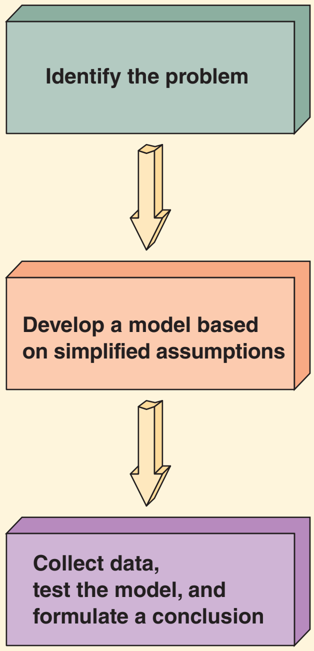
Exhibit 2 **The Steps in the Model-Building Process**

The first step in developing a model is to identify the problem. The second step is to select the critical variables necessary to formulate a model that explains the problem under study. Eliminating other variables that complicate the analysis requires simplifying assumptions. In the third step, the researcher collects data and tests the model. If the evidence supports the model, the conclusion is to accept the model. If not, the model is rejected.



Where have you seen a "model" in this sense before?

Hint: It wasn't in Social Studies, or Computer Science.

Problem Identification

The first step in applying the economic method is to define the issue. Suppose an economist wishes to investigate the microeconomic problem of why U.S. motorists cut back on gasoline consumption in a given year from, for example, 400 million gallons per day in May to 300 million gallons per day in December.

STOP & Check

Model Development

The second step in our hypothetical example toward finding an explanation is for the economist to build a **model**. A model is a simplified description of reality used to understand and predict the relationship between variables. The terms

Model
A simplified description of reality used to understand and predict the relationship between variables.

A map is a model because it is an abstraction from reality.

model and *theory* are interchangeable. A model emphasizes only those variables that are most important to explaining an event. As Albert Einstein said, "Theories should be as simple as possible, but not more so." The purpose of a model is to construct an abstraction from real-world complexities and make events understandable. Consider a model airplane that is placed in a wind tunnel to test the aerodynamics of a new design. For this purpose, the model must represent only the shapes of the wings and fuselage, but it does not need to include tiny seats, electrical wiring, or other interior design details. A highway map is another example. To find the best route to drive between two distant cities, you do not want extraneous information on the location of all roads, streets, potholes, telephone lines, trees, stoplights, schools, hospitals, and firehouses. This would be too much detail, and the complexity would make it difficult to choose the best route.

To be useful, a model requires simplified assumptions. Someone must decide, for example, whether a map will include only symbols for the major highways or the details of hiking trails through mountains. In our gasoline consumption example, several variables might be related to the quantity of gasoline consumed, including consumer incomes, the prices of substitutes for gasoline, the price of gasoline, the fuel economy of cars, and weather conditions. Because a theory focuses only on the main or critical variables, the economist must be a Sherlock Holmes and use a keen sense of observation to form a model. Using his or her expertise, the economist must select the variables that are related to gasoline consumption and reject variables that have only slight or no relationship to gasoline consumption. In this simple case, the economist removes the cloud of complexity by formulating the theory that increases in the price of gasoline *cause* the quantity of gasoline consumed to decrease during the time period.

Testing a Theory

An economic model can be stated as a verbal argument, numerical table, graph, or mathematical equation. You will soon discover that a major part of this book is devoted to building and using economic models. The purpose of an economic model is to *forecast* or *predict* the results of various changes in variables. Note that the appendix to this chapter provides a review of graphical analysis. An economic theory can be expressed in the form "If *A*, then *B*, other things held constant." An economic model is useful only if it yields accurate predictions. When the evidence is consistent with the theory that *A* causes outcome *B*, there is confidence in the theory's validity. When the evidence is inconsistent with the theory that *A* causes outcome *B*, the researcher rejects this theory.

In the third step, the economist gathers data to test the theory that if the price of gasoline rises, then gasoline purchases fall—all other relevant factors held constant. Suppose the investigation reveals that the price of gasoline rose sharply between September and December of the given year. The data are therefore consistent with the theory that the quantity of gasoline consumed per month falls when its price rises, assuming no other relevant factors change. Thus, the conclusion is that the theory is valid if, for example, consumer incomes or population size do not change at the same time that gasoline prices rise.

CheckPoint

Can You Prove There Is No Trillion-Dollar Person?

Suppose a theory says no U.S. citizen is worth $1 trillion. You decide to test this theory and send researchers to all corners of the nation to check financial records to see whether someone qualifies by owning assets valued at $1 trillion or more. After years of checking, the researchers return and report that not a single person is worth at least $1 trillion. Do you conclude that the evidence proves the theory?

Hazards of the Economic Way of Thinking

Models help us understand and predict the impact of changes in economic variables. A model is an important tool in the economist's toolkit, but it must be handled with care. The economic way of thinking seeks to avoid reasoning mistakes. Two of the most common pitfalls to clear thinking are (1) failing to understand the *ceteris paribus assumption* and (2) confusing *association* and *causation*.

STOP & Check

The Ceteris Paribus Assumption

As you work through a model, try to think of a host of relevant variables assumed to be "standing still," or "held constant." **Ceteris paribus** is a Latin phrase that means while certain variables change, "all other things remain unchanged." In short, the ceteris paribus assumption allows us to isolate or focus attention on selected variables. In the gasoline example discussed earlier, a key simplifying assumption of the model is that changes in consumer incomes and certain other variables do not occur and complicate the analysis. The ceteris paribus assumption holds everything else constant and therefore allows us to concentrate on the relationship between two key variables: changes in the price of gasoline and the quantity of gasoline purchased per month.

Ceteris paribus

A Latin phrase that means while certain variables change, "all other things remain unchanged."

"All things being equal…"

Now suppose an economist examines a model explaining the relationship between the price and quantity purchased of Coca-Cola. The theory is "If the price increases, then the quantity of Coca-Cola purchased decreases, ceteris paribus." Now assume you observe that the price of Coca-Cola increased one summer and some people actually bought more, not less. Based on this real-world observation, you declare the theory is incorrect. Think again! The economist responds that this is a reasoning pitfall because the model is valid based on the assumption of ceteris paribus, and your observation gives us no reason to reject the model. The reason the model appeared flawed is because another factor, a sharp rise in the temperature, *caused* people to buy more Coca-Cola in spite of its higher price. If the temperature and all other factors are held constant as the price of Coca-Cola rises, then people will indeed buy less Coca-Cola, as the model predicts.

CONCLUSION *A theory cannot be tested legitimately unless its ceteris paribus assumption is satisfied.*

Association versus Causation

STOP & Check

Just because something happened AFTER something else doesn't it mean it was CAUSED by something else.

Another common error in reasoning is confusing *association* (or correlation) and *causation* between variables. Stated differently, you err when you read more into a relationship between variables than is actually there. A model is valid only when a cause-and-effect relationship is stable or dependable over time, rather than being an association that occurs by chance and eventually disappears. Suppose a witch doctor performs a voodoo dance during three different months and stock market prices skyrocket during each of these months. The voodoo dance is *associated* with the increase in stock prices, but this does not mean the dance *caused* the event. Even though there is a statistical relationship between these two variables in a number of observations, eventually the voodoo dance will be performed, and stock prices will fall or remain unchanged. The reason is that there is no true systematic economic relationship between voodoo dances and stock prices.

Further investigation may reveal that stock prices actually responded to changes in interest rates during the months that the voodoo dances were performed. Changes in interest rates affect borrowing and, in turn, profits and stock prices. In contrast, there is no real economic relationship between voodoo dances and stock prices, and, therefore, the voodoo model is not valid.

CONCLUSION *The fact that one event follows another does not necessarily mean that the first event caused the second event.*

CHECKPOINT

Should Nebraska State Join a Big-Time Athletic Conference?

Nebraska State (a mythical university) stood by while Penn State, Florida State, the University of Miami, and the University of South Carolina joined big-time athletic conferences. Now Nebraska State officials are pondering whether to remain independent or to pursue membership in a conference noted for high-quality football and basketball programs. An editorial in the newspaper advocates joining and cites a study showing that universities belonging to major athletic conferences have higher graduation rates than nonmembers. Because educating its students is the number one goal of Nebraska State, will this evidence persuade Nebraska State officials to join a big-time conference?