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| Research Article

Econometrics formulas

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Abstract: Econometrics is a branch of economics that applies statistical methods and mathematical models to analyze economic data. It combines economic theory, mathematics, and statistical techniques to quantify and test hypotheses about economic relationships. Econometric analysis is used to study various economic phenomena, including supply and demand, consumer behavior, investment decisions, financial markets, and macroeconomic trends.

Keywords: economic theory, mathematics, and statistical techniques, supply, trends.

Introduction

The set of all possible outcomes of an experiment is called the sample space of the experiment. In case of tossing a coin, the sample space would consist of a head and a tail. If the experiment was to pick a card from a deck of cards, the sample space would be all the different cards in a particular deck. Each outcome of the sample space is called a sample point. An event is a collection of outcomes that resulted from a repeated experiment under the same condition. Two events would be mutually exclusive if the occurrence of one event precludes the occurrence of the other event at the same time. Alternatively, two events that have no outcomes in common are mutually exclusive. For example, if you were to roll a pair of dice, the event of rolling a 6 and of rolling a double have the outcome (3,3) in common. These two events are therefore not mutually exclusive. Events are said to be collectively exhaustive if they exhaust all possible outcomes of an experiment. For example, when rolling a die, the outcomes 1, 2, 3, 4, 5, and 6 are collectively exhaustive, because they encompass the entire range of possible outcomes. Hence, the set of all possible die rolls is both mutually exclusive and collectively exhaustive. The outcomes 1 and 3 are mutually exclusive but not collectively exhaustive, and the outcomes even and not-6 are collectively exhaustive but not mutually exclusive. Even though the outcomes of any random experiment can be described verbally, such as described above, it would be much easier if the results of all experiments could be described numerically. For that purpose we introduce the concept of a random variable. A random variable is a function that assigns unique numerical values to all possible outcomes of a random experiment. By convention, random variables are denoted by capital letters, such as X, Y, Z, etc., and the values taken by the random variables are denoted by the corresponding small letters x, y, z, etc. A random variable from an experiment can either be discrete or continuous. A random variable is discrete if it can assume only a finite number of numerical values. That is, the result in a test with 10 questions can be 0, 1, 2, …, 10. In this case the discrete random variable would represent the test result. Other examples could be the number of household members, or the number of sold copy machines a given day. Whenever we talk about random variables expressed in units we have a discrete random variable. However, when the number of unites can be very large, the distinction between a discrete and a continuous variable become vague, and it can be unclear whether it is discrete or continuous. A random variable is said to be continuous when it can assume any value within an interval. In theory that would imply an infinite number of values. But in practice that does not work out. Time is a variable that can be measured in very small units and go on for a very long time and is therefore a continuous variable. Variables related to time, such as age is therefore also considered to be a continuous variable. Economic variables such as GDP, money supply or government spending are measured in units of the local currency, so in some sense one could see them as discrete random variables.

Methodology

However, the values are usually very large so counting each Euro or dollar would serve no purpose. It is therefore more convenient to assume that these measures can take any real number, which therefore makes them continuous. Since the value of a random variable is unknown until the experiment has taken place, a probability of its occurrence can be attached to it. In order to measure a probability for a given events, the following formula may be used: P (A) The The number total of ways number of event A possible can occur outcomes (1.1) T his formula is valid if an experiment can result in n mutually exclusive and equally likely outcomes, and if m of these outcomes are favorable to event A. Hence, the corresponding probability is calculated as the ratio of the two measures: n/m as stated in the formula. This formula follows the classical definition of a probability.

Example 1.1 You would like to know the probability of receiving a 6 when you throw a die. The sample space for a die is {1, 2, 3, 4, 5, 6}, so the total number of possible outcome are 6. You are interested in one of them, namely 6. Hence the corresponding probability equals 1/6.

Example 1.2 You would like to know the probability of receiving 7 when rolling two dice. First we have to find the total number of unique outcomes using two dice. By forming all possible combinations of pairs we have (1,1), (1,2),…, (5,6),(6,6), which sum to 36 unique outcomes. How many of them sum to 7? We have (1,6), (2,5), (3,4), (4,3), (5,2), (6,1): which sums to 6 combinations. Hence, the corresponding probability would therefore be 6/36 = 1/6. The classical definition requires that the sample space is finite and that each outcome in the sample space is equally likely to appear. Those requirements are sometimes difficult to stand up to. We therefore need a more flexible definition that handles those cases. Such a definition is the so called relative frequency definition of probability or the empirical definition. Formally, if in n trials, m of them are favorable to the event A, then P(A) is the ratio m/n as n goes to infinity or in practice we say that it has to be sufficiently large.

Results and discussion

Example 1.3 Let us say that we would like to know the probability to receive 7 when rolling two dice, but we do not know if our two dice are fair. That is, we do not know if the outcome for each die is equally likely. We could then perform an experiment where we throw two dice repeatedly, and calculate the relative frequency. In Table 1.1 we report the results for the sum from 2 to 7 for different number of trials. Basics steps in hypothesis testing Assume that we would like to know if the sample mean of a random variable has changed from one year to another. In the first year we have population information about the mean and the variance. In the following year we would like to carry out a statistical test using a sample to see if the population mean has changed, as an alternative to collect the whole population yet another time. In order to carry out the statistical test we have to go through the following steps: 1) Set up the hypothesis In this step we have to form a null hypothesis that correspond to the situation of no change, and an alternative hypothesis, that correspond to a situation of a change. Formally we may write this in the following way: H H 1 0 : : μ μ X X μ ≠ = μ In general we would like to express the hypothesis in such a way that we can reject the null hypothesis. If we do that we will be able to say something with a statistical certainty. If we are unable to reject the null hypothesis we can only conclude that we do not have enough statistical material to say anything about the matter. The hypothesis given above is a so called a two sided test, since the alternative hypothesis is expressed with a “not equal to”. Form the test function In this step we will use the ideas that come from the Central Limit Theorem. Since we have taken a sample and calculated a mean we know that a mean can be seen as a random variable that is normally distributed. Using this information we will be able to form the following test function: Z = X σ − X μ X n ~ N (0 , 1) We transform the sample mean using the population information according to the null hypothesis. That will give us a new random variable, our test function Z, that is distributed according to the standard normal distribution. Observe that this is true only if our null hypothesis is true. We will discuss this issue further below.

Conclusion

At this point we have a random variable Z, and if the sample size is larger than 100, we know how it is distributed for certain. The fewer number of observations we have, the less we know about the distribution of Z, and the more likely it is to make a mistake when performing the test. In the following discussion we will assume that the sample size is sufficiently large so that the normal distribution is a good approximation. A random variable is said to be continuous when it can assume any value within an interval. In theory that would imply an infinite number of values. But in practice that does not work out. Time is a variable that can be measured in very small units and go on for a very long time and is therefore a continuous variable. Variables related to time, such as age is therefore also considered to be a continuous variable. Economic variables such as GDP, money supply or government spending are measured in units of the local currency, so in some sense one could see them as discrete random variables. However, the values are usually very large so counting each Euro or dollar would serve no purpose. It is therefore more convenient to assume that these measures can take any real number, which therefore makes them continuous. Since the value of a random variable is unknown until the experiment has taken place, a probability of its occurrence can be attached to it. In order to measure a probability for a given events, the following formula may be used: P (A) The The number total of ways number of event A possible can occur outcomes his formula is valid if an experiment can result in n mutually exclusive and equally likely outcomes, and if m of these outcomes are favorable to event A.

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