

# **Cause and Effect**

When one event causes another to happen. The **cause** is WHY it happens, the **effect** is WHAT happens.



### Introduction

A correlation study refers to the application of statistical methods to determine the relationship between two variables. Such a study is done in order to determine causeand-effect relationships. Usually, the main reason for a correlational study is to find evidence of a cause-and-effect relationship.

## Introduction

For example:

- A health researcher may wish to prove that even mild exercise reduces the risk of heart disease.
- A chemical company developing an oil additive would like to demonstrate that it improves engine performance.
- A school board may want to know whether calculators help students learn mathematics.

In each of these cases, establishing a strong correlation between the variables is just the first step in determining whether one affects the other. However, a strong correlation does not prove that the changes in one variable cause changes in the other.

# 1. Cause-and-Effect Relationship

A **cause and effect relationship** refers to a relationship in which a change in the independent variable produces, by some mechanism, a change in the dependent variable. Such relationships are sometimes clearly evident, especially in physical processes.

# 1. Cause-and-Effect Relationship

- Increasing the amount of quality time one spends studying for a test will increase the person's test mark.
- Increasing the height from which you drop an object increases its impact velocity.
- Increasing the speed of a production line increases the number of items produced each day (and, perhaps, the rate of defects).

# 2. Common-Cause Factor

A **common cause factor** refers to an external variable that causes two variables to change in the same way.

# 2. Common-Cause Factor

- The price of oranges and new housing prices have a strong positive correlation over many years. It is unlikely that an increase in the price of oranges causes an increase in the cost of new homes. Instead inflation is a common-cause factor that increases both the price of oranges and the prices of new homes.
- Suppose that a town finds that its revenue from parking fees at the public beach each summer correlates with the local tomato harvest. It is extremely unlikely that cars parked at the beach have any effect on the tomato crop. Instead good weather is a common-cause factor that increases both the tomato crop and the number of people who park at the beach.

### 3. Reverse Cause-and-Effect Relationship

A **reverse cause and effect relationship** refers to a relationship in which the presumed dependent and independent variables are reversed in the process of establishing causality.

## 3. Reverse Cause-and-Effect Relationship

- A researcher finds there is a strong positive correlation between the amount a person gets paid and his/her job performance. She assumes that the more a person gets paid, the better his/her job performance. This may sometimes be the case because people who are given a higher wage often take their job more seriously; however, the opposite is more likely true. There are often incentive programs and advancement opportunities for people who demonstrate a strong work ethic and who are continually retraining. As such, a person's salary will often depend on their job performance and not the other way around.
- Suppose that a researcher observes a positive linear correlation between the amount of coffee consumed by a group of medical students and their levels of anxiety. The researcher theorizes that drinking coffee causes nervousness.

## 4. Accidental Relationship

An **accidental relationship** refers to a correlation between two variables that occurs by random chance. In other words, a correlation exists without any causal relationship between variables.

# 4. Accidental Relationship

- The number of female students enrolled in undergraduate engineering programs and the number of "reality" shows on television both increased for several years. These two variables have a positive linear correlation, but it is likely entirely coincidental.
- There is a positive correlation between the number of deaths in Canada and the total sales of major appliances. Despite the correlation between these variables, it is likely to be coincidental.

## 5. Presumed Relationship

A **presumed relationship** refers to a correlation that does not seem to be accidental, even though no cause-and-effect relationship or common-cause factor is apparent.

# 5. Presumed Relationship

- Suppose you found a correlation between people's level of fitness and the number of adventure movies they watched. It seems logical that a physically fit person might prefer adventure movies, but it would be difficult to find a common cause or to prove that the one variable affects the other.
- Job performance and academic achievement are positively correlated. It seems logical that the better a person performs in his academic studies; the better the person will do at his job. Variables such as work ethic, the ability to work independently, the ability to work in a team, strong organizational skills, initiative, ability to grasp techniques and concepts quickly, all of which are very difficult to evaluate, may together be at the root of good marks and good job performance. Since it is difficult to identify the cause of this correlation, we say that there is a presumed relationship between these two variables.

### Extraneous Variables

Determining the nature of causal relationships can be further complicated by the presence of extraneous variables that affect either the dependent or the independent variable.

**Extraneous variables** are factors that influence the relationship between the independent and dependent variable. An **extraneous variable** does not imply that this factor is irrelevant; in contrast, these variables are usually highly relevant. The choice of term indicates that they are external factors, which are not accounted for in a simple correlation study between two variables.

## Extraneous Variables

- When trying to determine if a correlation exists between traffic congestion and traffic accidents, the time of day is an extraneous variable. Time of day may be one of many factors that influence traffic congestion and traffic accidents.
- A teacher might expect to see a strong positive correlation between term marks and final examination results for her students since both these variables are affected by each student's aptitude and study habits. However, there are extraneous factors that could affect the examination results, including the time each student had for studying before the examination, the individual examination schedules, and varying abilities to work well under pressure.