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Is Outdoor Recreation a Giffen Good?

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Abstract

Time-intensive goods like outdoor recreation are likely candidates for Giffen behavior when money price changes. For choices with binding money and time constraints, observable conditions for a good to be Giffen are developed. Model specifications and omitted variable biases are likely reasons why no Giffen recreation goods have been found.

Is Outdoor Recreation a Giffen Good?

The Giffen "paradox" has long intrigued students of economic theory. Put as a query, the phenomenon of interest is: "All else constant, under what circumstances will it be true that the quantity of a good demanded will move in the same direction as its price, thereby violating the first law of demand?" The conventional explanation for Giffen behavior, in the neoclassical theory of consumer choice subject to a constraint on money income, relies on unusually-shaped preferences. The strong inferiority of a good outweighs the negative substitution effect, so that the real income increase produced by a fall in its price results in a decline in its consumption. This story for the possible "existence" of Giffen behavior at the individual level has generally been dismissed as remote (George J. Stigler; John R. Hicks) or "pathological" (Eugene Silberberg and Donald A. Walker); furthermore, William R. Dougan has argued that one cannot expect to find the behavior at the market level, as it is ruled out by the Walrasian stability conditions.

Recently interest in the phenomenon of Giffen behavior at the individual level has been renewed by both empirical evidence and theoretical developments. Raymond C. Battalio *et al.* reported the first experimental confirmation of Giffen behavior, in studies of the behavior of "poor" rat consumers. Otis W. Gilley and Gordon V. Karels (GK hereafter) developed a theoretical framework that provides an explanation for Giffen behavior consistent with the experimental evidence. They showed that the presence of a second (minimum) constraint on consumption required for sustenance leads to Giffen behavior when both constraints are binding, because the consumer's response to a price increase consists only of an income effect. Both of these papers sound the same theme of the earlier literature, though: Giffen behavior is a relatively rare phenomenon, confined to poor consumers who have limited choice among staple items.

This paper's purpose is to suggest that Giffen behavior may be much more common than either the recent papers or earlier literature suggest, if only we know where and how to look for it. To develop this argument, we consider consumption of a commodity more common to consumers in rich, well-developed countries rather than in poor, less-developed ones: outdoor recreation.

A focus on outdoor recreation is useful for several reasons. First, outdoor recreation usually involves travel to a site distant from home, and consumption of the good itself involves spending time at the distant site; thus, the time-intensiveness is a characteristic often associated with outdoor recreation. This illustrates well the case of consumption subject to two binding upper constraints, on time and money, rather than one upper (money) and one lower (nutrition) constraint as GK used. The idea that time constrains choice is well-developed in economics (e.g., Gary Becker; Anthony DeSerpa). Both casual observation and empirical research point to the fact that in today's society many people wish they had more free time and more total time; an example is a recent study which found "...almost half of American workers say that they would give up a day's pay to get an extra day off" (John P. Robinson).

A second reason for the focus on outdoor recreation is that its time-intensiveness makes recreation a commodity especially likely to exhibit Giffen behavior. Third, finding evidence that outdoor receation may be Giffen puts the lie to the contention that Giffen behavior is most likely among poor consumers. Finally, because it is a *non*market good, the Dougan argument concerning impossibility of the behavior in the aggregate is moot since recreation is not traded in markets within which Walrasian stability conditions must hold. Thus, we argue that not only is Giffen behavior potentially much more widespread than currently believed, but also that there is nothing to prevent it from being observed in the aggregate when the good in question is not marketed.

Having demonstrated the plausibility, indeed perhaps even the likelihood, of recreation giving rise to Giffen behavior, we turn to the empirical question of why such behavior has not been reported at all in the literature. While part of the reason is undoubtedly the strong self-selection against publishing such "unusual" results, we provide an econometric explanation for this absence of results confirming Giffen behavior for recreation. Despite long recognition of the importance of time in recreation choices, most empirical models in the literature are one-constraint models, explaining recreation trips as a function of money prices and budget, either because the time parameters are omitted or because *a priori* reasoning is used to collapse the two constraint problem into a single constraint problem. In either case, the likely effect is to mask possible Giffen behavior or to render the model incapable of testing for it. Thus existing empirical evidence in the recreation demand literature is largely unable to address the question of whether recreation is a Giffen good.

I. The Choice Model

Consider an individual who allocates scarce time and money income in choosing consumption of three goods x, y, and z in order to maximize the utility function u(x,y,z). Each of the goods i, i=x,y,z, has a money (p_i) and a time (t_i) price of consumption, both of which are parametric to the individual, and the total amount of money income and time available are M and T, respectively. Given the focus of this paper, it is useful to think of x (and sometimes y) as a recreation good, such as trips of a fixed duration to a recreation site. It is necessary to incur both money and time costs of gaining access to recreation areas outside the home, and for recreation goods the time price is likely higher relative to the money price than for most other goods. For many non-recreation goods, the time price of consumption is low in relation to the money price, though some time must be spent in all consumption. Both constraints are assumed to bind throughout the analysis.

The constraints for the general model are written

(1) $$M= p_x x + p_y y + z \qquad \text{(money)}$$

(2) $$T = t_x x + t_y y + t_z z \qquad \text{(time)}$$

where the constraints are taken to be independent in order to have a two-constraint model, and both have been normalized over the money price of z, p_z. The choice problem is

(3) $$\max_{x,y,z} U(x,y,z) \qquad \text{s.t.} \quad (1), (2)$$

which yields (Marshallian) demands of the form $x^*=x(\alpha)$, $y^*=y(\alpha)$, $z^*=z(\alpha)$, where for notational convenience α is the vector of all parameters of the problem: $\alpha=(p_x,p_y,t_x,t_y,t_z,M,T)$.

Consider an equivalent, indirect representation of the problem which first optimizes out the consumption of good z and then considers the remaining choice of x and y given the (prior) choice of optimal z. This version of the problem is useful because, by properly accounting for how the optimal choice of z conditions the feasible choice set for x and y, the optimal choices of x and y are apparent immediately in x-y space from the intersection of the two conditional constraints. This simplifies the visual understanding of relationships between goods in the two-constraint model and how they interact to give rise to inferior and Giffen good effects, without direct reference to the preference map.

Substituting $z^*(\alpha)$ obtained from (3) above into the preference function, and noting that the time and money available for choice of x and y are reduced because of the choice of z^*, the choice problem can also be written as

(4) $$\max_{x,y} U(x,y,z(\alpha)) \qquad \text{subject to the conditional budgets}$$

(5) $$M_{xy} \equiv M - z^* = p_x x + p_y y \qquad \text{(conditional money budget)}$$

(6) $$T_{xy} \equiv T - t_z z^* = t_x x + t_y y \qquad \text{(conditional time budget).}$$

Since the constraints are independent, a single x-y combination solves the conditional problem (4) since there are two unknowns and two equalities to be satisfied. The solution to this problem yields conditional demands of the form

(7) $$x = \hat{x}(p_x,p_y,t_x,t_y,M_{xy},T_{xy})$$

(8) $$y = \hat{y}(p_x,p_y,t_x,t_y,M_{xy},T_{xy})$$

which are identical to the unconditional demands that solve (3). That is, the same first order conditions hold for the conditional choice functions $\hat{x}(\cdot)$ and $\hat{y}(\cdot)$ in (7) and (8) and for the unconditional $x(\alpha)$ and $y(\alpha)$ that solve (3). In particular, no separability assumptions about preferences are required to obtain (7) and (8), unless z is treated as a composite commodity.[1] However, by solving the conditional budget constraints for $\hat{x}(\cdot)$ and $\hat{y}(\cdot)$, a convenient visual depiction of comparative statics results.

Figure 1 gives the visual setup for analyzing the comparative statics of changes in goods x and y. The two conditional budget constraints, M_{xy} and T_{xy}, represent possible allocations of money and time expenditure between x and y, conditional on the optimal choice of the third good, z^*. The optimal choices of x and y, x^* and y^*, are identified by the intersection of the two conditional constraints; there is no need to introduce the preference map to find them. As opposed to the standard analysis, though, both conditional budgets depend on all parameters of the problem, so each will shift when any parameter changes.

Classifying Time- and Money-Intensive Goods

As a preliminary to comparative statics, some relationships that prove important to the analysis of the two-constraint model are developed. The first is the notion of whether a good is relatively more time- or money-intensive in relation to other good(s), which is determined by the relative slopes of the time and money budget lines for pairs of goods. Good x is *time-intensive relative to good y* if the ratio of its time to money price is higher; i.e., if

$$\frac{t_x}{p_x} > \frac{t_y}{p_y} \tag{9}$$

x is relatively more time-intensive than y.[2] Figure 1 is drawn so that x is time-intensive relative to y, in keeping with the interpretation of x as a recreation good and y and z as other non-recreation goods.

Two other characteristics of the time-intensive (x) and money-intensive (y) goods can be noted from Figure 1. Good x is referred to as *time-constrained*, because

$$\frac{M_{xy}}{p_x} > \frac{T_{xy}}{t_x}; \tag{10}$$

that is, the maximal quantity of x feasible under the (conditional) time budget is less than under the money budget, given the relative money and time prices of x. Similarly, good y is termed *money-constrained* because

$$\frac{T_{xy}}{t_y} > \frac{M_{xy}}{p_y}, \tag{11}$$

and the conditional money budget relative to money price is more binding on maximum y than is the conditional time budget.

II. Conditions for the Time-Intensive Good to be Giffen

By solving the two constraints (5) and (6), the conditional demands $\hat{x}$ and $\hat{y}$ can be written as

$$(12) \qquad x = \hat{x}(p_x,p_y,t_x,t_y,M_{xy},T_{xy}) \quad = \quad \frac{\dfrac{T_{xy}}{t_y} - \dfrac{M_{xy}}{p_y}}{\dfrac{t_x}{t_y} - \dfrac{p_x}{p_y}}$$

and

$$(13) \qquad y = \hat{y}(p_x,p_y,t_x,t_y,M_{xy},T_{xy}) \quad = \quad \frac{\dfrac{M_{xy}}{p_x} - \dfrac{T_{xy}}{t_x}}{\dfrac{p_y}{p_x} - \dfrac{t_y}{t_x}}$$

where the pre-conditioned optimal consumption of z enters through the conditional budgets $M_{xy} \equiv M - z^*$ and $T_{xy} \equiv T - t_z z^*$. Equations (9)-(11) imply that the numerators and denominators in (12) and (13) are all positive.

Consider a *ceteris paribus* change in p_x. The effects on consumption of x can be separated into a direct effect, holding z constant, and an indirect effect as z^* adjusts given the new level of p_x and both conditional budgets shift. The direct effect, from (12), is

$$(14) \qquad \left.\frac{\partial x}{\partial p_x}\right|_z = \frac{x/p_y}{D_x} > 0,$$

where $D_x \equiv (t_x/t_y - p_x/p_y) > 0$ is the denominator of the expression for x in (12), and is positive by (9). This is illustrated in Figure 2, where initial consumption is (x_0, y_0) at the intersection of the conditional budgets M_{xy}^0 and T_{xy}^0. As the price of x falls, the direct effect is given by the counterclockwise rotation of the money budget from M_{xy}^0 to M_{xy}^*; consumption of x falls to x_1 while consumption of y increases to y_1. The intuition behind this is that as the price of the time-intensive good, x, increases, its *relative time-intensiveness* decreases, so that more is demanded. If the indirect effect is small relative to this direct effect, consumption of x will tend to *increase* with an increase in own price. The indirect effect, as changes in z^* cause M_{xy} and T_{xy} to adjust, is

$$(15) \qquad \left(\frac{\partial x}{\partial z}\cdot\frac{\partial z}{\partial p_x}\right) = \frac{\dfrac{-t_z\dfrac{\partial z}{\partial p_x}}{t_y} - \dfrac{(-\dfrac{\partial z}{\partial p_x})}{p_y}}{D_x} = \frac{(\dfrac{1}{p_y} - \dfrac{t_z}{t_y})\dfrac{\partial z}{\partial p_x}}{D_x} .$$

In Figure 2 this is the shift in budget lines from M_{xy}^* and T_{xy}^0 to M_{xy}^1 and T_{xy}^1, respectively, which induces a further shift in consumption to (x_2,y_2). Thus the indirect effect depends on whether x and z are Marshallian substitutes or complements (i.e., on the sign of $\partial z/\partial p_x$) and on whether z or y is the more time-intensive (i.e., on the sign of $(1/p_y - t_z/t_y)$. Recalling that $p_z \equiv 1$ and using (9), $(1/p_y - t_z/t_y)$ is positive (negative) if y is more (less) time-intensive than z. Thus, several sets of *sufficient* conditions for x to be Giffen can be identified from (14) and (15). They are

a) x and z are substitutes ($\partial z/\partial p_x>0$) and y is more time-intensive than z ($\frac{1}{p_y}-\frac{t_z}{t_y}>0$); **or**

b) x and z are complements and z is more time-intensive than y; **or**

c) z is strongly separable from x and y in the preference function ($\partial z/\partial p_x=0$); **or**

d) y and z are equally time-intensive.

If either (a) or (b) holds, both the direct and indirect effects of the change in p_x are positive, reinforcing the Giffen effect; while for (c) and (d), the indirect effect is zero.

The time-intensiveness conditions are easily checked in applied studies from knowledge of the parameters (prices and budgets) an individual faces and their optimal consumption quantities.[3] The substitution relationship between x and z is a matter of conjecture, but a reasonable hypothesis would be that x and z are substitutes. The same intuition that explains the positive own-price response through the direct effect for x also suggests this. The increase in money price of the time-intensive good x also *decreases* the money-intensiveness of the money-intensive good, z; therefore one could expect an increase in z, implying $\partial z/\partial p_x>0$.

Condition (c) is a special case of the general analysis where z doesn't change as parameters concerning x and y change; this corresponds to the two-good analysis of the GK paper. Condition (d) is another special case where changes in expenditures on z and y exactly offset each other as the price of x changes, so the indirect effect is zero and x is Giffen because of the positive direct effect. This corresponds to the comparative statics analysis of the three-good case in the GK paper.[4] While restrictive, this condition is useful in identifying generic commodities likely to exhibit Giffen behavior such as outdoor recreation, which is particularly time-intensive. For example, if all other goods are of approximately equal time-intensiveness, condition (d) indicates that outdoor recreation will be a Giffen good regardless of its substitution relationships with those goods, because of its greater time-intensiveness.

Observable Sufficient Conditions for x to be Giffen

Directly observable, and weaker, sufficient conditions for x to be Giffen can be expressed by taking account of relative magnitudes of both the direct and indirect effects. This eliminates the need to appeal to intuition about the changes in the third good z as prices of x or y change.

The largest possible reduction in x through the indirect effect is $x^{min}-x$, where x is the initial quantity and x^{min} is the lowest possible consumption of x given prevailing relative prices and budgets. Thus, we seek the conditions for which

$$\frac{x/p_y}{D_x}+(x^{min}-x)>0; \tag{16}$$

and if these hold, x is necessarily Giffen.

Note from (16) that if $(1/p_y)>D_x$ x is necessarily Giffen, since quantities of all goods are taken to be positive initially and x^{min} is non-negative.[5] A little algebraic manipulation reveals that this is an easily checked condition: $(1/p_y)>D_x$ implies that

$$t_x/p_x < (1+1/p_x)t_y/p_y. \tag{17}$$

This is the condition on relative prices implicitly assumed by GK when they graphically illustrated the three good case and argued that "consumption of potatoes necessarily rises" when the price of potatoes increases (p. 186). The remaining case to be investigated, therefore, is where $(1/p_y)<D_x$.

The value of x^{min} is determined by, and will vary with, the relative prices and the budget constraints for the problem. Consistent with the earlier discussion, consider, for example, three goods for which the following relative prices and budgets apply:

$$\begin{cases} \text{x is time constrained } (M/p_x>T/t_x); \\ \text{y and z are money-constrained } (M/p_y>T/t_y,\ M>T/t_z); \text{ and} \\ t_x/p_x>t_y/p_y>t_z. \end{cases} \tag{18}$$

Using (1) and (2) to write y and z parametrically in terms of x,

$$z = \frac{t_y p_y \overbrace{\left\{\frac{M}{p_y} - \frac{T}{t_y}\right\}}^{\{-\}} - \overbrace{\left\{\frac{t_y}{p_y} - \frac{t_x}{p_x}\right\}}^{\{-\}} p_x x}{\underbrace{t_z \left\{t_y/t_z - p_y\right\}}_{\{+\}}} \tag{19}$$

and the signs of the terms, given in braces, are implied by conditions (18). The signs on the numerator of (19) imply that a minimum for x is given by z=0:

$$x^{min} = \frac{t_y p_y \left\{\frac{T}{t_y} - \frac{M}{p_y}\right\}}{p_x \left\{\frac{t_x}{p_x} - \frac{t_y}{p_y}\right\}}. \tag{20}$$

Using (20) in (16), with some rearrangement, gives

$$x\frac{(1/p_y) - D_x}{D_x} > -\frac{p_y\left\{\frac{T}{t_y} - \frac{M}{p_y}\right\}}{D_x},$$

which leads to an upper bound on the quantity of x that implies x is Giffen:

$$x < \frac{(p_y/t_y)T - M}{D_x - 1/p_y} \qquad \text{when } D_x - 1/p_y > 0. \tag{21}$$

Conditions (17), (18), and (21) are easily checked from data on relative prices and budgets, and eliminate the need for conjecture about the relationship between x and the third good z. In this particular case, only prices of the two primary goods of interest (x and y) alone are needed. Conditions such as (17) and (21) will vary with the actual price relationships among goods, but are easily derived. Table 1 presents a summary of observable conditions which imply that a good is Giffen with respect to money price changes.

Outdoor Recreation As a Potential Giffen Good

The preceding analysis demonstrates that time-intensive goods seem especially likely to exhibit Giffen behavior with respect to money price changes, when both constraints bind.[6] One of the key features which distinguishes outdoor recreation from other goods is the prominence of time in decisions concerning its consumption. Indeed, its consumption is often denominated in time units (days or hours spent at a site), and plays an important role in its cost as well because outdoor recreation is typically consumed at sites distant from the home. Thus, trips to engage in outdoor recreation (the x in the present model) usually require a substantially higher committment of time relative to money than do other consumption goods, so outdoor recreation is relatively time-intensive.

A couple of examples of the model's predictions will help to illustrate the point. Suppose that x is an outdoor recreation activity such as a day hike in the nearby woods or mountains, or a day at the park downtown; this is a relatively time-intensive activity. Let y and z be indoor activities such as housework and indoor recreation. Because y and z both require housing services, they are approximately equal in money-intensiveness and are more money-intensive (less time-intensive) than x. Because of their equal money-intensiveness, the indirect effect of a change in p_x is zero because $(1/p_y - t_z/t_y)$ in (15) is zero; thus an increase in the money price of the outdoor recreation (because, say, of an increase in gasoline prices) should, all else equal, lead to an *increase* in trips to the woods or local parks.

As a second example, suppose that x and y are two types of outdoor recreation activities, with x representing trips to the beach and y being a relatively expensive outdoor activity such as hot air ballooning, glider flying, or backcountry skiing; z is consumption of all other goods. Beach-going is the good x in the analysis since it is more time-intensive than ballooning (y), and both are more time-intensive than z. It is likely that x and z are substitutes, since an increase in the price of a beach visit reduces the money-intensiveness of z relative to x and leads to more of z being consumed. According to condition (a) in section II, the amount of beachgoing one does will also increase as the money price of a beach visit increases[7]; the quantity of ballooning will decrease and purchases of all other goods will increase.

III. Why Hasn't A Giffen Recreation Good Been Found?

The foregoing analysis shows that time-intensive goods appear to be especially susceptible to being Giffen goods; that in response to an increase in own money-price (own time-price and all else constant), an increase in consumption should be observed for at least some time-intensive goods. Given this bold prediction, and the fact that outdoor recreation offers a prominent example of time-intensive goods, one might well ask, Why it is that no evidence of Giffen behavior in outdoor recreation has been reported?[7]

One reason is that no recreation demand studies in the empirical literature have yet fully implemented the demand models implied by the choice problem (3).[8] While recent empirical recreation demand models are more comprehensive and sophisticated than those in earlier studies, data limitations have usually prevented the estimation of separate time and money price and time and money budget effects on the demand for recreation.

A substantial literature recognizes that omission of time prices from estimated outdoor recreation demand functions will lead to a downward bias in the estimated money price parameter. This has two consequences, the first of which is widely recognized: that consumer's surplus associated with the good will be underestimated (Clawson; Knetsch; Cesario).

The second consequence is of particular interest to the question of uncovering Giffen behavior for recreation goods. If x is a Giffen good, its true money price coefficient is positive. However, the downward bias in the estimated money price coefficient will reduce its statistical significance, or even change its sign (from positive to negative); the effect, in either case, will be to mask the Giffen behavior.

The recognition of the first consequence of omitting time parameters has led to a number of suggestions about how to value travel time, in order to collapse the two-constraint problem into a standard, one constraint problem. This usually results in an empirical specification of the following type:

$$x_i = \hat{\alpha} + \hat{\beta}(p_i + k w_i t_i) + \hat{\delta} M_i + v_i, \tag{22}$$

where w_i is the individual's wage rate and k is a fraction between 0 and 1 (Cesario; McConnell and Strand; Smith *et al.* SEJ; Bockstael *et al.*). The justification for these specifications is that the individual is making a labor-leisure choice which identifies an observable exogenous parameter as the value of time.

These specifications are essentially incapable of testing for Giffen behavior because they impose the *a priori* assumption that the own-time price and own-money price effects are of the same (usually negative) sign. By differentiating (12) with respect to t_x, it can be seen that if x is Giffen with respect to changes in p_x, it will most likely have *opposite* signs on the money- and time-price coefficients:

positive for the former and negative for the latter. Thus, imposing the assumption in (22) that time and money price have the same sign (through the common $\hat{\beta}$) virtually rules out the prospect of finding Giffen behavior.

To sum up, the reason no empirical evidence of Giffen recreation goods has yet been found is that existing empirical estimates of recreation demand are based on estimation frameworks that, because of omitted variables or *a priori* reasoning, are not sufficiently flexible to enable the behavior to be observed.

IV. Conclusions

Giffen behavior, i.e., an increase in quantity of a good demanded in response to an increase in its money price, may well be more widespread than is currently believed, if only we know where and how to look for it. To make this point, we develop a general three-good model where choices are made subject to money and time constraints, and show how the optimal choices can be conveniently represented graphically in two-space by analyzing an equivalent conditional choice problem. We develop easily-checked sufficient conditions for a good to be Giffen, involving relative time-intensiveness and budgets.

The intuition behind the results lies in the notion of time- and money-intensiveness: as the money price of the time-intensive good increases, its *time-intensiveness decreases*, and this tends through the direct effect to lead to a substitution toward the time-intensive good to achieve the highest possible level of utility. Analogously, increases in the own time-price of the money-intensive good leads to an increase in its consumption: a Giffen-like phenomenon with respect to time.

Given the suggestion that time-intensive goods such as outdoor recreation may be prone to Giffen behavior, the question of empirical verification arises. Virtually no published study has come up with a positive own-money price coefficient, with a couple of statistically-insignificant exceptions. However, the specifications estimated in existing recreation demand studies are not capable of reflecting such behavior, for reasons either of variable omission or *a priori* judgments about the nature of the individual's decision problem.

Perhaps the framework and results in this paper will stimulate a closer look at the empirical possibilities for finding Giffen behavior in recreation demand and other commodities for which choice is made subject to multiple constraints.

Footnotes

1. In general, if there were degrees of freedom for choosing $\hat{x}$ and $\hat{y}$ (as would be the case, for example, if there were only one constraint instead of two), they would also depend on z^* directly as it affects the shape of the preference map, in addition to its indirect effect through M_{xy} and T_{xy}; that is, $x = \hat{x}(p_x,p_y,t_x,t_y,z^*,M_{xy},T_{xy})$ and $y = \hat{y}(p_x,p_y,t_x,t_y,z^*,M_{xy},T_{xy})$. However, since the conditional budgets solve directly for $\hat{x}$ and $\hat{y}$, there is no opportunity for variations in z to affect the choice of x and y when the conditional budgets are fixed.
2. Using the same logic to define the notion of *relatively money-intensive*, it follows immediately that if x is time-intensive relative to y, y is money-intensive relative to x, since (9) can also be written as $(p_y/t_y) > (p_x/t_x)$.
3. In particular, because of the normalization over p_z, p_z=1 and $t_z= (T-T_{xy})/(M-M_{xy})$; these can be compared with p_y and t_y to determine whether y or z is more time-intensive.
4. Though they don't address the issue directly, for GK's statement that when the price of potatoes increases, "consumption of potatoes necessarily rises" (p. 186) to be correct without qualification requires that there be no change in potato consumption as the consumer substitutes among meat and their third good (x in their analysis) along the line segment AD. They are referring to the direct effect only in this passage.
5. This can also be expressed as $t_x/t_y < p_x/p_y + 1/p_y$; but also, by assumption $p_x/p_y < t_x/t_y$, so the two conditions together are $p_x/p_y < t_x/t_y < p_x/p_y + 1/p_y$. Thus, if x is only slightly more time-intensive than y, x is necessarily Giffen for this case.
6. Likewise, the money-intensive good is especially likely to have a positive response to changes in its time price, though this effect has not traditionally been labeled "Giffen."
7. The only examples we have found in the published literature of positive own-price elasticities is in the paper by Smith *et al.*, who report positive own-price elasticities for two of 22 ordinary least squares estimates of recreation demand models; neither is statistically significant at the 5% level. The authors do not suggest that Giffen behavior is responsible for these results.
8. The best empirical study to date is the work of Bockstael, Strand, and Hanemann, who estimate utility-theoretic demand functions for recreation that depend on both time and money budget parameters. They obtained a significant negative own-time price effect, which is expected for time-intensive goods (see (16)), and a negative (but very small in magnitude) own-money price effect which, in their specification, is tied to the (statistically insignificant) money income effect. Because three parameters are estimated for the two price and two money effects, their study does not appear to offer any evidence one way or the other regarding possible Giffen behavior.

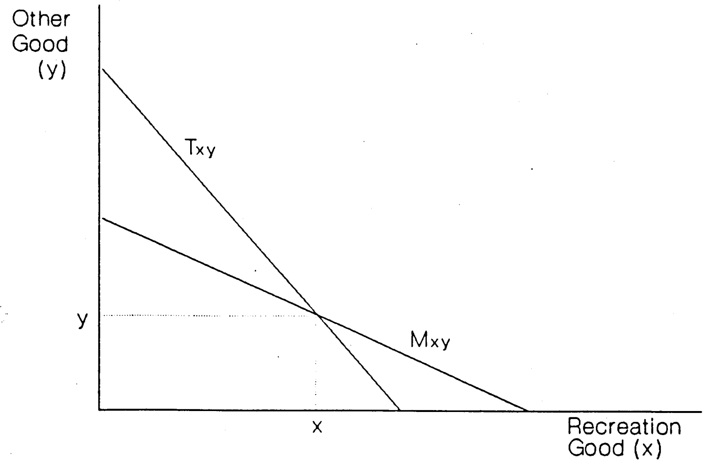

Figure 1. The Optimal Choice of x and y in the Three-Good, Two-Constraint Model.

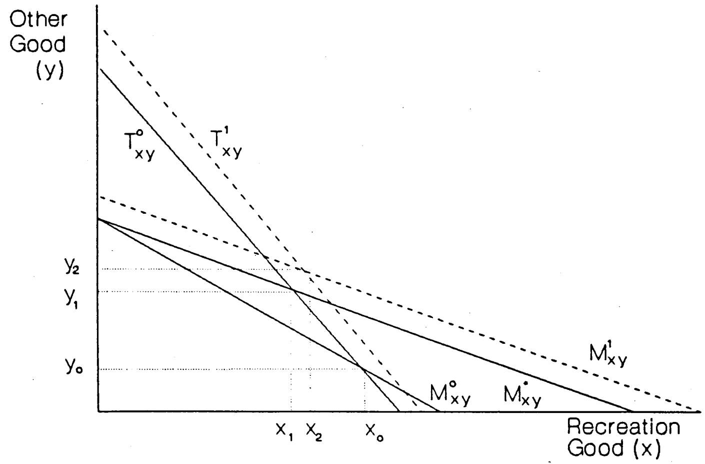

Figure 2. The Time-Intensive (Recreation) Good as a Giffen Good.

Table 1. Sufficient Conditions For the Time-Constrained Good to be Giffen.

Time Intensiveness of x Relative to y	Range where x is Giffen[a]	
	$t_y/t_z > p_y$	$p_y > t_y/t_z$
$\frac{t_y}{p_y} < \frac{t_x}{p_x} < (1+\frac{1}{p_x})\,\frac{t_y}{p_y}$	all x	all x
$(1+\frac{1}{p_x})\,\frac{t_y}{p_y} < \frac{t_x}{p_x}$	$x < \frac{(p_y/t_y) - M}{D_x - 1/p_y}$	$x < \frac{(M - T/t_z)\,D_x}{(t_x/t_z - p_x)\,(D_x - 1/p_y)}$

[a]The term $D_x \equiv t_x/t_y - p_x/p_y$, and $D_x - 1/p_y$ is positive when $t_x/p_x > (1+1/p_x)t_y/p_y$.

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