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ARE GIFFEN GOODS REALLY SO RARE?

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Abstract

Giffen behavior is probably much more widespread than is currently believed, if only we know where and how to look for it. Using a model of choice subject to binding money and time constraints, time-intensive goods are seen to be most likely to be Giffen with respect to money price changes, and observable sufficient conditions, expressed in terms of relative prices and budgets, are presented. Outdoor recreation activities, being time-intensive, are a logical candidate for observing this behavior, but model specification and omitted variable biases are likely explanations for why no Giffen recreation goods have been found.

Are Giffen Goods Really So Rare?

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 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 previous papers have 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, as we will show, its time-intensiveness makes recreation a commodity especially likely to exhibit Giffen behavior. This proclivity, it should be noted, is wholly apart from the phenomenon of backward-bending labor supply. The analysis in this paper purposely excludes the labor-leisure choice, as would be the case in short-run decisionmaking or where institutional factors or transactions costs make work hours fixed. Thus the interest here is in the allocation of fixed money and time endowments between competing leisure (or more precisely, nonwork) activities.

Third, finding evidence that outdoor recreation may be Giffen puts the lie to the contention that Giffen behavior is most likely among poor consumers, particularly in today's society where the more affluent may more frequently have binding constraints on time and money. Finally, because it is a *non*market good, the Dougan argument concerning impossibility of Giffen 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.

Section I presents the general model for choice of three goods subject to two constraints, and identifies some relationships among the goods based on relative prices that prove important to the analysis of potential Giffen behavior. Section II develops the comparative statics for this model, which leads to observable conditions under which a time-intensive good will exhibit Giffen behavior, based on relative prices and budgets, irrespective of preferences aside from the requirement that both constraints bind throughout. Section III addresses outdoor recreation as a possible Giffen good, and shows that a version of Hicks' composite commodity theorem applies for goods of equal time-intensiveness. When these goods are more time-constrained than the third good, at least one will be Giffen but determining which one(s) requires the preference map. Since outdoor recreation does seem a plausible candidate for Giffen behavior, Section IV explores why no empirical evidence for this has yet turned up in the literature. Section V concludes.

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, in contrast, 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

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

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

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

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

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

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

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

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

Because 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

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

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

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 less-intensive recreation goods or 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

$$(11) \qquad \frac{T_{xy}}{t_y} > \frac{M_{xy}}{p_y},$$

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

II. Comparative Statics of the Two-Constraint Model

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

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

and

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

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^0_{xy} and T^0_{xy}. As the price of x falls, the direct effect is given by the counterclockwise rotation of the money budget from M^0_{xy} 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 money price of the time-intensive good, x, falls, its *relative time-intensiveness* increases, so that less is demanded. If the indirect effect is small relative to this direct effect, consumption of x will tend to *decrease* with a decrease in own price.

The indirect effect, as changes in z^* cause M_{xy} and T_{xy} to adjust, is

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

In Figure 2 this is the shift in budget lines from M^*_{xy} and T^0_{xy} to M^1_{xy} and T^1_{xy}, 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 $(\frac{\partial z}{\partial p_x}>0)$ 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; 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.[4] While restrictive, this latter 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.

It can be seen that under the conditions which make x exhibit Giffen behavior, y will typically be a complement to x. From (13), the (total) change in y with respect to a change in p_x is

$$\frac{\partial y}{\partial p_x} = \frac{-x/p_x}{D_y} + \frac{(\frac{t_z}{t_x} - \frac{1}{p_x})\frac{\partial z}{\partial p_x}}{D_y}$$

where $D_y \equiv (p_y/p_x - t_y/t_x) > 0$ is the denominator of (13). The first term, representing the direct effect of changing p_x while holding z constant, is always negative, and the second term, which is the indirect effect as z adjusts, is non-positive under conditions (a), (c), and (d) above. In each of these cases the change in y with p_x is unambiguously negative, indicating (Marshallian) complementarity when x is Giffen. Only in the counterintuitive case (b), where z and x are complements with respect to changes in money price, are the effects potentially offsetting, giving rise to the possibility that the Giffen good and y are substitutes.

Likewise, when x is Giffen with respect to own-money price changes, it will more likely be non-Giffen with respect to own-time price changes. Differentiating (12) with respect to t_x,

$$(16) \qquad \frac{\partial x}{\partial t_x} = \frac{-x/t_y}{D_x} + \frac{(\frac{1}{p_y} - \frac{t_z}{t_y})\frac{\partial z}{\partial t_x}}{D_x}$$

so that the direct own-time price effect is negative for the time-intensive good. The rise in t_x increases the money-intensiveness of the money-intensive good z, which would be expected to lead to a decrease in z; i.e., $\partial z/\partial t_x < 0$ is most plausible. Then, when y is more time-intensive than z and x is Giffen with respect to a money price change, x is non-Giffen with respect to a time price change.

In a similar manner, since y is relatively more money-intensive than x, it will most likely have a negative response to changes in its own-money price. From (13), the total effect on y of a change in p_y is

$$(17) \qquad \frac{\partial y}{\partial p_y} = \frac{-y/p_x}{D_y} + \frac{(\frac{t_z}{t_x} - \frac{1}{p_x})\frac{\partial z}{\partial p_y}}{D_y} ,$$

so that once again the direct effect is negative. Also, when z is more money-intensive than y (as in condition (a)), the increase in p_y leads to a decrease in the money-intensiveness of z, suggesting an increase in its consumption ($\partial z/\partial p_y > 0$). Since y is more money-intensive than x by assumption, z is more money-intensive than x so the term $(t_z/t_x - 1/p_x)$ is negative; thus the indirect effect in (17) is also negative and y is non-Giffen. Thus, contrary to the result for the time-intensive good, the effect of an own-money price change for a money-intensive good is more likely negative.

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.

As both the direct and indirect effects depend on the time-intensiveness relationships among all three goods, the discussion will proceed by illustrating the case where x is the most time-intensive good. The analysis also turns on whether y is relatively more time-intensive than z ($t_y/p_y > t_z$) or vice-versa. The first of these cases is considered in some detail to develop the line of analysis, then the second is briefly considered. Analysis of other cases (e.g., where z is more time-intensive than x, etc.) can easily be accommodated by taking account of the appropriate changes in the time-intensiveness inequalities.

The observable sufficient conditions are based on the fact that x will be Giffen, for a given discrete own-money price change, if the (positive) direct effect is larger in absolute value than the maximum possible offsetting (i.e., negative) indirect effect of the price change. The indirect effect, as consumption of z adjusts given the new price of x, causes simultaneous adjustment to the conditional time and money constraints, as Figure 2 showed. The specific adjustment in z in a given situation will depend on the preferences of the individual being analyzed; but the range of possible values of z, given prices and budgets, is known directly from the two budget constraints because of the non-negativity of all consumption variables. As z varies among its possible values, an adjustment locus (the set of optimal x-y combinations) is induced in x-y space, as illustrated in Figure 3.

Consider, for example, an *increase* in own price from p_x^0 (corresponding to consumption x^0) to p_x^1. Since x is time-intensive relative to y, the direct effect is positive and leads to an increase in consumption of x, from (14). The maximum possible decrease in x as z adjusts depends on the relative prices of all three goods. This can be seen by rewriting (12) and (13) to express both x and y parametrically in terms of z:

$$(18) \qquad x = \frac{\overset{\{+\}}{\left\{\frac{T}{t_y} - \frac{M}{p_y}\right\}} + \overset{\{+\}}{\left\{\frac{1}{p_y} - \frac{t_z}{t_y}\right\}} z}{\underset{\{+\}}{t_x/t_y - p_x/p_y}}$$

and

$$(19) \qquad y = \frac{\overset{\{+\}}{\left\{\frac{M}{p_x} - \frac{T}{t_x}\right\}} - \overset{\{+\}}{\left\{\frac{1}{p_x} - \frac{t_z}{t_x}\right\}} z}{\underset{\{+\}}{p_y/p_x - t_y/t_x}},$$

where the signs above and below the individual terms follow from the fact that x is more time-intensive than y, and y is more time-intensive than z ($t_x/p_x > t_y/p_y > t_z$). From (18) and (19), it can be seen that as z adjusts, x increases and y decreases; that is, the adjustment locus is negatively sloped, as per aa and bb in Figure 3.[5] Its slope is

$$\frac{\partial y}{\partial x} = \frac{\partial y/\partial z}{\partial x/\partial z} = -\frac{t_x - p_x t_z}{t_y - p_y t_z}$$

using (18) and (19) to obtain the needed partial derivatives and simplifying. Since for the case under consideration $t_y/p_y > t_z$, the slope of the adjustment locus varies from $-t_x/t_y$ (the slope of the conditional time budget) to $-\infty$ as z approaches y in time-intensiveness (i.e., as $t_z \to t_y/p_y$); the key point for the analysis is that it is steeper than the time budget, as drawn in Figure 3.[6]

The fact that x and z vary together (for this case) means that for an own price increase from p_x^0 to p_x^1, the largest possible *decrease* in x through the indirect effect occurs when z adjusts all the way to zero. In this case, from (18), the minimum value x can take after the price change is

$$x' = \frac{T/t_y - M/p_y}{t_x/t_y - p_x^1/p_y}$$

and x is necessarily Giffen if $x' > x^0$, or if

$$\text{(20)} \qquad \frac{T/t_y - M/p_y}{t_x/t_y - p_x^1/p_y} > x^0.$$

Equation (20) is an observable condition involving the parameters of the problem and the initial consumption level of a time-intensive, and potentially Giffen, good x. Not surprisingly, the condition involves the new price level p_x^1 since it is developed in the context of a discrete price change. Since the denominator is always positive for the case of x more time-intensive than y, the larger the increase in price, the higher the likelihood of x being Giffen. The reason is that this causes a larger direct effect, while the maximum offsetting indirect effect has already been accounted for in the development of (20). The adjustment locus aa in Figure 3 satisfies (20), because for the price increase from p_x^0 to p_x^1 x necessarily increases (from x^0 to at least x').

Now consider a *decrease* in own price from p_x^1 to p_x^0. To avoid needless cluttering of the graph, initial consumption is taken to be at x^1 (which will be different from x' if the indirect effect is nonzero.) In this situation, since the direct effect leads to a decrease in x we look for the maximum possible *increase* in x through the indirect effect; since x and z vary positively this occurs when z reaches its maximum value $\bar{z}$. This can be identified from (19); since y and z also vary inversely, $\bar{z}$ occurs when y=0, so

$$\bar{z} = \frac{M/p_x - T/t_x}{1/p_x - t_z/t_x}.$$

Using $\bar{z}$ in (18), the maximum value of x associated with the price decrease is

$$x'' = \frac{T/t_z - M}{t_x/t_z - p_x^0}$$

where p_x^0 represents the subsequent price for this situation; and x is necessarily Giffen if

$$\text{(21)} \qquad \frac{T/t_z - M}{t_x/t_z - p_x^0} < x^1.$$

The locus bb in Figure 3 is drawn for a set of relative prices that assure that x is Giffen for the postulated price decrease.

Comparing (20) and (21), the observable conditions for x to be Giffen in light of an own price decrease and an own price decrease are asymmetric. On reflection this is not surprising, given that each posits a situation where, as a result of the maximum indirect effect, only two goods are consumed. In the case of a price increase, only x and y are consumed after the price change, hence (20) only depends on the relative time and money prices of x and y and the total budgets; for a price decrease, only x and z are consumed after the change, so (21) turns on their relative prices. Each condition is simply the solution of the two independent constraints for the two goods being consumed after the change in p_x.

To complete the analysis of observable conditions, we briefly turn to the case where z is more time-intensive than y, though x remains more time-intensive than both; i.e., $t_x/p_x > t_z > t_y/p_y$. Here, (18) and (19) show that both x and y decline with increasing z, so the adjustment locus is positive. When the price of x increases from p_x^0 to p_x^1, with initial consumption at x^0, the smallest possible value of x through the indirect effect occurs when $z=\bar{z}$ (or, equivalently, when $y=0$) since x and z vary inversely.[7] Using (19) to solve for $\bar{z}$ and substituting into (18), the minimum possible value of x associated with the price increase is

$$x' = \frac{T/t_z - M}{t_x/t_z - p_x^1}$$

and the condition for x to be Giffen with this price increase is

$$\frac{T/t_z - M}{t_x/t_z - p_x^1} > x^0.$$

This is similar to (20), but the difference in relative time-intensiveness of z and y in this case implies that only z and x are consumed for the most extreme offsetting indirect effect. Visually, this is depicted in Figure 4 for the price increase and subsequent movement along the adjustment locus aa.

Analogously, the locus bb in Figure 4 shows the possible x-y combinations for a price decrease from p_x^1 to p_x^0, with initial quantity at x^1, and the largest possible x associated with the price decrease is x'' corresponding to $z=0$. The observable algebraic condition for x to be Giffen in this setting is

$$\frac{T/t_y - M/p_y}{t_x/t_y - p_x^1/p_y} < x^1.$$

Table 1 summarizes these observable conditions (initial consumption levels for x and relative prices and budgets) which imply that the time-constrained good is Giffen. They suggest that the likelihood of a Giffen response is related to relative endowments of time and money, in addition to relative prices.

Consider, for example, two individuals with identical preferences for three activities on which discretionary time and money can be spent; in order of decreasing time-intensiveness, the activities are recreational fishing (x), recreational flying (y), and high-stakes gambling (z). These activities are available at the same time and money prices for both people, and both are observed to be taking the same number of recreational fishing trips. One individual is a retired mill worker, and the other is a business executive; the labor supply decisions of each person (which are assumed fixed) result in different time-money endowments for expenditure on the three recreational activities.

The first line of Table 1 describes the conditions applicable for this situation. If the money price of recreational fishing increases, the retiree is more likely to have a Giffen response (increase in fishing trips) than is the executive; intuitively, the time-intensiveness of the time-intensive good x has decreased, which results in a greater quantity consumed, with a bigger response from the individual with who has more "surplus time" (i.e., $T/t_y - M/p_y$) and is less time-constrained in all activities.

If, on the other hand, the money price of fishing decreases, this is an increase in its time-intensiveness; since fishing is already time-intensive, this may lead to a decrease in consumption of fishing trips, and for given relative prices and initial consumption the Giffen effect i.e., the reduction in quantity consumed of the time-intensive good) will more likely be seen for the individual who is most time-constrained, i.e., the executive (who has a smaller $T/t_z - M$). This illustrates the asymmetry, noted above, which is implicit in the sufficient conditions.

Similar interpretations can be given to line 2 of Table 3. The main points are the role that relative endowments play in the likelihood of observing a Giffen response for a given individual, all else equal; and the fact that expressing the sufficient conditions for Giffen behavior can aid the analyst in the search for situations in which such behavior is more likely to be found.

III. Outdoor Recreation As a Potential Giffen Good

This section develops further a theme alluded to in the previous section: the case of outdoor recreation activities as possible Giffen goods. The general conclusion from the analysis in Section II is that time-intensive goods seem especially likely to exhibit Giffen behavior with respect to money price changes, when both constraints bind.[8] 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 at-home activities such as gardening and indoor recreation. Because y and z both involve 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;[9] the quantity of ballooning will decrease and purchases of all other goods will increase.

A second characteristic of many recreation activities, in addition to time-intensiveness, is the strong correlation of both money and time prices with distance; this suggests that many outdoor activities are similar in their relative time-intensiveness. Explicitly considering the allocation of time and money expenditure to, and between, two activities with equal time-intensiveness illustrates Hicks' composite commodity theorem in the two-constraint setting, and demonstrates the role non-separable preferences play in the analysis of Giffen behavior.

Suppose x and y are both time-constrained, and of equal relative time-intensiveness; i.e., $M/p_x > T/t_x$, $M/p_y > T/t_y$, and $t_y/p_y = t_x/p_x$. Equations (12) and (13) cannot be used as is for this case since the denominators are infinite. However, solving (1) for x and substituting into (2) results, after gathering terms, in

$$\left\{T - \frac{t_x}{p_x}M\right\} - \left\{t_y - \frac{p_y}{p_x}t_x\right\}y - \left\{t_z - \frac{t_x}{p_x}\right\}z = 0$$

which, noting that the second term in braces is zero, solves for

$$z = \frac{\left\{T - \frac{t_x}{p_x}M\right\}}{\left\{t_z - \frac{t_x}{p_x}\right\}}.$$

When this value for z is substituted into the money budget equation (1), the conditional money budget for x and y is

$$(22) \qquad \frac{(\mathrm{T}-\mathrm{Mt}_z)}{\mathrm{t}_x\left\{\frac{1}{\mathrm{p}_x} - \frac{\mathrm{t}_z}{\mathrm{t}_x}\right\}} = \mathrm{xp}_x + \mathrm{yp}_y = \mathrm{B}/\mathrm{t}_x,$$

and when z is substituted into (2), the conditional time budget is

$$(23) \qquad \frac{(\mathrm{T}-\mathrm{Mt}_z)}{\mathrm{p}_x\left\{\frac{1}{\mathrm{p}_x} - \frac{\mathrm{t}_z}{\mathrm{t}_x}\right\}} = \mathrm{xt}_x + \mathrm{yt}_y = \mathrm{B}/\mathrm{p}_x.$$

where $\mathrm{B} \equiv (\mathrm{T}-\mathrm{Mt}_z)/(1/\mathrm{p}_x - \mathrm{t}_z/\mathrm{t}_x)$ is the common budget term in both (22) and (23). When x and y are of equal time-intensiveness, (22) and (23) are identical, which can be seen by multiplying (22) by t_x and (23) by p_x and subtracting. The result is

$$\mathrm{y}(\mathrm{t}_x\mathrm{p}_y - \mathrm{t}_y\mathrm{p}_x) = 0,$$

which holds for all x and y because the term in parentheses is identically zero. Thus the conditional budgets (22) and (23) do not identify a unique (x,y) corresponding to a given set of relative prices and budgets; instead they identify a feasible set of (x,y) points illustrated by the line aa in Figure 5. The maximum feasible consumption of x, corresponding to y=0, is $\mathrm{B}/(\mathrm{p}_x\mathrm{t}_x)$, from either (22) or (23). Similarly, maximum consumption of y is $\mathrm{B}/(\mathrm{p}_y\mathrm{t}_x)$.

Now suppose that p_x increases; since x and y are equally time-intensive this also implies an increase in p_y. The effect on the conditional budget can be seen most clearly from (23); if B/p_x increases then the conditional budget for x and y clearly shifts out, since time prices t_x and t_y are fixed. The conditions for which this will occur can be seen by differentiating the left hand side of (23) with respect to p_x, obtaining

$$\frac{\partial(\mathrm{B}/\mathrm{p}_x)}{\partial \mathrm{p}_x} = \frac{\mathrm{Bt}_z/\mathrm{t}_x}{\mathrm{t}_x/\mathrm{p}_x - \mathrm{t}_z}$$

which is positive if x is more time-intensive than z, and negative otherwise. Thus, as the price of p_x increases from p_x^0 to p_x^1, expenditure on the time-intensive goods x and y increases as the conditional budget shifts out to bb, as illustrated in Figure 5. This shift in the conditional budget is not sufficient to identify the changes in consumption of x and y individually, so the preference map is required to determine the specific values x_1

and y_1 as a result of the reduction in time-intensiveness of the two goods. The preference map shifts as z adjusts, and the adjustment illustrated is for a utility function nonseparable in x, y, and z. Regardless of the specific resulting allocation between x and y, at least one of the goods must be Giffen, increasing in quantity as its price increases and the level of utility decreases from U^0 to U^1. Thus, preferences are nonseparable in x,y, and z, but the allocation of expenditure to categories of goods can be determined without reference to the preference map, as before; to know the within-group allocation to x and y it is necessary to consult preferences.

This illustrates the point that when goods are of equal time-intensiveness, they can be aggregated into a composite commodity under conditions analogous to those assumed by Hicks. Money expenditure on x and y can, from (22), be written as $p_x w$, where w is the composite commodity defined as $w \equiv x + (p_y/p_x)y$. Likewise, in (23) the time expenditure on x and y can be written as $t_x w$, since $p_y/p_x = t_y/t_x$. Thus equal price ratios serve as a natural aggregator of consumption in the two-constraint model, much as proportional movements in money prices alone permit aggregation in Hicks' theorem.

When t_x increases, (23) can be used to show that expenditure on x and y decreases if x is more time-intensive than z. This is the opposite of the effect of an increase in p_x, but is expected because the increase in t_x increases the time-intensiveness of the time-intensive goods. Both results are due solely to the "direct effect" of changes in the time-intensiveness of w relative to z, as in equation (14).

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?[10]

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).[11] 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. Thus in assessing currently available empirical results, the results of variable omission on coefficient estimates must be considered.

Suppose, first, that a one-constraint model is estimated instead of the true two-constraint model. While recreation demand analysis generally is not this primitive, the results for this case may be instructive about the effects of ignoring a constraint in other two-constraint models. The true unconditional demand for recreation good x is linear in parameters,

$$x_i = \alpha + \beta_p p_i + \beta_t t_i + \delta_M M_i + \delta_T T_i + \epsilon_i, \tag{24}$$

where the i subscript is an index of individuals; p and t are money and time prices; M and T are the money and time budgets; x is some monotonic transformation of the quantity of recreation consumed; and ϵ_i is a mean-zero error.[12]

Because the role of time constraints is not recognized, the researcher instead estimates the model

$$x_i = \alpha^* + \beta^* p_i + \delta^* M_i + e_i,$$

where e_i is the regression residual. The effects of omitting the time variables on the estimate β^* can be assessed as follows. Prices and budgets are unlikely to be correlated across the sample, since prices are dependent primarily on distance, so the covariances σ_{Mt}, σ_{Mp}, σ_{Tt}, and σ_{Tp} are taken to be zero. Since both money and time prices depend positively on distance, the covariance $\sigma_{pt} > 0$, while the correlation between money and time budgets may be either positively or negatively correlated.[13]

Denoting the matrix of included and omitted regressors as $[z_1, z_2] = [(1, p_i, M_i), (t_i, T_i)]$ and the corresponding (transposed) parameter vector as $[\gamma_1', \gamma_2'] = [(\alpha, \beta_p, \delta_M), (\beta_t, \delta_T)]$, it is well-known (e.g., George Judge *et al.*) that the least squares estimates of γ_1 can be written as

$$\gamma_1 = (z_1' z_1)^{-1} (z_1' z_2) [\gamma_2]$$

and in the context of this problem the estimated parameter for money price can be expressed as

$$\beta^* = \beta_p + \beta_t \frac{\sigma_{pt}}{\sigma_{pp}} + \delta_t \frac{\sigma_{pT}}{\sigma_{pp}},$$

where σ_{pp} is the variance of money price. Since $\sigma_{pt} > 0$ and $\sigma_{pT} \doteq 0$, the bias in β^* will be proportional to the time price coefficient β_t, which for a time-intensive good like recreation is most likely negative, from (16). Thus, the result of ignoring the second, time constraint is that the estimated parameter, β^*, is biased downwards:

$$\beta^* < \beta_p.$$

The implication is that the estimated money price coefficient will likely be too small, resulting in one of two possible consequences. The first consequence is well-known in the literature on measuring the value of recreation: if the true β_p is negative, the estimated money price coefficient will be more negative than it should be, resulting in overstated significance levels and underestimates of consumer's surplus (Marion Clawson; Jack Knetsch).

The second consequence is of particular interest to the question of uncovering Giffen behavior for recreation goods. If x is a Giffen good ($\beta_p > 0$), the downward bias in β^* will reduce the statistical significance of the money price coefficient, 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:

$$x_i = \hat{\alpha} + \hat{\beta}(p_i + kw_it_i) + \hat{\delta}M_i + v_i,$$

where w_i is the individual's wage rate and k is a fraction between 0 and 1 (Frank Cesario; Kenneth McConnell and Ivar Strand; V. Kerry Smith and colleagues Aug. 1983, Oct. 1983, 1985; Nancy 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. As such, these specifications are 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.[14] They also represent a different class of models than the one considered in this paper, because the use of a fixed money-time tradeoff has the effect of reducing a two-constraint problem to a single-constraint problem. In contrast, the maintained hypothesis of this analysis is that two independent constraints bind choice: thus, the analysis of this paper applies to cases where institutional or labor market constraints prevent the wage rate (or any other fixed parameter) from collapsing the problem. It is for these situations that the two independent constraint approach of this paper is required.

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. In the alternative analysis, there is a direct effect of changing parameters on consumption of the two goods of interest (x and y), and an indirect effect through changes in the constraints as consumption of the third good (z) adjusts. The direct own-money price effect is positive for time-intensive goods, and under conditions that are plausible for (indeed, likely satisfied by) outdoor recreation commodities, the net effect will also be positive. 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. Consumption of the time-intensive good increases because it remains the cheaper good (being less money-intensive than the other goods) even as its money price increases; as the money constraint becomes more binding, the consumer loses less utility by economizing on use of the more "expensive" goods. 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 the demand for recreation and other commodities for which choice is made subject to multiple constraints.

Footnotes

1. 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, by design the conditional budgets solve directly for $\hat{x}$ and $\hat{y}$, so 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. These correspond to the two- and three-good cases analyzed in a recent paper by Otis Gilley and Gordon Karels. In considering the three good case, their statement that when the price of potatoes increases, "consumption of potatoes necessarily rises" (p. 186) is correct, in general, only when there is no change in potato consumption as the consumer substitutes among meat and the third good (x in their analysis) along the line segment AD.

5. If, however, z were more time-intensive than y, the adjustment locus would be positively sloped. This is considered in more detail below.

6. In the more general case, as the time intensiveness of z (t_z) varies from zero to infinity, the slope of the adjustment locus varies from $-t_x/t_y$ to $-\infty$ (as $t_z \rightarrow t_y/p_y$); is undefined for $t_z = t_y/p_y$ (there is no change in x because z and y are equally time-intensive); varies from $+\infty$ to 0 as $t_y/p_y < t_z < t_x/p_x$; then varies from 0 to $-p_x/p_y$ as t_z varies from t_x/p_x to $+\infty$.

7. It is straightforward to show that y=0, rather than x=0, defines the maximum $\bar{z}$ when x is more time-intensive than y.

8. Likewise, the money-intensive good is more likely to have a positive response to changes in its time price, though this has not traditionally been called "Giffen."

9. This could be, say, due to imposition of (or an increase in) day use fees for beach-going, as recently happened in Northern California.

10. The only examples we have found in the published literature of positive own-price elasticities is in the paper by V. Kerry Smith *et al.* (Oct. 1983), 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, and indeed it is difficult to distinguish between competing hypotheses, such as measurement or specification error, in explaining such results. Also, the structure of the models estimated in this study is different for reasons that are explained below.

11. The best empirical study to date is the work of Nancy Bockstael *et al.*, 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.

12. Other shifters (e.g., substitute prices) are taken as uncorrelated with the included variables in (24) so that their effects can be ignored in the interest of simplicity.

13. For an individual at a point in time, M and T would be inversely related because increases in income could only be generated by working more hours in the short term. However, looking across individuals in the sample, those with higher wages may be observed to work fewer hours, resulting in a positive correlation.

14. The analysis of Section II [e.g., equation (16)] suggests the likelihood that the time price and money price coefficients in a demand model will be of *opposite* sign, especially when its money price coefficient is positive. Further complications in interpreting price coefficients also arise because of the omission of the total discretionary time (T) variable, which is usually forced by data limitations.

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

Time Intensiveness of y Relative to z	Condition for x to be Giffen[a]	
	Price increase	Price Decrease
$\frac{t_y}{p_y} > t_z$	$\frac{T/t_y - M/p_y}{t_x/t_y - p_x^1/p_y} > x^0$	$\frac{T/t_z - M}{t_x/t_z - p_x^0} < x^1$
$\frac{t_y}{p_y} < t_z$	$\frac{T/t_z - M}{t_x/t_z - p_x^1} > x^0$	$\frac{T/t_y - M/p_y}{t_x/t_y - p_x^0/p_y} < x^1$

[a] x^0 (x^1) denotes initial quantity prior to the price increase (decrease).

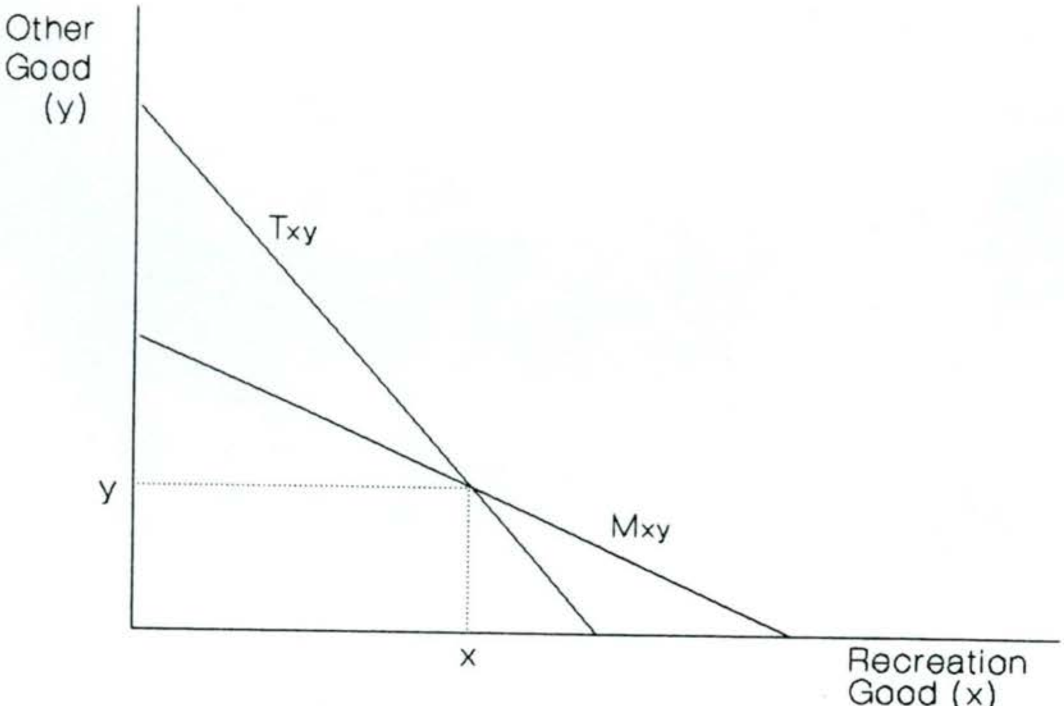

Figure 1. The Optimal Choice of x and y in the Three-Good, Two-Constraint Model.

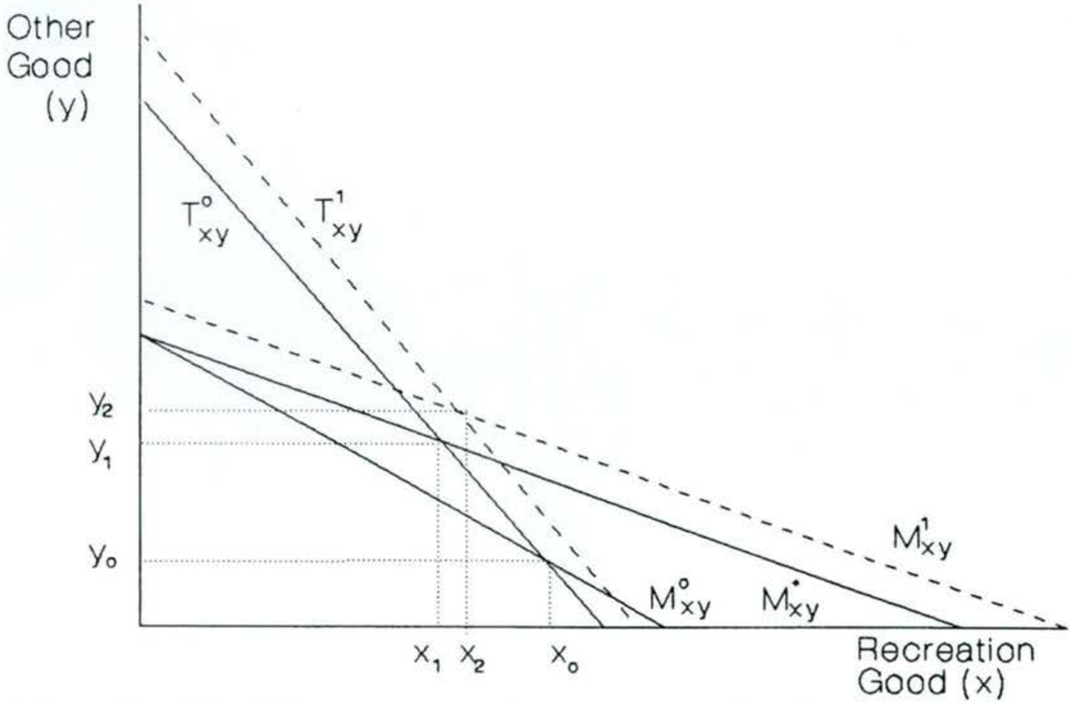

Figure 2. The Time-Intensive (Recreation) Good as a Giffen Good.

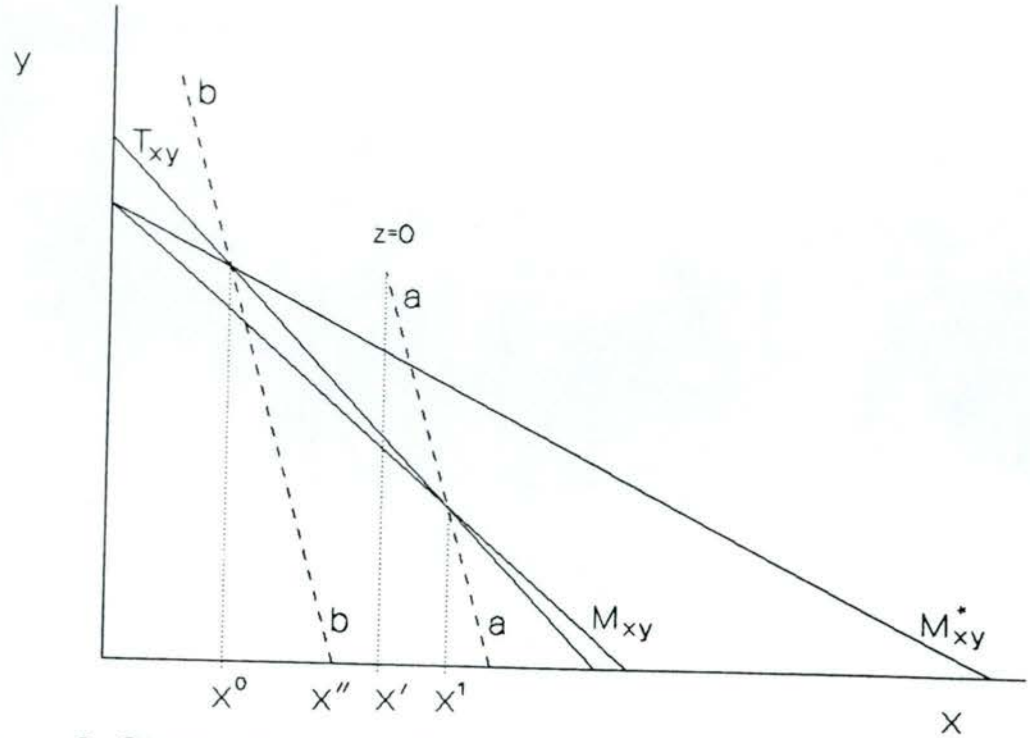

Figure 3. Observable Conditions for x to be Giffen- Case I

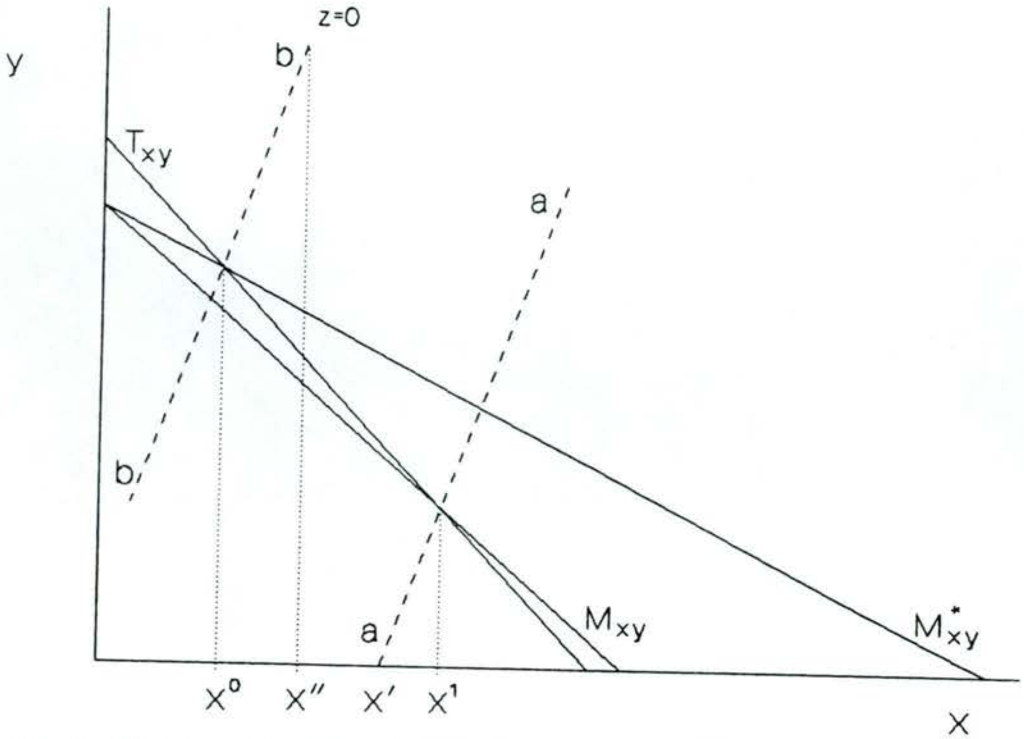

Figure 4. Observable Conditions for x to be Giffen- Case II

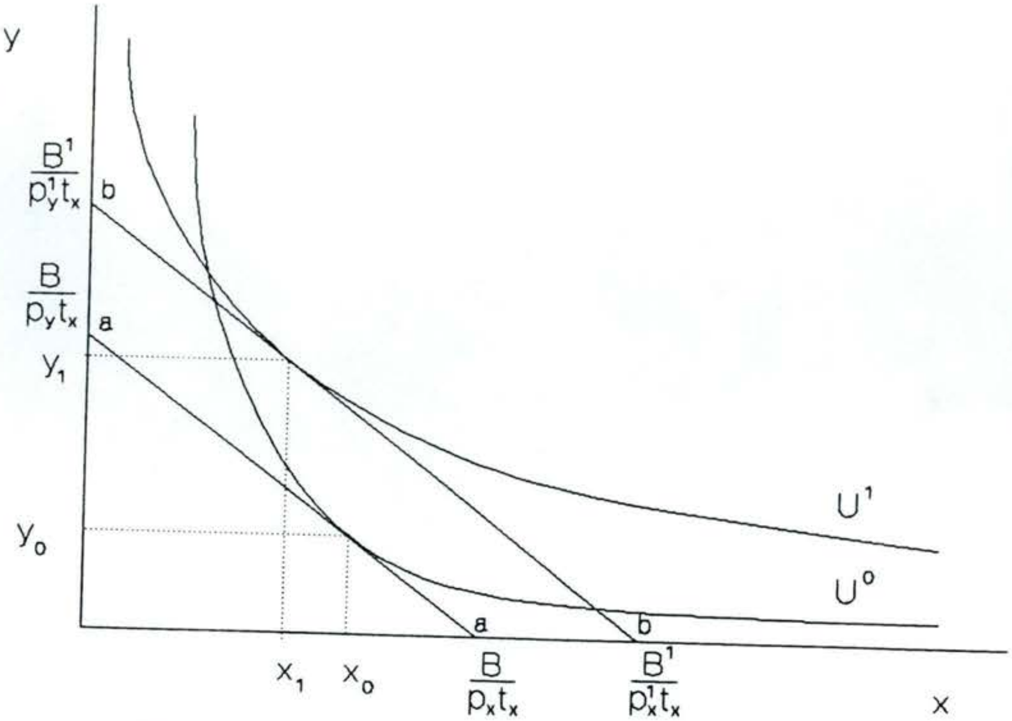

Figure 5. Effects of an Increase in Money Price for Two Time-Constrained, and Equally Time-Intensive, Goods