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Incorporating the effect of successfully bagging big game into recreational hunting: An examination of deer, moose and elk hunting

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A B S T R A C T

This analysis aims to quantify the effect that the probability of bagging game will have on the demand for recreational hunting. A two equation structural model has been developed which allows the probability of bagging game to be simultaneously entered into the travel cost model. The basic model is based on a Poisson distribution for the travel cost, and a Negative Binomial distribution is used to deal with the issue of overdispersion. Likelihood ratio tests and non-nested model selection tests have been adopted to choose the model which best fits the data. The results show that a Negative Binomial structural model is the best and the probability of bagging game has a significant effect on the travel cost model. The welfare per hunting day is around $300.

Introduction

According to the national survey, 12.5 million people 16 years old and older enjoyed hunting a variety of animals within the United States in 2006. Among the hunting games, big game hunting was the most popular type of hunting, such as deer and elk (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau, 2006). Hunting success or harvest was commonly linked to hunter satisfaction. Hendee (1974) first suggested a multiple-satisfaction for hunter. The satisfaction is not solely on bagging game, but more complex elements. This concept recognizes the factors such as enjoying nature, exploring outdoors, adventure, companionship and so on (Hendee, 1974; McCullough and Carmen, 1982; Vaske et al., 1986; Hammitt et al., 1990). However, generally the studies found the harvest is still the strong predictor of hunter satisfaction. Successful hunters reported greater satisfaction than unsuccessful ones. Thus, the importance of maintaining some probability of harvest success to uphold hunter satisfaction is emphasized (Stankey et al., 1973; Decker et al., 1980; Vaske et al., 1982; McCullough and Carmen, 1982; Gigliotti, 2000).

There have been numerous studies done by economists to estimate the recreational demand for hunting. Although the literature is rich, it has not paid much attention to hunting success which is recognized in the hunter satisfaction literature. This study attempts to discuss the role of successful bagging in recreational demand through hunter satisfaction (utility). We believe besides the pleasure of exploring nature, the successful bagging of game on a hunting or fishing trip also contributes to the hunter's (or angler's) utility. Incorporating the hunting success or harvest into the recreational demand for hunting will bridge the gap between the hunting demand and hunter satisfaction. It will also contribute the literature by investigating the significance of harvest success in hunting demand.

In literature about fishing demand, there are two ways to understand the role of bagging success. McConnell and Sutinen (1979) developed a bioeconomic model of recreational fishing by assuming that the catch rate is exogenous to private decisions. Greene et al. (1997) and Gillig et al. (2003) also treated catch rate as exogenous when estimating fishing demand. Conversely, some studies no longer assume that catch rate is exogenous in their models. Bockstael and McConnell (1981) introduced a household production function where the catch rate will be affected by exogenous factors like the stock of wildlife and the individual's experience. This allowed them to model the theoretical interaction between the household's behavior and public inputs into recreation. McConnell (1979) used a household production function to estimate the empirical value of fish where fish caught per trip is set as a function of the inputs used to catch more fish per trip, the stock density of available fish and the attributes of individual anglers. The 2SLS method is used and the predicted value of fish caught per trip is the instrument variable. McConnell and Strand (1994) instituted an individual catch rate, which is a random variable depending on the density of fish at the site and the characteristics of individual

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anglers used in the model, such as hours fished and years of experience. Englin et al. (1997) constructed a two equation structural model that included a total catch function representing angling success within the travel cost model.

As for hunting demand, Miller and Michael (1981) studied hunter participation in duck hunting in Mississippi. Hunter success, which is measured by the number of ducks bagged, is included in their model. Creel and Loomis (1990) used truncated Poisson distribution and Negative Binomial count data models to evaluate deer hunting in California. In their model, a dummy variable is included to represent the successful bagging of an animal. They further discussed the confidence intervals for welfare measures in 1991. Lisa and Goodwin (1992) evaluated the demand for hunting trips in Kansas by including the time spent on site in the travel cost method. They concluded that the hunter's age, investment in hunting equipment, and quality of the site do significantly influence demand. Sarker and Surry (1998) adopted a travel cost method to estimate the demand for and the economic value of recreational moose hunting in Ontario by using 4 alternative count data models (Poisson, Geometric, Negative Binomial type II, and Creel and Loomis). Hansen et al. (1999) developed a multi-site demand model to estimate the demand for pheasant hunting and evaluate the impact of the Conservation Reserve Program on pheasant hunting quality. Cooper (2000) presented two nonparametric approaches and developed one semi-nonparametric count model for travel cost as applied to waterfowl hunting trips for the six national wildlife refuges in California's San Joaquin Valley. Bennett and Whitten (2003) examined the benefits and costs of duck hunting on wetland conservation. Groothuis (2005) used a linear form travel cost function which includes the number of deer a respondent bagged to estimate the consumer surplus for deer hunting.

In addition, there are some other interesting topics related to hunting in the literature. Among them, the regulation of hunting is an important issue that has received much attention. Nickerson (1990) evaluated the demand for regulation of big game hunting for elk and deer in Washington state. Creel and Loomis (1992) developed a Truncated Joint Trip-Bag model which accounts for the effects of bag limits on the behavior of hunters in California. Little et al. (2006) investigated the elk permit lottery demand. Schwabe et al. (2001) studied the value of changes in deer season length in welfare rather than bag limit, which is the traditional method. Wam et al. (2012) used Norwegian grouse hunting data to study the number of permits or the bag size allowed per hunter in sustainable management. Some studies are devoted to hunting license demand (Brown and Connelly, 1994; Loomis et al., 2000; Scrogin et al., 2000; Sun et al., 2005). Milon and Clemmons (1991) evaluated the economic determinants of demand for species variety in wildlife recreation choices. Additionally, the site choices of recreational hunters were also examined (Adamowicz et al., 1997; Newbold and Massey, 2010; Zimmer et al., 2012).

From the hunting literature review, although Miller and Michael (1981), Creel and Loomis (1990) and Groothuis (2005) included an exogenous bag variable into their studies, the issue of bagging success in hunting has not drawn as much attention as catching success in fishing. In the United States, hunting of game animals is regulated to ensure the long term viability of hunted wildlife populations. All hunters are required to get licenses to hunt and face bag limits on the number of animals they can take on a single trip or over the length of the season. As mentioned above, these regulations also play an important role in the hunting literature. Although a bagged game attribute will complicate the measurement of demand for hunting and of welfare since it affects hunters' satisfaction and utility, it should not be neglected. As for the policy of regulation, licenses, tags, permits, and stamps issued in a hunter's state were included in the hunting demand in this study. Wam et al. (2012) found that selling permits gains profits for the government, but crowding causes a loss of hunter satisfaction.

The goal of this study is to investigate the effect of game bagging success on hunting trips. The method is to incorporate the expected probability of bagging game as explanatory variable in estimating the demand for hunting trips which has been absent in the previous literature. This study will employ a structural model to estimate hunting demand with the probability of bagging incorporated. The next section introduces the structural model, which combines the traditional travel cost model and probability of bagging game. The section "Data and results" presents the data and estimated results. The final section concludes the study.

Methodology

A structural model

Travel cost demand function

The travel cost method assumes that users try to maximize their utility when choosing a site to visit and that utility is related to socioeconomic characteristics of the consumer and depends on the full cost incurred by it with his/her visit. A typical approach that the individuals increase their utility depending on the number of visits, time spent at the site, characteristics of the site and the quantity of the numeraire. Analytically the maximization problem can be presented as:

$$Max : u(S, r, q) \tag{1}$$

where S stands for the numeraire whose price is 1, r represents the number of visits to the recreation site and q is the environmental quality at the site.

The maximization of the individual is subject to monetary and time constraints.

$$M + w \cdot t_w = S + c \cdot r \tag{2}$$

$$t = t_w + (t_1 + t_2)r \tag{3}$$

where M is exogenous income, which stands for the individual's demand; w is the wage rate; c is the monetary cost of visiting; t is the time endowment; t_w is the time of working; t_1 is the time of visiting; t_2 is the time spent at the site.

The utility maximization problem yields the travel cost demand function (Freeman, 1993).

$$r = r(c, M, q) \tag{4}$$

The structural model

The structural model is based on the travel cost method in the section "Travel cost demand function" which assumes that hunters try to maximize their utility related to their socioeconomic characteristics and the full cost incurred for their trips. The hunting demand is defined as:

$$Trips = f(TC, X, Z) \tag{5}$$

Trips is the number trips taken in a year by *hunter*; *TC* is the travel cost; X represents a set of individual characteristics of the hunter; Z is a vector of site characteristics.

The probability of bagging is used to obtain the expected probability of success that each hunter has, and is mainly based on measures of personal input and site quality characteristics as per the fishing literature mentioned in the introduction. The model has the following general form:

$$bag = g(X, Z) \tag{6}$$

It states that the probability of a bag is linked to a vector of individual characteristics (X) such as hunter experience, skill, and investment in hunting, as well as site quality (Z).