Allocating Time:
Individuals' Technologies and Household Technology

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Abstract

The household production model remains the lens through which virtually all economists and many other social scientists view household time allocation. I begin by arguing that a model that integrates household production with household bargaining involves three basic elements: the technology of the household and of each individual in the household, the preferences of each individual in the household, and the household governance structure.

The emphasis on individuals' technologies is new, but I argue that individuals' technologies are required to analyze individuals' decisions to enter or exit marriage. I then focus on the neglected relationship between the household technology and individuals' technologies. Individuals' technologies are visible at three crucial points in the life cycle: before household formation, after divorce, and after the death of a spouse. I identify individuals' technologies with specialized household production (i.e., with the household production function for a commodity when only one spouse allocates time to its production). Thus, knowledge of the household technology allows us to infer individuals' technologies. But knowledge of individuals' technologies allows us to infer household technology only if we make strong assumptions about the relationship between individuals' technologies. More specifically, I show that if the household technology is "additive" (i.e., the sum of the individuals' technologies), then we can infer the household technology from individuals' technologies. Treating additivity as the benchmark case, I then show that Becker's assumption that spouses' time inputs are perfect substitutes is compatible with additivity only in a narrow class of implausible special cases. To the extent that the standard explanation of specialization and the division of labor within the household rests on the perfect substitutes assumption, I argue that we need to reconsider the motives for specialization.

The household production model remains the lens through which virtually all economists and many other social scientists view household time allocation. For many social scientists, certainly for economists, the starting point of the modern time-use literature is Becker (1965), "A Theory of the Allocation of Time." In that paper, Becker introduced the household production model which has become the centerpiece of what Nerlove (1974) called the "new home economics."[1] Becker's 1965 article placed household time allocation on the agenda for economics and, directly and indirectly, influenced the other social sciences.

Becker (1965) provided a clear statement of the foundations of the household production model in the context of a single-person household, but barely mentioned families or multiperson households. Becker wrote: households are "assumed to combine time and market goods to produce more basic commodities that directly enter their utility functions." As the phrase "their utility functions" suggests, Becker (1965) focused on single-person households, devoting only one paragraph to "The Division of Labour Within Families."[2] Without additional assumptions, the implications of the new home economics for labor supply and for the demand for market goods are essentially equivalent to the implications of the traditional neoclassical theory of consumer behavior.[3] [4]

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[1] Of course there were precursors -- most immediately Mincer (1963), and three decades earlier, Reid (1934), *Economics of Household Production*, a book whose title suggests its concerns.

[2] The distinction between household and family is often ignored in the literature on households and families and I continue in this unfortunate but venerable tradition. The difficulty is suggested by such phrases as "household production" which often refers to family production and by "traditional nuclear family" and "stem family" which refer to types of households

[3] Proof: Suppose that there are n goods and n commodities, and that the household production functions are such that one unit of good i produces one unit of commodity i; this corresponds to a degenerate household technology in which commodities are produced by market goods without any input of household time. The utility function defined over commodities thus becomes a utility function defined over market goods.

[4] As Pollak and Wachter (1975) argued, this equivalence shows that the power of the new home economics to place restrictions on labor supply or the demand for goods beyond those implied by neoclassical theory

In retrospect, the most important contribution of the new home economics has been to draw attention to behavior *within* households. Examples include fertility, investments in health, and investments in children's human capital as well as time allocation. When "A Theory of the Allocation of Time" appeared in 1965, "revealed preference" rhetoric held sway in economics and economists equated "observable behavior" with "market behavior." Most economists recognized only two uses of time: market work ("labor") -- observable because it passed through a market -- and an aggregate residual consisting of all other uses of time ("leisure"). Labor economists, unlike most of their colleagues, rejected this dichotomous classification of time use and distinguished among various categories of market work. In this they followed Adam Smith whose analysis of occupational choice and equalizing wage differentials emphasized the pleasantness or unpleasantness of various occupations.

The household production model refocused the discussion of time use away from the labor/leisure and occupational choice and toward the allocation of nonmarket time. This refocusing required at least a trichotomous classification of time use (market work/ leisure/ household production) and, for some purposes, a finer classification of activities within the household. Unlike the labor economics literature on equalizing differentials, however, the new home economics typically assumed that individuals received no "process benefits" (or disbenefits) corresponding to the pleasantness or unpleasantness of engaging in various household production activities. Instead, the new home economics

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depends on imposing additional assumptions. These assumptions may take the form of restrictions on household technology, restrictions on preferences, or assumptions about the number of basic commodities relative to the number of market goods.

typically assumed that individuals were indifferent between market work and household work, and indifferent among household production activities.

The theoretical literature of time allocation within households is surprisingly thin. Becker's 1965 *Economic Journal* article, Pollak and Wachter's 1975 *Journal of Political Economy* article, and the three chapters on time use in Becker's *Treatise on the Family* nearly exhaust the theoretical literature. Since the mid 1980s, virtually all research on time use has been empirical rather than theoretical. The most recent theoretical work cited in most time use papers is the 1991 edition of Becker's *Treatise on the Family*, although two of its three chapters on household production and time allocation appeared in the 1981 edition of the *Treatise*. The first of these chapters, "Single-Person Households," generalized the household production model of Becker (1965) by introducing human capital that augments the productivity of time in household production.[5] The second of these chapters, the "Division of Labor in Households and Families," presented the celebrated specialization theorems, concluding that efficiency requires one spouse to specialize in the market sector and the other in the household sector. The third chapter on time use, which originally appeared as Becker (1985), examines the allocation of "effort" and elaborates the earlier discussion of the "sexual division of labor."

For multiple-person households the theory of time use is curiously underdeveloped. Issues of time allocation, specialization, and division of labor arise in all multiple-person households: married couple households, cohabiting heterosexual couples, gay and lesbian couples, multigenerational households in which adult children coreside with disabled elderly parents, and nonfamily households (e.g., college roommates).

Furthermore, as the title of Becker's chapter "Division of Labor in Households and Families" suggests, specialization implicates families as well as households.[6]

Becker (1965) devotes only a paragraph to multiple-person households; Pollak and Wachter (1975) ignore them completely. Becker (1981, 1991) discusses multiple-person households, but his conclusions about specialization and the division of labor follow not from the basic assumption that households "combine time and market goods to produce more basic commodities" but from dubious auxiliary assumptions.[7] To understand the role of Becker's auxiliary assumptions, I begin by reformulating the analysis of multiple-person households.

The analysis of multiperson household involves three basic elements or primitives: the technologies of the household and its individual members, the preferences of individuals, and the household governance structure.

- Household technology specifies the constraints, other than the market and time constraints, that define a household's feasible set. Household technology can be represented by production sets or, in the absence of joint production, by production functions.[8] Individuals' technologies specify the constraints, other than the market and time constraints, that individuals would face if they were on their own rather than members of the household. Individuals' technologies are required to analyze individuals' decisions to enter or leave marriage, a point that does not appear to have been recognized in the literature

[5] Becker (1965) did not discuss the role of human capital in household production.
[6] Of course family formation and the sorting of individuals into households is endogenous.
[7] In Pollak (2003) I argue that many of Becker's conclusions about the family do not follow from such basic assumptions as maximizing behavior and equilibrium but from special and often dubious auxiliary assumptions.
[8] As Pollak and Wachter (1975) argue, process benefits are associated with household production activities and process benefits imply joint production.

on marriage and divorce.[9] In some bargaining models individuals' well-being outside the marriage serves as a threat point or as an outside option. Both the roles of individuals' technologies and the relationship between individuals' technologies and household technology have thus far been ignored.

- Individuals' preferences specify the objective functions that individuals seek to maximize. In order to focus on other issues, I assume the absence of process benefits and of interdependent preferences (e.g., preferences in which each spouse cares about the consumption or time use of the other).[10]
- The household governance structure determines the mapping from individuals' preferences and the feasible set into an allocation. The term governance structure is broad enough to include not only cooperative and noncooperative bargaining models, but also Becker's altruist model, and, indeed, any model that determines the sharing of benefits and burdens within the household.[11] Restricting their attention to single-person households, Becker (1965) and Pollak and Wachter (1975) assume utility maximization. In the *Treatise*, Becker restricts his attention to multiple-person households that maximize a *household* utility function subject to household budget, time, and technology constraints. He justifies this assumption by appealing to the *altruist model*

[9] Analogous, to analyze a young adult's decision to leave the parents' household requires us to specify the individual's technology.
[10] The three chapters on time use in Becker's *Treatise* assume away joint production. The introduction to the 1991 edition acknowledges that the specification of interdependent preferences that Becker calls "altruism" is overly restrictive because it excludes "merit goods," which are a plausible type of interdependence preferences.
[11] Borrowing from Williamson and the transaction costs literature, Ellickson (2006) uses the term "governance structure" in the context of the household. Chiappori's "sharing rule" can be interpreted as a reduced form corresponding to an unspecified household governance structure that yields Pareto-efficient allocation; see Chiappori (1988, 1992).

which implies that multiple-person households behave as if they were single person households (i.e., maximizing a household utility function -- the utility function of the altruist -- subject to household constraints.) Models implying household behavior that is consistent with maximization of a household utility function subject to household resource and technology constraints are called *unitary* models.[12] Unitary models imply that household members "pool" their resources, so that a lump sum transfer of nonlabor income from one spouse to the other would have no effect on houseshold behavior. Resource pooling is a testable implication of the unitary model, an implication that is rejected by empirical data; Lundberg and Pollak (forthcoming) summarize the evidence.[13] An analysis that begins with a household utility function assumes away the bargaining issues that now play a central in the economics of the family.[14]

This basic three-element framework -- technology, preferences, and household governance structure -- clarifies the roles of technology and bargaining considerations as determinants of patterns of specialization within households. Except in very special cases, the allocation of time, like the allocation of other benefits and burdens, reflects both technology and bargaining considerations. In addition to technology, preferences, and household governance structures, in multiperiod models three dynamic factors

[12] I treat transaction costs -- the costs of negotiating, monitoring, and enforcing agreements -- as a component of household governance structure, although an argument can be made for treating transaction costs as a fourth basic element in the analysis of multiple-person households. The application of transaction cost analysis to the household began with Ben-Porath (1980) and Pollak (1985). Ellickson (2006) provides an insightful transaction cost analysis of household size, composition, and governance, emphasizing the importance of norms in household governance. Pollak (2007) relates Ellickson's analysis to the literature on household and family bargaining.

[13] Samuelson (1956) pointed out that the unitary models, which often begin by postulating rather than deriving a household utility function, fail to address the problem of aggregating individuals' preferences into household preferences; Pollak (2006) discusses Samuelson's contribution.

[14] Bargaining models of marriage were introduced in the early 1980s by Manser and Brown (1980) and by McElroy and Horney (1981).

influence household time allocation: human capital, household physical capital, and preference formation.

The pattern of sector gender specialization predicted by Becker's *Treatise* -- husbands specializing in market work, wives specializing in household production -- has become less common since the 1950s. Both husbands and wives now participate in both the home and the market sectors, while gender specialization among activities within households remains strong. Lundberg and Pollak (2007) summarize the evidence.

In this paper I reformulate the theory of household time allocation and reexamine its implications for the pattern of specialization and the division of labor within households. I focus on theoretical explanations for specialization and, more specifically, the conditions under which conclusions about patterns of specialization follow from assumptions about household technology, and the plausibility of these assumptions.

I argue that Becker's conclusion that husbands specialize in the market sector and wives in the household sector does not follow from the basic assumptions about household technology. Instead, the specialization conclusion rests on auxiliary assumptions to which neither economic theory in general, nor the household production model in particular, have any commitment. For example, as Lundberg (2005) points out, the home/market specialization conclusion depends crucially on the assumption that the household "sector" produces only a single "commodity." If a household produces m household commodities and both the husband and the wife participate in the market, then Becker's reasoning implies that the husband will specialize in the production of m^* of these home-produced commodities and the wife will specialize in the production of the remaining $m-m^*$ commodities.

Even this m-commodity specialization conclusion requires auxiliary assumptions about the household technology. For example, it requires that the household technology for all commodities exhibit constant or increasing returns to scale. If both spouses' production functions exhibit decreasing returns to scale, Pareto efficiency *may* require nonspecialization. Yet decreasing returns to scale are quite plausible: if individuals who increase the time they devote to an activity become tired or bored, and if fatigue or boredom causes them to become less productive, then the household production functions exhibit decreasing returns to scale.[15] [16]

Becker attributes specialization and the division of labor within the household to the perfect substitutability of spouses' time inputs in production and to the accumulation of household or commodity-specific human capital. I argue that neither of these explanations is plausible. I argue that spouses' time inputs are unlikely to be perfect substitutes, and that the returns to commodity specific human capital in household production are likely to be low. I argue that specialization and the division of labor within the household, to the extent that we observe it, are likely to reflect other factors, including economies of scope, returns to *market* human capital, transaction costs, process preferences, gender norms, and bargaining power.

I begin by arguing that the relationship between the household technology and the technologies of the individuals in the households is interesting both for its own sake and because, under plausible assumptions, it implies strong restrictions on household technology. I argue that the relationship between household technology and individuals'

[15] Even if productivity is undiminished, individuals may become less willing to devote additional time and effort to an activity if they become tired or bored. The disutility effects of fatigue and boredom require recognizing "process preferences" -- that is, time allocated to an activity is itself an argument of the utility function.

technologies is especially interesting because it or its effects are potentially observable at three crucial transition points: household formation, divorce, and the death of a spouse.

- At the point of household formation, the technologies of individuals before they enter the household are related to the technology of the newly-formed household.
- At the point of divorce, the household's technology prior to divorce is related to the technologies of the newly-divorced individuals. In some models of marital bargaining, individuals' well-being in the event of divorce plays the role of a threat point that determines bargaining power. In virtually all bargaining models, divorce is an "outside option" that determines the range within which any allocation acceptable to both spouses must lie.
- When a spouse dies, the household's technology prior to the death and any commodity-specific human capital that the surviving spouse acquired prior to or during the marriage will determine his or her technology as a widow or widower. Anecdotes about widowers who cannot cook and widows who have never made financial decisions and find themselves confronted by a host of unfamiliar problems exemplify the difficulties that specialization can imply for surviving spouses.[17]

I argue that Becker's assumption that spouses' time inputs are perfect substitutes in production is inconsistent with plausible assumptions about the relationship between household technologies and individuals' technologies.

[16] Unless this effect is offset by nonlabor inputs becoming more productive as their use increases. The easy case is a commodity that is produced by labor alone.

Preliminaries: Single-Person Households

I begin by introducing terminology and notation, and clarifying some under-analyzed issues that arise in single-person households. For a single-person household, I denote the production function for commodity z_i by

$$f^i(t_i,y_i) = z_i$$

where t_i denotes the input of household time (or "labor") into its production and y_i the vector of market goods used as inputs. Alternatively, y_i may be interpreted as the total cost of the market inputs used to produce z_i. This cost or expenditure interpretation, which takes the prices of the market goods as given, has the advantage of reducing y_i from a vector to a scalar. Hired labor (e.g., for housework or child care) may be one of these market goods, although I assume that hired labor requires supervision and, hence, is not a perfect substitute for household or family labor. Until recently the time allocation literature ignored household physical capital. Greenwood, Seshadri and Yorukoglu (2005) depart from this tradition and argue that household physical capital (e.g., electric washing machines) was important in transforming women's roles in the twentieth century. Household physical capital can be analyzed in a single period framework if there are perfect rental markets or perfect capital and second-hand markets. Without one or the other of these very strong assumptions, physical capital substantially complicates the analysis because the intertemporal budget constraint is not separable by periods.

Focusing on a particular commodity, z, and dropping the identifying commodity superscripts and subscripts, we write

$$f(t,y) = z.$$

[17] Disability of a spouse raises related issues. The nondisabled spouse must either find market substitutes or take over household production activities previously performed by the now disabled spouse. Disability,

The assumption that technology can be represented by production functions rules out joint production and presupposes that production is efficient.[18] [19] I say that an individual's time input is *essential* for production if

$$f(0,y) = 0.$$

If an individual's time input is essential, then t=0 implies z=0 regardless of the quantities of the nonlabor inputs.

Both theoretical and empirical work often assume that the household technology exhibits constant returns to scale:

$$f(\lambda t,\lambda y) = \lambda f(t,y) \quad \text{for all } \lambda > 0.$$

When time is the only input, constant returns to scale implies

$$f(t) = ct.$$

The assumption that the household technology exhibits nondecreasing returns to scale plays a crucial role in specialization theorems in multiple-person households

Individuals who devote more time to an activity may become tired or bored and, as a result, less productive. The productivity effect of fatigue or boredom provides the

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however, also raises new issues about caregiving.

[18] To avoid imposing efficiency, the production function can be reinterpreted as the maximum output that can be obtained from the input vector (t,y). The household production literature, however, has not adopted this interpretation.

[19] The no joint production assumption is important because, in conjunction with constant returns to scale, it implies a pattern of specialization that depends on household technology but is independent of preferences. More specifically, under these assumptions, the frontier of the production possibility set is linear and, hence, "commodity shadow prices" are determined solely by technology (i.e., are independent of preferences). A technology exhibits joint production when the same production process produces two or more outputs. The standard textbook example of joint production is a sheep ranch producing both wool and mutton. Pollak and Wachter (1975) show that joint production is present whenever individuals have "process" preferences (i.e., "direct" preferences for spending time engaging in some activities rather than others.) For example, if I would rather spend my time cooking than cleaning, then the time I spend cooking and the time I spend cleaning are arguments of my utility function and, hence, are "commodities." "Home-cooked meals" and "a clean house" also enter my utility function and, hence, are also commodities. Thus, the activity "cooking" produces two commodities, "home cooked-meals" and "time spent cooking," and the activity "cleaning" produces two commodities, "a clean house" and "time spent cleaning." To deal formally with joint production requires representing technologies by production sets rather than production

rationale for concern about, and regulation of, the working hours of medical interns and residents, truck drivers, air-traffic controllers, and pilots. If output is produced by labor alone, these productivity effects imply that an increase in hours worked will not yield a proportionate increase in output. With many inputs, if individuals who devote more time to an activity become less productive, then the production function will eventually exhibit decreasing returns to scale: that is, increasing all inputs, including the time input, by 10 percent would increase output by less than 10 percent. If productivity effects of fatigue or boredom are present in household production as well as in market activities, then household technology will eventually exhibit decreasing returns to scale.

Individuals who devote more time to an activity may become tired or bored and, as a result, find the activity less pleasant. A disutility effect of fatigue or boredom presupposes "process preferences" -- that is, time allocated to an activity is an argument of the utility function.[20] Disutility effects and productivity effects may operate simultaneously but they are analytically distinct.[21] As Pollak and Wachter (1975) point out, the household production literature often fails to distinguish between activities that produce utility directly and activities that produce utility indirectly by producing "commodities." For produced commodities that are observable and measurable, this distribution has empirical content. But for commodities that are not observable and

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functions, and describing the allocation of time among "activities" (e.g., "cooking," "cleaning"). I rely on production functions whenever possible and ignore joint production except when necessary.

[20] The disutility effects of fatigue or boredom imply an increasing marginal disutility of time devoted to the activity (This intuition generalizes to indifference curves and marginal rates of substitution.) Although Becker's assumption of no joint production excludes process preferences, process preferences have a venerable place in labor economics. Adam Smith in *The Wealth of Nations* (1776) recognized process preferences -- the pleasantness or unpleasantness of various occupations -- as the source of what labor economists now call "compensating differentials." Smith famously wrote: "The whole of the advantages and disadvantages of the different employments of labour and stock must, in the same neighborhood, be either perfectly equal or continually tending to equality." Rosen (1986) provides an authoritative discussion of pecuniary and nonpecuniary returns in the labor market.

measureable, the distinction between activities that produce utility directly and activities that produce unmeasurable commodities which are arguments of a utility function is more metaphysics than economics.[22]

Household Production in Multiple-Person Households

I begin by introducing notation for the household production function for a commodity, $z_{i,.}$ By working with production functions, I implicitly assume away joint production and, hence, process preferences. Dropping the commodity superscripts and subscripts, I denote the household production function for z by $g[t_1,t_2,y]$, where t_1 and t_2 denote the spouses' time inputs into the production of z. I denote the individuals' production functions by $f^1(t_1,y_1)$ and $f^2(t_2,y_2)$ where y_1 and y_2 the vectors of market goods used as inputs. Alternatively, we can interpret y_1 and y_2 as total expenditure on the market inputs used in conjunction with t_1 and t_2, respectively.

I interpret the individuals' production functions as those that each spouse would have if the marriage were to end immediately. This interpretation assumes an ongoing marriage; the individual production functions are those that the spouses would have in the event of divorce or that the surviving spouse would have if the other were to die. An alternative interpretation is that $f^1(t_1,y_1)$ and $f^2(t_2,y_2)$ are the production functions of prospective spouses and $g[t_1,t_2,y]$ the production function of the household if they were to marry. (Marriage is a convenient shorthand but, with some qualifications, the analysis applies to cohabiting couples regardless of their sexual orientation or marital status.)

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[21] It is tempting but inaccurate to say that fatigue operates through productivity and boredom through disutility.

What is the relationships between the specialization household production functions, $g[t_1,0,y]$ and $g[0,t_2,y]$, and the individuals' production functions, $f^1(t_1,y_1)$ and $f^2(t_2,y_2)$? Under what conditions does the household production function reveal the individuals' production functions? The *Revelation Assumption* provides a straightforward answer to these questions.

Revelation Assumption: The specialization household production functions, $g[t_1,0,y]$ and $g[0,t_2,y]$, and the individuals' production functions, $f^1(t_1,y_1)$ and $f^2(t_2,y_2)$, are related by:

$$g[t_1,0,y] = f^1(t_1,y)$$

and

$$g[0,t_2,y] = f^2(t_2,y).$$

Specialization implies that one spouse or the other allocates 0 time to the production of a commodity. Thus, with specialization the relevant portion of the household production function is either $g[t_1,0,y]$ or $g[0,t_2,y]$. The new home economics, because it ignores individuals' production functions, never asks about the relationship between the household production function and individuals' production functions. The revelation assumption links the household production function to the individuals' production functions in a way that permits us to infer the individuals' production functions from the household production function. Indeed, we can infer the individuals' production functions even if we do not know the household production function on its entire domain, but only on a highly restricted subset of its domain corresponding to the specialization

[22] Multiple-person households compound this identification problem, requiring an observer to distinguish not only between production and the preferences of the individuals in the household, but also to infer the household governance structure.

household production function. When there is specialization in household production, the revelation assumption implies that we observe the production function of the specialized spouse.

The household production and time allocation literatures have generally followed Becker in assuming that the time inputs of husbands and wives are perfect substitutes in production.

Perfect substitutes assumption: The household production function is of the form

$$g[t_1,t_2,y] = G[t_1 + \alpha t_2,y]$$

where α converts the time input of spouse 2 into units comparable to the time input of spouse 1.

Thus, $(t_1 + \alpha t_2)$ represents the total time input into the production of the focal commodity, measured in "efficiency units" (i.e., $1/\alpha$ hours of the time of spouse 2 is equivalent to one hour of the time of spouse 1). The perfect substitutes assumption does not require $\alpha = 1$ and, hence, it does not imply that the husband's time and the wife's time are equally productive. It does imply that the isoquants in the (t_1,t_2) are linear.

Theorem: The revelation assumption and the perfect substitutes assumption imply that the individuals' production functions are identical to each other except for an "efficiency factor.":

$$f^1(t_1, y) = G[t_1, y]$$

$$f^2(a\, t_2\, , y) = G[\acute{a}t_2, y].$$

Proof: : Perfect substitutes implies that the household production function is of the form

$$g\,[t_1,t_2\, y\,]= G[t_1+\acute{a}t_2, y]$$

so

$g\,[t_1,0,y\,] = f^1(t_1, y) = G[t_1, y]$

$g\,[0,t_2,y\,] = f^2(a\,t_2, y) = G[\acute{a}t_2, y]$.

When can we infer the household production function from individuals' production functions? The *Additivity Assumption* allows us to do so.

***Additivity Assumption*:** Suppose all nonlabor inputs are household private goods which must be allocated between the spouses. The household technology satisfies the additivity assumption if

$$g[t_1, t_2, y] = \max \{f^1(t_1,y_1) + f^2(t_2,y_2)\}$$

subject to $y_1 + y_2 \leq y$.

That is, when the nonlabor inputs are private goods, the additivity assumption implies that input vector (t_1,t_2,y) yields the maximum output the spouses would obtain by allocating nonlabor inputs to maximize total output. The additivity assumption rules out positive and negative externalities associated with side-by-side (i.e., nonspecialized) production. When within household externalities are present, total output may be greater or less than the sum of the outputs that the spouses could produce separately from the specified vector of nonlabor inputs.. Negative externalities are reflected in the adage, "Too many cooks spoil the broth." Positive externalities, suggested by the adage "Many hands make light work," are most plausible in a dynamic setting in which spouses learn from one another.[23]

The additivity assumption is easily modified to take account of cases in which not all of the nonlabor inputs are household private goods. When household time is the only input (i.e., when there are no nonlabor inputs), the additivity assumption becomes:

[23] The adage is perhaps more plausibly interpreted in terms of process benefits associated with side-by-side production: household members may enjoy working together more than they enjoy working separately.

$$g[t_1, t_2] = f^1(t_1) + f^2(t_2).$$

That is, the output associated with side-by-side production is simply the sum of the outputs the spouses could produce separately -- there are no within household externalities associated with side-by-side production. When nonlabor inputs are household public goods, each spouse has full use of the nonlabor inputs.

Additivity Assumption When Inputs Are Household Public Goods:

Suppose all nonlabor inputs are household public goods. The household technology satisfies the additivity assumption when all inputs are household public goods if

$$g[t_1, t_2, y] = f^1(t_1, y) + f^2(t_2, y).$$

I assume that household time inputs are *essential* for positive output.

***Essentiality Assumption*:** If an individual's time input is 0, then that individual's output is 0. If both spouses' time inputs are 0, then household output is 0.

In the additive case, the assumption that individuals' time inputs are essential

$$f^1(0,y) = 0 \quad \text{and} \quad f^2(0,y) = 0$$

implies the corresponding restrictions on household technology:

$$g[t_1,0,y] = f^1(t_1,y) \text{ and}$$

$$g[0,t_2,y] = f^2(t_2,y).$$

Theorem: Suppose that the perfect substitutes assumption, the addtivitiy assumption, and the essentiality assumption hold, and that output is produced by household time alone. Then

$$f^1(t_1) = c\, t_1$$

$f^2(t_2).= c\ \alpha\ t_2$

and

$G[t_1 + \alpha t_2] = c(t_1 + \alpha t_2)$.

That is, each spouse's output is proportional to his or her time input.

Proof: When time is the only input, combining the assumption that the spouses' time inputs are perfect substitutes with the assumption that the household technology is additive implies:

$$g[t_1,t_2] = G[t_1 + \alpha t_2] = f^1(t_1) + f^2(t_2).$$

Making use of the assumption that individuals' time inputs are essential so that a time input of 0 implies 0 output, we obtain

$G[t_1] = f^1(t_1)$

$G[\alpha t_2] = f^2(t_2)$

so

$G[t_1 + \alpha t_2] = G[t_1] + G[\alpha t_2]$.[24]

Differentiating with respect to t_1 yields

$$G'[t_1 + \alpha t_2] = G'[t_1].$$

Because t_2 appears on the left hand side but not on the right hand side, the function G'[ ] must be constant (i.e., independent of t_1 and t_2). Hence, the function G[ ] must be linear in t

$G[t] = b + c\ t.$.[25]

Again making use of the assumption that individuals' time inputs are essential, we conclude that the constant, b, is 0. Hence

[24] This is Cauchy's functional equation (see Aczél and Dhombres, 1989).
[25] Although the argument in the text depends on differentiability, the result does not.

$$G[t] = c\ t$$

so

$$f^1(t_1) = c\ t_1$$

$$f^2(t_2).= c\ \alpha\ t_2$$

and

$$G[t_1 + \alpha t_2] = c(t_1 + \alpha t_2).$$

That is, each spouse's output is proportional to his or her time input.

This specification of the household's technology is unappealing because it is highly restrictive. It is, however, a straightforward consequence of four assumptions:

- output is produced by time alone,
- household time is an essential input,
- household's technology is additive, and
- spouses' time inputs are perfect substitutes.

The first three assumptions are consistent with fatigue or boredom causing productivity to decline as additional time is allocated to the production of a commodity.

Example 1: Consistent with the first three assumptions, suppose the spouses' production functions might be of

the form:

$$f^1(t_1) = A_1\ (t_1)^{\sigma 1} \quad \text{and} \quad f^2(t_2) = A_2\ (t_2)^{\sigma 2}$$

where the parameters σ_1 and σ_2 represent the returns to scale properties of the spouses' technologies. Adding the perfect substitutes assumption rules out both increasing and decreasing returns to scale. That is, imposing the additional assumption that the spouses' time inputs are perfect substitutes implies $\sigma_1 = \sigma_2 = \sigma$ and, furthermore, $\sigma = 1$. Thus,

imposing the perfect substitutes assumption on this particular household technology rules out decreasing returns to scale and implies that both spouses' production functions collapse to the one input constant returns to scale case.

Theorem: Suppose that the household production function is concave, and that the perfect substitutes assumption, the addtivitiy assumption, and the essentiality assumptions all hold. Then

$$G[2t,2y] = 2G[t,y].$$

Proof: $G[t_1 + \alpha t_2, y^*] = G[t_1, y_1] + G[\alpha t_{2,}.y_2]$,

where y^* is allocated between y_1 and y_2 to maximize output.

Let $t_2 = t_1 / \alpha$ so

$G[t_1 + \alpha t_2, y^*] = G[t_1 + t_1, y^*] = G[t_1, y_1] + G[t_{1,}.y_2]$.

Because $G[\ ]$ is concave, allocating y^* to maximize output implies $y_1 = y_2 = y^*/2$. Hence

$$G[t_1 + t_1, y^*] = G[2t_1, y^*] = 2G[t_1, y^*/2]$$

Define $t = t_1$ and $y = y^*/2$. Then

$$G[2t,2y] = 2G[t,y].$$

Theorem: Suppose $G[t,y]$ is concave and $G[2t,2y] = 2G[t,y]$. Then $G[t,y]$ is homogeneous of degree 1:

$$G(\lambda t, \lambda y) = \lambda G(t,y) \quad \text{for all } \lambda > 0.$$

Proof: See Appendix. I own the proof to Massimo Marinacci and Luigi Montrucchio.

Specialization in the production of a commodity means that only one spouse allocates time to its production; that is, $t_1 = 0$ or $t_2 = 0$. Formally, a household exhibits specialization in the production of the focal commodity if the product $t_1\ t_2 = 0$.[26] The alternative to specialization is nonspecialization, $t_1 t_2 > 0$. With an additive technology, if

fatigue or boredom affects productivity, then nonspecialization rather than specialization might be efficient.[27] An example in which Pareto efficiency *requires* nonspecialization involves at least two commodities.

Example 2: Suppose the household produces two commodities each with an additive technology. Suppose further that the individuals' production functions are identical and exhibit decreasing returns to scale. Suppose that both spouses have identical, homothetic, fixed-coefficient preferences, an assumption that fixes the ratio in which a Pareto-efficient household produces and consumes the two commodities regardless of the spouses' bargaining power.[28] Finally, suppose that both spouses allocate some time to household production. Under these conditions, it is easy to see that in an efficient household both spouses allocate time to the production of both commodities and, hence, that efficiency requires nonspecialization.

How does Becker rule out this case and conclude that Pareto efficiency implies specialization? His key assumption is that the time inputs of the spouses are perfect substitutes together with nondecreasing returns to scale. Becker's chapter on multiple-person households focuses on specialization and the division of labor; he presents his conclusions in 5 theorems. To give their flavor, I quote three of these in full:

"Theorem 2.1 If all members of an efficient household have different comparative advantages, no more than one member would allocate time to both the market and household sectors. Everyone with a greater comparative advantage in the

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[26] This definition specialization includes the case in which both t_1 and t_2 are 0.

[27] Nonspecialization rather than specialization might also be Pareto efficient because of the disutility effects of fatigue and boredom, but this requires process (dis)benefits.

[28] In demand analysis, the assumption of identical homothetic preferences avoids aggregation issues because it implies that the aggregate demand functions of a group of individuals are independent of the distribution of income among them.

market than this member's would specialize completely in the market, and everyone with a greater comparative advantage in the household would specialize completely there."

"Theorem 2.3. At most one member of an efficient household would invest in both market and household capital and would allocate time to both sectors."

"Theorem 2.4 If commodity production functions have constant or increasing returns of scale, *all* members of efficient households would specialize completely in the market or household sectors and would invest only in market or household capital." (italics in original)

Four general points deserve attention:

- The statements of the theorems do not include all of the assumptions. Becker explicitly states some additional assumptions in the nearby text, but others are left unstated. In Pollak (2003) I argue that this style of presentation -- results presented as "theorems" without explicit statements of their hypotheses -- is vintage Becker: the "Rotten Kid Theorem" is a prime example.
- The theorems are not restricted to married couple or two-adult households, but purport to apply to all multiple-person households. ftn: ((Ellickson (2006) provides an interesting discussion of governance in complex households, especially nonfamily households.))
- Efficiency in household production is assumed, sometimes explicitly in the statement of the theorems, sometimes in the surrounding text. The efficiency of households and families is a major theoretical and empirical issue. In the light of Becker's Theorem 2.3 ("At most one member of an efficient household would invest in both market and household capital and would allocate time to both

sectors.") a debater arguing that households are often Pareto inefficient might try to score points with the following argument: "We see many households in which both husbands and wives participate in both the market sector and the household sector; hence, these households are inefficient." This argument is flawed, but the flaw is instructive. Becker's specialization conclusion depends on his assumption that there is only one household commodity. With many household commodities, the analogue of Theorem 2.3 does not imply the pattern of specialization between home and market that Becker predicts: in a world with m household commodities, Becker's reasoning implies that one spouse would specialize in m^* household activities and the other spouse in the remaining $m - m^*$ activities. [29]

Empirical evidence of efficiency or inefficiency within families is very scarce. Udry (1996) found inefficiency in the allocation of family labor between men's and women's farm plots in Burkina Faso, but Akresh (2006) casts doubt on whether Udry's findings generalize even to other regions of Burkina Faso. Weiss and Willis (1985, 1993) argue that asymmetric information is a likely source of inefficiency in the context of child support by absent fathers. Lundberg and Pollak (2003) argue that inefficiency is most likely to arise in situations in which couples make big up-front decisions that affect future bargaining power and are unwilling or unable to make binding commitments (e.g., the two- earner couple location problem). Chiappori and his collaborators find no evidence of inefficiency in

[29] This assumes that m is the number of household activities operated at strictly positive levels; it does not include activities to which neither spouse allocates time.

household expenditure patterns, but household expenditure patterns are an unlikely place to find evidence of inefficiency.[30]

- Human capital -- market human capital and household human capital -- plays a central role. Becker says nothing about household physical capital, but recent work, especially Greenwood, Seshadri and Yorukoglu (2005), has emphasized its importance.

Three specific points deserve special notice:

- Some of the theorems assume that there are only two "sectors" -- home and market -- and that these sectors correspond to "commodities." This assumption is crucial for Becker's conclusion about the efficiency of wives specializing in the home and husbands specializing in the market.[31] The assumption that there is only one household commodity is crucial. First, it rules out the possibility that individuals have process preferences, because process preferences would imply additional household commodities. Second, in a world with two household commodities, it might be efficient for the wife to specialize in the production of one commodity and the husband to specialize in the production of the other. The empirical literature on time allocation is now looking at specific household activities or tasks; see, for example, South and Spitze (1994), Stratton (2005) and Bonke, Deding, Lausten, and Stratton (2007).

[30] See, for example, Bourguignon, Browning, Chiappori, and Lechene (1993) and Browning, Bourguignon, Chiappori, and Lechene (1994). But the statistical power of these tests is weak.
[31] At this point in the chapter, Becker's analysis of specialization is gender neutral: he has not yet argued that it is wives who specialize in the home and husbands in the market.

- The assumption that returns to scale are constant or increasing rules out the possibility that an individual who devotes more time to an activity becomes less productive (e.g., as a result of fatigue or boredom). If both spouses experience reduced productivity due to fatigue or boredom and the household technology is additive, then efficiency may require nonspecialization rather than specialization.
- Sometimes in the text, although not in the statements of the theorems, Becker assumes that the time inputs of husbands and wives are "perfect substitutes" (*Treatise*, p. 32). Neither Becker nor the subsequent literature argues the plausibility of the perfect substitutes assumption, yet its role is crucial. Apart from the perfect substitutes assumption and assumptions about returns to scale, Becker says virtually nothing about the technology of married couple households.[32]

The perfect substitutes assumption implies that the isoquants of the household production function are linear in (t_1, t_2) making corner solutions and, hence, specialization, the overwhelmingly likely outcome. Thus, the perfect substitutes assumption comes uncomfortably close to assuming the specialization conclusion. The perfect substitutes assumption does not imply the absence of gender differences in productivities nor does it imply that the individual technologies of the spouses are identical.

The pattern of specialization or nonspecialization in household production depends not only on the production functions for all commodities, but also on preferences and the household governance structure. Hence, the patterns of time allocation cannot be

[32] Some of the theorems begin with assumptions about comparative advantage rather than assumptions about the underlying household technology.

inferred from technology alone. Nevertheless, decreasing returns to scale increases the incentives for nonspecialization, while increasing returns to scale increases the incentives for specialization.

Nonlabor Inputs as Household Public Goods

Consider the case in which the nonlabor inputs are household public good which both spouses can use simultaneously. For example, consider a home in which the heating system does not have thermostats in each room but a single thermostat whose setting imposes the same temperature on all rooms in the house. In this case, the common temperature is a household public good. Denoting nonlabor inputs by y and using the obvious notation, we write $f^1(t_1,y)$ and $f^2(t_2,y)$. Assuming that the household technology is additive, we write

$$g[t_1,t_2,y] = f^1(t_1,y) + f^2(t_2,y).$$

If the time inputs of the spouses are perfect substitutes in production, we have :

$$g[t_1,t_2,y] = G[t_1 + \alpha(y)t_2,y],$$

where the efficiency parameter α depends on the vector of nonlabor inputs. This assumption allows but does not require the efficiency parameter which converts the time input of spouse 2 into units comparable to the time input of spouse 1 to depend on the vector of nonlabor inputs. Making use of the assumption that individuals' time inputs are essential, we obtain

$$G[t_1,y] = f^1(t_1,y)$$

$$G[\alpha(x)t_2,y] = f^2(t_2,y).$$

Hence,

$$G[t_1 + \alpha(x)t_2, y] = G[t_1, y] + G[\alpha(y)t_2, y].$$

Differentiating with respect to t_1 we obtain:

$$G'[t_1 + \alpha(x)t_2, y] = G'(t_1, y)$$

where $G'[t,y]$ denotes the partial derivative of $G[t,y]$ with respect to its first argument. Because t_2 appears on the left hand side but not on the right hand side, the function $G'(t,y)$ must be independent of t_1 and t_2. Hence, the function $G[t,y]$ must be linear in t.[33] :

$$G[t,y] = B(y) + C(y)t.$$

Again making use of the assumption that individuals' time inputs are essential yields

$$G[t,y] = C(y)t$$

and, hence

$$G[t_1 + \alpha(x)t_2, y] = C(y)\,[t_1 + \alpha(y)t_2]$$

or, equivalently,

$$G[t_1 + \alpha(y)t_2, y] = A_1(y)t_1 + A_2(y)t_2$$

where

$$A_1(y) = C(y)$$

and

$$A_2(y) = C(y)\,\alpha(y).$$

Thus, when nonlabor inputs are household public goods, the individuals' production functions are proportional to the time inputs, where the factor of proportionality may depend on the vector of nonlabor inputs. The household production function is linear in the spouses' time inputs, where the coefficient of the spouses time inputs depends on the vector of nonlabor inputs.

[33] Although the argument in the text depends on differentiability, the result does not.

These proportinality and linearity properties imply that the individuals' production functions and the household production function exhibit increasing returns to scale. More precisely, if output is an increasing function of the nonlabor inputs, then the household production function and the individuals' production functions exhibit increasing returns to scale.

Nonlabor Inputs as Household Private Goods

I assume that nonlabor inputs are allocated efficiently between the spouses, although this assumption is not innocuous.[34]

The easy case is one in which α is a constant independent of x. That is, provided we measure the time inputs of the spouses in efficiency units, their production functions are identical. For example, if the wife's technology can be represented by a constant returns to scale Cobb-Douglas production function

$$f^1(t,x) = At^{\beta}y^{1-\beta}$$

then the husband's technology must be a constant returns to scale Cobb-Douglas production function with the same coefficient

$$f^2(t,x) = A(\alpha t)^{\beta}y^{1-\beta}.$$

This is an extremely strong restriction on the spouses' individual technologies: the only admissible difference is that an hour of one spouse's time may be equivalent to $1/\alpha$ hours of the time of the other spouse.

Conclusion

[34] The definition of additivity assumes that the nonlabor inputs are allocated efficiently (i.e., to maximize total output, given t_1 and t_2. The assumption that the constraint $y_1 + y_2 \leq y$ holds as an equality is not entirely innocuous either.

I say that a household technology is "additive" if it is the sum of the individuals' technologies. Additivity -- the assumption that the household's technology is the sum of the spouses' individual technologies -- is a simple and plausible assumption about the relationship between individuals' technologies and household technology.

Decreasing returns to scale is also a plausible assumption about individuals' technologies: if individuals who increase the time they devote to an activity become tired or bored, and if this causes them to become less productive, then their production functions exhibit decreasing returns to scale. If household technology is additive and exhibits decreasing returns to scale, I show that production efficiency may require nonspecialization (i.e., that the spouses engage in side-by-side production.)

Additivity and Becker's assumption that spouses' time inputs are perfect substitutes are compatible only in a narrow class of cases. More specifically, if time is the only input into household production, then additivity and perfect substitutes imply that individuals' production functions and household production functions are linear in the spouses' time inputs.

I argue that specialization conclusions rest on auxiliary assumptions to which neither economic theory in general, nor the household production model in particular, have any commitment. These include assumptions about household preferences (e.g., the absence of "process benefits"), household technology (e.g., nondecreasing returns to scale; spouses' time inputs are perfect substitutes), and the number of "commodities" (e.g., one household commodity).

In retrospect, the greatest contribution of the new home economics has been to focus attention on behavior *within* households and families. Specialization and the division of labor in families and households are central empirical and theoretical issues. Becker's specialization claim -- in efficient married couple households, husbands specialize in the market sector and wives in the household sector – has dominated the theoretical landscape. Since the 1950s, sector specialization has declined, while activity specialization is alive and well in married couple households. To understand these changes requires moving beyond the special assumptions of Becker's *Treatise on the Family*.

References:

Aczél, J., and J. Dhombres, *Functional Equations in Several Variables*, Cambridge: Cambridge University Press, 1989.

Akresh, Richard, "Understanding Pareto Inefficient Intrahousehold Allocations," IZA Discussion Paper No. 1858, May 2006.

Becker, Gary S., "A Theory of the Allocation of Time," *Economic Journal*, Vol. 75, No. 299, (September 1965), 493-517.

Becker, Gary S., "Human Capital, Effort, and the Sexual Division of Labor," *Journal of Labor Economics*, Vol. 3, No. 1, pt. 2, (January 1985), S33-S58.

Becker, Gary S., *A Treatise on the Family*, Cambridge: Harvard University Press, 1981; Enlarged edition, 1991.

Ben-Porath, Yoram, "The F-Connection: Families, Friends, and Firms and the Organization of Exchange," *Population and Development Review*, Vol. 6, No. 1, (March 1980), 1-30.

Bonke, Jens, Mette Deding, Mette Lausten, and Leslie Stratton, "Intrahousehold Specialization in Housework in the United States and Denmark," IZA Working Paper No. 2777, May 2007.

Bourguignon, François, Martin Browning, Pierre-André Chiappori, and Valerie Lechene, "Intra Household Allocation of Consumption: A Model and some Evidence from French Data," *Annales d'Economie et de Statistique*, No. 29, (January/March 1993), 137-156.

Browning, Martin, François Bourguignon, Pierre-André Chiappori, and Valerie Lechene, "Income and Outcomes: A Structural Model of Intrahousehold Allocation," *Journal of Political Economy*, Vol. 102, No. 6, (December 1994), 1067-1096.

Chiappori, Pierre-Andrė, "Rational Household Labor Supply," *Econometrica*, Vol. 56, No. 1, (January 1988), 63-89.

Chiappori, Pierre-Andrė, "Collective Labor Supply and Welfare," *Journal of Political Economy*, Vol. 100, No. 3, (June 1992), 437-467.

Ellickson, Robert C., "Unpacking the Household: Informal Property Rights Around the Hearth," *Yale Law Journal*, Vol. 116, No. 2, (November 2006), 226-328.

Folbre, Nancy, "A Theory of the Misallocation of Time," in Folbre and Bittman, eds., *Family Time: The Social Organization of Care*, London: Routledge, 2004, 7-24

Greenwood, Jeremy, Ananth Seshadri and Mehmet Yorukoglu, "Engines of Liberation," *Review of Economic Studies*, Vol. 72, No. 1, (January 2005), 109-133.

Lundberg, Shelly, "Limits to Specialization: Family Policy and Economic Efficiency," June, 2002.

Lundberg, Shelly, "Gender and Household Decision-Making," Lecture notes, University of Siena International School of Economic Research, XVIII Workshop on Gender and Economics, 4-7th July 2005. Forthcoming in *Frontiers in Gender Economics*, ed. Francesca Bettio, Routledge.

Lundberg, Shelly and Robert A. Pollak, "Efficiency in Marriage," *Review of Economics of the Household*, Vol. 1, No. 3, (September 2003), 153-168.

Lundberg, Shelly and Robert A. Pollak, "The American Family and Family Economics," *Journal of Economic Perspectives*, Vol. 21, No. 2, (Spring 2007), 3-26.

Lundberg, Shelly and Robert A. Pollak, "Family Decision-Making," forthcoming in *The New Palgrave, Dictionary of Economics, 2nd Edition*, Larry Blume and Steven Durlauf, eds. Palgrave Macmillan, 2007.

Manser, Marilyn and Murray Brown, "Marriage and Household Decision-Making: A Bargaining Analysis," *International Economic Review*, Vol. 21, No. 1, (February 1980), 31-44.

McElroy, Marjorie B. and Mary J. Horney, "Nash-Bargained Household Decisions: Toward a Generalization of the Theory of Demand," *International Economic Review*, Vol. 22, No. 2, (June 1981), 333-349.

Mincer, Jacob, "Market Prices, Opportunity Costs, and Income Effects." In C. Christ et al., eds., *Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld*, Stanford: Stanford University Press, 1963. 67-82.

Nerlove, Mark, "Household and Economy: Toward a New Theory of Population and Economic Growth," *Journal of Political Economy*, Vol. 83, No.2, Part II, (March/April 1974), S200-S218.

Pollak, Robert A., "Gary Becker's Contributions to Family and Household Economics," *Review of Economics of the Household*, Vol. 1, No. 1-2 (January-April 2003), 111-141.

Pollak, Robert A., "Samuelson's 'Dr. Jekyll and Mrs. Jekyll' Problem: A Difficulty in the Concept of the Consumer." In M. Szenberg, L. Ramrattan, and A. Gottesman, eds., *Samuelsonian Economics and the Twenty-First Century*, Oxford: Oxford University Press, 2006, 116-126.

Pollak, Robert A. "Bargaining Around the Hearth," *Yale Law Journal Pocket Part* 116 (April 16, 2007) 414 http://thepocketpart.org/4/16/pollak.html NBER Working Paper 13142, May 2007.

Pollak, Robert A., and Michael L. Wachter, "The Relevance of the Household Production Function and Its Implications for the Allocation of Time," *Journal of Political Economy*, Vol. 83, No. 2, (April l975), 255-277.

Reid, Margaret G., *Economics of Household Production*, New York: John Wiley & Sons Inc., 1934.

Rosen, Sherwin, "The Theory of Equalizing Differences," in O. Ashenfelter and R. Layard, eds., *Handbook of Labor Economics*. Vol. 1. Amsterdam: North Holland, 1986, 641-692.

Samuelson, Paul A., "Social Indifference Curves," *Quarterly Journal of Economics*, Vol. 70, No. 1, (February 1956), 1-22.

South, Scott J. and Glenna Spitze, "Housework in Marital and Nonmarital Households," *American Sociological Review*, Vol. 59, No. 3, (June 1994), 327-347.

Stratton, Leslie S., "The Degree of Intrahousehold Specialization in Housework and How Specialization Varies Across Couple Households," May 2005.

Udry, Christopher, "Gender, Agricultural Production and the Theory of the Household," *Journal of Political Economy*, Vol. 104, No. 5, (October 1996), 1010-1046.

Weiss, Yoram, and Robert J. Willis. "Children as Collective Goods in Divorce Settlements," *Journal of Labor Economics*, Vol. 3, No. 3, (July 1985), 268-292.

Weiss, Yoram, and Robert J. Willis, "Transfers among Divorced Couples: Evidence and Interpretation," *Journal of Labor Economics*, Vol. 11, No. 4, (October 1993), 629-679.