Multinomial Distribution

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What Is the Multinomial Distribution?

The multinomial distribution is the type of probability distribution used to calculate the outcomes of experiments involving two or more variables. The more widely known binomial distribution is a special type of multinomial distribution in which there are only two possible outcomes, such as true/false or heads/tails.

In finance, analysts use the multinomial distribution to estimate the probability of a given set of outcomes occurring, such as the likelihood that a company will report better-than-expected earnings while its competitors report disappointing earnings.

KEY TAKEAWAYS

- The multinomial distribution is a probability distribution used in experiments with two or more variables.
- There are different kinds of multinomial distributions, including the binomial distribution, which involves experiments with only two variables.
- The multinomial distribution is widely used in science and finance to estimate the probability of a given set of outcomes occurring.

Understanding Multinomial Distribution

The multinomial distribution applies to experiments in which the following conditions are true:

- The experiment consists of repeated trials, such as rolling a dice five times instead of just once.
- Each trial must be independent of the others. For example, if you roll two dice, the outcome of one dice does not impact the outcome of the other dice.
- The probability of each outcome must be the same across each instance of the experiment. For example, if a dice has six sides, then there must be a one in six chance of each number being given on each roll.
- Each trial must produce a specific outcome, such as a number between two and 12 if rolling two six-sided dice.

Staying with dice, suppose we run an experiment in which we roll two dice 500 times. Our goal is to calculate the probability that the experiment will produce the following results across the 500 trials:

- The outcome will be "2" in 15% of the trials;
- The outcome will be "5" in 12% of the trials;
- The outcome will be "7" in 17% of the trials; and
- The outcome will be "11" in 20% of the trials.

The multinomial distribution would allow us to calculate the probability that the above combination of outcomes will occur. Although these numbers were chosen arbitrarily, the same type of analysis can be performed for meaningful experiments in science, investing, and other areas.

Real-World Example of the Multinomial Distribution

In the context of investing, a portfolio manager or financial analyst might use the multinomial distribution to estimate the probability of (a) a small-cap index outperforming a large-cap index 70% of the time, (b) the large-cap index outperforming the small-cap index 25% of the time, and (c) the indexes having the same (or approximate) return 5% of the time.

In this scenario, the trial might take place over a full year of trading days, using data from the market to gauge the results. If the probability of this set of outcomes is sufficiently high, the investor might be tempted to make an overweight investment in the small-cap index.

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