

A Demand Curve Is Given By $p = 420 / (q + 9)$. Find The Consumer Surplus When The Selling Price Is \$10. (Round

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Understanding the Demand Curve and Consumer Surplus

In economics, understanding the relationship between the price of a good and the quantity demanded by consumers is crucial. The demand curve represents this relationship, illustrating how much of a product consumers are willing and able to purchase at various price points. In this article, we analyze a specific demand function given by $p = 420 / (q + 9)$ and determine the consumer surplus when the selling price is set at \$10. We will break down the steps involved, interpret the findings, and discuss the significance of consumer surplus in economic analysis.

What Is a Demand Curve?

Definition and Significance

A demand curve graphically depicts the relationship between the price of a good and the quantity demanded. Typically, it slopes downward from left to right, indicating that as the price decreases, the quantity demanded increases. This inverse relationship is a fundamental principle in economics, reflecting consumer behavior and preferences.

Mathematical Representation

The demand curve can be expressed mathematically through a demand function, which relates price (p) to quantity demanded (q). For example, in our case, the demand function is given by:

$$\bullet p = 420 / (q + 9)$$

This function allows us to determine how much of the good consumers are willing to buy at different prices, and vice versa.

Understanding the Given Demand Function $p = 420$

$$/ (q + 9)$$

Interpreting the Function

The demand function $p = 420 / (q + 9)$ indicates that the price p decreases as the quantity q increases. The addition of 9 in the denominator shifts the curve, affecting the elasticity and the quantity demanded at various prices. As q approaches infinity, p approaches zero; as q approaches zero, p approaches $420 / 9 \approx 46.67$.

Key Characteristics

- **Inverse relationship:** Higher quantities lead to lower prices.
- **Vertical intercept:** When $q = 0$, price $p \approx 46.67$.
- **Behavior at large q :** p approaches zero, indicating diminishing willingness to pay as quantity increases.

Calculating Consumer Surplus at a Price of \$10

Definition of Consumer Surplus

Consumer surplus is the difference between what consumers are willing to pay for a good and what they actually pay. It measures the benefit or surplus that consumers receive when they purchase a product at a market price lower than their maximum willingness to pay.

Step 1: Find the Quantity Demanded at the Selling Price of \$10

Given the demand function $p = 420 / (q + 9)$, and the market price $p = \$10$, we need to solve for q :

$$10 = 420 / (q + 9)$$

Multiply both sides by $(q + 9)$:

$$10(q + 9) = 420$$

Expand:

$$10q + 90 = 420$$

Subtract 90 from both sides:

$$10q = 330$$

Divide both sides by 10:

$$q = 33$$

Thus, when the price is \$10, the quantity demanded is 33 units.

Step 2: Find the Maximum Willingness to Pay (Intercept Price)

The maximum willingness to pay corresponds to the highest point on the demand curve, which occurs when $q = 0$. Substituting $q = 0$ into the demand function:

$$p = 420 / (0 + 9) = 420 / 9 \approx 46.67$$

Therefore, consumers are willing to pay up to approximately \$46.67 for the first unit.

Step 3: Calculate Consumer Surplus

The consumer surplus is the area of the triangle between the demand curve and the market price line, from $q=0$ up to $q=33$. The formula for consumer surplus is:

$$\text{Consumer Surplus} = 0.5 \times (\text{Maximum Willingness to Pay} - \text{Market Price}) \times \text{Quantity Demanded}$$

Plugging in the values:

$$\text{Consumer Surplus} = 0.5 \times (46.67 - 10) \times 33$$

1. Calculate the difference in prices:

$$46.67 - 10 = 36.67$$

3. Multiply by the quantity demanded:

$$36.67 \times 33 \approx 1210.11$$

1. Multiply by 0.5 to get the area of the triangle:

$$\text{Consumer Surplus} \approx 0.5 \times 1210.11 \approx 605.06$$

Therefore, the consumer surplus when the selling price is \$10 is approximately **\$605.06**.

Implications of the Consumer Surplus Calculation

Understanding Consumer Benefits

The consumer surplus of approximately \$605 indicates that consumers derive significant benefit when purchasing the good at \$10, compared to their maximum willingness to pay (\$46.67). This surplus reflects consumer satisfaction and economic efficiency in the market.

Market Efficiency and Welfare

Consumer surplus, along with producer surplus, contributes to the overall economic welfare in a market. A higher consumer surplus suggests that consumers are gaining more value, which can lead to increased demand and market activity. Policymakers often analyze consumer surplus to assess the impact of taxes, subsidies, and regulations.

Additional Considerations

Elasticity of Demand

The price elasticity of demand measures how sensitive the quantity demanded is to changes in price. Given the demand function $p = 420 / (q + 9)$, the elasticity can be calculated to understand market responsiveness.

Limitations and Assumptions

- The calculation assumes the demand function accurately reflects consumer preferences.
- External factors such as income changes or substitute availability are not considered.
- The model presumes a perfect market without external distortions.

Conclusion

In summary, analyzing the demand function $p = 420 / (q + 9)$ reveals that when the market price is set at \$10, the quantity demanded is 33 units. The maximum willingness to pay for the first unit is approximately \$46.67. Using these values, the consumer surplus is calculated to be roughly \$605.06, illustrating the benefit consumers receive in this market. Understanding consumer surplus is essential for evaluating market efficiency, consumer welfare, and the impact of economic policies.

Key Takeaways

- The demand curve $p = 420 / (q + 9)$ depicts how quantity demanded varies with price.
- At a selling price of \$10, demand is 33 units.
- The maximum willingness to pay is approximately \$46.67.
- The consumer surplus at this price is roughly \$605.06.

By mastering these concepts and calculations, economists and market analysts can better understand consumer behavior, market dynamics, and the overall health of an economy.

Frequently Asked Questions

What is the demand function provided in the problem?

The demand function is $p = 420 / (q + 9)$.

How do we determine the quantity demanded when the selling price is \$10?

Set $p = 10$ and solve for q : $10 = 420 / (q + 9)$, which gives $q + 9 = 420 / 10 = 42$, so $q = 33$.

How do we find the consumer surplus in this context?

Consumer surplus is the area between the demand curve and the selling price, from $q=0$ to $q=33$, calculated as the integral of the demand function minus the total revenue at the market price.

What is the maximum price consumers are willing to pay when quantity is zero?

When $q=0$, $p = 420 / (0 + 9) = 420 / 9 = 46.67$ (approx.), which is the maximum price consumers are willing to pay.

How do we compute the consumer surplus numerically for this problem?

Calculate the integral of the demand function from 0 to 33, subtract the total revenue at price \$10 (which is 10×33), and find the difference to get consumer surplus.

What is the rounded value of consumer surplus when

the price is \$10?

The consumer surplus is approximately \$540.83 when rounded to two decimal places.

Additional Resources

A Demand Curve Is Given By $p = 420/(q + 9)$. Find The Consumer Surplus When The Selling Price Is \$10. (Round

Understanding Consumer Surplus in Context: Analyzing the Demand Function $p = 420/(q + 9)$ at a Price of \$10

In the realm of microeconomics, understanding how consumer surplus functions provides vital insights into market efficiency and consumer welfare. Suppose we are presented with a demand curve expressed as $p = 420/(q + 9)$, where p is the price consumers are willing to pay for a good or service, and q is the quantity demanded. The challenge is to determine the consumer surplus when the selling price is set at \$10. This calculation involves interpreting the demand function, identifying key points, and applying the concept of consumer surplus to quantify the benefit consumers receive at this price.

This article delves into the process of calculating consumer surplus for this specific demand curve, elaborating on the underlying principles, mathematical steps, and economic implications of the result. Whether you're an economics student, a market analyst, or simply curious about how consumer benefits are measured, this comprehensive exploration aims to make the topic accessible and insightful.

The Fundamentals: What Is Consumer Surplus?

Before diving into the specifics, it's essential to understand what consumer surplus actually signifies.

Definition of Consumer Surplus

Consumer surplus is the difference between what consumers are willing to pay for a good or service and what they actually pay. It's a measure of consumer welfare and indicates the additional benefit consumers receive when they purchase a product at a market price lower than their maximum willingness to pay.

Visual Representation

Graphically, consumer surplus is represented as the area between the demand curve and the market price line, extending from the y-axis up to the quantity purchased. When demand is represented as a downward-sloping curve, and the market price is constant, the consumer surplus is the area of a triangle (or sometimes more complex shapes) above the price level.

Interpreting the Demand Function $p = 420/(q + 9)$

The demand function provided is:

$$p = 420 / (q + 9)$$

This hyperbolic form indicates that as the quantity demanded (q) increases, the price consumers are willing to pay decreases.

Key Characteristics of the Demand Function

- Inverse Relationship: As q increases, p decreases.
- Asymptotic Behavior: When q approaches zero, p approaches $420/9 \approx 46.67$. This represents the maximum willingness to pay when no units are purchased.
- Behavior at Large q : As q becomes very large, p approaches zero, indicating that at high quantities, consumers' maximum willingness to pay diminishes significantly.

Finding the Maximum Willingness to Pay

At $q = 0$:

$$p = 420 / (0 + 9) = 420 / 9 \approx 46.67$$

This is the highest price consumers are willing to pay for zero units, effectively the upper bound of the demand curve.

Calculating the Consumer Surplus at a Price of \$10

Given that the actual selling price (market price) is set at $p = \$10$, the goal is to compute the consumer surplus, which involves:

1. Finding the maximum quantity consumers are willing to buy at this price.
2. Determining the corresponding quantity demanded at $p = \$10$.
3. Calculating the consumer surplus as the area between the demand curve and the price level, from $q = 0$ up to the quantity demanded at $p = \$10$.

Step 1: Find the Quantity Demanded at $p = \$10$

Starting with the demand function:

$$p = 420 / (q + 9)$$

Set $p = 10$:

$$10 = 420 / (q + 9)$$

Multiply both sides by $(q + 9)$:

$$10(q + 9) = 420$$

Expand:

$$10q + 90 = 420$$

Solve for q :

$$10q = 420 - 90 = 330$$

$$q = 330 / 10 = 33$$

Interpretation: At a price of \$10, consumers demand 33 units of the good.

Step 2: Find the Maximum Willingness to Pay

As previously calculated, when $q = 0$:

$$p_{\max} = 420 / 9 \approx 46.67$$

This is the highest price consumers would pay if they purchased zero units, representing their maximum willingness to pay.

Step 3: Calculate the Consumer Surplus

Consumer surplus is the area of the triangle formed between the demand curve and the market price line, from $q = 0$ to $q = 33$.

Area of a triangle:

$$CS = (1/2) \times \text{Base} \times \text{Height}$$

- Base: The quantity demanded at $p = \$10$, which is 33 units.
- Height: The difference between the maximum willingness to pay and the market price:

$$p_{\max} - p_{\text{market}} = 46.67 - 10 \approx 36.67$$

Thus,

$$CS \approx 0.5 \times 33 \times 36.67$$

Calculating:

$$0.5 \times 33 = 16.5$$

$$16.5 \times 36.67 \approx 604.55$$

Rounded result:

$$\text{Consumer Surplus} \approx \$605$$

Economic Significance of the Result

The calculated consumer surplus of approximately \$605 indicates the total extra benefit consumers derive when buying 33 units at the market price of \$10, given their maximum willingness to pay. This surplus reflects consumer welfare and market efficiency; higher consumer surplus generally suggests a more favorable market for consumers.

Factors Influencing Consumer Surplus

- Price Level: Lower prices increase consumer surplus, as consumers pay less than their maximum willingness to pay.
- Demand Elasticity: The shape of the demand curve influences the size of the consumer surplus. More elastic demand leads to a larger surplus.
- Market Interventions: Taxes, subsidies, or price controls can alter

consumer surplus by changing prices or demand.

Limitations and Assumptions

- The calculation assumes the demand curve accurately reflects consumer preferences.
- It considers only consumer surplus, not producer surplus or total welfare.
- The demand function is valid within the relevant range of q ; extrapolating beyond this range may be misleading.

Broader Implications and Practical Applications

Understanding consumer surplus has practical applications across various sectors:

- **Policy Formulation:** Governments assess consumer welfare impacts when designing taxes, subsidies, or regulations.
- **Market Analysis:** Firms evaluate how pricing strategies influence consumer benefits and demand.
- **Economic Welfare Measurement:** Consumer surplus serves as a key indicator in cost-benefit analyses of projects or policies.

In real-world scenarios, data on demand functions can be more complex, involving multiple factors. However, the principles demonstrated here form the foundation for analyzing consumer benefits in simplified models.

Recap and Final Thoughts

Analyzing the demand curve $p = 420/(q + 9)$ at a market price of \$10 reveals that consumers gain a surplus of approximately \$605 for the 33 units they purchase at this price. This calculation underscores the value of understanding demand functions and their applications in economic analysis.

Consumer surplus quantifies the additional benefit consumers receive beyond what they pay, serving as a crucial metric in assessing market efficiency and welfare. While simplified models like the one discussed provide clarity, real-world applications often involve more variables and complexities, making such analyses both challenging and rewarding.

By mastering these concepts and calculations, economists, policymakers, and business strategists can better interpret market dynamics and make informed decisions that optimize overall welfare.

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