

If OPEC wants to take in more revenues from the sale of oil should they increase the price of oil, decrease the price of oil, or hold steady on the price?

erm: draft Oct 13, 2011.

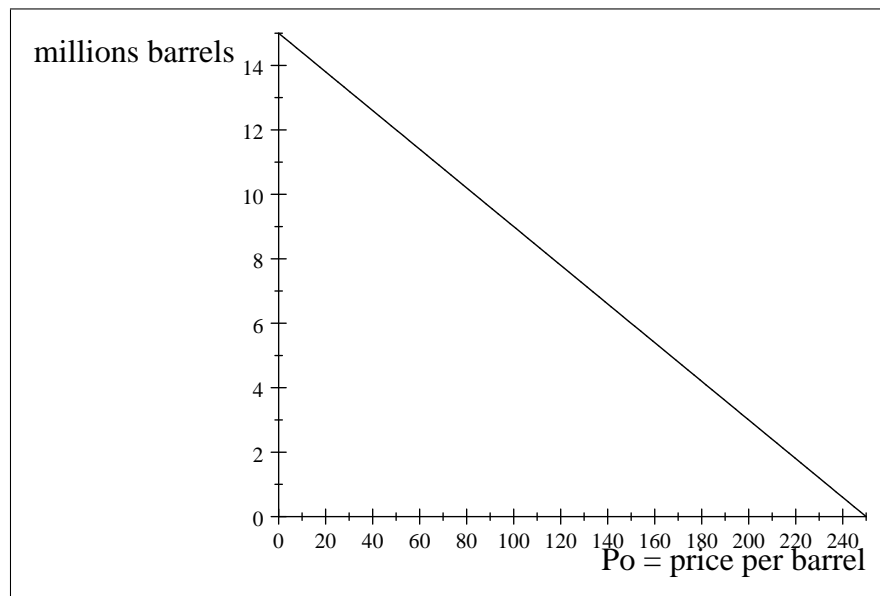
The answer depends on the price elasticity of demand for oil, $\frac{\% \Delta O_D}{\% \Delta p_O}$ where O_D is the world demand for oil and p_O is the world price of oil.

Note that for OPEC total revenue is highly related to total profit (the cost of pumping additional barrels is close to zero)

Note that $O_D = O_D(p_o)$ such that $O_D \downarrow$ when $p_o \uparrow$ Read $O_D = O_D(p_o)$ as the demand for oil is a function of the price of oil.

1 I have imagined the linear demand function $O_D = O_D(p_o) = 15 - .06p_o$, where world demand drops to zero at \$250 a barrel (so OPEC does not want to charge \$250 a barrel).

p_o is price per barrel measured in dollars and quantity is measured in millions of barrels. E.g if price were zero demand would be 15 million barrels¹



¹In 2011 daily U.S. consumption is approximately 19 million barrels, so demand is too low in my example function.

World daily demand for oil (millions of barrels)

Note that the slope of this curve is $\frac{\Delta O_D}{\Delta p_O} = -.06$, a constant because the demand curve is a straight line, a minus number because the line slopes down. (in the real world it is probably not a straight line.)

2 Simply put, total revenue is price multiplied by quantity, in this case $TR(p_o) = p_o(O_D(p_o))$

(make sure you understand this notation_

If OPEC raises the price of oil demand will go down, $O_D \downarrow$. The question is whether $p_o(O_D)$ increases or decreases when price increases or decreases.

Let's calculate total revenue at a few prices.

When $p_o = \$25$ a barrel, total revenue is $25(15 - .06(25)) = 337.5$ million

When $p_o = \$50$ a barrel, total revenue is $50(15 - .06(50)) = 600.0$ million

When $p_o = \$100$ a barrel, total revenue is $100(15 - .06(100)) = 900.0$ million

When $p_o = \$150$ a barrel, total revenue is $150(15 - .06(150)) = 900.0$ million

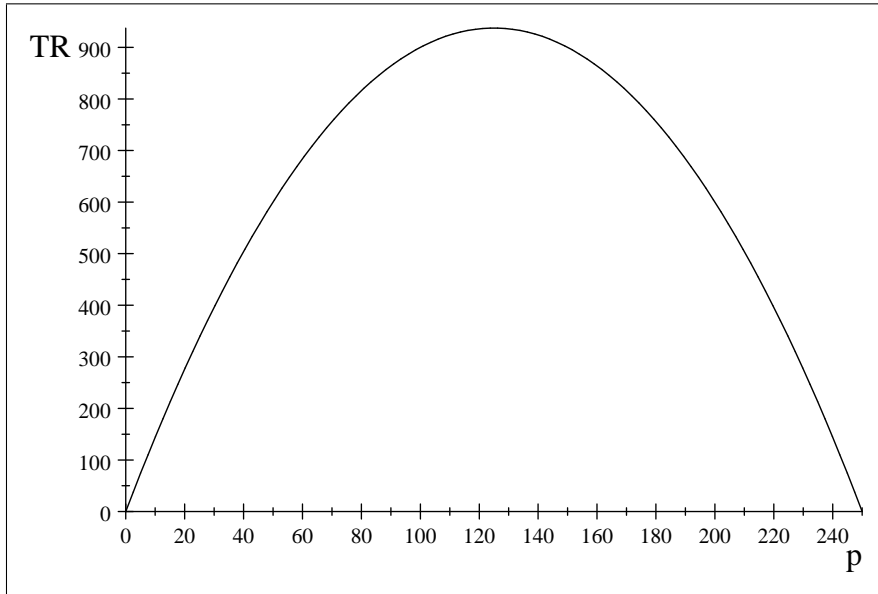
When $p_o = \$200$ a barrel, total revenue is $200(15 - .06(200)) = 600.0$ million

When $p_o = \$250$ a barrel, total revenue is $250(15 - .06(250)) = 0$

Total revenue, $TR(p_o)$ first increases in price and then decreases in price.

$$TR(p_o) = p_o(15 - .06(p_o)) = 15p_o - .06(p_o)^2$$

Graphing this



OPEC's total revenue as function of the price of oil/barrel

3 Whether $TR(p_o)$ increases, stays the same, or decreases when p_o increases depends on the $\frac{\% \Delta O_D}{\% \Delta p_o}$ at the current price/quantity.

If at the current price, $\frac{\% \Delta O_D}{\% \Delta p_o}$ is between zero and -1 (price inelastic), marginally raising the price will increase OPECs total revenue from the sale of oil.

If at the current price, $\frac{\% \Delta O_D}{\% \Delta p_o}$ is less than -1 (price elastic), marginally raising the price will decrease OPECs total revenue from the sale of oil.

In words (and hopefully some intuition), if at the current price the demand for oil is elastic (price sensitive in % terms) and OPEC raises the price by 1% ,demand for oil will fall by more than 1% and total revenue will fall.

If at the current price the demand for oil is inelastic (price insensitive in % terms) and OPEC raises the price by 1% ,demand for oil will fall by less than 1% and total revenue will rise.

3.1 For our imagined demand curve for oil, let's calculate the price elasticity of demand curve at two different prices (one low, one high)

3.1.1 When $p_o = \$50$ and it increases to $\$55$

$$\begin{aligned} \frac{\% \Delta O_D}{\% \Delta p_O} &= \frac{\frac{\Delta O_D}{(O_D(p_o^1) + O_D(p_o^0))/2}}{\frac{\Delta p_O}{(p_o^1 + p_o^0)/2}} \\ &= \frac{\frac{\Delta O_D}{(O_D(55) + O_D(50))/2}}{\frac{5}{(55 + 50)/2}} \end{aligned}$$

But how much does demand change?

$$O_D = O_D(p_o) = 15 - .06p_o$$

So, $O_D(50) = 15 - .06(50) = 12.0$ million barrels and
 $O_D(55) = 15 - .06(55) = 11.7$, million barrels

Plugging these into the elasticity formula above

$$\begin{aligned} \frac{\% \Delta O_D}{\% \Delta p_O} &= \frac{\frac{\Delta O_D}{(O_D(p_o^1) + O_D(p_o^0))/2}}{\frac{\Delta p_O}{(p_o^1 + p_o^0)/2}} \\ &= \frac{\frac{\Delta O_D}{(O_D(55) + O_D(50))/2}}{\frac{5}{(55 + 50)/2}} \\ &= \frac{-0.3}{(11.7 + 12)/2} \\ &= \frac{-0.3}{5} \\ &= -.26582 \end{aligned}$$

In this price range a 1% increase in price leads to a .27% drop in demand, so in this range world demand for oil is inelastic. OPEC would raise the price of oil if its intent was to maximize its total revenues.

3.1.2 Alternatively, When $p_o = \$200$ and it increases to $\$205$

$$\begin{aligned} \frac{\% \Delta O_D}{\% \Delta p_o} &= \frac{\frac{\Delta O_D}{(O_D(p_o^1) + O_D(p_o^0))/2}}{\frac{\Delta p_o}{(p_o^1 + p_o^0)/2}} \\ &= \frac{\frac{\Delta O_D}{(O_D(205) + O_D(200))/2}}{\frac{5}{(205 + 200)/2}} \end{aligned}$$

But how much does demand change?

$$O_D = O_D(p_o) = 15 - .06p_o$$

So, $O_D(200) = 15 - .06(200) = 3.0$ million barrels and

$O_D(205) = 15 - .06(205) = 2.7$ million barrels

Plugging these into the elasticity formula above

$$\begin{aligned} \frac{\% \Delta O_D}{\% \Delta p_o} &= \frac{\frac{\Delta O_D}{(O_D(p_o^1) + O_D(p_o^0))/2}}{\frac{\Delta p_o}{(p_o^1 + p_o^0)/2}} \\ &= \frac{\frac{\Delta O_D}{(O_D(205) + O_D(200))/2}}{\frac{5}{(205 + 200)/2}} \\ &= \frac{\frac{-3}{(2.7 + 3)/2}}{\frac{5}{(205 + 200)/2}} \\ &= -4.2632 \end{aligned}$$

In this price range a 1% increase in price leads to a 4.26% drop in demand, so in this range world demand for oil is very elastic, so OPEC would not raise the price from here. In fact, they would want to lower the price if their intent was to maximize their total revenue.

So, OPEC, even though they can set the price as high as they want, they do not want to set it too high.