lambda^*Q_N^*C_N(1,w_N, p_2)$$

$$= \lambda^*Q_N^*P_N = (\partial f^*/\partial Q_N)Q_N^*. \tag{18}$$

The last line of the expression above suggests that $P_N$ is indeed the shadow price of household production, $Q_N^*$.

When the value of own-account production is decomposed into a price and a quantity component, there are two possibilities. First, the movement of $Q_N$, the volume of services produced by the household, is observed independently from the volume of inputs used in its production. Thus, if there is, for example, a way of counting the (quality-adjusted) number of meals produced in the household, this would constitute an independent volume measure of output. More often than not, such an independent measure will not be available and we shall be obliged to recur to measuring the volume change of output by the volume change of inputs. In the present case, this would be a volume index of labour input, and intermediate inputs (including capital services). For empirical purposes, this is the avenue that will be followed although it neglects productivity changes.

"Although the total values of inputs and outputs may be identical for a single period of time, there is no corresponding identity between changes in the real values of inputs and outputs over time or between average changes in input and output prices. They diverge because of changes in productivity. Thus, even if satisfactory price indices could be compiled for each of the inputs, a weighted average of the price indices for the inputs into household production would not provide a satisfactory estimate of the price index for the outputs except possibly in the very short term."
The cost side of the consumer/producer’s activity will constitute our main tool for further analysis, including the development of a cost-of-living index later on. Formally, we capture the cost side by an expenditure function \( e \) that is dual to the production function \( f \). Note that we use (13) to put a shadow price to the ‘commodity’ \( t_N \) that directly shows up in the utility function.

\[
(19) \quad e(u^*, p_1, P_N, w, w_N) \equiv \min_{q_1, q_2, q_N, t_F, t_N} \{ p_1 q_1 + P_N Q_N + (w-w_N)t_N + w t_F : f(q_1, Q_N, t_F, t_N) \geq u \}.
\]

Under the regularity conditions imposed on \( f \), actual expenditure equals minimum expenditure so that \( e(u^*, p_1, P_N, w, w_N) = FC = F I_N \). Here, \( u^* \) is the utility level commensurate with the cost-minimising choice of \( q_1^* \), \( Q_N^* \), \( t_F^* \) and \( t_N^* \), given prices \( p_1 \), \( P_N \), \( w_N \) and \( w \). Thus

\[
(20) \quad e(u^*, p_1, P_N, w, w_N) = p_1 q_1^* + P_N^* Q_N + (w-w_N)t_N^* + w t_F^* = p_1 q_1^* + p_2^* q_2^* + w_N q_N^* + w t_N^* + w t_F^* \quad \text{by using (15)}
\]

\( t_N^* \) is valued at its total shadow price, so we end again up with \( w t_N^* \) as the household work component of full income. But we already noted that the input value to household production alone is \( w_N t_N^* \). This lends a theoretical justification to many empirical studies\(^4\) whose aim has been to put a value on the service produced by the household, \( P_N^* Q_N^* \), and which valued labour input at \( w_N \). The limitation of these approaches is that they do not go all the way towards accounting for full consumption and full income by also valuing the ‘commodity’ \( t_N^* \) that constitutes a direct element in the utility function.

**Households that are not active on labour markets**

We now turn to the part of the population that is not active on the labour market due to some institutional or economic constraint – compulsory retirement age, or unemployment come to mind. For this group of persons we start again off with a general utility function \( U(q_1, Q_N, t_F, t_N) \) from which the labour supply variable has been eliminated since it is fixed at zero. As before, \( U \) is increasing in \( q_1 \), \( Q_N \), \( t_F \), and either decreasing or increasing in \( t_N \). Nothing changes with regard to the production function \( f_N \). The new time constraint is

\[
(21) \quad t_F + t_N = T.
\]

Absent labour market income, the new household budget constraint is:

\[
As already noted, the problem is the same as that of measuring inflation and real growth for government non-market output. However, the problem is even more acute for household production because the values of the labour inputs have to be imputed whereas the values of the labour inputs into government production can be measured by the compensation of employees actually paid.

It is only possible to make a satisfactory estimate the rate of inflation or real growth of non-market output from input data if there is an independent estimate of the rate of growth of productivity. However, there is little or no hard evidence about changes in productivity for household production. It may be conjectured that household productivity has been rising over the long term because, as the general standard of living rises, households tend to equip themselves with more and better quality household fixed assets, while the technology of household production is also likely to be improving over time. Estimating the rate of inflation or growth of the output from household production from the rates of inflation or growth of the inputs cannot be acceptable if no account is taken of household productivity growth.” (Hill forthcoming, p. 14)

\(^4\) For example Landefeld, Fraumeni and Vojtech (2008), Fraumeni (2008); Ruger and Varjonen (2008).
(22) \[ Y = p_1q_1 + p_2q_2 + w_Nq_N. \]

Note that in the end, household purchases of household services inputs, \( w_Nq_N \), can simply be reclassified into the purchases of household intermediate inputs, \( p_2q_2 \). Also, \( ts \) can be eliminated from the utility function using the time constraint (21) so as before we define a \textit{reduced form utility function}, \( F \):

(23) \[ F(q_1,Q_N,t_F) \equiv U(q_1,Q_N,t_F,T-t_F). \]

The consumer’s utility maximization problem can be written as follows:

(24) \[ \max_{q_1,q_2,Q_N,t_F} \{ F : p_1q_1 + p_2q_2 + w_Nq_N \leq Y; Q_N=f_N(t_N+q_N, q_2) \}. \]

As before we assume that \( q_1^*, q_2^* \) and t_f^* are all positive and solve (24). With a monotonicity condition on the utility function \( F \), the budget constraint will hold with equality so we will have \( p_1q_1^* + p_2q_2^* + w_Nq_N^* = Y \). When \( F \) is differentiable, the following first order necessary conditions are:

(25) \[ \lambda^* p_1 = \partial F^*/\partial q_1; \]
(26) \[ \lambda^* p_2 = \partial F^*/\partial Q_N[\partial f_N^*/\partial q_2]; \]
(27) \[ \lambda^* w_N = \partial F^*/\partial Q_N[\partial f_N^*/\partial q_N]; \]
(28) \[ 0 = -\partial F^*/\partial Q_N[\partial f_N^*/\partial q_N] + \partial F^*/\partial t_F. \]

Adding (27) and (28) gives us the following equation:

(29) \[ \lambda^* w_N = \partial f_N^*/\partial t_F. \]

Equation (29) tells us that the price of leisure, \( t_F \), is now equal to \( w_N \), the market price for purchased labour services. Note also that since \( \partial f_N^*/\partial q_N \) equals \( \partial f_N^*/\partial t_N \), equation (29) implies that

(30) \[ \lambda^* w_N = \partial F^*/\partial Q_N[\partial f_N^*/\partial t_N]. \]

Now multiply both sides of (26) by \( q_2^* \), both sides of (27) by \( q_N^* \), both sides of (30) by \( ts^* \) to obtain the following equation:

(31) \[ \lambda^*[p_2q_2^*+w_Nq_N^*+w_Nt_N^*] = \partial F^*/\partial Q_N[\partial f_N^*/\partial q_N]+q_N^*\partial f_N^*/\partial q_N \]
\[ = \partial F^*/\partial Q_N f_N^* \]
\[ = \partial F^*/\partial Q_N Q_N^* \]
\[ = \partial F^*/\partial Q_N[\partial f_N^*/\partial t_N] \]
\[ \text{using the linear homogeneity of } f_N \]
\[ \text{using (1)}. \]

From equations (25), (15) and (29) it can be seen that the three first order partial derivatives of \( F(q_1^*,Q_N^*,t_F^*) \) are proportional to the prices \( p_1, P_N^* \) and \( w_N \) and we have:

(32) \[ E(u^*,p_1,P_N,w_N) = p_1q_1^* + P_N^*Q_N^* + w_Nt_F^* \]
\[ = p_1q_1^* + p_2q_2^*+w_Nq_N^*+w_Nt_N^* + w_Nt_F^* \]
\[ \text{using (15)}, \]

where \( E \) is the expenditure function that is dual to the utility function \( F(q_1,Q_N,t_F) \). Finally, using (22), the two equations in (32) imply the following equation

(33) \[ p_1q_1^* + P_N^*Q_N^* + w_Nt_F^* = Y + w_Nt_N^* + w_Nt_F^* \]
\[ = Y + w_NT \]
\[ \equiv F_N. \]
where \( F_N \) is a Becker-like nominal full income, except that we are using the wage rate for market home services \( w_N \) in place of the opportunity market wage rate that the household member could earn in the marketplace.

**Cost-of-living index**

Two analytical questions are now of interest. First, given the value of full consumption, how should its movements be split into a price and a volume component? And second, is the associated price index a cost-of-living index? This is important because a cost-of-living index is a conceptually appropriate tool for deflation of income flows so as to derive temporal or spatial comparisons of standards of living.

A cost-of-living index gauges the relative cost of achieving the same level of utility when households face different sets of prices for the components of full consumption. For a single type of household, the Konüs (1924) cost-of-living index is defined as the ratio of two expenditure functions, each evaluated at price vectors for the comparison periods and for a reference set of utility levels. For the purpose at hand, we have two types of households, and need to develop a group cost-of-living index. We start by simplifying our notation and define the following vectors.

(34) \[
\begin{align*}
\mathbf{u} & \equiv [u_a, u_p, n_a, n_p] \\
\mathbf{P}_a & \equiv [p_1, P_N, w_N, w] \\
\mathbf{Q}_a & \equiv [q_{1,a}, Q_{N,a}, t_{N,a}, t_{F,a}] \\
\mathbf{P}_p & \equiv [p_1, P_N, w_N] \\
\mathbf{Q}_p & \equiv [q_{1,p}, Q_{N,p}, t_{N,p} + t_{F,p}] \\
\mathbf{p}_a & \equiv [p_1, p_2, w_N, w] \\
\mathbf{p}_p & \equiv [p_1, p_2, w_N] \\
\mathbf{q}_a & \equiv [q_{1,a}, q_{2,a}, Q_{N,a}, t_{N,a} + t_{F,a}] \\
\mathbf{q}_p & \equiv [q_{1,p}, q_{2,p}, Q_{N,p} + t_{N,p} + t_{F,p}].
\end{align*}
\]

The subscripts ‘\( a \)’ and ‘\( p \)’ stand for the ‘active’ and non-active (‘passive’) part of the population with regard to their involvement in the labour market. Vectors in upper case capital letters indicate prices and quantities including the (often unobserved) prices and quantities of household production. Vectors in lower case letters indicate prices and quantities including the (typically observable) prices and quantities of the inputs into household production. \( n_a \) and \( n_p \) is the number of active and inactive households, respectively. Combine the expenditure functions of the active and non-active households to an aggregate expenditure function \( \epsilon \) by weighting each expenditure function by the number of households:

(35) \[
\epsilon(\mathbf{u}, \mathbf{P}_a, \mathbf{P}_p) = n_a \epsilon(\mathbf{u}_a, \mathbf{P}_a) + n_p \epsilon(\mathbf{u}_p, \mathbf{P}_p).
\]

We then follow Pollak (1980) and Diewert (1983) and call \( P^* \) a plutocratic cost-of-living index:

(36) \[
P^*(\mathbf{u}, \mathbf{P}_a^0, \mathbf{P}_p^0, \mathbf{P}_a^1, \mathbf{P}_p^1) = \epsilon(\mathbf{u}, \mathbf{P}_a^1, \mathbf{P}_p^1)/\epsilon(\mathbf{u}, \mathbf{P}_a^0, \mathbf{P}_p^0)
\]

In (36), the price index \( P^* \) is the ratio of the minimum expenditure of the two groups of households, given prices in period 1 and in period 0, and given reference utility measures and household numbers \( \mathbf{u} \). Time periods have been indicated via superscripts. Diewert (1983) shows how the Laspeyres and the Paasche-type index form the upper and the lower bound of the true group price index \( P^* \). The Fisher index constitutes the point estimate for the change in cost of living:

(37) \[
P^*(\mathbf{u}^0, \mathbf{P}_a^0, \mathbf{P}_p^0, \mathbf{P}_a^1, \mathbf{P}_p^1) \leq \sum_{j=a,p} n_j P_j^1 Q_j^0 / \sum_{j=a,p} n_j P_j^0 Q_j^0
\]
\[ P^*(u^1, P_a^0, P_p^0, P_a^1, P_p^1) \geq \sum_{j=a,p} p_j^1 q_j^1 / \sum_{j=a,p} p_j^0 q_j^1 \]
\[ = \sum_{j=a,p} p_j^1 q_j^1 / \sum_{j=a,p} p_j^0 q_j^1 \equiv P_L \] using (20);

\[ (38) \]

\[ P_F = (P_1 P_D)^{0.5}. \]

\( P_F \) is useful for two purposes. It provides the price change that is required to break the value change of full consumption into a price and a volume component. Thus, by applying the Fisher price index \( P_F \) to the measure of full consumption as defined earlier, we obtain a Fisher volume index \( Q_F \) of full consumption:

\[ (39) \]

\[ Q_F = \left( \frac{[FC_1]}{FC_0} \right) / PF, \]

where \( FC_0 = \sum_{j=a,p} p_j^0 q_j^0 \) and \( FC_1 = \sum_{j=a,p} p_j^1 q_j^1 \).

The second usage of the price index is as a deflator for nominal full income \( FIN \), to derive an index of the change of full income in real terms which shall be labelled \( FIR \):

\[ (41) \]

\[ FIR = \left( \frac{\sum_{j=a,p} FIN_{ij}^1}{\sum_{j=a,p} FIN_{ij}^0} \right) / PF \]

where \( FIN_{i,a}^1 = w^1 T+Y^1; FIN_{i,p}^1 = w_N^1 T+Y^1; FIN_{i,a}^0 = w^0 T+Y^0; FIN_{i,p}^0 = w_N^0 T+Y^0. \)

\( FIR \) measures income in units of full consumption – it constitutes a real measure of full income, to be distinguished from a volume or quantity measure of full consumption \( Q_F \). Both are of interest from a consumer and welfare perspective. Real income gives an indication of the consumption possibilities (expressed in consumption units), the volume of consumption gives an indication of the quantities of consumer commodities that the household actually consumes. The two indices will only coincide if consumers neither save nor credit-finance consumption expenditure.

**Illustration: a cross-country comparison of full consumption**

The concepts developed above can be implemented for a given country by deriving temporal comparisons of full consumption and full income or they can be implemented for a given point in time by deriving spatial comparisons across countries. Recent work by the OECD (Ahmad and Koh 2011) has followed the second route and some of their results will be presented here. To date, international comparisons of full consumption and full income over time are still strongly inhibited by the absence of consistent time series of time-use surveys, one of the key statistical ingredients to measure household production.

**Valuing labour and capital services**

Current-price valuation of household production uses an input-based approach and sums the value of labour and capital services devoted to household production. Information from time use surveys forms the first ingredient for measuring labour input. Ahmad and Koh (2011) start with empirical information from the latest time use surveys of OECD countries as compiled by the OECD (2011). People’s activities during a typical day are classified into time devoted to (i) paid work or study (work-related activities); (ii) unpaid work (household activities); (iii) personal care; (iv) leisure; and (v) other activities not included elsewhere. Allocation of time to these categories is not always straightforward, in particular in the case of multiple activities and activities that can constitute both
acts of production and leisure activities such as cooking. For the purposes of measuring household production of non-market services, the relevant activity is unpaid work, which can, in theory, be broken down into the following six sub categories: routine housework; shopping; care for household members; care for non household members; volunteer work; and travel related to household activities. Figure 1 shows the respective shares of household work and paid work or study in total time use for OECD countries.

Valuation of labour follows two alternative approaches to provide some measure of the potential range of estimates. The first is the replacement cost approach, where an average post-tax, hourly wage, representative of the broad range of activities covered in the production of household production of non-market services, is constructed using wage data collected in the Eurostat-OECD Purchasing Power Parities (PPP) programme. In terms of the earlier derivations, this approach corresponds to measuring the value of labour input into household production as $w_N t_N$. As demonstrated in expression (14), the replacement cost approach is valid if the nature of $t_N$ as a commodity in itself is ignored and only its use as labour input is considered. Alternatively, the approach is justified for those households that are constrained from offering their services on the labour market. The second approach is the opportunity cost approach, which values time spent on household work using the average post-tax hourly wage across the whole economy. In terms of earlier derivations, this corresponds to estimating $w t_N$.

As time spent on household production $t_N$ and hired time $q_N$ were considered perfect substitutes in the theoretical set-up, the valuation of hourly labour $w_N$ under the replacement cost approach should ideally be the quality-adjusted price of a specialist worker in the activity being measured, where the quality is adjusted to reflect the productivity of non-specialised individuals. In practice however, as is the case in Ahmad and Koh (2011), many studies do not adjust for quality, and those that do generally do so using relatively simple estimates that assume that the quality/productivity of the non-specialist is likely to be lower. Landefeld et al. (2008), for example, assumed that the average hourly wage, used as a proxy for the replacement cost, was 75% of the specialist hourly wage in a number of activities. Because no information is available on the prices of specialised labour in specific activities Ahmad and Koh (2011) use a general hourly labour cost based on prices of market activities that are representative of the main activities conducted by households in the production of non-market services, such as the costs for unregistered household employees. The estimates of hourly wages for both the replacement and opportunity cost approach used were net-of taxes and social security contributions.
Similarly, for the opportunity cost approach, wages were measured 'net', that is at post-tax prices. The overall approach to measure the (replacement of opportunity) costs of labour used in the production of household non-market services for own use can then be simply described as follows:

value of annual labour used in household production of non-market services in nominal currencies = average hourly post-tax labour costs * average hours worked per day * 365 (in 2008)*population 15 years and above.

Like any other activity, both capital and labour are used in the production of household non-market services. Capital is measured as the services of consumer durables, which includes household appliances, motor vehicles and also categories of consumer durables, such as furniture, that provide capital services related to dwelling services.

The usual approach, also followed by the authors, is to create estimates of the value of capital services by estimating the productive stock of consumer durables constructed using the perpetual inventory method and valuing the flow of capital services (Jorgenson and Griliches, 1967) as unit user costs multiplied by the productive stock.

5 It is important to note that the estimates of capital services produced below will be biased upwards since some consumer durables, such as cars, also provide capital services to commuting and leisure activities; and not just household non-market services.

6 Unit user costs were measured as a real rate of return plus a rate of depreciation times the price index of new consumer durables.
Figure 2 below presents the value of labour costs in household production of non-market services as a percentage of GDP based on the replacement cost approach and the opportunity cost approach.

Not surprisingly (given the significant differences in the values of labour between the replacement and opportunity cost approaches), the chart shows considerable variations in the contribution of labour to household production of non-market services, depending on the approach. The contribution is close to 70% of GDP for example in the United Kingdom using the opportunity cost approach but about 25% using the replacement cost approach.

Figure 2: Value of labour costs in household production of non-market services, % of GDP, 2008

This point reinforces the care needed in selecting the price of labour. However, although the range of estimates at current prices is acutely sensitive to the choice of the price of labour, volume comparisons across countries of full consumption or full income using an appropriate cost-of-living price index are much less affected by the choice of labour valuation. Indeed Landefeld et al. (2008) also demonstrated that this was the case (for the United States) for volume comparisons over time.

Figure 3 below illustrates the fact that the selection of either a replacement cost or opportunity cost approach does not significantly change comparisons by comparing replacement cost and opportunity cost estimates of full household consumption per capita in 2008 PPPs with the United States set at 100. Full household consumption refers to adjusted individual consumption (AIC) plus the imputed value of households’ non-market services.

Figure 3: Replacement cost vs. Opportunity cost estimates of full household consumption per capita, 2008 PPPs

When references to adjusted individual consumption are made in the context of estimates of total household consumption, AIC is exactly equivalent to household actual final consumption as described in the 2008 SNA (#9.81). When references to AIC are made in the context of total household consumption including the contribution of capital services however, AIC reflects household actual final consumption minus final expenditures on consumer durables.
It is of note that the spatial price indices underlying the present comparison are in line with the theoretical price indices spelled out above. The PPPs used here are adjusted versions of the official OECD-Eurostat PPPs for adjusted individual consumption. Adjustment of the official PPPs was put in place by augmenting existing PPPs with an additional product, non-market services produced by households. However, no distinction was made by Ahmad and Koh (2011) between those households that are active and those households that are inactive on the labour market. Thus, full implementation of the cost-of-living index in expression (39) would imply a result that is a weighted average of the replacement cost and the opportunity cost approach. The expenditure shares of active and inactive households would constitute the appropriate weights.

Figure 3: Full household consumption (including capital services from consumer durables but excluding leisure) per capita: 2008 PPPs, US=100

Summary and conclusions

The preceding discussion has established a theoretical framework for the main empirical approaches\(^8\) towards valuing household work and leisure. In particular, we were able to identify conditions under which each of the approaches towards valuing household work holds. The first approach towards valuing household labour is the opportunity cost approach. Here, household time that is spent producing \(Q_N\) is valued with the household’s labour market wage. This is appropriate if the household is unconstrained in its supply of labour to the labour market. The second approach towards valuing time spent on household work is the replacement cost approach that imputes a wage rate for labour services that could be purchased by the household for household work. This valuation

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8 Little has been said about direct valuation, the approach that consists in directly valuing \(P_NQ_N\), the output of household production rather than the inputs used to produce it. Direct valuation is only conceivable if it is possible to quantify \(Q_N\) and if there is a market equivalent production that permits putting a price \(P_N\) to the quantity. Absent a market equivalent or absent the possibility to measure \(Q_N\), one of the input-based approaches mentioned above will have to be used.
is warranted when households are constrained in their labour market supply. In this case, leisure is equally valued with the wage rate for labour services. We also showed that in partial valuations of $t_N$ – only as an input into household production but with no ‘commodity’ value in itself and absent a valuation of leisure, the choice of $w_N$ (valuation with the wage rate of hired labour) can be justified, even in the case of an unconstrained household.

The second main element of this paper has been the definition of a cost-of-living index of full consumption. We used the economic approach towards index numbers to define this price index with a view to measuring volume changes in full consumption and changes in real full household income.

For empirical applications, we conclude that an average valuation of labour services is warranted where averaging across opportunity costs and replacement costs is based on the relative importance of households that are actually or potentially active on labour markets and those households that are not. The recent work by Ahmad and Koh (2011) demonstrates that the two methods give rise to widely different estimates of the current-price levels of household production but differences are smaller in volume comparisons across countries or over time. Whatever the quantitative impact, our methodology shows how to combine the two approaches.

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