2 Part Tariffs: A (Very) Simple Example

Victor Bennett

Imagine a population of two types of people, bachelors and parents. In this population, the two types are totally indistinguishable. They look the same, and if it is at all beneficial for parents to appear to be bachelors by not bringing children, parents would find a babysitter, and if it is at all beneficial for bachelors to appear to be parents, they could easily borrow a child.

Costco wants to operate in this world selling a single homogeneous good (85 gallon jugs of mustard, or something). Assume that, thanks to the difficulty of reselling mustard from a jug, arbitrage will not to be a problem.

In this world there is a single parent, and five bachelors. Parents demand Costco goods as a function of price as follows:

\[ q_{parents} = -2p + 7 \]

and bachelors demand goods as follows:

\[ q_{bachelors} = -\frac{3p}{2} + \frac{9}{2} \]

Costco’s marginal cost of producing these jugs of mustard is $1.00.

What is the optimal way to sell this mustard?

Because customers cannot be distinguished from one another, 1st and 3rd degree discrimination are out. We could do volume discounts (selling two packs as well as single packs), but we would be better off with 2 part tariffs. Since arbitrage is not an issue, let’s go forward with 2 part tariffs.

Having decided that what we want is a 2 part tariff system. When working with 2PTs, we know we will have one price and a fixed price of entry. We’ll follow the following strategy: Choose a price, determine the parties willingnesses to pay, at that price, and solve for the fixed price Use the fixed prices to determine which customers we want to include (by not pricing too high for them to participate) Knowing who we want to include, choosing which of our two fixed prices we want to use. Solve for the actual optimal price using the fixed price we chose.

Given that our efforts are going to be to take as much from our lowest willingness to pay customer (that we want to include) we want to make sure that she has
as much to extract as possible. Thus, we want to "grow the pie" or make sure there is as little dead weight loss (happiness that makes it neither to the business nor the customers) and we’ll start with the notion of pricing at MC as a benchmark. At a price of $p = 1$, what are the two customer types' willingness to pay? Well, when we graph the demand functions, we know that the willingness to pay is the area under the demand curve, bounded on the left by a quantity of 0, and bounded on the right by the quantity demanded at the price in question. As such, the willingness to pay equation is the area of a shape that looks like a rectangle, with a triangle on top. The rectangle is the firm’s revenue, and the triangle is the consumer surplus.

\[ WTP(p) = \frac{1}{2} \text{base}_{\text{triangle}} \times \text{height} + \text{price} \times \text{quantity}(\text{price}) \]  
\[ = \frac{1}{2} (\text{max}_\text{price} \times \text{demand}(\text{price}) + \text{price} \times \text{quantity}(\text{price}) \]  

For bachelors, this is as follows (when price = Marginal Cost = 1):

\[ WTP(p) = \frac{1}{2} (3 - p) \times q(p) + p \times q(p) = \frac{1}{2} (3 - 1) \times 3 + 1 \times 3 = 6 \]

For parents, willingness to pay is

\[ WTP(p) = \frac{1}{2} (7 - 1) \times 5 + 1 \times 5 = \frac{25}{4} + 5 = 11 \frac{1}{4} \]

Consumer surplus is the "triangle" portion of the area, as computer below:

\[ CS(p) = \frac{1}{2} \text{base}_{\text{triangle}} \times \text{height} \]

\[ CS_{\text{parents}}(p) = \frac{1}{2} (7 - 1) \times 5 = \frac{25}{4} \]

\[ CS_{\text{bachelors}}(p) = \frac{1}{2} (3 - 1) \times 3 = 3 \]

We know that the only fixed prices that we need to worry about are those that are equal to the consumer surplus of our consumers (and we are pricing out anyone with a consumer surplus lower than our fixed price).

Our profit is the sum of what we earn from charging everyone the same fixed price plus what we earn from selling the goods. Because our price is set to marginal cost, we’ll earn nothing on the goods (we’re selling "at cost") and only making money from people coming in the door.

\[ \pi = (1 + 5) \times F(p) + 1(5 \times (1 - 1)) + 5(3 \times (1 - 1)) = 6 \times F(p) \]
What is our profit if we set our fixed price to extract all happiness from bachelors?

\[ \pi_{\text{bachelors' fixedprice}} = 6 \times 3 = 18 \]

Because parents’ willingness to pay, 17.5, is higher than the happiness the bachelors would get by entering the store, that price is prohibitive, and they just don’t come. Therefore, you’ll only end up with one customer.

\[ \pi_{\text{parents' fixedprice}} = 1 \times \frac{25}{4} = \frac{25}{4} \]

Obviously, we do better by including bachelors in the market, so, lets go forward including them, and making sure that any fixed price we charge is exactly equal to the bachelors’ willingness to pay at that price.

It seems intuitive that we would be able to do slightly better than we are currently if we could make money on our sales. Even a little bit of profit from each seems like it would help. We have to be careful, though, because raising the price of our goods leads to dead weight loss, which means that our customers are slightly less well off, and there is less for us to take from them. So we have to deal with this tension. The graphs don’t make it obvious, so we have to switch to the math. Let’s write our profit as a function of the price we charge (including the fixed price, bachelor’s consumer surplus, as a function of price) and then optimize it. How do we optimize functions? Take the derivative, and set it equal to 0. The price that makes the derivative equal to 0, is the optimal price.

\[
\begin{align*}
\pi &= 6 \times F(p) + 5(q_{\text{bachelors}}(p) \times (p - 1)) + 1(q_{\text{parents}}(p) \times (p - 1)) \\
&= 6 \times \left[ \frac{1}{2}(3 - p) \times q_{\text{bachelors}}(p) \right] + 5(q_{\text{bachelors}}(p) \times (p - 1)) + 1(q_{\text{parents}}(p) \times (p - 1)) \\
&= 6 \times \left[ \frac{1}{2}(3 - p) \times \left( \frac{-3p}{2} + \frac{9}{2} \right) \right] + 5\left( \frac{-3p}{2} + \frac{9}{2} \right) \times (p - 1) + 1((-2p + 7) \times (p - 1)) \\
\frac{d\pi}{dp} &= 12 - 10p
\end{align*}
\]

Therefore,

\[
12 - 10p^* = 0 \\
p^* = 1.2
\]

Which is only slightly higher than our rule of thumb price of \( MC \), and yields a profit of 18.2, which is greater than our profit from pricing marginally. This gain
comes from the fact that parents buy so much more, that a small sacrifice of dead
weight loss on each consumer is overcome by the gains from making a little money
on each sale!

What is the intuition behind this? Take a look at our profit function, and
notice that both bachelors and parents buy just as much after paying an entry fee
as they do if they didn’t. That’s because, the amount they spent on the entry fee
is now sunk, and they’ve forgotten about it. When you are at Costco, you don’t
ever think about the amount you spent on the membership, its the same as any
other store. It never occurs to shoppers to think that the difference to the store is
that their profits are now coming mostly from entry fees. Consumers don’t really
care about where you get your profits! Don’t think, however, that this means
people are irrational. Both types make a rational choice when they are deciding
to buy the membership. They know they will forget the membership fees, but
since, at the point of this decision, they haven’t yet spent the fee, they can opt
not to spend it if the benefits of membership aren’t as great as the costs.