Chapter 2

Economic Methods and Economic Questions

Questions

1. What does it mean to say that economists use the scientific method? How do economists distinguish between models that work and those that don't?

Answer: The scientific method is the name for the ongoing process that economists and other scientists use to develop models of the world, test those models with data, and evaluate how well the models predict behavior. While this process may not reveal the 'true' model of the world, it does help identify models that are useful in understanding the world.

In order to decide whether models make accurate predictions or not, economists test them against real-world data. Data are facts, measurements, or statistics that describe the world. This process of testing models against data is called empiricism.

2. What is meant by empiricism?

Answer: Empirical evidence is a set of facts established by observation and measurement, which are used to evaluate a model. Empiricism refers to the practice of using data to test economic models. When conducting empirical analysis, economists refer to a model's predictions as hypotheses. Hypotheses are predictions (typically generated by a model) that can be tested with data.

3. What are two important properties of economic models? Models tend to be simplified descriptions of a real-world phenomenon. Does this mean that they are unrealistic?

Answer: A good economic model has two important properties. First, it is an approximation. The model predicts what would happen on average. Second, it makes predictions that can be falsified by data.

A model is a simplified description, or representation, of reality. Because models are simplified, they are not perfect replicas of reality. However, this does not mean that they are unrealistic. Models are usually simplified in order to be able to isolate the relationship between two variables. Even if a model is based on simplified assumptions, it may still help us make good predictions.

4. Suppose 5,000 people bought popsicles on a hot summer day. If the average number of popsicles that each person bought is 2, how many popsicles were sold that day?

Answer: The mean is calculated as the sum of all the different items divided by the number of items. The average value is the sum of all popsicles sold divided by the number of people who bought them. If each of the 5,000 people bought an average of 2 popsicles, that implies that 10,000 popsicles were sold that day.

5. How does the sample size affect the validity of an empirical argument? When is it acceptable to use only one example to disprove a statement?

Answer: The size of the sample used to test the argument can affect the results. A small sample may mean no conclusions can be drawn from a study. A key strength of economic analysis is the amount of data used. Using a large number of observations strengthens the force of an empirical argument. For example, if you collect information on consumption from 20,000 people as opposed to 20 people, you are likely to get a more representative result. However, a single example can be used to contradict a statement.

6. Explain why correlation does not always imply causation. Does causation always imply *positive* correlation? Explain your answer.

Answer: Correlation means that there is a relationship between two variables; as one variable changes, another variable changes. Causation occurs when one variable directly affects another through a cause-and-effect relationship. Correlation suggests that there is some kind of connection, but not necessarily a cause and an effect. For example, number of storks in a region might be correlated with the number of babies born in the region. But this doesn't mean that storks bring babies.

Positive correlation implies that two variables tend to move in the same direction. However, causation need not only imply positive correlation. For example, sleeping an extra hour per night may improve your energy level at work. However, this positive relationship is swamped by the fact that people who sleep a ton tend to be low energy; thus hours of sleep and energy will be negatively correlated even though there is a positive causal link.

7. Give an example of a pair of variables that have a positive correlation, a pair of variables that have a negative correlation, and a pair of variables that have zero correlation.

Answer: A person's IQ and his or her telephone number are likely to show zero correlation. The number of winter coats sold and the average temperature in a region are likely to show a negative correlation. The quantity of fertilizers used and crop yield (e.g., the number of bushels of wheat grown per acre) are likely to have a positive correlation.

8. What is meant by randomization? How does randomization affect the results of an experiment?

Answer: Randomization is the assignment of subjects by chance, rather than by choice, to the effect of a treatment. Assigning participants randomly will ensure that the result of the experiment is not biased. When randomization is employed, correlation *does* imply causation: How else can a positive correlation be explained? There is no other way (assuming perfect random assignment) except with a causal link between the treatment and the outcome.

9. This chapter discussed natural and randomized experiments. How does a natural experiment differ from a randomized one?

Answer: A natural experiment is an empirical study in which some process – out of the control of the experimenter – has assigned subjects to control and test groups in a random or nearly random way. The process of randomization involves the assignment of subjects by chance, rather than by choice, to a test group or control group.

10. Suppose you had to find the effect of seat belt rules on road accident fatalities. Would you choose to run a randomized experiment or would it make sense to use natural experiments here? Explain.

Answer: It would be difficult (and, in many people's view, unethical) to conduct a randomized experiment. Instead, the study should use a natural experiment. You can study data on the causes of road accident fatalities in cities where seat belt rules were not enforced, or in cities that have recently adopted new, more stringent seat belt laws. Controlling for other factors like an increase in the number of cars, etc., you can then look at similar data when seat belt rules have been implemented.

Problems

1. Although the mean and median are closely related, the difference between the mean and the median is sometimes of interest.

a. Suppose country A has five families. Their incomes are $10,000, $20,000, $30,000, $40,000, and $50,000. What is the median family income in A? What is the mean income?

b. Country B also has five families. Their incomes are $10,000, $20,000, $30,000, $40,000, and $150,000. What is the median family income in B? What is the mean income?

c. In which country is income inequality greater, A or B?

d. Suppose you thought income inequality in the US had increased over time. Based on your answers to this question, would you expect that the ratio of the mean income in the US to the median income has risen or fallen? Explain.

Answer:

a. We can find the mean by summing the observations and dividing by the number of observations. So the mean income in Country A is ($10,000 + $20,000 + $30,000 + $40,000 + $50,000) / 5 = $30,000. The median income is the income of the family in the middle of the income distribution. The median income in Country A is $30,000. Two families have income below $30,000 and two have income above $30,000.

b. A similar argument shows that the mean income in Country B is ($10,000 + $20,000 + $30,000 + $40,000 + $150,000) / 5 = $50,000. Median income in B is $30,000; as in Country A, two families have income below $30,000 and two have income above $30,000.

c. Income inequality is higher in Country B. The highest income family in Country B earns $150,000, 60% of the total income in that country. The highest income family in A earns $50,000, just 33% of total income in A. We found that the median income in the two countries was the same but the mean income was very different. Means will be heavily influenced by extreme values such as the incomes of the very wealthy; median income is less sensitive to extremes. Economists sometimes use the ratio of the mean to median income in a country as a rough measure of income inequality; higher values of this ratio reflect greater inequality.

d. You should expect to find that the ratio of the mean to median income has risen. As we argued above, the mean is more sensitive than the median to the incomes of the very wealthy.

2. Consider the following situation: your math professor tells your class (of five students) that the mean score on the final exam is 80 but the median is 100. How is that possible? Explain.

Answer: Typically, when the mean is lower than the median there is a skew in the data: The test scores that were below the median were way below the median. For example, with only five tests, the median may be 100 because three out of five people scored 100. If the lower scorers received scores of 40 and 60 then the average (i.e. the mean) will be (40+60+100+100+100)/5 = 80.

3. Suppose you come across a study that has discovered a correlation between reading books and life expectancy: People who read more books live longer. Come up with at least one plausible way that this correlation exists even though there is no direct causal link.

Answer: One possibility is that wealthier individuals can afford to spend more time reading; they also can afford better medical care. Another possibility is that sitting in a quiet place is good for health, and reading just happens to be one way to sit in a quiet place. Also, if you live longer you have more time to read more books (reverse causality), though any reasonable study would account for this effect before drawing conclusions.

4. Some studies have found that people who owned guns were more likely to be killed with a gun. Do you think this study is strong evidence in favor of stricter gun control laws? Explain.

Answer: Not necessarily. It is quite possible that people who thought they were at risk (perhaps because they live in dangerous neighborhoods) were more likely to buy a gun for self-protection. This is an example of a case where correlation may not imply causation. There has been a good deal of research on this question. See, for example, a Harvard School of Public Health 2011 interview with David Hemenway (http://www.hsph.harvard.edu/news/features/review-guns-politics-hemenway).

5. As the text explains, it can sometimes be very difficult to sort out the direction of causality.
   a. Why might you think more police officers would lead to lower crime rates? Why might you think that higher crime rates would lead to more police officers?
   b. In 2012, the *New England Journal of Medicine* published research that showed a strong correlation between the consumption of chocolate in a country and the number of Nobel Prize winners in that country. Do you think countries that want to encourage their citizens to win Nobel Prizes should increase their consumption of chocolate?
   c. A recent article in the Journal of Applied Physiology found that elderly runners had healthier muscles than a comparison group of the same age. Although the members of the comparison group were all still living independently, they had lower muscle mass and muscle strength than the athletes. The popular press framed the article as proof that exercise causes people to be healthier. Is that the only way to interpret causality in this example?

Answer:

   a. There is a great deal of evidence that increasing the number of police officers in a neighborhood can drive down crime. The police, for example, will deter criminals who realize the chances they will be caught have gone up and the police may be able to head off conflicts between gangs. Therefore more police could lead to less crime. Cities strategically assign more police to high crime areas (since by definition, those are the areas where crimes are more likely to occur). Therefore, more crime can lead to more police.
   b. Correlation does not necessarily imply causation. A strong positive correlation between chocolate consumption and Nobel Prize winners does not, by itself, suggest causation. It is possible that this is a chance correlation. It may also be case that certain variables that could explain this relationship have been omitted from the study.
   c. Another quite likely story that would generate the same correlation between running and muscle mass: Elderly people with enough muscle to go outside for a run are more likely to go outside for a run! It is likely some people who lose muscle mass and respond by not running as much; in fact, this almost surely happens. This argument is not definitive proof that the causal link from running to muscle mass is false, but the study is also not definitive proof that the causal link is true.

   See the June 11, 2013 New York Times article "Chicago Tactics Put Major Dent in Killing Trend" (http://www.nytimes.com/2013/06/11/us/chicago-homicides-fall-by-34-percent-so-far-this-year.html?hp) on the relationship between police and crime rates. See http://www.reuters.com/article/2012/10/10/us-eat-chocolate-win-the-nobel-prize-idUSBRE8991MS20121010 on the effects of eating chocolate.

6. The chapter shows that as a general rule people with more education earn higher salaries. Economists have offered two explanations of this relationship. The human capital argument says that high schools and colleges teach people valuable skills and employers are willing to pay higher salaries to attract people with those skills. The signaling argument says that college graduates earn more because a college degree is a signal to employers that a job applicant is diligent, intelligent, and persevering. How might you use data on people with 2, 3, and 4 years of college education to shed light on this controversy?

Answer: If the human capital explanation is correct, then we might expect to find that people who attend college but do not graduate earn salaries that are close to what college graduates earn. Consider the extreme case of people who drop out of college the week before graduation. It is very unlikely that they would have improved their job skills much in that last week. The human capital school of thought would suggest that they should therefore earn roughly the same salaries as college graduates. On the other hand, the signaling school of thought would argue that these people should earn significantly less than college graduates. Employers would interpret their failure to graduate as a signal they are not as diligent or persevering as people who see their college educations through to the end. There is substantial literature on what is often called the "sheepskin effect" (college diplomas used to be written on sheepskin; Notre Dame continued to use sheepskin until 2012). That literature suggests that human capital and signaling both contribute to the returns to education that we observe in the data.

For recent evidence, see the Michael Greenstone and Adam Looney 2013 Brookings Institution study **"**Is Starting College and Not Finishing Really That Bad?" (http://www.brookings.edu/blogs/jobs/posts/2013/06/07-return-to-some-college-greenstone-looney). They find that people with some college education but who do not graduate from college earn an average of $8,000 more per year than high school graduates who never attend college.

7. You decide to run an experiment. You invite 50 friends to a party. You randomly select 25 friends and tell them that there will be free food; most of them show up to your party. For the other 25 friends you do not mention the free food; none of these friends show up. Based on the correlation in your data, you conclude that free food causes people to come to parties. A buddy points out "be careful, correlation does not imply causation." How should you respond?

Answer: Assuming you really did choose the two groups randomly, then the *correlation does in fact imply causation*. If your friend challenges you, ask him "what else could it be?" Given randomization, the relationship is not due to omitted variables, nor is it due to reverse causality. (It is possible that due to a small sample you just happened to get a spurious correlation, but this is another matter related to statistical inference, not correlation vs causation.)

8. Oregon expanded its Medicaid coverage in 2008. Roughly 90,000 people applied but the state had funds to cover only an additional 30,000 people (who were randomly chosen from the total applicant pool of 90,000). How could you use the Oregon experience to estimate the impact of increased access to health care on health outcomes?

Answer: The Oregon experience is a natural experiment. The state chose people randomly from the pool of applicants, and so on average the new Medicaid recipients were very similar to the people who applied but were turned down. By tracking the health outcomes of people in these two groups we can study the effect of better access to health care.

See "Medicaid Access Increases Use of Care, Study Finds," New York Times, May 1, 2013 (http://www.nytimes.com/2013/05/02/business/study-finds-health-care-use-rises-with-expanded-medicaid.html?_r=0).

9. A simple economic model predicts that a fall in the price of bus tickets means that more people will take the bus. However, you observe that some people still do not take the bus even after the price of a ticket fell.
   a. Is the model incorrect?
   b. How would you test this model?

Answer:

a. The model is not necessarily incorrect. Models are only approximations of real-life behavior. Even very good models make predictions that are often correct. So, on average, more people will take the bus. The model is also likely to have made some assumptions, such as no change in costs of other types of transport, or that people have no specific preferences and cost is the only determinant of the mode of transport used. In reality, some of these assumptions may be violated which could explain why a fall in the price of bus tickets does not induce everyone to take the bus. That does not imply that the model's conclusion is incorrect. In situations where the assumptions it makes are satisfied, its prediction will often be correct.

b. The hypothesis here states that as bus prices fall, the number of passengers who take the bus will increase. A natural experiment can be used to test this model. You can use data on price changes and changes in revenues earned from tickets to see whether the model is accurate.

A1. How would you represent the following graphically?

a. Income inequality in the U.S. has increased over the past 10 years.

b. All the workers in the manufacturing sector in a particular country fit into one (and only one) of the following categories: 31.5 percent are high school dropouts, 63.5 percent have a high school diploma, and the rest have vocational training certificates.

c. The median income of a household in Alabama was $43,464 in 2012, and the median income of a household in Connecticut was $64,247 in 2012.

Answer:

a. Since the graph needs to show how income inequality increases over a period of time, a time-series graph needs to be used here.

b. A pie chart is a circular chart split into segments to show the percentages of parts to the whole. Since the given data is in percentages, a pie-chart can be used to represent each category of workers.

c. A bar chart would be a good way to compare income in Alabama and Connecticut. The height of each bar would represent the income in each one of the states.

A2. Consider the following data that shows the quantity of coffee produced in Brazil from 2004-2012.

Year	Production (in tons)
2004	2,465,710
2005	2,140,169
2006	2,573,368
2007	2,249,011
2008	2,796,927
2009	2,440,056
2010	2,907,265
2011	2,700,440
2012	3,037,534

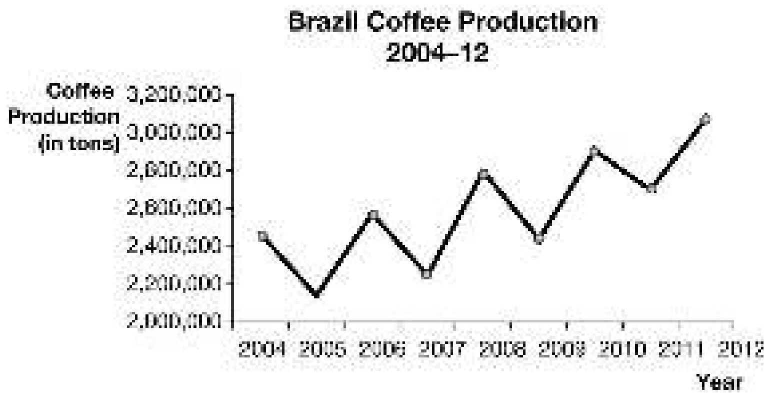
a. Plot the data in a time series graph.

b. What is the mean quantity of coffee that Brazil produced from 2009 to 2011?

c. In percentage terms, how much has the 2012 crop increased over the 2009-2011 mean?

Answer:

a. A time-series graph can be used to represent the quantity of coffee produced from 2004 to 2012.



b. The average quantity of coffee that Brazil produced during the 2009-11 period is 2,682,589 587 tons. This is the sum of the total quantity produced divided by the number of years.

c. The coffee crop in 2012 is 14.6% larger than the average coffee crop in 2009-2011. The increase in production is 3,073,534 – 2,682,589 = 390,945. In percentage terms, the change is 390,945 / 2,682,589 587 = 14.6%.

Data taken from: http://faostat.fao.org/site/567/default.aspx#ancor

A3. Suppose the following table shows the relationship between revenue that the Girl Scouts earn and the number of cookie boxes that they sell.

Number of cookie boxes	Revenue ($)
50	200
150	600
250	1,000
350	1,400
450	1,800
550	2,200

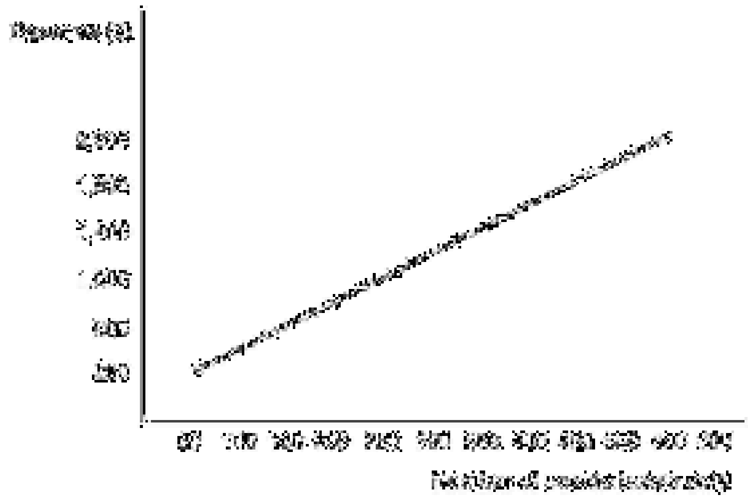
a. Present the data in a scatter plot.

b. Do the two variables have a positive relationship or do they have a negative relationship? Explain.

c. What is the slope of the line that you get in the scatter plot? What does the slope imply about the price of a box of Girl Scout cookies?

Answer:

a. The following line chart shows the relationship between the Girl Scouts' revenue and the number of cookie boxes that they sell:



b. Since the values of both variables increase together in the same direction, they have a positive relationship. This means that as more cookie boxes are sold, the revenue earned increases.

c. The slope is constant in this problem and so we can choose any two points to calculate the slope. Suppose we use the first and last data points. The slope is calculated as

$$\frac{\text{Change in revenue}}{\text{Change in cookie boxes sold}} = \frac{2200 - 200}{550 - 50} = \frac{2000}{500} = 4$$

. The slope implies that one extra box of cookies sold is associated with $4 more in revenue.

CHAPTER 2
Economic Methods and Economic Questions

I. Key Ideas

A model is a simplified description of reality.

Economists use data to evaluate the accuracy of models and understand how the world works.

Correlation does not imply causality.

Experiments help economists measure cause and effect.

Economic research focuses on questions that are important to society and can be answered with models and data.

II. Getting Started

A. The Big Picture

Chapter 2 emphasizes the importance of using real-world data to test hypotheses and decide which of our competing theories is most compelling. Chapter 2's discussion of empirical methods and common pitfalls (e.g., argument by anecdote, omitted variables bias, nonrandom sampling) prepares the reader to understand the special Evidence-Based Economics sections found in each textbook chapter; a list of key economic questions by chapter is provided on page 32. For illustrative purposes, the authors construct a simple model of the returns to education.

Where We've Been

By reading Chapter 1, students have been introduced to an economist's basic perspective and some common terminology, summarized here: *Scarcity* is everywhere, so *economic agents* such as households, firms, and governments must make tough decisions and face *trade-offs* sometimes presented in the form of a *budget constraint*. For each option chosen, there is a runner-up choice; we refer to (the value of) the best alternative forgone as the *opportunity cost*. For example, when pondering whether to spend an hour per day on Facebook, a student might recognize that she is forgoing roughly $10 in wages, so a year's worth of Facebooking implicitly costs her nearly $4,000, which could have been spent on something like foreign vacations or leasing a sports car. *Optimizing* economic agents identify and weigh the relevant costs and benefits for each option, and choose the option with the highest *net benefit*; in other words, when economists say someone is optimizing, we think of them using *cost-benefit analysis.* When two or more economic agents are optimizing, we may find an *equilibrium*: a situation in which no party has an incentive to unilaterally change its behavior. Economists study small pieces of the economy (*microeconomics*) as well as the entire economy (*macroeconomics*) and use equilibrium analysis to describe the world *(positive economics)* and offer advice on the choices one should make (*normative economics*). Finally, *empiricism* was introduced as the third of three pillars of the textbook (along with optimization and equilibrium), so students are ready for Chapter 2's more detailed treatment of empirical methods.

Where We're Going

Armed with a basic understanding of decision-making economic agents, systems of multiple, self-interested agents in equilibrium, and some empirical issues, we turn next to an in-depth look at optimization in Chapter 3. Building around a person's choice of how close to live to her job in the city center, the authors develop a cost-minimization model that considers both living costs (apartment rent) and commuting costs (based on gas prices and distance from the apartment to her job). Thousands of like-minded potential tenants compete to rent scarce apartments, generating equilibrium rental rates. This discussion of the market for living space sets up the reader to apply Chapter 2's empirical insights as s/he learns more about supply, demand, and equilibrium in the next four microeconomic chapters:

- Chapter 4 *Demand, Supply, and Equilibrium*: Brazil heavily taxes gasoline, Mexico modestly subsidizes it, and Venezuela aggressively subsidizes it, so the quantity of gasoline demanded in the three nations varies significantly, and it is negatively related to the effective price, as the Law of Demand predicts.
- Chapter 5 *Consumers and Incentives*: In the Philadelphia Veterans Affairs experiment, volunteer smokers offered $100 to quit smoking for a month had a much higher quit rate than those who were not offered a financial incentive; smokers who did not quit effectively gave up $100 of increased income that could have been spent on other goods and services.
- Chapter 6 *Sellers and Incentives*: After President George W. Bush promoted ethanol in his 2006 State of the Union Address, the number of new plants under construction or expansion rose and the number of ethanol plants rose; experimental evidence confirms that production subsidies encourage production.
- Chapter 7 *Perfect Competition and the Invisible Hand*: Field experiments of markets show that observed prices quickly converge to the equilibrium price predicted by economic theory, showing that Adam Smith's invisible hand metaphor is alive and well.

B. Number of Lectures

Chapter 2's material can be covered adequately in one 50-minute lecture. Here are the essential elements:

- Introduce key question: Is college worth it? [5 mins.]
- Scientific methods, why build models, examples of models [5 mins.]

- Introduce the basic returns-to-education model; show EBE's Exhibit 2.3 [10 mins.]
- Empirical Issues: argument by anecdote, correlation versus causation, omitted variables, reverse causality [15 mins.]
- Empirical Methods: experiments, test versus control groups, randomization, natural experiments [10 mins.]
- What makes a good economic question? [5 mins.]

C. Opening Question and Evidence-Based Economics

"Is college worth it?" This question should resonate with most students, not only because they are currently investing substantial time, energy, and money in a college education, but also because they might wonder whether it makes sense to pursue a subsequent graduate degree. In the past few years, we have read more and more headlines about the rising cost of higher education and whether it adequately prepares college graduates for the working world. This chapter helps frame that discussion and prepares the student for Chapter 11, which covers hiring decisions and the relationship between labor productivity and wages.

- This issue is complicated by the fact that college financial aid officers are skilled at using first-degree (perfect) price discrimination, which is covered in Chapter 12. It could be the case that the 30 or 300 students in a class are each being charged a different price for their college education.
- The question "Is college worth it?" begs the question of how we measure value. E.g., perhaps a college education adds few marketable skills and doesn't translate into higher future earnings, but is immensely enjoyable, rewarding, and memorable. As we saw in the previous chapter, when applying cost-benefit analysis to the choice of spending a daily hour on Facebook, our answer critically depends on the numbers we use, which in turn depends on how we choose to measure costs and benefits.

III. Chapter Outline

2.1 The Scientific Method

To better understand the world, economists develop models, gather relevant data, and then use that data to evaluate the models. Economists expand the models that seem better at explaining or predicting outcomes, while reworking or discarding the inferior models, and then repeat the entire process with new and improved models.

- *Teaching Ideas:* At some point in the term one might compare economics and physics, which are arguably the most rigorous of the social and natural sciences, respectively. Both use models, optimization, and equilibrium concepts, but it is easier to study the interaction of two billiard balls than the interactions of two human subjects, who may be aware that they are the subjects of a study; a person asked to "act normally" may become self-conscious and behave in unusual ways.

Models and Data—The authors use the topic of navigation to weigh the advantages and disadvantages of using two-dimensional maps, like those shown in Exhibits 2.1 and 2.2. Determining an optimal flight path is better done with a three-dimensional globe than a two-dimensional world map, but the two-dimensional subway map is very useful for subway commuters.

- Models omit unnecessary details, but what is unnecessary varies from user to user. One can imagine whether a single city map could help one identify city parks (for the noisy kids in the back seat), low-traffic bike routes, post office drop boxes, public drinking fountains, streets appropriate for a heavy dump truck, or addresses of celebrities. Interestingly, Google Maps can accomplish many of these tasks, though it is not a standard printed map.
- *Alternative Teaching Examples:* One might ask a class to imagine trying to model the trajectory of a stuffed toy (e.g., a Sesame Street Elmo doll) thrown out of a third story window. Could we replace Elmo with a sphere or cube with the same mass? Does wind speed matter? Does it matter that the Earth isn't technically flat? Which physical laws apply to this situation?
- *Alternative Teaching Examples:* What are some other examples of models? We attempt to simplify reality in numerous ways besides maps. Before shooting a movie, one might draw a series of storyboards. An architect builds a scaled-down version of a skyscraper. An inventor builds a prototype and a manufacturer builds a mock-up. Astronauts and pilots train with simulators.

An Economic Model—The simple returns-to-education model assumes that investing in one extra year of education increases your future wages by 10 percent; this model predicts that those with higher educational attainment will have higher income, on average. This model is an approximation that ignores many subtleties about the labor market but it does generate a prediction that can be tested empirically if one has sufficient data on years of education and wages.

- *Alternative Teaching Examples:* One could launch a fruitful discussion by asking some of the following questions:
  - Will your wages rise 10 percent if you stick around for the fifth year of college?
  - Why might employers be willing to pay higher wages to workers with more educational experience? Would all employers do this?
  - One sometimes hears that averages mask variation. What does this mean? One could explain this by showing students' two very different distributions of exam scores that have the same mean but very different standard deviations. For example, both (90, 70, 50) and (72, 70, 68) have average scores of 70, but the first distribution is spread out much more than the tightly bunched second distribution. If one only learns the average score, then one cannot tell much about how much the scores varied. Another example one might choose to use is in Chapter 12. When discussing monopoly and antitrust economists prefer the Herfindahl-Hirschman Index (HHI) to the concentration ratio; the former

is a sum of the squared market shares, whereas the latter is a sum of the market shares, so two very different market structures can give different HHIs but identical concentration ratios.

- Starting now, how many additional years of education would you need to roughly double your wage? (Seven! One might introduce the Rule of 72, which says that if you divide 72 by the percentage growth rate, your answer is a good approximation of the number of periods needed to double your wage. So if your wage grew 4 percent each year, it would double in about 72/4 = 18 years, whereas if it grew at 8 percent, it would double in about 72/8 = 9 years. This is an easy rule of thumb to remember, and fun math tricks like this help the math-phobic students settle in and recognize the value of learning some math shortcuts.)
- Does it matter where one obtains education? (Does all education count?)
- Someone who started working right out of high school may have four years of experience by the time another person is graduating from college. Does the college graduate start at a higher wage immediately, or start at a lower wage, but then quickly catch and exceed the wage of the high school graduate?

- You might recognize the future value formula from finance. If X is principal, r is the discount rate (or growth rate), and t is the number of periods, then the future value is given by: $FV = X(1+r)^t$. The time value of money is a major topic in Chapter 15.

Evidence-Based Economics: How much more do workers with a college education earn? With *public-use data* on wages and education from the Current Population Survey, the authors determined average salaries for 30-year-old workers with either 12 or 16 years of education. The actual ratio of the average wages (college wage divided by high school wage) is 1.56, whereas the basic returns-to-education model predicts a theoretical ratio of 1.46, which is very close.

- For discussion: Why did the authors choose to compare 30-year-olds rather than workers of a different age? Why did they get such ugly numbers, like $32,912?
- For a nice collection of economic data, a student may explore FRED (Federal Reserve Economic Data) at http://research.stlouisfed.org/fred2/.
- The caveat on page 24 is worth emphasizing: "These are averages for a large population of individuals. Each individual's experience will differ." In other words, it should not be very surprising if we find college graduates who are earning less than $30,000, as well as workers who only finished high school and yet are earning more than $55,000.

Means and Medians—The *average* wage is the sum of wages divided by the number of wages added. The *median* wage is found by ordering the wages from least to greatest and then finding the value halfway through the list (and if there is an even number of items, the median is the midpoint of the middle two values). The more *observations* (or pieces of data) used in statistical analysis, the stronger the empirical argument.

- Easy examples of means: Average height of all students in the classroom; a student's overall grade point average; a baseball player's batting average; the Earth's average surface temperature
- Tougher examples of means: Average net worth of all Americans. If your college considers a standard full-time course to be worth one credit, how do you compute your quarterly GPA when you took 3.5 credits?
- One reason is it nice to report both mean and median is because an outlier can affect the mean substantially. For example, in the series 11, 12, 13, 14, 15, 16, 17, 18, 19, 165, the mean is (11+12+13+14+15+16+17+18+19+165)/10 = 300/10 = 30, whereas the median is (15+16)/2 = 15.5.

Argument by Anecdote—Harvard dropouts Bill Gates (Microsoft founder) and Mark Zuckerberg (Facebook CEO) seem to be an exception to the rule: Both are billionaires despite having less than 16 years of education. However, for the vast majority of workers, higher educational attainment means higher income. One should be wary when someone uses a tiny sample—such as two observations—to draw a general conclusion.

- *Common Mistakes or Misunderstandings:* After reading a compelling article about a particular individual, it is tempting to draw general conclusions. One version of this is the celebrity success story, which makes us think that if we make similar decisions, we, too, could end up with fame and fortune! E.g., dropping out of college to pursue our high tech entrepreneurial dreams may work out well, but there is no guarantee, and experience suggests that this is generally not the case. Statistics reminds us that But statistics reminds us that if we take a single random observation, who knows what we'll get, but as our random sample size increases, the sample mean should become increasingly similar to the population mean. Also, if we don't sample randomly, then we could pick a series of outliers and get just about any desired result. In short, now is a good time to provide some basic intuition about statistics. If students seem bored with income, replace it with economics exam scores and watch their ears perk up.
- Emphasize that an anecdote can disprove an all or nothing claim, but it cannot prove an all or nothing claim. For that matter, when we talk about statistics, the word "prove" is usually not as appropriate as "supports."
- The term "cherry-picking," which means selectively choosing the most favorable items from a set, is useful here because it is essentially what someone is doing when s/he tries to argue by anecdote.

2.2 Causation and Correlation

If two things (A and B) move together, then it could be the case that A causes B, B causes A, each causes the other, or the two are independent and the co-movement is coincidental. This section helps us sort out the possible relationships.

The Red Ad Campaign Blues—A firm's red-themed ad campaigns seem to outperform blue-themed ad campaigns, but if the former occur primarily during the Christmas season while the latter are mostly spread out over the year, then the crowds of Christmas shoppers are more likely responsible for a boost in sales than the red-themed ads. Red-themed ads and sales increases are correlated, but the red-themed ads don't cause sales increases; here, correlation does not imply causation.

- *Common Mistakes or Misunderstandings:* Some students will not know the difference between sales and profits, or that in most simple economic problems, we treat sales and revenues as synonyms. We'll address revenues later in the book, but for now, sales = (price per unit)(units sold). For example, if Walmart sells 1,000 shirts for $5 each, then its sales are ($5)(1,000) = $5,000. Profit is the difference between revenues and costs, so it considers not only inflows, but also outflows.

Causation versus Correlation—When two things are mutually related and move together, then there is correlation, but not necessarily causation. Correlation can be positive (heatstroke cases rise when the temperature rises), negative (frostbite cases fall when the temperature rises), or zero (the formula for the area of a circle remains unchanged when the temperature rises). Complicating our efforts to determine the direction (if any) of causation for two correlated variables are the problems of omitted variables and reverse causality; indeed, these two concerns are the chief reasons why we should not jump to the conclusion that correlation implies a causal relationship.

- In the example above, the *omitted variable* is the Christmas season: sales increases are caused by Christmas shopping, not the color of the red-themed ads.
- *Reverse causality* occurs when we assume A causes B, but it could be the case that B causes A, or the causality runs in both directions. The book gives the example of the wealth-health bi-directional causality: Healthy people may work harder and attain higher wealth, and wealthier people may afford better health care, so health causes wealth and vice versa.
- Where are we going with this? Soon we'll discuss supply and demand and argue that each is a function of many variables. For example, the quantity demanded of strawberry jam is correlated with (and caused by) the strawberry jam price, the grape jelly price, the peanut butter price, the bread price, and average household income, among other things. Next, we'll introduce the concept of *ceteris paribus*, which is Latin for "other (relevant) factors being equal [or held constant]." If we hold all other factors (the grape jelly price, peanut butter price, bread price, and income) constant, then we can track the causal effect of strawberry jam prices on the quantity of strawberry jam demanded. Likewise, we will isolate the effect of higher average household income on strawberry jam consumption.
- *Teaching Ideas:* http://www.correlated.org/ is a website dedicated to finding "surprising connections between seemingly unrelated things." To illustrate, the correlation from July 24, 2017 was as follows: "In general, 49 percent of people say the worst fight they've ever been in has been with a family member. But among those who are fans of Beyoncé, 70 percent say the worst fight they've ever been in has been with a family member." It might be both informative and entertaining if you found several examples of strong correlations with dubious causality logic.

- Assuming correlation implies causality is a very common logical mistake, so reminding students multiple times during a term is not a bad idea. There are several entertaining videos on YouTube on the topic, including one from Freakonomics on polio and ice cream: www.youtube.com/watch?v=lbODqslc4Tg

Experimental Economics and Natural Experiments—To set up an economics experiment, researchers gather a large set of human subjects and randomly assign them to either the control group or the test (treatment) group; the two groups are treated similarly, except that the treatment group gets the treatment while the control group does not. For example, the only difference between the two groups in a drug testing experiment is that the treatment group gets the new drug, while the control group gets the old drug (or a placebo). In a natural experiment, the investigator needn't design the experiment because an event or policy has effectively created control and treatment groups in a (nearly) random way.

- This is an opportunity to discuss the importance of careful experiment design; it would be a shame to invest many resources in a study just to find that the results are not believable because of a fundamental design flaw. For example, because not all people have telephones, one would doubt the results of a study on poverty that used data collected by telephone surveys. Remember, "garbage in, garbage out."
- *For discussion:* Why might it be important for an experiment participant to be unaware of whether s/he is in the control group or the treatment group?

Evidence-Based Economics: How much do wages increase when mandatory schooling laws force people to get an extra year of schooling? An education reform law in the United Kingdom in 1947 raised the legal dropout age from 14 to 15, creating a natural experiment. Students turning 14 before 1947 could be considered a control group whereas students turning 14 in or after 1947 would be the treatment group. By comparing income levels, a researcher found that those compelled to stay in school an extra year earned 10 percent more on average.

- Some students may wonder why researchers don't study a U.S. state in 2010 rather than the UK in 1947. The answer is that empirical researchers must often take what data they can get; an ideal, modern dataset may not be available.

2.3 Economic Questions and Answers

A good economic question addresses an issue that affects social welfare and is a question that can be answered. The authors introduce a long list of good economic questions that will be answered in this book, one per chapter.

- If it is the case that we want to get students interested in research, then our standards for their research questions are probably lower, as there is much that can be learned from doing research, even if the topic isn't popular or there is a struggle in determining how to answer it or adapt it.

- This is an opportunity to show the range of topics that economics can handle!

Appendix

Constructing and Interpreting Graphs—This is a very important skill to develop, not only to do well in an economics course, but also to improve one's ability to digest the news and get along in society.

A Study About Incentives—The authors mention whether a student might spend more time studying for a class if s/he were paid a bonus of $50 or $500 for earning an A. This might be the topic of an interesting discussion: When is it appropriate to use financial "carrots or sticks" to change behavior? What size of a reward or penalty is necessary to get the desired behavioral change? Why might researchers use financial rewards rather than non-pecuniary rewards?

Experimental Design—The authors describe an experiment in which some Chicago Heights high school students (or their parents) were given $50 monthly rewards for achieving particular academic performance goals. One might ask his/her class what they predict the results would be from this incentive scheme. Also, would the students in the instructor's economics class put in more effort if given a financial incentive?

Describing Variables—There are four commonly used ways to graphically describe data. The aptly named *pie chart* breaks up a variable into various categories, with the size of each "slice" indicating the percentage of the whole. A *bar chart* makes it easy to compare a single variable across multiple categories, which are displayed as parallel bars, the length of the bar representing the value of the variable. To see how a variable changes over time, we use a *time series graph*, which features many points, each mapping a point in time to a value of the variable.

- For discussion:
  - When would you expect to see a pie chart with two equally sized slices? What would a pie chart look like for your class if the segments represented home states? Home nations? What issues can complicate pie charts? (The chart is pretty boring if everyone is from the U.S., and the chart would be very busy if each student was from a different state!)
  - What does it mean if you have a bar chart with equally long bars for the control group and the treatment group in some experiment? (That the treatment didn't seem to have any effect on the subjects.)
  - What would a multi-year time series graph look like for a seasonal data series, such as monthly sales or monthly swimming beach use? (There would likely be a repeating pattern with peaks or valleys at certain times of the year.)
  - It is not shown here, but a *scatter plot* can show how two variables are related. E.g., the scatter plot with years of education on the x-axis and weekly earnings on the y-axis would probably look like a swarm of points with most of the points in the lower left, middle, and upper right of the graph.

Cause and Effect—From a public policy perspective, economists are interested in causal relationships; it would be nice to know, for instance, if higher education spending led to higher academic test scores, higher graduation rates, higher post-graduation incomes, or longer life expectancy. Finding correlations is a first step in establishing causality, but there is more work to be done so we don't fall into the trap of assuming that correlation implies causality; it does not! As noted in Chapter 2, an omitted variable might cause two things to move together. A humorous application of this is found in Exhibit 2A.5, where it looks like ice cream production is linked with drownings; the key insight is that hot weather causes increases in both ice cream production (and sales) and swimming activity, and more swimmers, *not* additional ice cream consumption, leads to more drownings.

- *Teaching Ideas:* Students might enjoy coming up with other twists on this theme of two apparently related things as a result of an omitted variable. For example, unseasonably hot weather also causes higher electricity use (for air conditioning), increased sales of fans, and sales of other cold consumables (soda, beer, ice). However, we wouldn't want to conclude that beer sales causes higher electricity use. Suppose the recent spring was unusually rainy; what are some predictable results from this natural phenomenon?

VI. Active Learning Exercises

1. (Causation and Correlation) Many professors notice that the students who sit in the first or second row in the classroom frequently earn higher grades in the course than students who sit toward the back of the classroom. Should professors view this relationship as one of causation? As one of correlation? Explain your answer.

Solution: While there is a positive correlation between where students sit and their grades in class, it is not clear that sitting in the front causes higher grades. This may be a case of reverse causality where students who take the class more seriously are the students who choose to sit close to the professor. While there may be benefits to sitting in the front, such as clearly seeing the board, fewer distractions, and pressure to pay attention as the professor can watch your behavior, most students do not randomly sit in the front rows. Instead, the students often have a particular interest in the course.

2. (Means and Medians) Suppose there are six students in the class and the individual test scores are: 80, 90, 74, 92, 96, and 84.

   a) Calculate the mean test score and the median test score for the class.
   b) How would the mean and median test scores change if the seventh observation were a score of 93?
   c) How would the mean and median test scores change if the seventh observation were 2?
   d) What do we learn from part (c) about using means and medians?

Solutions:

a) *The mean (or average) is calculated by the summing the scores (80 + 90 + 74 + 92 + 96 + 84 = 516) and dividing by the number of observations (6). Therefore, the mean is 86. The median is found by ordering the scores from lowest to highest, and then identifying the middle score; if there is an even number of scores, then use the midpoint of the two middle scores. Here, the ordered scores are 74, 80, 84, 90, 92, 96, so the median is (84+90)/2 = 87.*
b) *Adding in a 93 as the 7th score yields 516 + 93 = 609, and then the mean is 609/7 = 87, while the ordered scores become 74, 80, 84, 90, 92, 93, 96, so the median is 90.*
c) *Adding in a 2 as the 7th score yields 516 + 2 = 518, and then the mean is 518/7 = 74, while the ordered scores become 2, 74, 80, 84, 90, 92, 96, so the median is 84.*
d) *An outlier tends to have a larger effect on the mean than on the median. One could make this point even more dramatically by making the last score 10,000.*

3. (Causation and Correlation) Why might you doubt the causality implied by the following statements?
a) "Married men live longer than unmarried men."
b) "People who spend more time on a website buy more items."
c) "Students who illegally download lots of music spend more on music." HINTS: What type of person would illegally download lots of music? What type of person would spend more on music?

Solutions:
a) Maybe it is the case that healthy, comparatively wealthy men are more likely to attract a mate and get married, whereas not-so-healthy, less wealthy men are more likely to remain single. It would not be surprising to learn that healthy men live longer, or that men who can afford better health care live longer. Here, there seems to be a reverse causality: perhaps marriage increases expected longevity, but longer expected longevity probably increases the likelihood of marriage!
b) While people uninterested in buying probably leave sooner, there is a reverse causality complication here: it takes more time to buy more items, so people who buy five items are likely shopping on the site longer than those who buy just a single item.
c) It could be the case that illegal downloading and music expenditures just coincidentally are correlated and that neither causes the other. The omitted variable might be a love of music: people who love music would be more likely to acquire more of it, either legally or illegally! Just as hot weather causes more ice cream consumption and drownings, rather than ice cream causing the drownings.

4. (Models) Why might we think of the following as examples of models?
a) A campus map
b) Movie storyboards
c) An architect's 1:1000 scale model of a new proposed skyscraper
d) A virtual tour of the International Space Station
e) An inventor's prototype of a new gadget
f) Flight simulator software

Solutions: All of the above involve simplification descriptions of reality, with unnecessary details omitted for the sake of capturing essential elements. For example, we might want to look at the miniature version of the skyscraper to think about how it would fit into the city skyline or to visualize what kind of windows would work best; we do not need this miniature version to have miniature working elevators or restrooms. The movie storyboards allow us to quickly think about the ordering of scenes, the necessary costumes and sets, how to spend a limited digital effects budget, etc. A computerized flight simulator can test how a pilot would deal with engine failure due to a bird strike – all without harming any actual birds or expensive jet engines.

5. (Natural Experiments) Astronaut Scott Kelly spent a year in space while his identical twin Mark spent a year on Earth. Researchers are using the two to study the effects of space travel on the human body. Why do you think there are so many experiments involving pairs of twins? Inspired by this example, how might economists measure the impact of a change in the minimum wage on a particular community?

Solution: Scott and Mark started with the same genetics and background, so it will be easier to isolate the effects of space travel without worrying about other factors. In contrast, Scott and your course instructor probably differ in many more ways, so your instructor would make an inferior control subject. Ideally, the economist finds a pair of communities that arguably are "twins," and then observes the impact of a change in the minimum wage.