**Price Control**

**Purpose:** The purpose of the assignment is to determine the price of the board game that will lead to the maximum profit. There are multiple cases that each need separate conditions in order to achieve the highest income. Each board game needs 7QR to manufacture and distribute, and increasing the price by 7QR reduces demand by 40,000 (arbitrary) units. At 7QR, the initial demand is 320000 units.

\[
\begin{array}{|c|c|c|}
\hline
\text{X} & \text{Price-cost} & \text{Demand} & \text{Profit} \\
\hline
2 & 7QR & 280,000 & 1,960,000QR \\
3 & 14QR & 240,000 & 3,360,000QR \\
\hline
\end{array}
\]

In our project, we’ve set y to be the profit made and x to be the “number of 7’s” in the price; that is to say, by how many 7’s we are increasing the price.

a) Find the maximum profit that can be made.

This is the simplest case. In order to find a formula for the profit, we need to find the number of units sold and the final price. (Profit = (Units sold) x (Price – cost))

To come up with a formula for our profits, we made a table of values:

\[
\begin{align*}
\text{X} = 2 & \quad \text{Price-cost (7QR)} & \quad \text{Demand (280,000)} & \quad \text{Profit (1,960,000QR)} \\
\text{X} = 3 & \quad \text{Price-cost (14QR)} & \quad \text{Demand (240,000)} & \quad \text{Profit (3,360,000QR)} \\
\end{align*}
\]

We end up with this,

\[
F(x) = (320000 - 40000(x - 1)) \times (7x - 7)
\]

Making the derivative:

\[
F'(x) = 2,814,000 - 588,000x
\]

\[
F'(x) = 0 \Rightarrow 2,814,000 - 588,000x = 0 \Rightarrow \text{X} = \frac{2814}{588} = 4.714, \text{making the price 26.5QR.}
\]

\[
X = \frac{2814}{588} = 4.714 \text{ is the only critical number.}
\]

b) The consumer must now pay a 5% tax when purchasing the board game. Find the new maximum profit.

In this case, the only person affected is the consumer (the cost of manufacturing is not changed). This will result in lower demand, as the price of the good for the buyer has gone up by 5%. Because of this, it is necessary to revise the demand part of the formula. After taking points and plotting them on the graph below:

\[
F(x) = 320000 - 40000(x - 1)(1.05x - 1)(7x - 7)
\]

Making the derivative:

\[
F'(x) = 2,814,000 - 588,000x
\]

\[
F'(x) = 0 \Rightarrow 2,814,000 - 588,000x = 0 \Rightarrow \text{X} = \frac{2814}{588} = 4.714, \text{making the price 26.5QR.}
\]

\[
X = \frac{2814}{588} = 4.714 \text{ is the only critical number.}
\]

The graph of \(F(x)\) looks like this.

The graph of \(F(x)\) is a parabola with a vertex at \((6.714, 3,937,500QR)\), indicating a local maximum.

By the first derivative rule:

When \(x\) = 6, \(F'(x) = 550,000\)

When \(x = 5\), \(F'(x) = -550,000\)

Because the derivative of \(x\) increases and then decreases, it’s a local maximum.

That means that the maximum profit is:

\[
F(x) = 320000 - 40000(6.714 - 1)(7(6.714) - 7) = 3,937,500QR
\]

The maximum profit that can be earned under these conditions is 3,937,500QR

In this case, the domain is \(x \geq 1.5\) and \(x \leq 9\).

\[
\text{Therefore, the only change needed in the original formula is in the “price” section. If we graph the equations of both lines before and after tax, we get this:}
\]

\[
\text{The derivative of this is:}
\]

\[
F'(x) = 2,800,000 - 560,000x
\]

\[
F'(x) = 0 \Rightarrow 2,800,000 - 560,000x = 0 \Rightarrow \text{X} = 5, \text{making the price 25QR.}
\]

\[
X = 5 \text{ is the only critical number.}
\]

By the first derivative rule:

When \(x = 6\), \(F'(x) = 550,000\)

When \(x = 5\), \(F'(x) = -550,000\)

Because the derivative of \(x\) increases and then decreases, it’s a local maximum.

That means that the maximum profit is:

\[
F(x) = 320000 - 40000(5.714)(7(5.714) - 7) = 3,937,500QR
\]

The maximum profit that can be earned under these conditions is 3,937,500QR

In this case, the domain is \(x \geq 1.5\) and \(x < 9\).

c) An excise tax has been imposed on our company, forcing us to pay 3.5QR to the government. Find the new maximum profit.

Because the tax increases the cost of making the board game, we can assume that it increases the total cost, and increases the price of manufacturing from 7QR to 10.5QR.

\[
F(x) = (320000 - 40000(x - 1)) \times (7x - 10.5)
\]

Making the derivative:

\[
F'(x) = 2,940,000 - 560,000x
\]

\[
F'(x) = 0 \Rightarrow 2,940,000 - 560,000x = 0 \Rightarrow \text{X} = \frac{2940}{560} = 5.214, \text{making the price 26.25QR.}
\]

\[
X = \frac{2940}{560} = 5.214 \text{ is the only critical number.}
\]

By the first derivative rule:

When \(x = 6\), \(F'(x) = 550,000\)

When \(x = 5\), \(F'(x) = 550,000\)

Because the derivative of \(x\) increases and then decreases, it’s a local maximum.

That means that the maximum profit is:

\[
F(x) = 320000 - 40000(5.214 - 1)(7(5.214) - 10.5) = 3,937,500QR
\]

The maximum profit that can be earned under these conditions is 3,937,500QR

In this case, the domain is \(x \geq 1.5\) and \(x \leq 9\).

\[
\text{All of these examples demonstrate the challenges that must be overcome in choosing the correct price in order to maximize the revenue made in any business. It is of critical importance to solve this problems so that the business can run successfully.}
\]

**Conclusion**