Examples

Example

A state has a population of 17 million people and an average ownership of 1.5 cars per person, each driven an average of 10,000 mi/year and at 20 mi/gal of gasoline (mpg). Officials estimate that an additional $75 million per year in revenue will be required to improve the state's highway system, and they have proposed an increase in the gasoline tax to meet this need. Determine the required tax in cents per gallon.

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- **Example 2.1 Selecting a Transportation Mode (p29)**

  An individual is planning to take a trip between the downtown area of two cities, A and B, which are 400 km apart.

  There are three options available:

  –**Travel by air.** This trip will involve driving to the airport near city A, parking, waiting at the terminal, flying to airport B, walking to a taxi stand, and taking a taxi to the final destination.

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- **Example 2.1 Selecting a Transportation Mode (continued)**

  –**Travel by auto.** This trip will involve driving 400 km through several congested areas, parking in the downtown area, and walking to the final destination.

  –**Travel by rail.** This trip will involve taking a cab to the railroad station in city A, a direct rail connection to the downtown area in city B, and a short walk to the final destination.

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- **Example 2.1 Selecting a Transportation Mode (continued)**
  - –It is a business trip
  - –The traveler is willing to pay $25 for each hour of travel time reduced

–Mode	cost $	time (hours)
–Air	250	5
–Auto	200	8
–Rail	150	12

  - –Which mode is selected based on travel time and cost factors alone?
  - –What other factors might be considered?

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Solution:

Since travel time is valued at $25/hr, the following costs would be incurred:

- Air: 250 + 25(5) = $375
- Auto: 200 + 25(8) = $400
- Rail: 150 + 25(12) = $450

In this instance, the air alternate reflects the lowest cost and is the selected mode.

Other factors:

Safety, reliability and convenience.

Example 2.2 Computing the Toll to Maximize Revenue Using a Supply–Demand Curve

A toll bridge carries 5000 veh/day. The current toll is 150 cents. When the toll is increased by 25 cents, traffic volume decreases by 500 veh/day. Determine the amount of toll that should be charged such that revenue is maximized. How much additional revenue will be received?

Solution: Let x = the toll increase in cents.

Assuming a linear relation between traffic volume and cost, the expression for V is

$$V = 5000 - x/25\,(500)$$

The toll is

$$T = 150 + x$$

Revenue is the product of toll and volume:

$$\begin{aligned} R &= (V)\,(T) \\ &= \{5000 - x/25\,(500)\}\,(150 + x) \\ &= (5000 - 20x)\,(150 + x) = 750{,}000 - 3000x + 5000x - 20x^2 \\ &= 750{,}000 + 2000x - 20x^2 \end{aligned}$$

For maximum value of x, compute the first derivative and set equal to zero:

$$dR/dt = 2000 - 40x = 0$$
$$x = 50 \text{ cents}$$

The new toll is the current toll plus the toll increase.

$$\text{Toll for maximum revenue} = 150 + 50 = 200 \text{ cents or } \$2.00$$

The additional revenue, AR, is

$$\begin{aligned} AR &= (V_{max})(T_{max}) - (V_{current})(T_{current}) \\ &= \{(5000 - (50/25)(500)\}\{2\} - (5000)(1.50) \\ &= (4000)(2) - 7500 \\ &= 8000 - 7500 \\ &= \$500 \end{aligned}$$