

INTRODUCTION TO A THEORY OF THE ALLOCATION OF TIME BY GARY BECKER*

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Gary Becker's classic study, 'A theory of the allocation of time', laid the analytical foundations for the study of household production and the allocation of time within the household. It spawned a large literature and continues to influence economics and other social sciences.

The article was written when Becker was in his mid-30s, teaching at Columbia University and conducting research at the National Bureau of Economic Research, then headquartered in New York. Over the period 1958–69, Becker, along with Jacob Mincer, organised the legendary Columbia Labour Economics Workshop. Becker, Mincer and their students applied price theory to study the economics of fertility, labour supply, income inequality, education, on-the-job training, crime and punishment and the theory of irrational behaviour, among other topics. The interplay between theory and data was the hallmark of that group. From this crucible emerged the modern theory of human capital (Becker, 1964, 1975) and important components of the modern economics of the family that were distilled and extended in Becker's classic *A Treatise on the Family* (1981, enlarged in 1991). A generation of productive and influential scholars was trained at Columbia during this period (Heckman, 2014).

In his introduction to this article, Becker discusses the body of research on the economics of time that was being conducted at Columbia, to which he contributed and from which he had drawn. This article is the analytical synthesis of a body of ideas developed in that intense intellectual climate.

Many scholars have tried to disentangle the contributions of Jacob Mincer from those of Gary Becker during the period of their synergistic collaboration. Attempts to do so miss the highly interactive and mutually supportive intellectual environment of the Columbia group and the ability of Becker to create clean analytical insights from diverse bodies of empirical work and to stimulate all those around him.

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1. Some Background on This Article

Prior to the work of Becker, the household had a shadowy place in analytical economics. Mitchell (1912) wrote about the ‘backward art of spending money’ and compared the efficiency of firms in producing goods for the market to the inefficiency of households in producing domestic services. Kuznets (1934) lamented that GNP accounts omitted important components of household production.¹ Reid (1934) wrote a textbook on home production aimed at students of home economics. It offered practical advice, sketched some analytical principles and offered interesting speculation about the future of the household and the role of women.²

It was not until the work of Becker (1965) that economists began to model households formally as engaged in activities producing outputs such as food, children and housing (the Z_i for commodity i in his article) that bundled goods and time. The household consumed these commodities as the direct objects of utility.³ The outputs of the activities were produced by distinct inputs.⁴ The commodities were associated with consumption in different time periods (Ghez and Becker, 1975) or production of different activities (meals, health, housing, child rearing) as in Becker (1965), Muth (1966), Grossman (1972*a, b*) and Michael (1972, 1973).⁵ Becker and Mincer breathed empirical life into these models and spawned a large literature (Gronau, 1970, 1977, 1986, 1997, 2008; Grossman, 1972*a, b*; Michael, 1973, 1974; Michael and Becker, 1973; Leibowitz, 1974; Rosenzweig and Schultz, 1983; Juster and Stafford, 1985, 1991; Pollak, 2003).

The Becker–Mincer research on human capital (Mincer, 1958, 1962*a*, 1974; Becker, 1962, 1964, 1975) emphasised the importance of time foregone from earnings as the primary cost of education and job training, far more important than costs arising from tuition or fees. In other work, Mincer (1962*b*, 1963) made a major contribution to empirical research on the labour supply of women by isolating the effects of wages (the price of time) from pure income effects, explaining both the cross-section and time series of married female labour supply.⁶

While Robbins (1930) had previously distinguished income effects from substitution effects in labour supply, the empirical literature on female labour supply had not made this distinction. Long (1958), in an extensive empirical study, emphasised the role of consumer durables in releasing female time from housework for market uses but did

¹ See Bridgman *et al.* (2012) for a recent discussion of household production in national accounts. Nordhaus and Tobin (1973) created estimates of non-market production to supplement GNP accounts. See also the National Research Council (2005) chapter ‘Home Production,’ and Stiglitz *et al.* (2009).

² Gary Becker checked out her book from the University of Chicago Library in 1956.

³ Muth (1966) modelled household production in this fashion but did not focus on the crucial role of time or on the range of phenomena analysed by Becker. Gorman (1956, 1980) and Lancaster (1966, 1971) analysed the demand for characteristics produced by goods. Characteristics in that model play a role analogous to commodities in Becker’s model. As in Becker’s model, goods produce outputs that are valued in final consumption. In Becker’s model, goods are allocated to produce a single commodity. In the Gorman–Lancaster model, the same market goods can produce multiple characteristics (commodities) so there is joint production, which is ruled out in Becker’s model. See Pollak and Wachter (1975) and Gronau (1986).

⁴ Later work incorporated joint production (Pollak and Wachter, 1975).

⁵ Closely related analytically was the work on separability in preferences studied by Strotz (1957) and Gorman (1959). See also Green (1964) and Blackorby *et al.* (1978).

⁶ Mincer (1963) analysed the bias in estimating pure income effects when the price of time was omitted from consumer demand analyses.

not study the effects of wages on labour supply.⁷ In a similar spirit, Becker's (1960) early work on fertility focused on income effects and did not discuss the importance of female time and its price in explaining fertility.⁸ It was Mincer who first emphasised the role of the rise in the wage of women as a primary force explaining the growth of female labour supply.

Mincer (1962*b*) introduced another feature of household production that is formalised in Becker (1965). Mincer claimed that the multiple uses of non-market time (in child care and other household activities) produced a greater wage elasticity for women than for men because they faced more margins of substitution. While formally this argument is incorrect, the intuition behind it is powerful and continues to shape thinking about female labour supply (Heckman, 1988).

2. The Becker Model

The household is assumed to produce and consume a vector of commodities $\mathbf{Z} = (Z_i), i = 1, \dots, I$. These commodities are associated with different levels of activities performed by the household (e.g. consumption of food, child-rearing, leisure activities), including leisure on the job (Juster and Stafford, 1985; Aguiar and Hurst, 2007; Aguiar *et al.*, 2012). Utility is a function of these commodities:

$$U(Z_1, \dots, Z_I), \quad (1)$$

where

$$Z_i = f^{(i)}(\mathbf{X}_i, T_i), \quad i = 1, \dots, I. \quad (2)$$

\mathbf{X}_i is a vector of goods used to produce Z_i and T_i is time (usually assumed scalar but allowed to be a vector in Becker, 1965).⁹ The price of Z_i depends on the prices of its components. Assuming that each $f^{(i)}$ is homogeneous of degree 1, one can construct a scale-invariant price index π_i for each commodity.

The household faces both time and traditional budget constraints. Using elementary algebra, Becker shows that under his assumptions the household effectively faces one constraint.¹⁰ Under the assumption that T_i is scalar, and that the price of time is w across all uses, the maximum amount of income that the person can earn is full income $B = wT + V$ where $T = \sum T_i$ and V is the amount of unearned income accruing to the household. The Z_i encompass all activities in which time can be used (including the consumption of leisure on the job) and

$$\sum_{i=1}^I \pi_i Z_i = wT + V = B. \quad (3)$$

The household is assumed to maximise (1) subject to (2) and (3). The demands for inputs \mathbf{X}_i, T_i are derived from the demands for Z_i . The responsiveness of the demands for different activities in response to changes in the prices of goods and time depends,

⁷ Greenwood *et al.* (2005) formalise Long's idea in a general equilibrium setting.

⁸ However, he hints at the role of the price of time in his footnote 7.

⁹ See Becker (2007*a*) for one exposition of this model.

¹⁰ See Heckman (1988) for an analysis of households facing multiple constraints.

in part, on the time and goods intensities in producing the commodities. Becker goes on to develop a more general analysis where the marginal cost of time varies across activities.

Becker's model of commodity demand is an instance of Gorman's (1959) general separability analysis where U is weakly separable in the arguments producing the Z_i , and the $f^{(i)}$ are homogeneous of degree 1.¹¹ Under homogeneous weak separability, consumer decision making can be characterised by a two stage budgeting process. Agents allocate budgets E_i to each commodity i , based on the price index π_i and in a second stage maximise each Z_i subject to these allocations determined from the first stage to determine X_i and T_i (Strotz, 1957; Gorman, 1959).¹² Pollak and Wachter (1975) present a definitive analysis of the limitations of the Becker model when the assumption of homogeneous separability is relaxed and when joint production is considered.¹³ See also the discussion in Gronau (1977, 1986).¹⁴

3. Its Influence

Although others had developed analytical frameworks with similar features, Becker's great contribution was to apply the model to interpret a broad array of empirical phenomena and to inspire the generations that followed in his wake to investigate the economics of home production. The concept of non-market production of human capital (Ben-Porath, 1967), children (Becker and Lewis, 1973; Willis, 1973), health (Grossman, 1972*a,b*; Becker, 2007*b*), the value of life (Viscusi and Aldy, 2003), the production of child quality (Leibowitz, 1974; Cunha and Heckman, 2007), transportation (Gronau, 1970), the consumption of leisure on-the-job (Juster and Stafford, 1985; Aguiar and Hurst, 2007; Aguiar *et al.*, 2012) are just a few of the numerous applications of these ideas.¹⁵ Becker's article also stimulated the collection of data on time use in household production (Juster and Stafford, 1985, 1991; Aguiar *et al.*, 2012).

4. Theory of Labour Supply

When Becker's article was initially published, many scholars noted that under the assumption that the price of time was uniform across alternative uses, application of Hicks's composite commodity theorem (Hicks, 1939) leads back to the elementary analysis of labour supply by Lionel Robbins. All non-market time can be aggregated into a single composite 'leisure' (Heckman, 1988). There was no need for household production theory to analyse the supply of labour to the market.

¹¹ However, Gorman does not specifically analyse time or allow marginal prices to vary across activities.

¹² See Green (1964) and Blackorby *et al.* (1978) for discussions of this literature.

¹³ They stress a key limitation that time spent in producing commodities is not valued in itself. Thus, in producing children, the time spent in producing them is not valued, although the final output is. For a discussion of estimation of non-separable technologies see Pollak and Wales (1987).

¹⁴ Gronau (1977) distinguishes between the non-utility bearing use of time in producing goods (work at home) from use of time in producing utility.

¹⁵ Gronau (1997) gives a useful survey of the applications of the model in both micro and macro economics.

While formally true, this commentary misses several key points. First, Becker analysed a situation in which the marginal prices of time may differ in different uses.¹⁶ Second, his article reconciled the Long (1958) interpretation of the growth of the labour supply of women as arising from a shift in the supply of labour through the introduction of labour-saving consumer durables, and the model favoured by Mincer (1962*b*) that shifts in the demand for female labour led to higher wages and higher labour supply (Greenwood *et al.*, 2005).

More generally, Becker's framework allowed for a deeper understanding of the mechanisms of consumer choice, and interpretation of income and substitution effects. Its continuing relevance to empirical economics is a testimony to its power.

5. Developments After This Article

Becker was near the beginning of his long and productive career when he wrote this article. He elaborated the model in his later work. However, the analytical framework of household production theory developed in this article remained a pillar of his later work on the economics of the family and the economics of non-market activities more generally.

He devotes only one paragraph of this article to the idea that household members might specialise in the production of commodities. He developed it much further in Becker (1973, 1974, 1981, 1991). There he developed theories of household formation and marital sorting and investigated the consequences of intrahousehold specialisation in tasks for life cycle earnings and productivity.¹⁷ For a recent exposition of the development of these themes, see Browning *et al.* (2014).

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References

- Aguiar, M. and Hurst, E. (2007). 'Measuring trends in leisure: The allocation of time over five decades', *Quarterly Journal of Economics*, vol. 122(3), pp. 969–1006.
- Aguiar, M., Hurst, E. and Karabarbounis, L. (2012). 'Recent developments in the economics of time use', *Annual Review of Economics*, vol. 4, pp. 373–97.
- Becker, G.S. (1960). 'An Economic Analysis of Fertility', in *Demographic and Economic Change in Developed Countries*. New York, NY: Columbia University Press, pp. 209–40. <http://www.nber.org/chapters/c2387>. (last accessed: 12 November 2014).
- Becker, G.S. (1962). 'Irrational behavior and economic theory', *Journal of Political Economy*, vol. 70(1), pp. 1–13.
- Becker, G.S. (1964). *Human Capital: A Theoretical and Empirical Analysis, With Special Reference to Education*. New York: National Bureau of Economic Research.
- Becker, G.S. (1965). 'A theory of the allocation of time', *ECONOMIC JOURNAL*, vol. 75(299), pp. 493–517.
- Becker, G.S. (1973). 'A theory of marriage: Part I' *Journal of Political Economy*, vol. 81(4), pp. 813–46.
- Becker, G.S. (1974). 'A theory of social interactions', *Journal of Political Economy*, vol. 82(6), pp. 1063–93.
- Becker, G.S. (1975). 'Human capital and the personal distribution of income: an analytical approach', in *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, 2 edn. New York: National Bureau of Economic Research.

¹⁶ For example, overtime pay, weekend pay and nighttime pay may differ.

¹⁷ Pollak (2013) presents an illuminating discussion of Becker's work on specialisation in the household.

- Becker, G.S. (1981). *A Treatise on the Family*, Cambridge, MA: Harvard University Press.
- Becker, G.S. (1991). *A Treatise on the Family* enlarged edn., Cambridge, MA: Harvard University Press.
- Becker, G.S. (2007a). *Economic Theory*, New Brunswick, NJ: Transaction Publishers.
- Becker, G.S. (2007b). 'Health as human capital: synthesis and extensions', *Oxford Economic Papers*, vol. 59(3), pp. 379–410.
- Becker, G.S. and Lewis, H.G. (1973). 'On the interaction between the quantity and quality of children', *Journal of Political Economy*, vol. 81(2, Supplement), pp. S279–S88.
- Ben-Porath, Y. (1967). 'The production of human capital and the life cycle of earnings', *Journal of Political Economy*, vol. 75(4), pp. 352–65, part 1.
- Blackorby, C., Primont, D. and Russell, R.R. (1978). *Duality, Separability, and Functional Structure: Theory and Economic Applications, Dynamic Economics*, Amsterdam: North-Holland.
- Bridgman, B., Dugan, A., Lal, M. and Osborne, M. (2012). 'Accounting for household production in the national accounts, 1965–2010', *Survey of Current Business*, vol. 92(5), pp. 23–36.
- Browning, M., Chiappori, P.A. and Weiss, Y. (2014). *Family Economics*, Cambridge: Cambridge University Press.
- Cunha, F. and Heckman, J.J. (2007). 'The technology of skill formation', *American Economic Review*, vol. 97(2), pp. 31–47.
- Ghez, G.R. and Becker, G.S. (1975). *The Allocation of Time and Goods over the Life Cycle*, New York: National Bureau of Economic Research.
- Gorman, W.M. (1956). 'The demand for related goods', Journal Paper J3/29, Iowa Experimental Station, Ames IA.
- Gorman, W.M. (1959). 'Separable utility and aggregation', *Econometrica*, vol. 27(3), pp. 469–81.
- Gorman, W.M. (1980). 'A possible procedure for analysing quality differentials in the egg market', *Review of Economic Studies*, vol. 47(5), pp. 843–56.
- Green, H.A.J. (1964). *Aggregation in Economic Analysis; an Introductory Survey*, Princeton, NJ: Princeton University Press.
- Greenwood, J., Seshadri, A. and Yorukoglu, M. (2005). 'Engines of liberation', *Review of Economic Studies*, vol. 72(1), pp. 109–33.
- Gronau, R. (1970). *The Value of Time in Passenger Transportation: The Demand for Air Travel*, New York, NY: Columbia University Press.
- Gronau, R. (1977). 'Leisure, home production and work—the theory of the allocation of time revisited', *Journal of Political Economy*, vol. 85(6), pp. 1099–23.
- Gronau, R. (1986). 'Home production—a survey', in (O. Ashenfelter and R. Layard, eds.), *Handbook of Labor Economics*, pp. 273–304, vol. 1, Amsterdam: Elsevier Science Publishers.
- Gronau, R. (1997). 'The theory of home production: the past ten years', *Journal of Labor Economics*, vol. 15(2), pp. 197–205.
- Gronau, R. (2008). 'Household production and public goods,' in (Steven N. Durlauf and Lawrence E. Blume, eds.), *The New Palgrave Dictionary of Economics* 2nd edn. Basingstoke, UK: Palgrave Macmillan. http://www.dictionaryofeconomics.com/article?id=pde2008_H000164 doi:10.1057/9780230226203.0750. (last accessed: 11 December 2014).
- Grossman, M. (1972a). *The Demand For Health: A Theoretical and Empirical Investigation*, New York: Columbia University Press.
- Grossman, M. (1972b). 'On the concept of health capital and the demand for health', *Journal of Political Economy*, vol. 80(2), pp. 223–55.
- Heckman, J.J. (1988). 'Time constraints and household demand functions', in (T. P. Schultz, ed.), *Research in Population Economics: A Research Annual, 1988*, p. 3–14. Greenwich, CN: JAI Press
- Heckman, J.J. (2014). 'Private notes on Gary Becker'. IZA Discussion Paper, no. 8200.
- Hicks, J. (1939). *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*, Oxford: Clarendon Press, 2nd ed. 1946.
- Juster, F.T. and Stafford, F.B. eds. (1985). *Time, Goods, and Well-Being*, Institute for Social Research, University of Michigan, a book of research findings from the 1975–76 Time Use Survey.
- Juster, F.T. and Stafford, F.P. (1991). 'The allocation of the time: empirical findings, behavioral models, and problems of measurement', *Journal of Economic Literature*, vol. 29(2), pp. 471–522.
- Kuznets, S. (1934). *National Income, 1929–1932*, National Bureau of Economic Research, Research Bulletin No. 49.
- Lancaster, K.J. (1966). 'A new approach to consumer theory', *Journal of Political Economy*, vol. 74(2), pp. 132–57.
- Lancaster, K.J. (1971). *Consumer Demand: A New Approach*, New York: Columbia University Press.
- Leibowitz, A. (1974). 'Home investments in children', *Journal of Political Economy*, vol. 82(2), pp. S111–S31.
- Long, C. (1958). *The Labor Force Under Changing Income and Employment*, (Gen. Ser. 65), New York: Princeton University Press.
- Michael, R.T. (1972). *The effect of education on efficiency in consumption*, New York: Columbia University Press for NBER.

- Michael, R.T. (1973). 'Education in nonmarket production', *Journal of Political Economy*, vol. 81(2), pp. 306–27.
- Michael, R.T. (1974). 'Education and the derived demand for children,' in (T. W. Schultz, ed.) *Economics of the Family: Marriage, Children, and Human Capital*, pp. 120–59, Chicago, IL: University of Chicago Press for NBER, pp. 120–59.
- Michael, R.T. and Becker, G.S. (1973). 'On the new theory of consumer behavior', *Swedish Journal of Economics*, vol. 75(4), pp. 378–96.
- Mincer, J. (1958). 'Investment in human capital and personal income distribution', *Journal of Political Economy*, vol. 66(4), pp. 281–302.
- Mincer, J. (1962a). 'On-the-job training: Costs, returns, and some implications', *Journal of Political Economy*, vol. 70(5, Part 2), pp. 50–79.
- Mincer, J. (1962b). 'Labor force participation of married women', in (H. G. Lewis, ed.), *Aspects of Labor Economics*, pp. 63–97, Princeton, NJ: Princeton University Press.
- Mincer, J. (1963). 'Market prices, opportunity costs, and income effects, in (Carl F. Christ ed.) *Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld*, pp. 67–82, Stanford, CA: Stanford University Press.
- Mincer, J. (1974). *Schooling, Experience and Earnings*, New York: Columbia University Press.
- Mitchell, W. (1912). 'The backward art of spending money', *American Economic Review*, vol. 2(2), pp. 269–81.
- Muth, R.F. (1966). 'Household production and consumer demand functions', *Econometrica*, vol. 34(3), pp. 699–708.
- National Research Council (2005). 'Home production,' in (Katharine G. Abraham and Christopher Mackie, eds.), *Beyond the Market: Designing Nonmarket Accounts for the United States*, Washington, DC: The National Academies Press, pp. 55–78.
- Nordhaus, W.D. and Tobin, J. (1973). 'Is Growth Obsolete?,' in (Milton Moss, ed.), *The Measurement of Economic and Social Performance*, pp. 509–31, New York: Columbia University Press.
- Pollak, R.A. (2003). 'Gary Becker's contributions to family and household economics', *Review of Economics of the Household*, vol. 1(1-2), pp. 111–41.
- Pollak, R.A. (2013). 'Allocating household time: When does efficiency imply specialization?', NBER Working Paper No. 19178.
- Pollak, R.A. and Wachter, M.L. (1975). 'The relevance of the household production function and its implications for the allocation of time', *Journal of Political Economy*, vol. 83(2), pp. 255–78.
- Pollak, R.A. and Wales, T.J. (1987). 'Specification and estimation of nonseparable two-stage technologies: The Leontief CES and the Cobb-Douglas CES', *Journal of Political Economy*, vol. 95(2), pp. 311–33.
- Reid, M. (1934). *Economics of Household Production*, New York: Wiley.
- Robbins, L. (1930). 'On the elasticity of demand for income in terms of effort', *Economica*, 29, pp. 123–29.
- Rosenzweig, M.R. and Schultz, T.P. (1983). 'Estimating a household production function: heterogeneity, the demand for health inputs, and their effects on birth weight', *Journal of Political Economy*, vol. 91(5), pp. 723–46.
- Stiglitz, J.E., Sen, A. and Fitoussi, J.P. (2009). 'Report of the commission on the measurement of economic performance and social progress'. Commission on the Measurement of Economic Performance and Social Progress. <http://www.stiglitz-sen-fitoussi.fr/> (last accessed: 11 December 2014).
- Strotz, R.H. (1957). 'The empirical implications of a utility tree', *Econometrica*, vol. 25(1), pp. 269–80.
- Viscusi, W.K. and Aldy, J.E. (2003). 'The value of a statistical life: a critical review of market estimates throughout the world', *Journal of Risk and Uncertainty*, vol. 27(1), pp. 5–76.
- Willis, R.J. (1973). 'A new approach to the economic theory of fertility behavior', *Journal of Political Economy*, vol. 81(2), pp. S14–S64, reprinted in T.W. Schultz, (ed.), *Economics of the Family: Marriage, Children and Human Capital*, Chicago, IL: University of Chicago Press, 1974.