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The Quantitative Analysis of Economic Behavior With Laboratory Animals

Abstract

Studies of animal behavior in the laboratory provide an extensive data set on economic behavior under controlled and replicable conditions. In the studies reported, the food consumption of rodents and non-human primates was studied under a wide variety of conditions of work effort, commodity value, and substitute availability. The results conformed to a single underlying demand function that assumed that demand elasticity was linear in price. Price was defined as a cost-benefit ratio that included consideration of both the effort of the work and the value of the commodity purchased. The parameters of the elasticity equation appeared related to the amount and temporal proximity of a substitute food.

These data from non-human subjects have limitations for predicting human economic behavior. However, these data provide clear evidence that the basic principles of consumer demand theory can be observed in a primitive system. This suggests that the theory is "biological" in the sense that it does not depend on the "cultural" mechanisms of either verbal behavior or money.

The views of the authors do not purport to reflect the position of the Department of the Army of the Department of Defense, (para 4-3, AR 360-5). In conducting the research described in this report, the investigator(s) adhere to the "Guide for the Care and Use of Laboratory Animals," as promulgated by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Animal Resources, National Research Council.

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Introduction

Recently, a number of investigators have applied consumer demand theory to analyze the behavior of non-human species working under laboratory conditions (see Hursh, 1980, 1984; Lea, 1978; Rachlin, Green, Kagel, & Battalio, 1976). According to the theory, the consumption of most goods will decrease with increases in price (see Figure 1). Any application of this approach to consumption by laboratory animals requires a definition of price in the absence of a medium of exchange (money). The typical animal experiment involves daily observations of performance, usually pressing a lever or push-button mounted on the wall of the cage, which produces some desirable consequence such as presentation of a pellet of food or a drink of water. The performance is called an "operant response" since it "operates" on the environment and the consequence that maintains the performance is called a "reinforcer" since it "strengthens" the performance. Price has been defined as the number of responses emitted per reinforcer.

In the experiments discussed here, the apparatus arranged that following a set number of responses a food reinforcer was presented, a procedure called a fixed-ratio (FR) schedule because it insures a constant ratio of responses to food presentations. For example, a fixed-ratio 10 (FR 10) schedule arranges for a food reinforcer to be delivered after every tenth response. This has been considered a "price" of 10. Hursh (1980) and Collier, Johnson, Hill, and Kaufman (1986) have suggested that a more fundamental definition of price is probably a cost-benefit ratio that considers both the amount of work performed and the amount and value of the commodity consumed. This ratio is called a "unit price" since it specifies the amount of effort expended per unit of the commodity.

In the first study reported here, the unit price concept was tested. Four factors that each alter unit price were manipulated: responses per reinforcer (FR schedule), force requirement of each lever press response, food pellets per reinforcer, and probability of reinforcement. We define unit price as:

$$\text{(1)} \qquad \text{Unit price} = \frac{\text{Responses x Lever weight}}{\text{Pellets x Probability}}$$