Gary Becker's "A Theory of the Allocation of Time"

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Abstract

Becker's (1965) paper, "A Theory of the Allocation of Time" revolutionized the modeling of household behavior, by unifying Marshallian demand functions for goods with labor supply and related time use decisions within the household. In this paper we first summarize Becker's time allocation model and associated key contributions, then we show how his original framework extends to modern collective household models.

1 Introduction

In, "A Theory of the Allocation of Time," Gary Becker (1965) stated that his goal was to provide, "a basic theoretical analysis of choice that includes the cost of time on the same footing as the cost of market goods" (p. 494). He notes that economists before him routinely accounted for foregone earnings from devoting time to human capital investment rather than working, but, "economists have not been equally sophisticated about other non-working uses of time" (p. 493-94).

Becker (1965) is not the first paper to consider time use in the home, e.g., he cites Jacob Mincer (1962), which considers a married woman's time trade-off between housework and paid work. Nor is it quite the first to propose a household production function, in which purchased goods are converted into commodities like meals that generate utility. An earlier household production paper he does not cite is Terence Gorman (1980), which was written in 1956 and widely circulated as a working paper for decades before it was finally published.

However, what Becker does uniquely do is merge goods consumption with time use in the production of household utility. Previous models of labor supply considered consumption and leisure as distinct goods that

separately provide utility. In contrast, Becker emphasizes that there are many different types of time use, just as there are many types of consumption goods, and that different types of time use and consumption goods combine in different ways to yield commodities, e.g., prepared meals, from which we get utility. He then draws a variety of important implications from the observation that various types of time and consumption combine into a single household objective function with a single overall budget constraint. In doing so, Becker (along with Mincer) created the foundational modeling framework for virtually all modern household level analyses of consumption and time use, in what was sometimes called the "New Home Economics."

Becker's model is in some ways more general than those in common use today, in particular, he emphasizes that different types of time (e.g., weekends vs weekdays) should have different shadow prices within the household. This is in contrast to the vast majority of models today that associate a single observable wage rate to each individual's time.

For the most part the modern literature has generalized Becker in two main directions. One is that modern models are often dynamic and forward looking. Becker would have recognized the current typical assumption of time additivity of utility as a natural extension, but although he wrote his time allocation theory after John Muth's (1961) introduction of rational expectations, the forward looking rational expectations revolution was not pushed forward by his colleague Robert Lucas and others until later.

But perhaps the most substantial difference between modern formulations and Becker (1965) is the application of another line of his research, namely, Becker's (1974), "A Theory of Social Interactions." Becker's original time allocation theory treats the household as maximizing a single utility function, and so the household behaves in ways that are empirically indistinguishable from the behavior of a single utility maximizing individual. In modern terminology, this is called a "unitary" model. Many of the behavioral implications of the consumption-leisure trade-off that Becker points out were difficult to verify empirically, in part because of the unitary model's observational equivalence between the purchasing behavior of one person and that of a family.

However, as Becker (1974) observes, the allocation of resources within a household is determined by bargaining among household members, with outcomes that may therefore depend on the determinants of the bargaining power of each household member (what later became known as distribution factors). In general, the existence of a decision process involving several agents can produce household demand functions that are no longer equivalent to those obtained by maximizing a single well

behaved household utility function. This has led to the rise of collective household models, where nonunitary behavior is exploited to empirically identify and estimate resource allocations and other intrahousehold behavior.

In the next section we summarize Becker's model and key contributions. Later sections consider econometric issues that arise in bringing Becker's model to data, and the extension of Becker's work to nonunitary models, thereby showing how his original theory of time allocation has evolved into modern collective household models. Section 4 concludes.

2 Time for Becker

Becker's model starts with households having a utility function $U(Z_1,...,Z_m)$ over quantities of commodities $Z_1,...,Z_m$. Each commodity Z_i is produced by the household using a production function $Z_i = f_i(x_i, T_i)$, where each x_i is a bundle (quantity vector) of goods purchased at the vector of prices p_i, and T_i is a bundle of time use quantities. Becker defined T_i as a vector also, to distinguish between, e.g., daytime from nighttime hours, or weekdays from weekends. Moreover he assigns a vector of wage rates w_i to T_i, thereby assuming that, e.g., the cost of a unit of time on weekends and weekdays would generally be different.

Rather than have one budget constraint for goods and another one for time, Becker's first insight is that, despite the complexity of nesting m production functions inside a utility function, the household can still simply trade off time for money, and so only faces the single budget constraint $\sum_{i=1}^{m} p_i' x_i + w_i' T_i \leq S$. Much of his analysis then consists of drawing implications from the fact that the household faces just one constraint.

Becker called S full income (crediting Milton Friedman for helping invent the term), and notes that full income is fixed and easily interpreted only if average wage rates w_i do not depend on T_i. Although the vast majority of household demand models today make this fixed wage assumption, Becker thought this case was "special and unlikely," and did not impose it for most of his analysis. So for Becker, full income is defined by maximizing an "earnings" function $W(Z_1,...,Z_m)$ subject to the household's single budget constraint and to the production functions for each commodity. In this more general framework, average time costs w_i do not generally equal marginal time costs (both are functions of the chosen bundles of goods and time), and of course marginal costs are what determine behavior. However, one still gets the useful two stage decomposition of the household's problem, in which we can decompose the problem into first calculating full income S, then maximizing household utility $U(f_1(x_1, T_1),...,f_m(x_m, T_m))$ under the single budget constraint

that total resources do not exceed S.

Much of Becker's subsequent analysis consists of examining the first order conditions associated with the household's maximization problem, and extending traditional Marshallian income and substitution effects to trade-offs between time use and consumption. In doing so, he notes that the traditional division of time into labor (market and not) vs leisure, treating all leisure as essentially the same, is inappropriately simplistic. Some uses of time may be difficult to categorize, e.g., is commuting to work labor or leisure? What about an afternoon nap that makes you more productive the rest of the day? For Becker, attempts at such categorization are both unnecessary and irrelevant. The only economically relevant features of any type of consumption or leisure activity are its associated foregone earnings and contributions to utility. One strength of his model is that it can incorporate these types of "productive consumption."

Becker proceeds to describe many implications of his model. For example, even if consumers all pay the same market prices for consumption goods, variation in earnings across individuals results in cross sectional variation in the shadow prices for consumption goods, and as a result, estimated Engel curves will, by omitting these shadow price effects, tend to underestimate the true income effects of earnings-intensive goods. He goes on to suggest that child care is likely to be earnings-intensive (by taking up a lot of time that could otherwise have produced income), and this effect could partly explain the low income elasticity of the demand for children.

Other implications he considers, which are second nature for economists now but were novel at the time, include adding the shadow costs of commuting time (in foregone labor or leisure) to the direct costs of commuting to work, or observing that as wages rise, people will tend to waste more food in an effort to save on meal preparation or shopping time.

3 Some econometric issues

Becker engages in extensive "casual empiricism," showing how his model can be used to interpret a host of observed economic phenomena, but he does not attempt any formal identification or estimation of parameters. In this section, we discuss issues associated with bringing versions of his model to data in a more formal manner. What type of data would be needed to perform statistical tests of Becker's theory? And to what extent can his models be econometrically identified, i.e., when can underlying concepts like individual utility functions and household production functions be recovered from observed household behavior?

Since the theory deals with the allocation of time, a minimal requirement is that this allocation should be observable, so empirical researchers should observe time use data. Moreover, since Becker's theory postulates that each consumed good Z_i is produced using time and a bundle of goods x_i purchased at the vector of prices p_i, it would be desirable to observe the household's demand for produced goods, that is, to recover each Z_i as a function of prices, wages and non labor incomes.

Whether ultimate consumption goods Z_i are observable is debatable; the answer mostly depends on the context. For example for rural households in developing economies, a large component of consumed goods Z_i are the outcomes of actual, observable production processes (e.g., grown crops) that may be recorded. Alternatively, one may think of (some of) the Z_i as human capital, produced through education and other types of investments. Then some (possibly noisy) output indicators may be available: school performance, health status, nutrition, etc. A testimony to Becker's influence is the extent to which a significant fraction of the empirical literature has taken this route and tried to estimate the corresponding production functions A prominent example is Heckman's (2013) presidential address to the Econometric Society. Still, it is fair to say that Becker's analysis is not primarily intended to address observable outputs. The model is much more general: in Becker's view, the conceptual relevance of the model does not hinge on the observability of Z_i.

Equally problematic are the relevant 'wages' (or, more precisely, shadow prices of various types of time). The simplest approach, that has been adopted by most of the literature, is to assume that each household member has a unique shadow price for time equal to their market wage (and, as such, exogenous to the allocation of time); a case that, as noted above, Becker considered as "special and unlikely." However, for empirical work this simplifying assumption is hard to avoid, at least if testability and identifiability are to be established. Specifically, consider Becker's model as described above, and assume that for each 'productive consumption' good i, one can observe the vectors x_i, T_i, p_i *and* w_i. Then in theory one could observe (and in practice one could estimate) the time supply and commodity demand functions:

$$x_i = x_i\left(w_1, ..., w_m, p_1, ..., p_m\right)$$
$$T_i = T_i\left(w_1, ..., w_m, p_1, ..., p_m\right)$$

Testable properties these functions must satisfy are then straightforward to derive, based on the separability properties of the model. Specifically, define s_i as total expenditures on commodity i:

$$s_i = p_i' x_i + w_i' T_i$$

Then for each i, (x_i, T_i) solves the program:

$$\max f_i(x_i, T_i)$$

under the constraint $p_i' x_i + w_i' T_i = s_i$. In other words, there exist functions τ_i and ξ_i such that:

$$x_i = x_i(w_1, ..., w_m, p_1, ..., p_m) = \xi_i(w_i, p_i, s_i)$$
$$T_i = T_i(w_1, ..., w_m, p_1, ..., p_m) = \tau_i(w_i, p_i, s_i)$$

which generates standard rank restrictions on observed supply and demand functions. Moreover, knowledge of the τ_i and ξ_i functions would then allow the researcher to identify the production function f_i up to a monotonically increasing transform, even when the associated output Z_i is not observed. In particular, the marginal rates of substitution between time and physical commodities, which characterize the crucial trade-off Becker is interested in, can then be identified from observed behavior.

This construction becomes much more problematic when the shadow price (or prices) of time remain unobservable. While testable restrictions can still be derived, they are both limited and complicated. Moreover, in this case the model will typically not be identified. Specifically, with unobserved shadow prices for time there will in general exist a continuum of different combinations of utility and production functions that are observationally equivalent, in that they generate the same observable demands and time allocations.

In summary, users of Becker's model face a difficult choice: its fully general version, although conceptually attractive, is too broad to permit empirical identification of its core notions. This is perhaps exemplified by Pollak (2003), who shows that some strong conclusions Becker later arrived at using his model could be overturned by relaxing simplifying assumptions, while still remaining entirely within Becker's general framework.

4 Time for Collectives

As mentioned earlier, one limitation of Becker (1965) is that it treats the household as maximizing a single utility function, or household social welfare function, imposing what would now be called a unitary model. He devotes just a single paragraph to consideration of division of labor and goods among household members, noting little more than that time allocations are interdependent, so members with higher wages would use less of their time on consumption generating activities than others. Although, formally, the framework he adopts can encompass individual-specific time in the production function, Becker does not follow this

path in this paper; his seminal work on division of labor within the household came later. See, e.g., Becker (1974) and, for a comprehensive presentation, Becker (1981).

Recent work in this literature emphasizes the relevance of Becker's allocation of time framework for analyzing issues related to household behavior and intrahousehold allocation from a nonunitary framework. Most empirical work in this literature uses the so-called 'collective' approach, whereby members each have their own utility function, commodities may be privately or publicly consumed, and the household makes Pareto efficient decisions. This implies that the household maximizes a weighted sum of individual utilities, where the (Pareto) weights may depend on prices, wages, incomes and the economic environment in general.[1]

Becker's time allocation and household production framework readily extends to this collective framework, which permits analysis of many policy relevant issues. For example, an important question regards the relationship between male and female time within household production functions. If male and female time are perfect substitutes for home production (as assumed by Becker himself in other contributions), then one expects a specialization result: the member with a comparative advantage in domestic production is likely to give up market work altogether. On the contrary, if they are complements, then typically both husband and wife may work both at home and on the market. Pollak (2012) provides a modern reconsideration of the issue of household labor specialization.

New and important issues arise in the non-unitary context. The notion of 'power' within the household, which is de facto omitted in a unitary framework, becomes crucial, and has a natural interpretation in terms of Pareto weights. Loosely speaking, keeping the cardinal representation of preferences unchanged, a shift of power over resources in favor of one member (say, the wife) will correspond to a relative increase in her Pareto weight. The question then arises, what would be the impact of such a power shift on the intrahousehold allocation of time? This is a difficult problem, for which a Beckerian representation is indispensable, if only because the answer closely depends on the properties of the household production functions, as well as on the nature of, and tastes for, the produced commodities.

To give an example, if produced commodities are 'marketable' (in the sense that they can be purchased or sold on a competitive market, as would be the case, e.g., for agricultural production), and if shadow values of time are exogenous (as when both spouses work on the market and

[1] See Browning, Chiappori and Weiss (2014) for a detailed presentation.

have wages equal their marginal value of time), then efficiency requires that intrahousehold production decisions be driven by profit maximization, and therefore be independent of each spouse's relative power over household allocations. If, on the contrary, internally produced commodities are not marketable, but the production function exhibits constant returns to scale (with respect to time inputs), then the ratio of male to female domestic time depends only on the ratio of the male to female wage rate. In this case, changes in power may affect the volume of household production (as when the spouses value internally produced commodities differently), but then male and female domestic time should either both increase or both decrease. See Blundell, Chiappori, and Meghir (2009) and Browning, Chiappori and Weiss (2014) for a more extensive analysis of these issues.

Finally, the collective extension of Becker's framework has generated a host of recent empirical work aimed at econometrically estimating household production functions and the associated allocation of resources among family members. Browning, Chiappori and Lewbel (2013) consider a model in which individuals' preferences over goods do not depend on their marital status, but marriage gives access to a different (and potentially more productive) domestic production technology. They show that, under this assumption, observable demand functions of singles and couples generally provides sufficient information to identify individual preferences, the household's production technology, and the intrahousehold allocation of power as summarized by the 'sharing rule'. This approach was later extended (and some of its assumptions relaxed) by Dunbar, Lewbel and Pendakur (2013), who apply their framework to intrahousehold allocation in Malawi. Moreover, while Browning, Chiappori and Lewbel (2013) does not include time allocation in the household production as Becker did, their model can be readily extended in this direction. See for instance Couprie and Ferrant (2012).

Another important contribution is due to Cherchye, De Rock and Vermeulen (2012), who propose a collective labor supply model with household production that generalizes several previous contributions. In their framework, adults' preferences depend not only on own leisure and individual private consumption of market goods, but also on the consumption of Becker type commodities, which are produced by combining market goods with individuals' time. They provide conditions that, while requiring detailed household level data, suffice to identify the entire model, including individual preferences, production functions and the Pareto weights. In particular, the trade-offs between time and consumption of goods, stressed in Becker's initial work, can be recovered for each household member in their model. An application to data

on Dutch couples with children is provided. Quite uniquely, their data set fulfills all the requirements evoked above; i.e., they observe detailed information about wages, prices, consumption, labor supply, and time use within the household.

Recognizing the importance of household effects, other rich data sets are starting to become available, e.g., recent waves of the US Panel Study of Income Dynamics surveys have augmented household level wage and incomes with detailed consumption measures. Given the ongoing progress on both data collection and theoretical modeling, we expect to see many further applications and extensions of Becker's work in the near future.

5 Conclusions

Becker's approach to family economics is so mainstream today that it is difficult to recognize how revolutionary his models and methods were at the time. Pollak (2003) documents how many researchers were openly hostile to Becker's application of mathematical microeconomic tools to intrahousehold decision making. Many believed Becker's analyses were sterile and vacuous, and it was considered cold and immoral to think about loving families in such terms. In contrast, the enormous literature on family economics that exists today vindicates Becker's methodology.

The works cited here, and many others, extend Becker's ideas well beyond his initial framework. But this is above all a testimony to the fecundity of the insights he put forth in his 1965 *Economic Journal* paper. As such, it is fair to say that they are all part of his legacy.[2]

6 References

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[2]For a detailed analysis of Becker's influence on the so-called New Home Economics, see Grossbard (2001)

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