LABORATORY ECONOMICS AS A RESEARCH TOOL IN THE STUDY OF GAMBLING MARKETS

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ABSTRACT

In this short paper we discuss the use of experimental economics as a useful research tool in the study of gambling markets. Through a laboratory experiment, data can be collected that reveal individual choices in response to several parameters relevant in gambling markets. These data can then be analyzed using the same wealth of statistical techniques developed by econometricians for the analysis of market data. We provide an example experiment design that shows how the revenue-maximizing level of gambling taxation can be determined based on demand parameters revealed in a laboratory setting.

Introduction

The introduction of new products or services is a high risk endeavor, and often the manufacturer or provider engages in significant market research or controlled sales trials to ascertain the viability of the product, the potential sales price, and the existence of potential flaws—either real deficiencies or those imagined by the consumer. But this type of research is well down the road of the development cycle, and is generally quite costly to undertake.

The counterpart to this type of market research in the academic environment is to conduct laboratory studies. Laboratory investigations have rigorous, controlled conditions, and the results should be readily repeatable by other interested academicians. Obviously, certain disciplines lend themselves more readily to application of the accepted scientific method—such as those investigating physical laws which can be readily demonstrated—while other disciplines are seemingly precluded from systematic scientific examination due to the less tangible nature.

Unfortunately for the gaming industry, many of the most interesting features revolve around those less tangible qualities such as motivation, risk preferences, and potential loss absorption capacity of individual gamblers. These attributes are not readily generalizable, nor is there a definitive test or method for discovering the intensity of these attributes. Therefore, a laboratory and rigorous scientific investigation is not

normally seen as an available means to test gaming behavior or responses to changes in the gaming environment. But there is a technique in the social sciences which has heretofore been utilized for academic pursuit without specific applications to gambling.

The methodology of experimental economics is based on the pioneering work of Nobel Economics Laureate Vernon Smith. (See Smith (1982) for a clear and concise introduction to the use of controlled laboratory experiments to test the implications of microeconomic theory. Also see Smith (1962, 1965, 1976, 1989), Plott (1982, 1989), Kagel (1995), Binmore (1999) and Loewenstein (1999) for introduction to this fascinating literature). Although experimental economics studies cannot in themselves generate universally valid solutions or claims, the effects observed in such studies are credible evidence of the existence of incentive effects on the behavioral response of the individuals participating. The controlled laboratory setting also offers the advantage of reducing the confounding effects of outside influences, and by enabling the researcher to implement an orthogonalized experiment design it helps to isolate the comparative statics.

An economic experiment is used to generate the market data—data that could not be generated or collected using market transactions in non-laboratory setting. (Commercial transactions are proprietary, and this is one reason why doing empirical work in microeconomics can sometimes be nearly impossible. For example, the empirical study of "black markets" is difficult due to the death of market data, but these illegal markets can be studied in a laboratory setting (Harvey and Walls, 2003).) It is important to emphasize that the econometric technique used to analyze the data relies on revealed preference and not on stated preference, so the analysis proceeds in the same manner as it would for data generated in any non-experimental economic market.

The Design of Laboratory Experiments

To focus our discussion, we will discuss a proposed experiment designed to quantify the demand for gambling which, as will be shown in the following section, can be used to calculate the rate of gambling taxation that maximizes tax revenue.

The experiment consists of repeated trials of ten different levels of taxation. In total, the experiment consisted of one hundred rounds in which participants were faced with the various tax rates and provided with the opportunity to gamble or not. The experiment has two parts. First, the opportunity to gamble, with a roulette wheel serving as the element of chance. This option employed the variable tax assessment on gambling by requiring the participants to bet on either red or black, with the traditional 2 to 1 payoff. The green slots on the roulette wheel represent the gaming tax: Green spaces can be physically added on the roulette wheel by covering the existing red or black spaces.

The second option for the participant is to not gamble at all. If this option is chosen, the participant receives a payoff based on the flip of a coin. Since no decision as to heads or tails is made by the participant, this represents a lottery determined by nature and not a gamble. (This is important due to ethics regulations. For example, some participants may have a religious conviction that forbids actively gambling, but does permit them

to receive passively the outcome of a randomized trial.) The payment will be either 15 cents if a "head" is tossed, or 25 cents if a "tail" is tossed. The expected value is 20 cents, which is the payment per round for both gamblers and non-gamblers. There is no tax associated with this activity, and it also lacks the element of personal utility in the gambling action.

Each participant would be responsible for tracking his or her winnings by marking in the appropriate column what he or she chooses to do for that round of the experiment and then recording the associated payoff. The expected value of the payoff naturally decreases as the number of green spaces— the effective tax rate—increases. At some point gamblers will choose to participate in the coin flip rather than the roulette wheel spin and identifying this point is one of the goals of the experiment. Participants are free at any time to choose between the two options, and may switch back and forth at will.

To elicit effort, participants are to be compensated in real money with their rate of pay tied to their choices as discussed above. Each subject is to be trained in the mechanics of the experiment and satisfactorily completed a diagnostic quiz on probabilities and mathematical expectations prior to participation.

Analysis of a Laboratory Experiment

This experiment outlined in the preceding section is designed to investigate gaming behavior and see how the rate of gambling taxation affects gambler participation. In this section we demonstrate how the data generated in the economic experiment can be quantitatively modeled. In particular, we propose a particular model of the gamblers' participation as a function of the tax rate in the form a logit model. The parameters of the logit model can be estimated by standard maximum likelihood techniques and the revenue-maximizing tax rate can be computed directly. In this way we demonstrate concretely the use of laboratory economics as a practical tool in the gambling industry.

Given an effective tax rate t, defined so that in expectation the gross return on each dollar bet is 1 - t dollars, each individual makes the binary choice to gamble or not to gamble. Let us define the binary variable g that assumes a value of unity if the individual chooses to gamble, and zero otherwise. The exogenous variable that affects the gambling choice is the tax rate t in the closed interval unit interval (0, 1). The probability that an individual chooses to gamble is

$$\text{Prob}(g = 1) = \text{F}(t) \qquad (1)$$

where F(t) represents any cumulative distribution function. While any cumulative distribution function could be used in theory, the logistic cumulative distribution function and the Normal distribution function are most often used in applied work, and they correspond to the probit and logit (or logistic regression) models. The logit model is more convenient for the purpose of exposition, though none of our substantive empirical results depends on which model is used.

The logit model, which can be derived from Luce's (1959) random utility model of individual choice, has the following closed-form solution for the
choice probability

$$\text{Prob}(g=1) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 t)}} \tag{2}$$

where β_1 and β_2 are parameters to be estimated from the experimental data on t and the choices of the subjects. Given estimates of these parameters, we can proceed to determine the revenue-maximizing tax rate t^*. Define the tax revenue function to be

$$\text{R}(t) = t \times \text{F}(t) = \frac{t}{1 + e^{-(\beta_1 + \beta_2 t)}} \tag{3}$$

Then solve the maximization problem for revenue with respect to t

$$\max_t \text{R}(t) \tag{4}$$

by solving the first-order condition

$$\frac{d\text{R}(t)}{dt} = \frac{1 + (1 + \beta_2 t)e^{-(\beta_1 + \beta_2 t)}}{(1 + e^{-(\beta_1 + \beta_2 t)})^2} = 0 \tag{5}$$

We can numerically solve this equation for the optimal tax rate t^* after inserting our estimates of β_1 and β_2. (The parameters of the logit model can be estimated directly by the method of maximum likelihood. See Greene (1997), Amemiya (1981), Ben-Akiva and Lerman (1985) or Train 1986) for a graduate-level treatment of the logit model.)

Conclusion

In this paper we propose laboratory economics as a useful tool of analysis in the study of gambling markets. To illustrate the methodology of experimental economics applied to gambling, we discussed a proposed experimental design in which demand for various wagers could be quantified using data generated in an experimental laboratory casino. The methodology of experimental economics, together with the wealth of econometric methods developed to analyze market data, can be used to find pragmatic and scientifically rigorous answers to practical real-world questions. In our application, the data on individuals' choices can reveal the response of gaming demand to various effective rates of gaming taxation, and the estimates of the logit model of gaming choices can be used to estimate the revenue-maximizing rate of gaming taxation.

Acknowledgement

W. D. Walls acknowledges financial support received from the Alberta Gaming Research Institute.

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