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Volume Title: Measuring Economic Sustainability and Progress

Volume Author/Editor: Dale W. Jorgenson, J. Steven Landefeld, and Paul Schreyer, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-12133-X (cloth); 978-0-226-12133-8 (cloth); 978-0-226-12147-5 (eISBN)

Volume URL: <http://www.nber.org/books/jorg12-1>

Conference Date: August 6–8, 2012

Publication Date: September 2014

Chapter Title: Household Production, Leisure, and Living Standards

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Chapter URL: <http://www.nber.org/chapters/c12826>

Chapter pages in book: (p. 89 - 114)

Household Production, Leisure, and Living Standards

Paul Schreyer and W. Erwin Diewert

4.1 Introduction

Households are economic units that act as both 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 the consumption and production that households undertake on their own account or for other economic units, but without a monetary market transaction. In particular, the nonmarket production of services by households such as cooking or child care (but not dwelling services provided by owner-occupiers of houses) is outside the SNA production boundary. The reasons why most services produced by households are outside the SNA production boundary are mainly rooted in practical considerations. Absent market prices, it is “[. . .] therefore extremely difficult to estimate values not only for the outputs of services but also for the associated incomes and expenditures” (SNA 2008, paragraph 6.29). At the same time, the SNA acknowledges that for purposes of measuring economic welfare, it is useful to estimate the value and evolution of comprehensive household production. The 2009 report of the Stiglitz-Sen-Fitoussi Commission also advocates comprehensive measures of produc-

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We thank David Johnson and the participants at the 2012 CRIW “Measuring Economic Progress and Economic Sustainability” conference in Cambridge, Massachusetts, for valuable comments. The views expressed in this chapter are those of the authors and do not necessarily reflect the views of the OECD or its member countries. For acknowledgments, sources of research support, and disclosure of the authors’ material financial relationships, if any, please see <http://www.nber.org/chapters/c12826.ack>.

tion and consumption and a look at the literature shows that researchers have produced estimates for a number of countries and time periods.¹

Absent market transactions on own-account household production, the question of how to value these services is central. A vast majority of studies has used an input cost approach, valuing outputs by the costs of inputs, of which, the time household members spend on the task of production is the most prominent element. Two variants of valuing labor input have been prevalent: valuation with a market-wage rate (the opportunity cost approach) of the household member that carries out household production, and valuation with a wage rate for a household employee (the replacement cost approach). The former responds to the question, “What is the earning foregone by the household member due to the fact that he or she produces services at home rather than offering labor services on the labor market?” The latter responds to the question, “How much would it cost to hire someone on the labor market to produce the household services *in lieu* of the household member?” Hill (2009) summarizes the discussion as follows:

The procedure adopted in national accounts is to value nonmarket flows of goods and services whenever possible at the prices at which the same goods and services are sold on the market. To be consistent with this general principle, the labor inputs should be valued using the market wages payable to employees doing the same kind of work. However, a case can also be made for valuing at internal opportunity costs Valuing at internal opportunity costs is not generally favored in studies on household production, because it makes the value of the labor inputs depend on who does the work, rather than on the nature of the work done. . . . A further complication is that people may engage in certain household productive activities, such as child care, because they enjoy it. . . . The motivation behind some household activities may be quite complex. For example, the activity of gardening is recognized to be a good form of exercise, so it may be undertaken as a substitute for going to the gym. . . . The concept of the opportunity cost in these kinds of circumstances is not altogether clear. On balance, it seems preferable to value work done in household production at the corresponding market wage rate for that type of work. (440)

Although the literature has discussed this choice from conceptual and practical perspectives, such a discussion has not been framed in a formal economic model and with a clear distinction between household work as an input into production and household work as a potential source of utility (or disutility) *in itself*. Also, standard optimizing models of household

1. For valuations of household work see Bridgman, Dugan, Lal, Osborne, and Villones (2012), Ahmad and Koh (2011), Roy (2011), Landefeld, Fraumeni, and Vojtech (2005), Ruger and Varjonen (2008), Fraumeni (2008), Abraham and Mackie (2005), Landefeld and McCulla (2000), Goldschmidt-Clermont (1993), Folbre and Wagman (1993), Fouquet and Chadeau (1981), and Reid (1934). For the valuation of child care more specifically, see Folbre and Yoon (2008).

production à la Becker (1965) would always suggest an opportunity cost approach as the appropriate valuation, thus being at variance with the above reasoning. The first and main contribution of the present chapter consists of a generalization of Becker's (1965) full consumption model and shows how such an extended model can provide guidance to the valuation issue. We conclude that two elements condition the choice between an opportunity-cost and a replacement-cost approach:

- In the general case of an unconstrained household, a first element enters the considerations: Is the purpose of valuing time spent on household production to capture full consumption (a welfare-related concept) or is the purpose more narrowly defined at capturing only the value of own-account household production (not necessarily a welfare-related concept)? In the second case, the replacement cost method applies; whereas in the first case, household time should be valued using the opportunity-cost method.
- The second element is whether the household under consideration is constrained in its allocation of time between selling its labor services and other usages of time. If the answer is to the affirmative, as it would be in the case of an unemployed or retired person in our present model, the replacement-cost method will constitute the correct valuation for own-account household services as well as for other components of full consumption, in particular leisure.

(Current price) valuation of nonmarket activities is but one objective of research in this area. At least as much interest lies in comparing living standards over time or across countries. The evolution of living standards or their comparison across countries is intimately related to the construction of price indices (over time or across countries) that reflect a cost-of-living concept. These price indices are the appropriate vehicle to deflate the nominal values of full consumption. The second major contribution of this chapter is the development of a cost-of-living index for full consumption in line with our theoretical model. We show how the expenditure functions of constrained and unconstrained households can be combined to provide the theoretical basis for the derivation of an exact cost-of-living index for full consumption in the sense of Diewert (2001).

We conclude by providing some calculations of full income and household production for a cross section of OECD countries. As the main focus and contributions of the chapter are of a theoretical nature, these calculations are of an illustrative nature only. By the same token, no attempt is made here to provide a comprehensive picture of the empirical issues arising in measuring household production—such as the measurement of capital input or methods of quality adjustment—the reader will be referred to the relevant literature. Some of the implementation issues will no doubt constitute the object of future research.

4.2 The Model

We start by providing some intuition for our modeling. Essentially, we consider a household that faces two decisions: (a) the allocation of monetary income between various purchases, including final consumption products, but also purchases of labor services for household work; (b) the allocation of time between working in the labor market, time spent on household work, or production and leisure. In the simplest of all worlds, the household is only constrained by the twenty-four hours of the day and the various prices and wages it faces on the market. Under these conditions, when deciding on the amount of household production, a utility-maximizing household following Becker's (1965) model of the allocation of time will compare his or her own (after tax) wage rate w with the wage rate of a household employee w_N . If w exceeds w_N , it *always* pays to hire a household employee and no own-account household work takes place. In the opposite case, it *never* pays to hire a household employee, and the value of household work equals the market wage rate in this simple opportunity-cost approach. But this simple setup is not compatible with the observation that in practice there are households (probably many) whose wage rate w exceeds the wage rate of a household employee *and* they spend time on household production.

A more elaborate setting is thus needed and we introduce two extensions. The first extension acknowledges that household work may produce utility in itself.² By allowing, for instance, for the fact that parents value the time spent with children, the implicit price of child care—a household production activity—changes. Indeed, time spent on child care becomes a joint product: labor input into household production and a “commodity” with intrinsic value. As we will demonstrate, the joint product should be valued at opportunity costs, but the labor input part at replacement costs. The second extension considers the case where households are constrained in their free allocation of time. The example we use is unemployment, where no time can be allocated to supplying labor to the labor market. Absent an opportunity cost on the labor market, the correct valuation of household production turns out to be the replacement cost. With both extensions we are able to define a measure of full consumption that comprises traditional consumption, the consumption value of household production, the commodity value of household production, and the value of leisure. The following sections present these arguments in a more rigorous form.

4.2.1 Unconstrained Households

Our formal setup starts with a household that is unconstrained in its allocation of consumer expenditure and in its allocation of time. In particular, there are no constraints in offering labor services on the labor market at the

2. This first extension is due to Pollak and Wachter (1975, 266).

going wage rate. The household consumes the following types of commodities: (a) 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); and (b) a service Q_N such as washing or child care that the household produces itself.³ The own-account production process of this service is captured by the production function:

$$(1) \quad Q_N = f_N(t_N + q_N, q_2),$$

where t_N is the amount of 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.⁴ The variable q_2 is the quantity of intermediate inputs and/or capital services from consumer durables used in production. The variable 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. An important and rather restrictive assumption is implicit in the absence of disembodied productivity growth in the production of household services.⁵

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. Variable T can then be either spent on t_L hours of work in the labor market, t_N hours of work in own-account production, or t_F hours of leisure so that

$$(2) \quad T = t_L + t_N + t_F.$$

Next we specify the household's utility function as $U(q_1, Q_N, t_L, t_F, t_N)$. Variable U contains the items that the household "consumes" and values

3. The distinction between q_1 and Q_N is not strictly necessary, but helpful. In a general setup such as Becker (1965) and Lancaster (1966), all "goods" that the household purchases on the market (including ice cream) are combined with time or other inputs in a household production function to produce "commodities." The difference between q_1 and Q_N is that the time input for a work-type activity can be purchased on the market, whereas the time spent on consuming ice cream has to be allocated by the consumer.

4. This is a simplification. The empirical literature (for instance, Abraham and Mackie [2005]) has discussed whether one hour spent by a household member to accomplish a particular task such as plumbing equals one hour spent on the same task by a professional. In many cases, the answer will be "no," and a quality adjustment will be required. This is rather straightforward to introduce into the theoretical model. For instance, labor input into household production could be specified as $\mu t_N + q_N$ where $\mu > 0$ is a quality adjustment factor for household labor. The μ would be less than unity, if household labor is less proficient than purchased labor, and vice versa. It is also clear from the empirical literature that μ is hard to measure. For the theoretical purpose at hand, and to save on notation, we stick to the simple case of $\mu = 1$. If the quality adjustment term were carried throughout the analysis, all results for the valuation with replacement costs would carry over for the valuation with quality-adjusted replacement costs μw_N .

5. As with the case of quality adjustment of labor input spelled out in the preceding footnote, ignoring productivity change is in anticipation of the empirical problems associated with its estimation rather than a reflection of introducing productivity change into the theoretical model.

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 .⁶ The 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. Thus, in addition to serving as an 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. Along a similar vein, the household consumes leisure t_F —that is, the time not spent on paid work, on household work, and on personal care. This point had already been made by Pollak and Wachter (1975) who argue in favor 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. (270)⁷

Before going further, note two further 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 do not figure in data on private consumption. 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

6. We shall, however, assume monotonicity so that the derivative is nondecreasing or nonincreasing everywhere over the domains of interest.

7. For a more general debate on Pollak and Wachter’s approach toward modeling household production, see Barnett (1977) and Pollak and Wachter’s (1977) reply.

and outside the conventional measurement boundary. This is without consequences for the theoretical exposition.

Having dealt with consumption commodities and own-account production, we now come to consumption expenditure, monetary transactions, and income. Note the difference between consumption and consumption expenditures that arises in the present context. Hill (2009) explains this as follows:

In the present context, it is necessary to underline the fundamental distinction between consumption and consumption expenditures, even though the two terms are often casually used interchangeably. . . . 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. (432)

In our setup, the household's consumption expenditure consists of (a) final consumption goods q_1 , purchased at price p_1 ; (b) intermediate products q_2 , purchased at price p_2 ; (c) labor services q_N , purchased at price w_N ; and (d) 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, recognize 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 .

To define household consumption and consumption expenditure in our setup, we start by stating the monetary budget constraint that the household faces. Let w be the household's (after tax) wage rate on the labor market, so that (after tax) wage income is given by $w t_L$. Let Y stand for all other forms of money revenues (for instance, property income) that are spent during the period under consideration.⁸ Then the monetary budget constraint faced by the household (and pictured in the national accounts) indicates that households' disposable income equals consumption expenditure:

8. If the household's market purchases of goods and services during the period is less than its after tax labor income, then Y would be negative and would represent savings out of labor income.

$$(3) \quad wt_L + Y = p_1q_1 + p_2q_2 + w_Nq_N.$$

Substituting the time constraint into the monetary budget constraint yields the following extended budget constraint:

$$(4) \quad w(T - t_N - t_F) + Y = p_1q_1 + p_2q_2 + w_Nq_N.$$

The above constraint can be rewritten as follows:

$$(5) \quad FI \equiv wT + Y = p_1q_1 + p_2q_2 + w_Nq_N + wt_N + wt_F.$$

The left-hand side of equation (5) now shows a *nominal* measure of Becker's *full income* $FI \equiv wT + Y$. The first term in this full income expression is total time available to the household, T , which has been valued with the household's labor market wage rate w . 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. (498)

The right-hand side of equation (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 labor services, and leisure as *full consumption* $FC \equiv p_1q_1 + p_2q_2 + w_Nq_N + wt_N + wt_F$.

To make a statement about the valuation of the different components of household time, it will be necessary to move from definitional relationships to behavioural relationships. We start by using the time constraint to eliminate t_L from the utility function and define a reduced form utility function f as

$$(6) \quad f(q_1, Q_N, t_F, t_N) \equiv U(q_1, Q_N, t_F, t_N, T - t_N - t_F).$$

The household's maximisation problem is then

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

In words, households maximize utility given their monetary and time budget constraints and given a technology for the production of own-

account household services. Assume that q_1^* , q_2^* , q_N^* , t_F^* and t_N^* are positive and solve equation (7). With a monotonicity condition on the utility function f , the budget constraint will hold with equality so one has $p_1 q_1^* + p_2 q_2^* + w_N q_N^* + w t_N^* + w t_F^* = FI = FC$. The first-order conditions for an interior solution to the utility maximisation problem are:

$$(8) \quad \lambda^* p_1 = \partial f^* / \partial q_1;$$

$$(9) \quad \lambda^* p_2 = [\partial f^* / \partial Q_N][\partial f_N^* / \partial q_2];$$

$$(10) \quad \lambda^* w = [\partial f^* / \partial Q_N][\partial f_N^* / \partial t_N] + \partial f^* / \partial t_N;$$

$$(11) \quad \lambda^* w_N = [\partial f^* / \partial Q_N][\partial f_N^* / \partial q_N];$$

$$(12) \quad \lambda^* w = \partial f^* / \partial t_F;$$

where f_N^* and f^* denote functions evaluated at the utility-maximizing variables and λ^* is the corresponding marginal utility of income. We can now interpret the conditions for utility-maximizing behavior. From equation (12) it is clear that for a household that is not constrained in its supply of hours to the labor market, the implicit price of leisure is its opportunity cost or the hourly market wage rate w : households will adjust leisure time until the marginal utility from leisure ($\partial f^* / \partial t_F$) equals the marginal utility from offering an extra hour of paid work at the rate w . Comparison of equations (10) and (12) indicates that time will be allocated to leisure and household work such that, at the margin, they yield the same utility.

Next consider equations (10) and (11)—they contain information about the implicit price for time spent on household production t_N and on the optimal hiring of household labor q_N . Equation (10) indicates that the total shadow price of time spent in household work is the market wage w . But remember that t_N is a joint product that is both an input into household production and a commodity in itself (it constitutes an argument in the utility function), and consequently the total shadow price of t_N has two components as can be seen from the right-hand side of equation (10). The first component is the shadow price of t_N as an input into household production, the second component is the shadow price of the commodity t_N . As t_N and q_N are perfect substitutes, it must be true that the marginal product of t_N just equals the marginal product of q_N : $[\partial f^* / \partial Q_N][\partial f_N^* / \partial t_N] = [\partial f^* / \partial Q_N][\partial f_N^* / \partial q_N]$. Inserting this equality into equations (10) and (11) tells us that the shadow price of the commodity t_N is $(w - w_N)$, and consequently, the shadow price of household labor as a production input is w_N :

$$(13) \quad \lambda^* w_N = [\partial f^* / \partial Q_N][\partial f_N^* / \partial t_N].$$

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 welfare-relevant full consumption is to be valued,

comprising all aspects of t_N (as well as leisure) the correct price for an unconstrained household is w .

The shadow price of the commodity t_N is:

$$(14) \quad \lambda^*(w - w_N) = \partial f^*/\partial t_N.$$

This expression determines the allocation of time worked at home. If there is negative marginal utility to housework so that $\partial f^*/\partial t_N < 0$, a necessary condition for an interior solution, that is, 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 labor 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 ($\partial f^*/\partial t_N > 0$), 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 that it could earn is higher than the costs of hiring a domestic employee 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 labor market exceeds the costs of hiring a nanny. One can think of corner solutions where either no or a maximum amount of t_N is supplied. A corner solution will arise in particular when household labor is not an argument in the utility function but *only* an input into household production. In this case, all household work will be carried out by the household itself ($t_N > 0, q_N = 0$) if the wage rate of domestic labor exceeds the household's wage rate on the labor market ($w_N > w$) and the correct valuation of t_N is the market wage rate w . In the opposite case of ($w_N < w$), there would be no time spent on household production ($t_N = 0, q_N > 0$) and the issue of valuation of t_N does not arise. In the more complex case where household work is an argument in the utility function, a corner solution may arise when market wages exceed wages of a household employee ($w > w_N$) and the household derives disutility from home production ($\partial f^*/\partial t_N < 0$). No time would be spent on household production and a maximum of time would be spent on supplying labor to the labor market.⁹ Conversely, if a household whose market wage rate is less than the wage rate of a household employee at the same time derives positive utility from household work, a corner solution arises where the household would spend a maximum of time on household production.¹⁰ Although we have no evidence regarding the prevalence of corner solutions, we focus on interior

9. There are natural limits to supplying labor (minimum leisure, sleeping) that have not been modeled here. Institutional and legal limits such as maximum hours for full-time employment would bring us to the case of constrained households dealt with below.

10. The household's budget and time constraints imposes a limit to the time spent on household production, as the household needs a minimum market income to purchase q_1 -type products in line with the condition in equation (8). At this point, the only remaining trade-off is between household work and leisure. Such a situation may be relevant for low-income households with potentially important distributional implications.

solutions in what follows, assuming that they are the rule rather than the exception.

Having established that the implicit price of t_N in its usage as an input into producing Q_N is w_N , we can take a closer look at the household's own account production function in equation (1). In particular, we are interested in defining an implicit price of the own-account product Q_N , given that in practice it will rarely be possible to directly observe such a price. Define the cost function that is dual to this production function as follows:¹¹

$$(15) \quad C_N(Q_N, w_N, p_2) \equiv \min_{q_2, q_N, t_N} \{w_N(t_N + q_N) + p_2 q_2 : f_N(t_N + q_N, q_2) \geq Q_N\}$$

$$= Q_N C_N(1, w_N, p_2)$$

$$= Q_N P_N.$$

In the first line of equation (15), we have made use of equation (11) that essentially determined 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 cost, $C_N(1, w_N, p_2)$, where the latter is independent of the level of production/consumption Q_N . For the third equation, the implicit price of own-account production has been defined as its unit cost: $P_N \equiv C_N(1, w_N, p_2)$. For utility-maximizing levels of household production, Q_N^* , one gets

$$(16) \quad C_N(Q_N^*, w_N, p_2) = Q_N^* C_N(1, w_N, p_2) = w_N(t_N^* + q_N^*) + p_2 q_2^*.$$

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

$$(17) \quad \lambda^* p_2 q_2^* + \lambda^* w_N (t_N^* + q_N^*)$$

$$= (\partial f^* / \partial Q_N) [(\partial f_N^* / \partial q_2) q_2^* + (\partial f_N^* / \partial t_N) (t_N^* + q_N^*)]$$

$$= (\partial f^* / \partial Q_N) Q_N^* \quad \text{using the linear homogeneity of } f_N.$$

Next, combine equations (17) and (16) in order to obtain the following equations:

$$(18) \quad \lambda^* [p_2 q_2^* + w_N (t_N^* + q_N^*)] = \lambda^* Q_N^* C_N(1, w_N, p_2) = \lambda^* Q_N^* P_N$$

$$= (\partial f^* / \partial Q_N) Q_N^* \quad \text{and} \quad \lambda^* P_N = (\partial f^* / \partial Q_N).$$

The last line of the expression above suggests that the implicit price P_N , defined as the unit cost of producing Q_N , is indeed the shadow price of household production: P_N (times the marginal utility of income λ^*) equals the marginal utility that households derive from own-account services Q_N^* .

The final step toward deriving measures of full income and full consumption is accomplished by invoking minimum expenditure of the consumer/producer's activity. Formally, we capture the cost side by an expenditure

11. See Diewert (1993) for additional material and references to the literature on duality theory.

function e that is dual to the utility function f . Note that we use equation (14) to put a shadow price to the commodity t_N that directly shows up in the utility function.

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

Under the regularity conditions imposed on f and household behavior, actual expenditure equals minimum expenditure so that $e(u^*, p_1, P_N, w, w_N) = FC = FI$. 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,

$$(20) \quad \begin{aligned} e(u^*, p_1, P_N, w, w_N) &= p_1 q_1^* + P_N^* Q_N^* + (w - w_N) t_N^* + w t_F^* \\ &= p_1 q_1^* + p_2 q_2^* + w_N q_N^* + w t_N^* + w t_F^* && \text{by using equation (18)} \\ &= FC = FI. \end{aligned}$$

Note that t_N^* is valued at its shadow price, so in considering full consumption and substituting $P_N^* Q_N^*$ for $p_2 q_2^* + w_N q_N^* + w_N t_N^*$, we end up with $w t_N^*$ as the value of time spent on household work. We can now draw some conclusions concerning the case of an unconstrained household that supplies market labor services:

- In the absence of corner solutions, the replacement-cost approach is the relevant valuation of time spent on household work *as in input into producing the own-account service* Q_N . This lends support to many studies that have proceeded along these lines.
- The opportunity-cost valuation is, however, the appropriate approach toward valuing time spent on household labor when the objective is valuing *full consumption*, above and beyond household production Q_N . Full consumption also captures the value of t_N as a commodity and leisure, lending a welfare interpretation to time allocated by the household. Leisure should be valued with an opportunity-cost approach.

4.2.2 Households That Are Constrained in Their Labor Supply

To this point, we have dealt with a representative household that is free in its choice of allocating income and time between different uses. While this may be true for some households, it is certainly not true for all households. We therefore now examine the part of the population that is not active on the labor market due to some institutional or economic constraint and study the consequences for the valuation of household time.¹² One situation that characterises a constrained household is unemployment—a person seeking employment at a given wage rate without success. Similarly, a person with

12. Note that the approach that we followed in the previous section, which essentially follows that of Becker (1965), cannot be used when the household has no opportunity to supply market labor services.

involuntary part-time work is faced with a constraint to supply additional labor. In principle, a constraint on labor supply can also arise when there are legal limits to the maximum hours of work per week. Fully employed persons who wish to extend their labor supply would then not be able to do so.¹³ Similarly, persons who have reached retirement age and wish to keep supplying labor to the labor market may be constrained in their choice if retirement age is compulsory. While these and similar cases are covered by our model, it is apparent that identifying the existence of these constraints household by household is difficult in practice. Our empirical illustration below will, therefore, be confined to the most apparent case of constrained labor supply—unemployment.

For purposes of the theoretical exposition, we start with a general utility function $U(q_1, Q_N, t_F, t_N)$ from which the labor 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 labor market income, the new household budget constraint is:

$$(22) \quad Y = p_1 q_1 + p_2 q_2 + w_N q_N.$$

The variable t_N can be eliminated from the utility function using the time constraint in equation (21), so as before we define a *reduced form utility function*, F :

$$(23) \quad F(q_1, Q_N, t_F) \equiv U(q_1, Q_N, t_F, T - t_F).$$

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

$$(24) \quad \max_{q_1, q_2, q_N, t_F} \{F(q_1, Q_N, t_F) : p_1 q_1 + p_2 q_2 + w_N q_N \leq Y; Q_N = f_N(t_N + q_N, q_2)\}.$$

As before we assume that q_1^* , q_2^* , q_N^* and t_F^* are all positive and solve equation (24). With a monotonicity condition on the utility function F , the budget constraint will hold with equality so we will have $p_1 q_1^* + p_2 q_2^* + w_N q_N^* = Y$. When F is differentiable, the first-order necessary conditions are:

$$(25) \quad \lambda^* p_1 = \partial F^* / \partial q_1;$$

$$(26) \quad \lambda^* p_2 = [\partial F^* / \partial Q_N][\partial f_N^* / \partial q_2];$$

$$(27) \quad \lambda^* w_N = [\partial F^* / \partial Q_N][\partial f_N^* / \partial q_N];$$

$$(28) \quad 0 = -[\partial F^* / \partial Q_N][\partial f_N^* / \partial q_N] + \partial F^* / \partial t_F.$$

Expression (28) describes the choice between own-account production and leisure: at the margin, the utility from producing extra own-account

13. If one follows this reasoning, a necessary condition to be unconstrained in the choice of labor supply is to be in a situation of part-time work (or exactly at the optimising path with full-time employment).

output Q_N by spending an additional hour on household work has to equal the marginal utility from extra household work as a commodity minus the marginal utility lost by sacrificing an hour of leisure. The latter two effects are captured by $\partial F^*/\partial t_F$ (assumed to be nonnegative, otherwise we would face a corner solution with all time allocated to household production). Adding equations (27) and (28) gives us the following equation:

$$(29) \quad \lambda^* w_N = \partial F^*/\partial t_F.$$

Equation (29) tells us that the shadow price of leisure, t_F , is now equal to w_N , the market price for purchased labor services. As noted earlier, $\partial F^*/\partial t_F$ is a net effect, combining the direct effects of leisure on utility and the direct effects on utility of the change in t_N , that is necessarily associated with the time constraint in equation (21). Since $\partial f_N^*/\partial q_N$ equals $\partial f_N^*/\partial t_N$, equation (27) implies also that

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

Thus, for a constrained household, the correct valuation of the labor input into household production is the replacement-cost method. Now multiply both sides of equation (26) by q_2^* , both sides of equation (27) by q_N^* , both sides of equation (30) by t_N^* to obtain the following equation:

$$(31) \quad \begin{aligned} \lambda^*[p_2 q_2^* + w_N q_N^* + w_N t_N^*] \\ &= [\partial F^*/\partial Q_N][(q_N^* + t_N^*)(\partial f_N^*/\partial q_N) + q_2^*(\partial f_N^*/\partial q_2)] \\ &= [\partial F^*/\partial Q_N] f_N^* \quad \text{using the linear homogeneity of } f_N \\ &= [\partial F^*/\partial Q_N] Q_N^* = \lambda^* P_N^* Q_N^*. \quad \text{using equations (1) and (18).} \end{aligned}$$

There is no difference between the constrained and the unconstrained household as far the household's production function and cost function is concerned. Thus, it is still the case that P_N , the implicit price of own-account production, equals unit costs of household production. 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:

$$(32) \quad \begin{aligned} E(u^*, p_1, P_N, w_N) \\ &= p_1 q_1^* + P_N^* Q_N^* + w_N t_F^* \\ &= p_1 q_1^* + p_2 q_2^* + w_N q_N^* + w_N t_N^* + w_N t_F^* \quad \text{using equation (15),} \end{aligned}$$

where E is the expenditure function that is dual to the utility function $F(q_1, Q_N, t_F)$. Finally, along with (22), the two equations in (32) imply the following equations:

$$(33) \quad \begin{aligned} p_1 q_1^* + P_N^* Q_N^* + w_N t_F^* &= Y + w_N t_N^* + w_N t_F^* \\ &= Y + w_N T \quad \text{using the time constraint (21)} \end{aligned}$$

where the last expression is again *nominal full consumption and full income*, except that we are using the wage rate for market home services w_N in place of the opportunity market wage rate as was the case for an unconstrained household.¹⁴

We conclude the following in the case of a constrained household:

- In the absence of corner solutions, the replacement-cost approach is the relevant valuation of time spent on household work *as in input into producing the own-account service* Q_N . This valuation for valuing household work is the same as our suggested valuation for the case of an unconstrained household.
- Unlike unconstrained households, however, the replacement-cost valuation is also the appropriate approach toward valuing time spent on household labor when the objective is valuing full consumption, above and beyond Q_N . Full consumption also captures the value of t_N as a commodity and leisure, both of which are valued with replacement costs in the case of a constrained household.

4.2.3 Cost-of-Living Index

This is not the end of the story, however. 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 the conceptually appropriate tool for deflation of consumption or income flows when making intertemporal or interspatial welfare-based 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:

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

14. This concept for full income could be labeled as *restricted full income* in order to distinguish it from Becker's full income.

The subscripts a and p stand for the active and nonactive (passive) part of the population with regard to their involvement in the labor market. Vectors in uppercase letters indicate prices and quantities including the (often unobserved) prices and quantities of household production. Vectors in lowercase letters indicate prices and quantities including the (typically observable) prices and quantities of the inputs into household production. Variables n_a and n_p are the number of active and inactive households, respectively. Combine the expenditure functions of the active and nonactive households developed earlier into an aggregate expenditure function ε by weighting each expenditure function by the number of households:

$$(35) \quad \varepsilon(\mathbf{u}, \mathbf{P}_a, \mathbf{P}_p) \equiv n_a e(u_a, \mathbf{P}_a) + n_p E(u_p, \mathbf{P}_p).$$

We then follow Pollak (1980) and Diewert (1983) and call P^* a plutocratic cost-of-living index between period 1 and period 0:

$$(36) \quad P^*(\mathbf{u}, \mathbf{P}_a^0, \mathbf{P}_p^0, \mathbf{P}_a^1, \mathbf{P}_p^1) \equiv \varepsilon(\mathbf{u}, \mathbf{P}_a^1, \mathbf{P}_p^1) / \varepsilon(\mathbf{u}, \mathbf{P}_a^0, \mathbf{P}_p^0)$$

In equation (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, 2001) 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:

$$(37) \quad \begin{aligned} P^*(\mathbf{u}^0, \mathbf{P}_a^0, \mathbf{P}_p^0, \mathbf{P}_a^1, \mathbf{P}_p^1) \\ \leq \sum_{j=a,p} n_j \mathbf{P}_j^1 \cdot \mathbf{Q}_j^0 / \sum_{j=a,p} n_j \mathbf{P}_j^0 \cdot \mathbf{Q}_j^0 \\ = \sum_{j=a,p} n_j \mathbf{P}_j^1 \cdot \mathbf{q}_j^0 / \sum_{j=a,p} n_j \mathbf{P}_j^0 \cdot \mathbf{q}_j^0 \equiv P_L^* \text{ using equation (20);} \end{aligned}$$

$$(38) \quad \begin{aligned} P^*(\mathbf{u}^1, \mathbf{P}_a^0, \mathbf{P}_p^0, \mathbf{P}_a^1, \mathbf{P}_p^1) \\ \geq \sum_{j=a,p} n_j \mathbf{P}_j^1 \cdot \mathbf{Q}_j^1 / \sum_{j=a,p} n_j \mathbf{P}_j^0 \cdot \mathbf{Q}_j^1 \\ = \sum_{j=a,p} n_j \mathbf{P}_j^1 \cdot \mathbf{q}_j^1 / \sum_{j=a,p} n_j \mathbf{P}_j^0 \cdot \mathbf{q}_j^1 \equiv P_L^* \text{ using equation (32);} \end{aligned}$$

$$(39) \quad P_F = (P_L^* P_P^*)^{1/2}.$$

Variable P_F^* provides the price change that is required to break down 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:

$$(40) \quad Q_F \equiv [FC^1 / FC^0] / P_F^*,$$

where $FC^0 = \sum_{j=a,p} n_j \mathbf{p}_j^0 \cdot \mathbf{q}_j^0$ and $FC^1 = \sum_{j=a,p} n_j \mathbf{p}_j^1 \cdot \mathbf{q}_j^1$.

This completes our theoretical considerations concerning the valuation of household work and leisure as well as the measurement of full consumption

in real terms over time and across countries. The remainder of the chapter will deal with an empirical illustration of these concepts.

4.3 An Illustrative Cross-Country Comparison of Full Consumption

Recent work by the OECD (Ahmad and Koh 2011) has produced estimates of the value of own-account household production, using both a replacement-cost and an opportunity-cost method. Extended measures of household consumption were shown by the authors after adding the value of own-account household production to the value of actual final consumption (as available from the national accounts). Their conclusion, confirming other results from the literature, is that there are large differences in the resulting extended measures of consumption, depending on the valuation method chosen. Valuation methods matter in particular when results are expressed as a percentage of conventional measures of consumption of GDP. Our theoretical findings above lend support to giving preference to a replacement-cost valuation, as long as the purpose is measuring the value of household production.

The present empirical section will build on the authors' data and go one step further toward providing a valuation of full consumption, thus also incorporating the value of household work as a commodity and leisure. We rely on the model set out earlier and distinguish between unconstrained and constrained households before aggregating across these two types of households. To keep things manageable empirically, only unemployment is used as a criterion for identifying a constrained household. We then construct a spatial cost-of-living index in the form of an extended purchasing power parity to compare volume measures of full consumption across countries. It is important to stress that the resulting calculations are of an illustrative nature only. Full implementation requires separately identifying actual individual consumption of constrained and unconstrained households, an improved time use information of these two groups of households, and resolving additional conceptual issues such as the distinction between a household and a person that we have conveniently ignored here. A number of additional shortcuts were necessary, and consequently, the results presented here are orders of magnitude rather than precise estimates. Also, as we heavily rely on the data provided by Ahmad and Koh (2011) for our calculations, no attempt is made here to replicate the discussion of the various measurement issues that these authors provide, such as the statistical sources for the various wage rates and time use surveys. Consequently, the following section only presents the most salient features of the data work involved.

4.3.1 Valuing Labor and Capital Services

Ahmad and Koh (2011) start with empirical information from the latest time-use surveys of OECD countries as compiled by the OECD. People's activities during a typical day are classified into time devoted to (a) paid

work or study (work-related activities); (b) unpaid work (household activities); (c) personal care; (d) leisure; and (e) other activities not included elsewhere. Allocation of time across these categories is not always straightforward; in particular, the cases 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 nonmarket services, the relevant activity is unpaid work, which comprises the following six subcategories: routine housework, shopping, care for household members, care for nonhousehold members, volunteer work, and travel related to household activities.

The time-use data used by Ahmad and Koh (2011) makes no distinction between constrained and unconstrained households or persons. We derive a set of data that makes this distinction by separating each country's population (of persons sixteen years and older) into unemployed persons (that is, those seeking and available for employment), persons older than sixty-five, and all other persons (that is, persons in employment and persons of working age that are not in the labor force such as persons in education). In a rather stark simplification, the first two groups are considered constrained, and the third group is considered unconstrained in their time allocation.¹⁵ We next combine the statistics on time-use patterns for all households as in Ahmad and Koh (2011) with supplementary information from Krueger and Mueller (2008) on time use of unemployed and employed persons to approximate time-use patterns of constrained and unconstrained persons. Again this entails a number of shortcuts and, consequently, a likely source of measurement imprecision (differences in years, country coverage, classifications of activities, etc.).

Valuation with replacement costs (w_N) of household labor as an input into production uses the data developed by Ahmad and Koh (2011), an average posttax, and the hourly wage rate of a general household employee deemed to be representative of the broad range of activities covered in the production of household production of nonmarket services.

As time spent on household production t_N and hired time q_N were considered perfect substitutes in the theoretical setup, the valuation of hourly labor 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 nonspecialized individuals. In practice, however, many studies do not adjust for such quality differences, and those that do generally do so using relatively simple estimates that assume that the quality/productivity of the nonspecialist is likely to be lower

15. For instance, all employed persons are considered nonconstrained. This is clearly not true as persons may be employed and yet constrained, for instance, in their choice of working time. Also, discouraged workers who no longer seek employment are considered unconstrained in our classification, which may be subject to debate. It is also questionable whether persons outside the working age should be considered constrained in their choices, as we do.

by a certain ratio. Landefeld, Fraumeni, and Vojtech (2005), for example, assume that the average hourly wage, used as a proxy for the replacement cost, is 75 percent of the specialist hourly wage in a number of activities.

Measurement of the costs of labor used in the production of household nonmarket services for own use can simply be described as follows: value of annual labor used in household production of nonmarket services = average hourly posttax labor costs of household employee * average hours worked per day * 365 (in 2008) * population sixteen years and older. Where valuation of time with opportunity costs is called for (as would be the case for leisure of unconstrained households), we use Ahmad and Koh's (2011) average posttax wage rates for the economy.

Like any other activity, both capital and labor are used in the production of household nonmarket 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.¹⁶ 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.¹⁷

To get a sense for the orders of magnitude involved, table 4.1 presents results for the nominal value of household production that do not discriminate between types of households—average time-use patterns are applied. Two valuations of labor input are presented, at replacement costs and at opportunity costs. It is apparent (see last column) that results vary critically with the choice of valuation methods. Similarly, any ratio of household production over GDP or over actual individual consumption would vary strongly, depending on the method. However, as our theoretical considerations have shown, in an extended model of households, if the measurement purpose is valuation of household production only (rather than full consumption), the replacement-cost method is the correct way to proceed. As the same replacement-cost wage rate is applied to constrained and unconstrained households, our results for the value of household production are identical to Ahmad and Koh's (2011) computations at replacement costs.

But full consumption goes beyond the value of household production and includes the value of household production, both directly and as a commodity, the value of direct consumption p_1q_1 as well as the value of leisure. We use actual individual consumption as shown in the System of

16. It is important to note that the estimates of capital services produced below will be biased upward, since some consumer durables, such as cars, also provide capital services to commuting and leisure activities, and not just household nonmarket services.

17. Unit user costs were measured as a real rate of return plus a rate of depreciation times the price index of new consumer durables.

Table 4.1 Household production valued at replacement costs and at opportunity costs, 2008

	Value of own-account household production		Population above 15 years of age		Value of labor spent on own-account household production		Value of capital services after tax		Value of own-account household production		
	Hours per day per person	1,000 persons, total	At replacement costs, millions of national currency	At opportunity costs, millions of national currency	Millions of national currency	At replacement costs, millions of national currency	At opportunity costs, millions of national currency	Replacement costs in % of opportunity costs	At replacement costs, millions of national currency	At opportunity costs, millions of national currency	Replacement costs in % of opportunity costs
Australia	4.1	17,483	532,333	698,303	54,715	587,048	753,018	78	587,048	753,018	78
Austria	3.4	7,067	68,128	115,441	15,232	83,359	130,673	64	83,359	130,673	64
Belgium	3.3	8,937	79,302	144,912	15,410	94,713	160,323	59	94,713	160,323	59
Canada	3.3	27,718	238,817	636,099	102,054	340,870	738,153	46	340,870	738,153	46
Germany	3.5	71,204	584,718	1,177,610	168,311	753,029	1,345,921	56	753,029	1,345,921	56
Denmark	3.6	4,483	533,829	962,602	120,165	653,994	1,082,767	60	653,994	1,082,767	60
Spain	3.3	38,898	390,689	512,213	56,939	447,628	569,152	79	447,628	569,152	79
Finland	3.4	4,421	48,208	92,730	8,580	56,788	101,311	56	56,788	101,311	56
France	3.3	52,406	549,396	1,022,856	96,109	645,505	1,118,964	58	645,505	1,118,964	58
United Kingdom	3.5	50,488	368,906	981,179	92,433	461,338	1,073,612	43	461,338	1,073,612	43
Hungary	3.3	8,537	8,405,457	8,487,291	1,371,325	9,776,782	9,858,616	99	9,776,782	9,858,616	99
Ireland	3.5	3,526	49,501	86,458	7,043	56,544	93,500	60	56,544	93,500	60
Italy	3.6	51,382	466,069	702,785	98,135	564,203	800,920	70	564,203	800,920	70
Japan	2.7	110,358	193,979,541	266,309,877	193,679,898	213,659,439	285,989,774	75	213,659,439	285,989,774	75
Korea	4.2	40,149	162,559,680	431,270,701	37,275,187	199,834,867	468,545,888	43	199,834,867	468,545,888	43
Mexico	2.3	75,282	2,259,048	4,518,096	628,361	2,887,409	5,146,457	56	2,887,409	5,146,457	56
Netherlands	3.6	13,512	115,997	265,669	28,542	144,539	294,211	49	144,539	294,211	49
Norway	3.1	3,859	430,376	1,121,691	118,672	549,048	1,240,363	44	549,048	1,240,363	44
New Zealand	3.8	3,390	68,213	98,196	12,187	80,400	110,383	73	80,400	110,383	73
Poland	3.8	32,253	240,406	480,812	43,085	283,490	523,896	54	283,490	523,896	54
Portugal	3.7	8,996	74,815	87,626	13,402	88,218	101,028	87	88,218	101,028	87
Sweden	3.5	7,678	787,176	1,725,291	124,042	911,219	1,849,334	49	911,219	1,849,334	49
United States	3.4	243,169	2,590,250	6,925,596	870,534	3,460,784	7,796,130	44	3,460,784	7,796,130	44
Estonia	3.9	1,110	54,211	108,423	9,340	63,551	117,763	54	63,551	117,763	54
Slovenia	3.8	1,695	11,445	12,255	2,075	13,519	14,330	94	13,519	14,330	94

Source: Ahmad and Koh (2012).

National Accounts to capture p_1q_1 , the value of household production P_NQ_N is measured at replacement costs and the value of household production as a commodity plus leisure are valued at opportunity costs or replacement costs, depending on the type of household. Table 4.2 presents the results. It starts by discriminating between constrained and unconstrained households in their time use regarding household production and leisure. This is unnecessary for the computation of the nominal value of household production, but matters for the valuation of leisure as well as for the construction of price indices. The final columns in table 4.2 present the nominal values of household production and of full consumption as a percentage of actual individual consumption. On average, household production (and the equivalent additional consumption) with labor valued at replacement costs, adds about 50 percent to the value of actual final consumption, although there are significant variations between countries. Full consumption—a welfare-related measure—is considerably higher. On average, full consumption is more than 2.5 times the value of actual individual consumption. It is of note that the spread of these ratios declines as one moves from comparing the relative size of household production to the relative size of full consumption.

An important step involves moving from nominal to real considerations. To compare real full consumption across countries, the cost-of-living index derived in the theoretical part of this chapter takes the form of a new set of purchasing power parity (PPP)s. The new PPPs were constructed by introducing additional “products” into the traditional set of PPP calculations. These products are the labor input to household production, capital input to household production, t_N as a commodity, and leisure, where a distinction is made between constrained and unconstrained persons. The monetary value for each item relative to full consumption provides the relevant weight. As would be expected, the set of adjusted PPPs turns out to be quite different from the official PPPs for actual individual consumption.

The final step consists of applying the new set of PPPs to obtain a volume comparison of per capita full consumption. Results are shown in table 4.3. Given the empirical shortcuts, these should be interpreted with caution. However, it is notable that the vast majority of countries improve their position against the United States when material living standards are measured using full consumption as opposed to actual individual consumption. We are also in a position to compare our results for real full consumption with those shown by Ahmad and Koh (2012). The authors do not account for leisure and the intrinsic value of household production. The last column in table 4.3 shows the difference in volume indices. It is apparent that moving from actual individual consumption plus household production to full consumption tends to improve the position of high-income countries such as Norway, Denmark, and Australia, whereas it tends to worsen the position of lower-income countries such as Mexico, Poland, or Estonia. This is

Table 4.2

Household production with differentiated households, 2008

Country/Unit	Own-account household production (hours per day per person)		Millions of national currency (all persons)		Value of labor spent on own-account household production, at replacement costs		Value of own-account household production at replacement costs		Leisure (hours per day per person)		Value of leisure and household work as commodity (millions of national currency)		Millions of national currency (all persons)		Share of actual individual consumption (percentages)	
	All persons	Unconstrained persons ^a	All persons	Unconstrained persons ^a	All persons	Unconstrained persons ^a	All persons	Unconstrained persons ^a	All persons	Unconstrained persons ^a	All persons	Unconstrained persons ^b	Constrained persons ^{a,c}	Actual individual consumption (AIC)	Full consumption	Own-account household production
Australia	4.1	3.5	6.2	4.9	532,333	54,715	587,048	4.7	4.4	877,512	725,439	152,072	821,563	2,286,122	71	27
Austria	3.4	2.9	5.1	4.3	68,128	152,32	83,359	4.7	4.3	172,047	144,959	27,088	178,867	434,73	47	243
Belgium	3.3	2.8	5.0	5.0	79,302	15,410	94,713	5.4	5.0	244,817	205,041	39,776	229,307	568,837	41	248
Canada	3.3	2.9	4.8	4.2	238,17	102,054	340,870	5.1	4.6	1,087,743	982,332	105,411	1,081,953	2,510,567	32	232
Germany	3.5	2.9	5.2	5.1	584,718	168,311	753,029	5.6	5.1	1,896,523	1,571,243	325,280	1,683,560	4,333,112	45	257
Denmark	3.6	3.2	5.3	5.2	533,829	120,165	653,994	5.5	5.2	1,586,427	1,375,908	210,519	1,172,094	3,412,515	56	291
Spain	3.3	2.7	4.9	3.9	390,689	56,939	447,628	4.9	4.5	780,546	589,300	191,246	745,804	1,973,978	60	265
Finland	3.4	2.9	4.8	4.8	48,208	8,580	56,788	5.8	5.4	166,819	142,989	23,830	122,863	346,470	46	282
France	3.3	2.8	4.9	4.9	549,396	96,109	645,505	4.1	3.7	1,391,613	1,182,053	209,561	1,407,097	3,444,215	46	245
United Kingdom	3.5	3.0	5.4	5.4	368,906	92,433	461,338	5.3	4.9	1,621,522	1,464,127	157,396	1,122,561	3,205,422	41	286
Hungary	3.3	2.8	5.1	4.3	8,405,457	1,371,325	9,776,782	4.6	4.3	11,817,518	8,417,602	3,399,915	17,625,878	39,220,178	55	223
Ireland	3.5	3.1	5.6	4.9	49,501	7,043	56,544	5.3	4.9	142,870	126,430	16,441	111,887	311,301	51	278
Italy	3.6	3.0	5.3	4.6	466,069	98,135	564,203	4.7	4.3	966,044	763,302	202,742	1,115,941	2,646,189	51	237
Japan	2.7	2.3	4.0	4.0	193,979,541	19,679,898	213,659,439	3.8	3.4	378,730,840	283,964,970	94,765,870	344,176,400	936,566,679	62	272
Korea	2.3	2.0	3.6	3.6	162,539,680	37,275,187	199,814,867	4.9	4.6	1,023,260,163	956,985,704	66,274,460	628,693,900	1,851,788,931	32	295
Mexico	4.2	3.9	6.2	5.7	2,259,048	628,361	2,887,409	3.7	3.5	4,359,494	5,294,570	264,924	8,502,337	16,949,239	34	199
Netherlands	3.6	3.2	5.7	5.7	115,997	28,542	144,539	5.3	4.9	435,079	392,072	43,007	360,925	940,433	40	261
Norway	3.1	2.8	4.6	4.6	430,376	118,672	549,048	6.1	5.8	2,347,841	2,145,686	202,156	1,316,045	4,212,934	42	320
New Zealand	3.8	3.3	5.8	5.8	68,213	12,187	80,400	4.1	3.8	119,204	101,368	17,837	130,520	330,125	62	253
Poland	3.8	3.3	5.9	5.9	240,406	43,085	283,490	4.9	4.6	709,594	631,352	78,242	918,554	1,911,638	31	208
Portugal	3.7	3.1	5.5	5.5	74,815	13,402	88,218	4.0	3.7	98,277	72,420	25,857	134,650	321,144	66	239
Sweden	3.5	3.0	5.1	5.1	787,176	124,042	911,219	5.2	4.9	2,720,205	2,371,463	348,743	2,113,194	5,744,618	43	272
United States	3.4	2.9	5.5	5.5	2,590,250	870,534	3,460,784	4.9	4.5	11,212,133	10,297,205	914,928	11,020,000	25,692,917	31	233
Estonia	3.9	3.4	5.7	5.8	54,211	9,340	63,551	4.8	4.5	153,936	136,528	17,408	167,338	384,825	3	230
Slovenia	3.8	3.3	6.0	6.0	11,445	2,075	13,519	5.2	4.8	16,798	12,994	3,803	23,832	54,149	57	227

Source: Authors' calculations.

^aUnconstrained persons = population sixteen to sixty-four years, minus unemployed persons. Constrained persons = unemployed persons plus persons sixty-five years and older. Time-use data by type of person are first-order approximations only and should be interpreted with great caution. Estimates using data by Krueger and Mueller (2008).

^bValued at opportunity costs.

^cValued at replacement costs.

Table 4.3 Full consumption in real terms, 2008

Reference group	Value of own-account household production						Value of leisure and household work as commodity						Actual individual consumption (AIC) as share of full consumption						PPPs for full consumption relative to the USA						Full consumption per capita relative to the USA						Own-account production at replacement costs plus AIC, volumes as in Ahmad and Koh (2012)		Difference
	All persons ^b		Unconstrained persons ^a		Constrained persons ^a		All persons ^b		Unconstrained persons ^a		Constrained persons ^a		All persons		All persons		All persons		All persons		All persons		All persons		(2)		(1)-(2)						
	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Millions of national currency	Percentage		Percentage					
Australia	587,048	420,906	166,141	877,512	725,439	152,072	821,563	2,286,122	36	1,4614	1,569	71.9	79.9	67.8	12.1																		
Austria	83,559	56,432	26,928	172,047	144,959	27,088	178,867	434,273	41	0.8584	0.867	69.1	71.2	74.1	-2.9																		
Belgium	94,713	61,831	32,881	244,817	205,041	39,776	229,307	568,837	40	0.8976	0.894	66.0	70.5	73.4	-3.0																		
Canada	340,870	248,009	92,862	1,087,743	982,332	105,411	1,081,953	2,510,567	43	1.2439	1.203	72.2	74.3	84.6	-10.3																		
Germany	753,029	465,168	287,861	1,896,523	1,571,243	325,280	1,683,560	4,333,112	39	0.8078	0.802	70.2	78.0	79.6	-1.6																		
Denmark	653,994	460,731	193,263	1,586,427	1,375,908	210,519	1,172,094	3,412,515	34	8.3938	8.657	70.3	85.2	71.8	13.4																		
Spain	447,628	280,929	166,698	780,346	589,300	191,246	745,804	1,973,978	38	0.7462	0.778	60.6	66.0	62.7	3.3																		
Finland	56,788	38,150	18,639	166,819	142,989	23,830	122,863	346,470	35	0.9482	0.962	67.5	80.4	71.6	8.8																		
France	645,505	420,996	224,510	1,391,613	1,182,053	209,561	1,407,097	3,444,215	41	0.8806	0.899	68.9	70.9	71.0	-0.1																		
United Kingdom	461,338	315,245	146,093	1,621,522	1,464,127	157,396	1,122,561	3,205,422	35	0.6418	0.648	78.8	95.5	82.8	12.7																		
Hungary	9,776,782	6,529,313	3,247,469	11,817,518	8,417,602	3,399,915	17,625,878	39,220,178	45	126.0816	122.681	38.5	37.8	55.2	-17.4																		
Ireland	56,544	41,786	14,758	142,870	126,430	16,441	111,887	311,301	36	1.0392	1.065	67.0	78.0	69.1	8.9																		
Italy	564,203	355,660	208,543	966,044	763,302	202,742	1,115,941	2,646,189	42	0.8156	0.818	63.3	64.1	72.3	-8.2																		
Japan	213,659,439	129,612,328	84,047,112	378,730,840	283,964,970	94,765,870	344,176,400	936,566,679	37	119.0859	129.349	62.7	67.4	55.9	11.5																		
Korea	199,834,867	157,375,415	42,459,452	1,023,260,163	956,695,704	66,274,460	628,693,900	1,851,788,931	34	816.3230	796.801	43.8	56.7	52.7	4.0																		
Mexico	2,887,409	2,454,010	433,399	5,559,494	5,294,570	264,924	8,502,337	16,949,239	50	7.0863	6.574	31.1	28.7	61.0	-32.3																		
Netherlands	144,539	103,109	41,431	435,079	392,072	43,007	360,925	940,543	38	0.8336	0.828	72.9	81.6	81.6	0.3																		
Norway	549,048	399,440	149,607	2,347,841	2,145,686	202,156	1,316,045	4,212,934	31	9.4273	9.631	81.0	108.8	78.7	30.1																		
New Zealand	80,400	58,478	21,923	119,204	101,368	17,837	130,520	330,125	40	1.4336	1.472	58.8	62.2	64.3	-2.2																		
Poland	283,490	201,572	81,919	709,594	631,352	78,242	918,554	1,911,638	48	1.7617	1.606	37.8	37.0	68.7	-31.7																		
Portugal	88,218	56,370	31,847	98,277	72,420	25,857	134,650	321,144	42	0.6792	0.691	51.6	51.9	62.0	-10.1																		
Sweden	911,219	596,738	314,480	2,720,205	2,371,463	348,743	2,113,194	5,744,618	37	8.9600	9.005	70.8	82.1	76.7	5.4																		
United States	3,460,784	2,474,378	986,405	11,212,133	10,297,205	914,928	11,020,000	25,692,917	43	1.0000	1.000	100.0	100.0	100.0	0.0																		
Estonia	63,551	44,554	18,997	153,936	136,528	17,408	167,338	384,825	43	8.8065	8.160	39.2	41.7	66.3	-24.5																		
Slovenia	13,519	9,691	3,828	16,798	12,994	3,803	23,832	54,149	44	0.6387	0.633	51.0	50.2	65.8	-15.6																		

Source: authors' calculations.

^aUnconstrained persons = population sixteen to sixty-four years, minus unemployed persons. Constrained persons = unemployed persons plus persons sixty-five years and older. Time-use data by type of person are first-order approximations only and should be interpreted with great caution. Estimates using data by Krueger and Mueller (2008).

^bResults for all persons are sourced from Ahmad and Koh (2011).

consistent with the idea that the volume and value of leisure tends to rise with rising income.

4.4 Summary and Conclusion

This chapter has established a theoretical framework and identified conditions for the validity of the two most widely used approaches to value household labor. The first approach toward valuing time spent on household work is the replacement-cost approach that imputes a wage rate for labor services that could be purchased by the household for household work. This valuation is warranted when households are constrained in their supply of labor to the labor market. For unconstrained households, the replacement cost approach is also correct if the sole objective is valuing household production but with no commodity value of time spent on household production.

Our theoretical model also demonstrates that full consumption goes beyond measuring household production and should include the value of leisure and the intrinsic value of the time spent on household work. We show that these items should be valued at opportunity costs in the case of unconstrained households and valued at replacement costs in the case of constrained households.

Another main element of this chapter is the definition of a cost-of-living index of full consumption. We use the economic approach toward index numbers to define this price index with a view to measuring volume changes in full consumption.

Finally, we apply the findings empirically and compute comparative measures of the volume of full consumption per capita across a selection of OECD countries, thereby combining valuation and cost-of-living indexes. We conclude that moving from a comparison of actual final consumption to a comparison of full consumption has a marked influence on the relative position of countries.

Many research and measurement issues remain; for instance, the treatment of joint production within households, measuring productivity change in household production, and differentiating between types of expenditures such as educational investments and consumption. Another policy-relevant question is whether moving toward full consumption and full income affects distributional measures such as the Gini coefficient or the difference between average and median income.

References

Abraham, K. G., and C. Mackie, eds. 2005. *Beyond the Market; Designing Nonmarket Accounts for the United States*. Washington, DC: National Academies Press.

- Ahmad, N., and S. Koh. 2011. "Incorporating Estimates of Household Production of Non-Market Services into International Comparisons of Material Well-Being." OECD Statistics Working Papers, 2011/07, Organisation for Economic Co-operation and Development, <http://dx.doi.org/10.1787/5kg3h0jgk87g-en>.
- Barnett, W. 1977. "Pollak and Wachter on the Household Production Function Approach." *Journal of Political Economy* 85 (5): 1073–108.
- Becker, G. S. 1965. "A Theory of the Allocation of Time." *Economic Journal* 75 (299): 493–517.
- Bridgman, B., A. Dugan, M. Lal, M. Osborne, and S. Villones. 2012. "Accounting for Household Production in the National Accounts, 1965–2010." *Survey of Current Business* May:23–36.
- Diewert, W. E. 1983. "The Theory of the Cost of Living Index and the Measurement of Welfare Change." In *Price Level Measurement*, edited by W. E. Diewert and C. Montmarquette, 163–239. Ottawa: Statistics Canada.
- . 1993. "Duality Approaches to Microeconomic Theory." In *Essays in Index Number Theory*, vol. 1, edited by W. E. Diewert and A. Nakamura 105–75. London: Emerald Publishing Group.
- . 2001. "The Consumer Price Index and Index Number Purpose." *Journal of Economic and Social Measurement* 27:167–248.
- European Commission, IMF, OECD, World Bank, and United Nations. 2009. *2008 System of National Accounts*. New York: United Nations.
- Folbre, N., and Barnet Wagman. 1993. "Counting Housework: New Estimates of Real Product in the United States, 1800–1860." *Journal of Economic History* 53 (2): 275–88.
- Folbre, N., and J. Yoon. 2008. "The Value of Unpaid Child Care in the United States in 2003." In *How Do We Spend Our Time? Evidence from the American Time Use Survey*, edited by Jean Kimmel, 31–56. Kalamazoo, MI: W. E. Upjohn Institute for Employment Research.
- Fouquet, A., and A. Chadeau. 1981. *Le Travail Domestique: Essai de Quantification*. Paris: French National Institute for Statistics and Economic Studies.
- Fraumeni, B. M. 2008. "Household Production Accounts for Canada, Mexico, and the United States: Methodological Issues, Results, and Recommendations." Paper presented at the 30th General Conference of the International Association for Research in Income and Wealth, Slovenia.
- Goldschmidt-Clermont, L. 1993. "The Monetary Valuation of Non-Market Productive Time: Methodological Considerations." *Review of Income and Wealth* 39 (4): 419–33.
- Hill, T. P. 2009. "Consumption of Own Production and Cost of Living Indices." In *Price Index Concepts and Measurement*, Studies in Income and Wealth, vol. 70, edited by W. E. Diewert, J. S. Greenlees, and C. R. Hulten, 429–44. Chicago: University of Chicago Press.
- Jorgenson, Dale W. and Zvi Griliches. 1967. "The Explanation of Productivity Change." *Review of Economic Studies* 34 (3): 249–83.
- Konüs, Alexander A. 1924. "The Problem of the True Index of the Cost of Living." *Econometrica* 7:10–29.
- Krueger, A., and A. Mueller. 2008. "The Lot of the Unemployed: A Time Use Perspective." IZA Discussion Paper no. 3490, Institute for the Study of Labor.
- Lancaster, K. J. 1966. "A New Approach to Consumer Theory." *Journal of Political Economy* 74 (2): 132–57.
- Landefeld, S., B. Fraumeni, and C. Vojtech. 2005. "Accounting for Nonmarket Production: A Prototype Satellite Account Using the American Time Use Survey." BEA Paper no. 0056, Bureau of Economic Analysis.

- Landefeld, S., and S. McCulla. 2000. "Accounting for Nonmarket Household Production within a National Accounts Framework." *Review of Income and Wealth* 46 (3): 289–307.
- Pollak, R. A. 1980. "Group Cost-of-Living Indexes." *American Economic Review* 70:273–8.
- Pollak, R. A., and M. L. Wachter. 1975. "The Relevance of the Household Production Function and Its Implications for the Allocation of Time." *Journal of Political Economy* 83 (2): 255–77.
- . 1977. "Reply: 'Pollak and Wachter on the Household Production Approach.'" *Journal of Political Economy* 85 (5): 1083–6.
- Reid, M. G. 1934. *Economics of Household Production*. New York: Wiley and Sons.
- Roy, D. 2011. "La Contribution du Travail Domestique au Bien-être Matériel des Ménages: Une Quantification à Partir de l'enquête Emploi du Temps." Document de Travail INSEE F 1104. Paris: French National Institute for Statistics and Economic Studies.
- Ruger, Y., and J. Varjonen. 2008. "Value of Household Production in Finland and Germany." Working Paper no. 112, National Consumer Research Centre, Helsinki.