1.4.2 Exploratory Quiz: on PPED and PED formulas

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Our current goal is to define elasticity at a single point, by working with the formula for price elasticity between two points and approximating average rate of change with instantaneous rate of change (the derivative). The first question below helps you do this.

> **Note:** we will use the derivative notation $\frac{dq}{dp}\big|_{p_1}$, but this could also be written $q'(p_1)$. The other questions in this quiz allows you to explore some other ways to measure elasticity between two points.

Question 1

1/1 point (graded)

Here's the formula for price elasticity between two points $(p1, q1)$ and $(p2, q2)$:

$$Price\ Elasticity\ of\ Demand = \frac{\Delta q}{q_1} \bigg/ \frac{\Delta p}{p_1}$$

Rearrange the formula and use the assumption that $\frac{\Delta q}{\Delta p} \approx \frac{dq}{dp}\big|_{p_1}$ to write a formula for price elasticity of demand at the point p_1. Select the correct formula below.

- ( ) $\frac{dq}{dp}\big|_{p_1} \cdot \frac{q_1}{p_1}$
- (•) $\frac{dq}{dp}\big|_{p_1} \cdot \frac{p_1}{q_1}$ ✔
- ( ) $\frac{dq}{dp}\big|_{p_1} \cdot p_1$
- ( ) $\frac{dq}{dp}\big|_{p_1} \cdot q_1$
- ( ) None of the above.

Answer: Dividing by a fraction is equivalent to multiplying by the reciprocal:

$$\begin{aligned}\text{Price Elasticity of Demand} &= \frac{\Delta q}{q_1} \Big/ \frac{\Delta p}{p_1} \\ &= \frac{\Delta q}{q_1} \cdot \frac{p_1}{\Delta p} \\ &= \frac{\Delta q}{\Delta p} \cdot \frac{p_1}{q_1} \\ &\approx \frac{dq}{dp}\Big|_{p_1} \cdot \frac{p_1}{q_1}.\end{aligned}$$

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Answers are displayed within the problem

Question 2

1/1 point (graded)

The formula for price elasticity of demand almost looks an **average rate of change**, the change in demand for a change in price, except that we're using percent change.

With average rate of change, the order of the two points doesn't matter, as long as it is consistent. But with percent change, the order of points can matter, because we divide the change by the original quantity. For example, we looked at changes from 50 to 75 cents, so we divided by 50 cents.

If we want to consider a price reduction from 75 cents to 50 cents, we would divide by 75 cents. Would the price elasticity of demand be the same?

That's what you'll explore now.

The formula would change to:

$$\frac{(q_1 - q_2)}{q_2} \Big/ \frac{(p_1 - p_2)}{p_2}$$

Using the two data points here, compute elasticity for Boston using the formula relative to the second point. Round your answer to the nearest hundredth.

Year	Boston Subway Fare	Annual Ridership (in millions)
1980	0.50	158
1981	0.75	143

-0.31

Answer: -0.31

-0.31

Explanation

We plug into the formula: $\frac{(q_2-q_1)}{q_1} \Big/ \frac{(p_2-p_1)}{p_1}$

$$\begin{aligned} \frac{q_2-q_1}{q_2} \Big/ \frac{p_2-p_1}{p_2} &= \frac{143-158}{143} \Big/ \frac{0.75-0.50}{0.75} \\ &= \frac{-15}{143} \Big/ \frac{0.25}{0.75} \\ &\approx -0.31. \end{aligned}$$

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Question 3: Think About It...

1/1 point (graded)

You've now computed elasticity for the period from 1980 to 1981 using two different formulas. When percent changes are calculated relative to the first point, we got -.19, rounded to the nearest hundredth. Relative to the second point, we got -0.31.

What reasons can you think of for the significant difference in these numbers? What ideas do you have to address this?

Note: At this time, the text entry box for reflective questions does not support the percent symbol "%" - please type out the word "percent" if you need to refer to percents.

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change is computed w.r.t. which reference point is
important.
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Thank you for your response.

Explanation

From 50 to 75 cents is a 50% increase, but from 75 cents to 50 cents is only a 33% decrease. This large difference in denominator explains the significant difference in elasticity numbers.
Some alternatives would be to use a midpoint than an endpoint, or a continuous model where elasticity is defined at a single point.

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Answers are displayed within the problem

Question 4

1/1 point (graded)

Economists sometimes measure percent change relative to the midpoint between the two points. This is called **arc** or **midpoint elasticity**.

Here's a formula for midpoint elasticity:

$$\frac{(q_2 - q_1)}{.5(q_1 + q_2)} \bigg/ \frac{(p_2 - p_1)}{.5(p_1 + p_2)}$$

Compute elasticity for Boston from the period of 1980 to 1981 using midpoint elasticity. Round your answer to the nearest hundredth. (As you do this, think about why the formula looks like it does. For example, what is the midpoint between $p1$ and $p2$? Does it matter if you compute using $q1 - q2$ instead of $q2 - q1$?)

Year	Boston Subway Fare	Annual Ridership (in millions)
1980	0.50	158
1981	0.75	143

-75/301 **Answer:** -0.25

$-\frac{75}{301}$

Explanation

The midpoint between $p1$ and $p2$ is halfway between the two, thus it is the sum of the two points divided by two.

Notice that it doesn't matter if we compute midpoint elasticity using the points in the other order, as long as we are consistent with the price and quantity. This is because switching the order from $q1 - q2$ to $q2 - q1$ and from $p1 - p2$ to $p2 - p1$changes the sign (from positive to negative, or vice-versa) in both the numerator and denominator, so the effect is cancelled out.

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Answers are displayed within the problem

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