

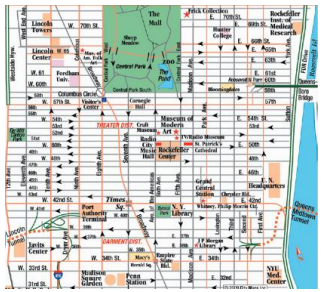
# Appendix: Using Graphs and Formulas

## Appendix: Using Graphs and Formulas

Use graphs and formulas to analyze economic situations.

A map is a simplified model of reality, showing essential details only.

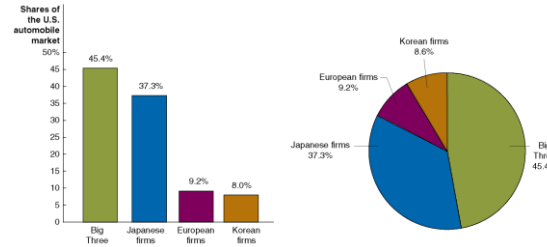
Economic models, with features like graphs and formulas, can help us understand economic situations just like a map helps us to understand the geographic layout of a city.



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**Figure 1A.1** Bar Graphs and Pie Charts



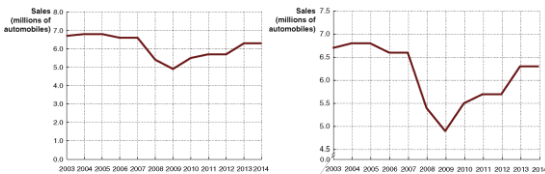
The left panel shows a bar graph of market share data for the U.S. automobile industry; market share is represented by the height of the bar.

The right panel shows a pie chart of the same data; market share is represented by the size of the "slice of the pie".

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**Figure 1A.2** Time-Series Graphs



The dashes (|) indicate that the scale on the vertical axis is truncated, which means that some numbers are omitted. The numbers on the vertical axis jump from 0 to 4.5.

Both panels present time-series graphs of Ford Motor Company's worldwide sales during each year from 2001 to 2010.

- The right panel has a truncated scale on the vertical axis, while the left panel does not.
- As a result, the fluctuations in Ford's sales appear smaller in the left panel than the right one.

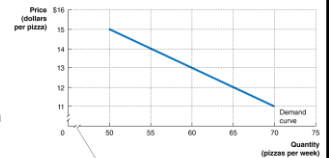
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**Figure 1A.3** Plotting Price and Quantity Points in a Graph

The figure shows a two-dimensional grid on which we measure the price of pizza along the vertical axis (or y-axis) and the quantity of pizza sold per week along the horizontal axis (or x-axis).

Price (dollars per pizza)	Quantity (pizzas per week)	Points
\$15	50	A
14	55	B
13	60	C
12	65	D
11	70	E



As you learned in Figure 1A-2, the dashes (|) indicate that the scales on the axes are truncated, which means that numbers are omitted. On the horizontal axis, numbers jump from 0 to 50, and on the vertical axis numbers jump from 0 to 11.

Each point on the grid represents one of the price and quantity combinations listed in the table.

By connecting the points with a line, we can better illustrate the relationship between the two variables.

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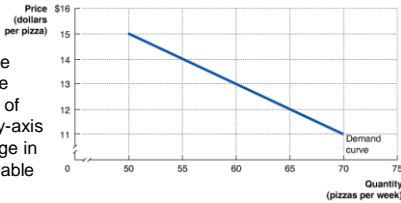
# Appendix: Using Graphs and Formulas

**Figure 1A.4 Calculating the Slope of a Line (1 of 2)**

We can calculate the slope of a line as the change in the value of the variable on the y-axis divided by the change in the value of the variable on the x-axis.

Because the slope of a straight line is constant, we can use any two points in the figure to calculate the slope of the line.

$$\text{Slope} = \frac{\text{Change in value on the vertical axis}}{\text{Change in value on the horizontal axis}} = \frac{\Delta y}{\Delta x} = \frac{\text{Rise}}{\text{Run}}$$



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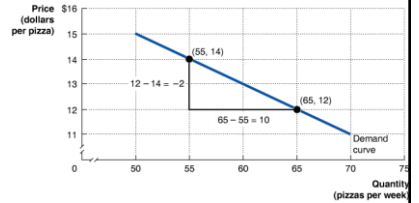
**Figure 1A.4 Calculating the Slope of a Line (2 of 2)**

For example, when the price of pizza decreases from \$14 to \$12, the quantity of pizza demanded increases from 55 per week to 65 per week.

$$\text{Slope} = \frac{\text{Change in value on the vertical axis}}{\text{Change in value on the horizontal axis}} = \frac{\Delta y}{\Delta x} = \frac{\text{Rise}}{\text{Run}}$$

So, the slope of this line equals  $-2$  divided by  $10$ , or  $-0.2$ .

$$\text{Slope} = \frac{\Delta \text{Price of pizza}}{\Delta \text{Quantity of pizza}} = \frac{(\$12 - \$14)}{(65 - 55)} = \frac{-2}{10} = -0.2$$

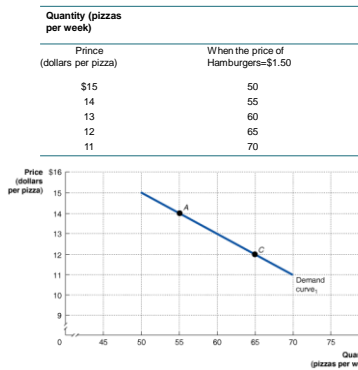


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**Figure 1A.5 Showing Three Variables on a Graph (1 of 3)**

The demand curve for pizza shows the relationship between the price of pizzas and the quantity of pizzas demanded, holding constant other factors that might affect the willingness of consumers to buy pizza.

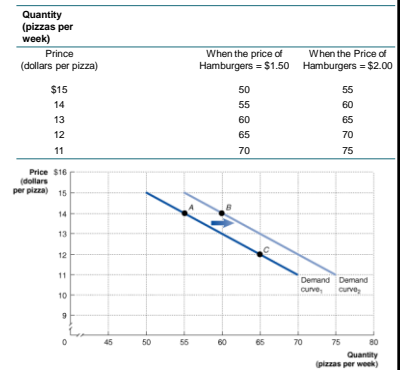


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**Figure 1A.5 Showing Three Variables on a Graph (2 of 3)**

If the price of pizza is \$14 (point A), an increase in the price of hamburgers from \$1.50 to \$2.00 increases the quantity of pizzas demanded from 55 to 60 per week (point B) and shifts us to Demand curve<sub>2</sub>.



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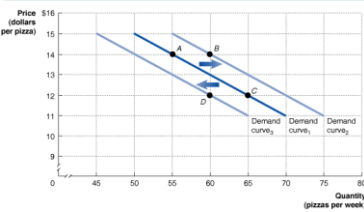
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# Appendix: Using Graphs and Formulas

**Figure 1A.5** Showing Three Variables on a Graph (3 of 3)

Or, if we start on Demand curve<sub>1</sub> and the price of pizza is \$12 (point C), a decrease in the price of hamburgers from \$1.50 to \$1.00 decreases the quantity of pizza demanded from 65 to 60 per week (point D) and shifts us to Demand curve<sub>3</sub>.

Price (dollars per pizza)	Quantity (pizzas per week)	When the Price of Hamburgers = \$1.00	When the price of Hamburgers = \$1.50	When the Price of Hamburgers = \$2.00
\$15	45	50	55	60
14	50	55	60	65
13	55	60	65	70
12	60	65	70	75
11	65	70	75	



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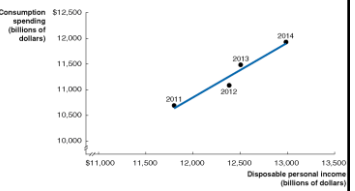
**Figure 1A.6** Graphing the Positive Relationship between Income and Consumption

In a positive relationship between two economic variables, as one variable increases, the other increases, the other variable also increases.

In a negative relationship, as one variable increases, the other decreases.

This figure shows the positive relationship between disposable personal income and consumption spending.

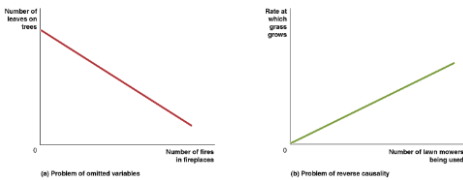
Year	Disposable Personal Income (billions of dollars)	Consumption Spending (billions of dollars)
2011	\$ 11,801	\$ 10,689
2012	12,384	11,083
2013	12,505	11,484
2014	12,986	11,930



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**Figure 1A.7** Determining Cause and Effect



Using graphs to draw conclusions about cause and effect is dangerous.

For example, in panel (a), as the number of fires in fireplaces increases, the number of leaves on trees falls; but the fires don't cause the leaves to fall.

In panel (b), as the number of lawn mowers being used increases, so does the rate at which grass grows.

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## Are Graphs of Economic Relationships Always Straight Lines?

The relationship between two variables is linear when it can be represented by a straight line.

Few economic relationships are actually linear. However linear approximations are simpler to use and are often "good enough" in modeling.

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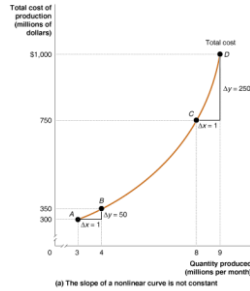
# Appendix: Using Graphs and Formulas

**Figure 1A.8** The Slope of a Nonlinear Curve (panel (a))

A non-linear curve has different slopes at different points. This curve shows the total cost of production for various quantities of Apple Watches.

We can approximate its slope over a section by measuring the slope as if that section were linear.

Between C and D, the slope is greater than between A and B; so we say the curve is steeper between C and D than between A and B.



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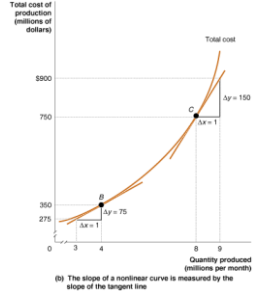
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**Figure 1A.8** The Slope of a Nonlinear Curve (panel (b))

Another way to measure the slope of a non-linear curve is to measure the slope of a tangent line to the curve, at the point we want to know the slope.

$$\frac{\Delta \text{Cost}}{\Delta \text{Quantity}} = \frac{75}{1} = 75$$

$$\frac{\Delta \text{Cost}}{\Delta \text{Quantity}} = \frac{150}{1} = 150$$



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## Formula for a Percentage Change

One important formula is the *percentage change*, which is the change in some economic variable, usually from one period to the next, expressed as a percentage.

$$\text{Percentage change} = \frac{\text{Value in the second period} - \text{Value in the first period}}{\text{Value in the first period}} \times 100$$

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## Summary of Using Formulas

Whenever you must use a formula, you should follow these steps:

1. Make sure you understand the economic concept the formula represents.
2. Make sure you are using the correct formula for the problem you are solving.
3. Make sure the number you calculate using the formula is economically reasonable. For example, if you are using a formula to calculate a firm's revenue and your answer is a negative number, you know you made a mistake somewhere.

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