

Subsistence and the Giffen Good

a toy model, after Jensen and Miller (2008)

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A Giffen good is the exception that every demand course mentions and almost none can show: a good so central to a poor household's survival that, when its price rises, the household buys *more* of it, not less. For over a century the case sat in textbooks as a curiosity without clean field evidence. Jensen and Miller (2008) supplied it. They subsidized the staple of very poor households in two Chinese provinces, rice in Hunan and wheat in Gansu, and watched demand for rice rise as the subsidy was withdrawn and its price went back up. This note builds the simplest subsistence model that produces a Giffen good, and shows that its upward-sloping demand is entirely an income effect.

1 The model

A household divides its income I between two foods, a cheap staple (rice, quantity r) and a costlier, tastier food (meat, quantity m), at prices p_r and p_m . Each unit of rice yields a_r calories and each unit of meat a_m calories. Rice is the cheaper source of calories,

$$\frac{p_r}{a_r} < \frac{p_m}{a_m} \quad \Longleftrightarrow \quad D \equiv a_r p_m - a_m p_r > 0.$$

The household must reach a calorie floor $\bar{c}$ to get through the month. It takes no pleasure in rice as such; rice is a way to buy calories, and the tasty food is what the household actually enjoys. So it eats as much meat as its budget and its calorie needs allow,

$$\max_{r, m \geq 0} m \quad \text{subject to} \quad p_r r + p_m m \leq I \quad \text{and} \quad a_r r + a_m m \geq \bar{c}.$$

2 Solution

For a household poor enough that food is tight, both constraints bind: it spends all its income and meets the calorie floor exactly,

$$p_r r + p_m m = I \quad \text{and} \quad a_r r + a_m m = \bar{c}.$$

To find r , eliminate m : multiply the budget by a_m and the calorie floor by p_m , then subtract the first from the second, which gives $(a_r p_m - a_m p_r) r = \bar{c} p_m - I a_m$, that is, $D r = \bar{c} p_m - I a_m$. To find m , eliminate r in the same way: multiply the budget by a_r and the calorie floor by p_r , and subtract the second from the first, which gives $(a_r p_m - a_m p_r) m = I a_r - \bar{c} p_r$. Dividing by $D > 0$,

$$r^* = \frac{\bar{c} p_m - I a_m}{D}, \quad m^* = \frac{I a_r - \bar{c} p_r}{D}.$$

The household buys meat ($m^* > 0$) when $I a_r > \bar{c} p_r$, that is, when spending everything on rice would more than cover its calories, leaving room for some meat. It is poor, but not destitute.

Now raise the price of rice. The numerator of r^* , call it $N \equiv \bar{c} p_m - I a_m$, does not contain p_r , while the denominator $D = a_r p_m - a_m p_r$ falls as p_r rises, with $\frac{\partial D}{\partial p_r} = -a_m$. Differentiating $r^* = \frac{N}{D}$ with the quotient rule, $\frac{\partial r^*}{\partial p_r} = -\frac{N}{D^2} \frac{\partial D}{\partial p_r} = \frac{a_m N}{D^2}$, that is,

$$\frac{\partial r^*}{\partial p_r} = \frac{a_m(\bar{c} p_m - I a_m)}{D^2},$$

which is positive exactly when $\bar{c} p_m > I a_m$. Read the condition: $I a_m/p_m$ is the most calories the household could buy if it spent its whole income on meat, and the inequality says this falls short of $\bar{c}$. The household cannot feed itself on the tasty food alone; it depends on the cheap staple for survival. In that window, a rise in the price of rice raises the quantity of rice demanded. The staple is a Giffen good.

3 Why it is pure income effect

The Slutsky equation splits the response to a price change into a substitution effect and an income effect. Both pieces are easy to read here. Rice is inferior:

$$\frac{\partial r^*}{\partial I} = -\frac{a_m}{D} < 0,$$

so a richer household eats less rice and more meat. And the substitution effect is zero. Holding the household's welfare (its meat) fixed, the calorie floor pins down how much rice it must buy, $r^h = (\bar{c} - a_m m)/a_r$, a quantity that does not depend on p_r . With no substitution effect, Slutsky leaves only the income effect, and because rice is inferior that effect runs the wrong way: the price rise makes the household poorer, and a poorer household in this range needs more cheap calories. Upward-sloping demand is the income effect, standing alone. We can check this with the Slutsky equation itself,

$$\frac{\partial r^*}{\partial p_r} = \underbrace{\frac{\partial r^h}{\partial p_r}}_{=0} - r^* \frac{\partial r^*}{\partial I} = 0 - \frac{N}{D} \left(-\frac{a_m}{D} \right) = \frac{a_m N}{D^2},$$

which is exactly the derivative found above.

A numerical example. Let $a_r = 3$, $a_m = 2$, $p_m = 2$, $\bar{c} = 10$, and $I = 5$, so $D = 6 - 2p_r > 0$. Spending all income on meat buys $I a_m/p_m = 5$ calories, short of $\bar{c} = 10$: the household lives in the Giffen window. Here $N = \bar{c} p_m - I a_m = 20 - 10 = 10$ and $I a_r = 15$, so $r^* = \frac{10}{6-2p_r}$ and $m^* = \frac{15-10p_r}{6-2p_r}$. At $p_r = 1$, for instance, $D = 4$, so $r^* = \frac{10}{4} = 2.5$ and $m^* = \frac{15-10}{4} = 1.25$; at $p_r = 1.5$, $D = 3$, so $r^* = \frac{10}{3} \approx 3.33$ and $m^* = \frac{15-15}{3} = 0$. As the price of rice climbs, rice demand climbs with it while meat gives way, until the household can no longer afford any meat.

Price of rice p_r	Rice r^*	Meat m^*
1.00	2.50	1.25
1.20	2.78	0.83
1.40	3.13	0.31
1.50	3.33	0.00

Table 1. Demand as the price of rice rises ($a_r = 3$, $a_m = 2$, $p_m = 2$, $\bar{c} = 10$, $I = 5$; quantities rounded).

Figure 1 shows the mechanism. The household sits where its budget line meets the calorie floor, the highest-meat point it can afford while staying fed. A higher price of rice swings the budget line inward; the household slides down the calorie floor to point B , giving up meat and taking on more rice to keep its calories whole.

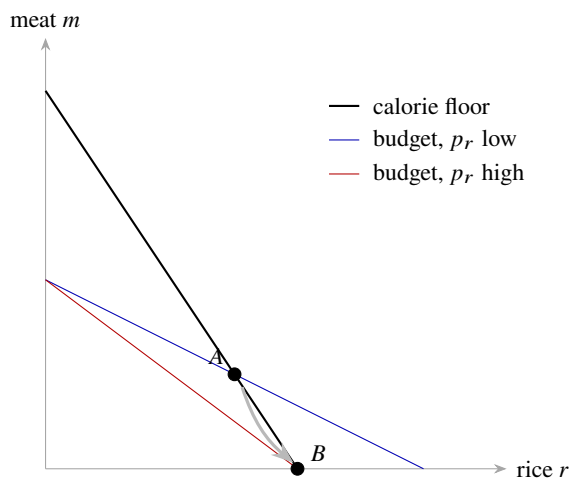


Figure 1: The household chooses the highest-meat point it can afford on the calorie floor, $a_r r + a_m m = \bar{c}$. A higher price of rice pivots the budget line inward (blue to red), and the optimum slides down the floor from A to B : less meat, more rice.

Lesson: When survival fixes how many calories a household must buy, a staple's price works through income alone, and for a household too poor to live on anything else that income effect points toward more of the staple. The Giffen good is not a violation of demand theory; it is what the theory predicts once a calorie floor makes the cheap good inferior and the household poor enough to lean on it. $\square$

References

Jensen, R. T., and N. Miller (2008) "Giffen Behavior and Subsistence Consumption." *American Economic Review* 98(4): 1553–1577.