McPeak
Lecture 4
PAI 723

Who gives a hoot about elasticities?

Well, as a policy matter, they make a big difference when considering the implications of implementing a tax.

What are things we might be concerned about when implementing a tax?

1) What will be the effect on the equilibrium price? What will be the effect on the equilibrium quantity? How much revenue will be generated?
2) Who will bear how much of the burden of the tax? What share will be borne by consumers? By producers?
3) What are the implications of different types of taxes? What is the difference between a tax on producers and a tax on consumers? What is the difference between a tax that is fixed at a given level per unit sold and a tax that is based on a fixed share of the selling price?

Two types of tax to keep in mind.

1) *Ad valorem.* For every unit of currency spent on a good, the government keeps a given fraction, the producer keeps the remainder.

2) *Specific tax.* For every unit of the good purchased, the government collects a given amount per unit.

Let's start by looking at the specific tax since it is easier. Then we will consider the ad valorem.

In addition, we can distinguish between a tax placed on consumers and a tax placed on producers.

A specific tax is often denoted as a tax of size tau (τ).

Go back to the processed pork example.

Say the government decides to impose a tax per unit ($1.05 per kg) on processed pork. τ=$1.05 per unit of Q sold.

First, consider the case of a tax on the pork producer. We collect the money from the producer before they deliver the pork to market.

So what they are responding to when they sell is the post-tax price.

The price the producer gets is $1.05 less than the price the consumer pays.

Q	Q=286-20*P P=(286/20)-(Q/20)	Q=88+40*P P=(Q/40)-(88/40)	{Q=88+40*P+40*1.05} P=(Q/40)-(88/40)+1.05
180	$5.30	$2.30	$3.35
190	$4.80	$2.55	$3.60
200	$4.30	$2.80	$3.85
210	$3.80	$3.05	$4.10
220	$3.30	$3.30	$4.35
230	$2.80	$3.55	$4.60

Let us look at the graph.

Legend:
- **P=(286/20)-(Q/20)**
- P=(Q/40)-(88/40)
- P=(Q/40)-(88/40)+1.05
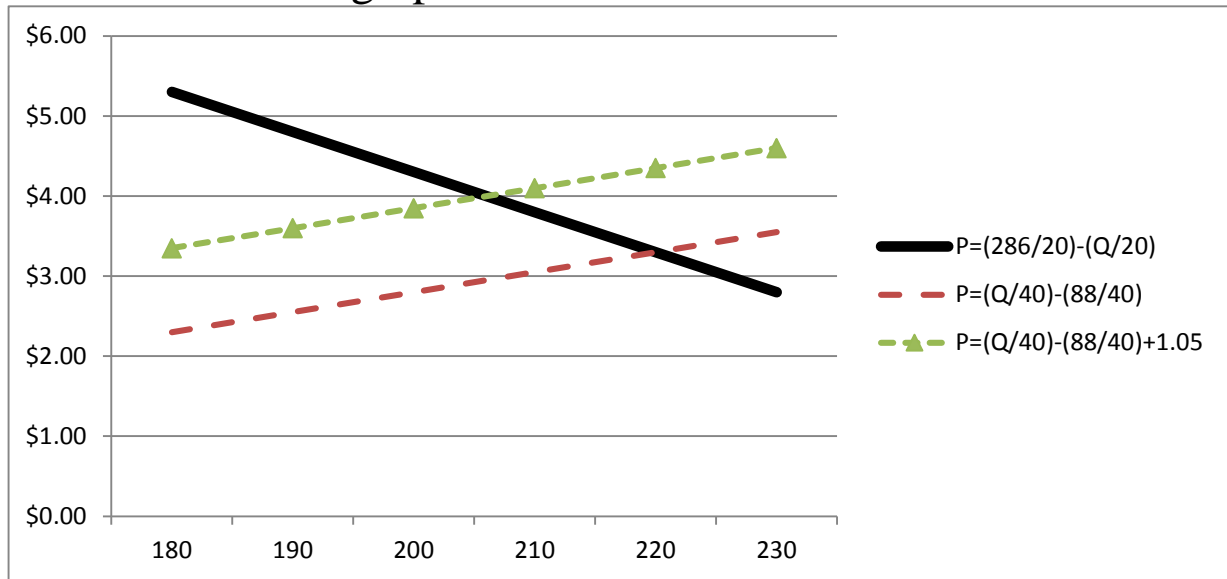
What is the qualitative story?

If the tax is imposed, consumers spend more per unit to get the good.

Producers receive less per unit than they did before the tax.

The market clearing quantity decreases from the pre-tax level.

The government gets revenue where it did not get it before.

What is the quantitative story?

Solve by algebra.

The specific tax creates a difference between the price received by producers and the price paid by consumers. The size of this difference is tau. So write:
$P^c = \tau + P^s$

This distinguishes between the price consumers pay (from the demand curve) and the price the sellers get (from the supply curve that does not include the tax).

Here, we are given $\tau = 1.05$.

$Q^c = 286 - 20 * P^c$
$Q^s = 88 + 40 * P^s$
$P^c = \$1.05 + P^s$

In equilibrium, Q^c still equals Q^s, so

$286 - 20 * (\$1.05 + P^s) = 88 + 40 * P^s$

$286 - 21 - 20 * P = 88 + 40 * P$
(drop the s notation for simplicity)

Seller's price = $2.95, 88+40*2.95=206 is quantity.

Check answer:
Buying price = $2.95+1.05, or $4.00. 286-20*4=206.

Here you have two different prices to keep in mind: the price the consumers pay and the price the sellers get that is the residual after the tax is taken by the government.

Equilibrium is composed here of four elements: a selling price, a buying price, a quantity, and tax revenue.

P^c=$4.00
P^s =$2.95
Q=206
What is the tax revenue? TR=Q*τ, or 206*1.05, or $216.

Summarize the outcome:
The consumer spent $3.30 per unit to get the good in equilibrium pre-tax, now they spend $4.00 per unit to get the good in equilibrium post tax.

The producer received $3.30 per unit to sell the good in equilibrium pre-tax, now they get $2.95 per unit to sell the good in equilibrium post tax.

The quantity sold / purchased in equilibrium is 206, a decrease from 220 before.

Note: if the policy maker had not been spending time drawing supply and demand curves in this class, they could make a common mistake of estimating revenue would be $1.05*220=$231, when if we take into account the behavior of consumers and producers in response to the higher price and the supply curve, we find in fact revenue is $1.05*206=$216.

Incidence: how much of the burden of the tax falls on consumers and how much falls on producers.

Consumer incidence = $$\frac{\Delta p \text{ consumer } pays}{\Delta \tau}$$

In the case of the consumer, the change in p is $0.70.

The change in the tax is $1.05 (from zero to $1.05).

Here we are looking at tax per unit and price per unit.

This means that when the tax is imposed, 70/105, or 2/3 of the tax falls on the consumer.

The incidence of the tax on consumers is 2/3rds

The price received by the suppliers falls by $0.35. The share of the tax burden falling on the producers is 35/105, or 1/3rd.

The incidence of the tax on producers is 1/3.

The relative share of the incidence depends on the elasticities.

Consider flatter demand curve (introduced before) and the same tax on suppliers

Q	P=(484/80)-(Q/80)	P=(Q/40)-(88/40)	P=(Q/40)-(88/40)+1.05
180	$3.80	$2.30	$3.35
190	$3.68	$2.55	$3.60
200	$3.55	$2.80	$3.85
210	$3.43	$3.05	$4.10
220	$3.30	$3.30	$4.35
230	$3.18	$3.55	$4.60
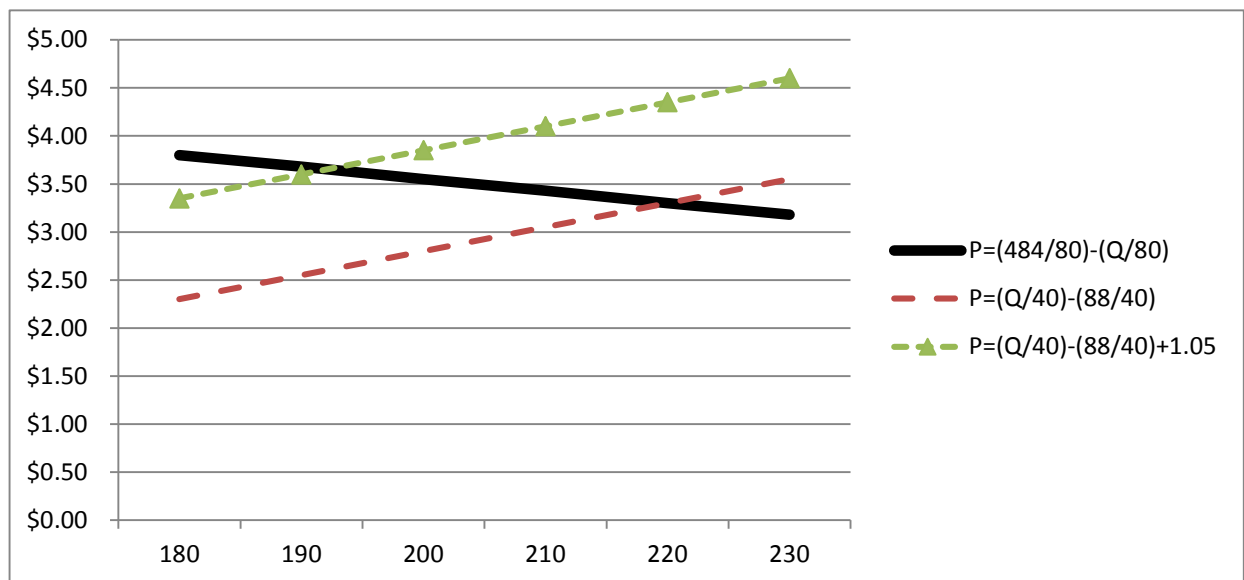
Skipping the math, but you can try it yourself

These cross at ($3.65, 192) after the tax is imposed and the equilibrium before the tax was our old friend ($3.30, 220).

[How? (484/80) - (Q/80) = (Q/40) - (88/40) + 1.05]

In this case, the price to the consumer has changed from $3.30 to $3.65, a 35 cent increase for the consumer.

The price for the producer has decreased from $3.30 to $2.60, a drop of 70 cents. Here the incidence on the consumer is $1/3^{rd}$, the incidence on the producer is $2/3^{rds}$.

In this case, the flattest case considered in the demand curve comparison, recall we calculated a price elasticity of demand of ε =-1.2

Also recall that the baseline demand curve had a price elasticity of demand of -0.3.

The price elasticity of supply for our baseline case was eta = 0.6 (we got .59, but let's round).

SHORT CUT
Incidence on consumers = eta/ (eta-epsilon)
=.6/(.6-(-.3))=2/3.
=.6/(.6-(-1.2))=1/3

This short cut tells us that the incidence that falls on consumers can be computed from the relative elasticities.

However, rather than memorize the formula, I want you to get the more important issue here – the relative elasticities tell you what burden of a tax will fall on consumers and what burden will fall on producers.

A common assumption is that a tax on producers will lead producers to "pass along" the tax to the consumers. This means that the analyst believes that producers can add the tax to the selling price without experiencing a change in the price they receive.
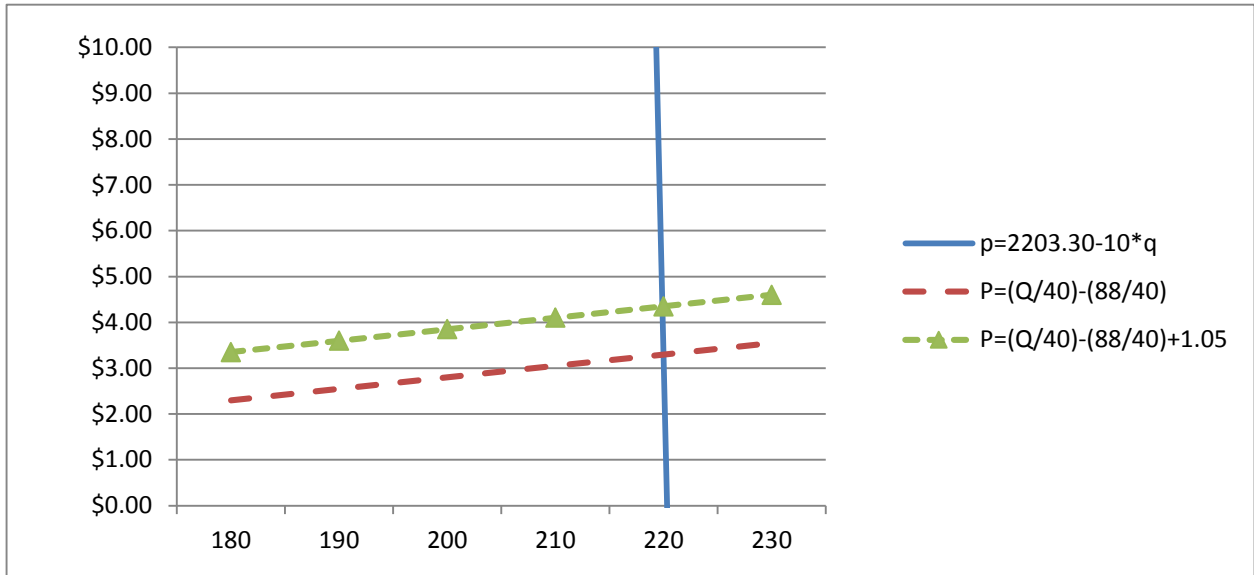
In what case can they do this?

Only if the price elasticity of demand is zero and / or the price elasticity of supply is infinite. The price elasticity of demand equal to zero means that no matter what the change in price, consumers demand a given quantity. This is REALLY inelastic. The supply elasticity equal to infinity means that a really small change in price leads to a huge increase in supply.

$$CI = \frac{\eta}{\eta - \varepsilon}$$

This goes towards 1 (100% consumer incidence) when epsilon goes to zero or eta gets really big.
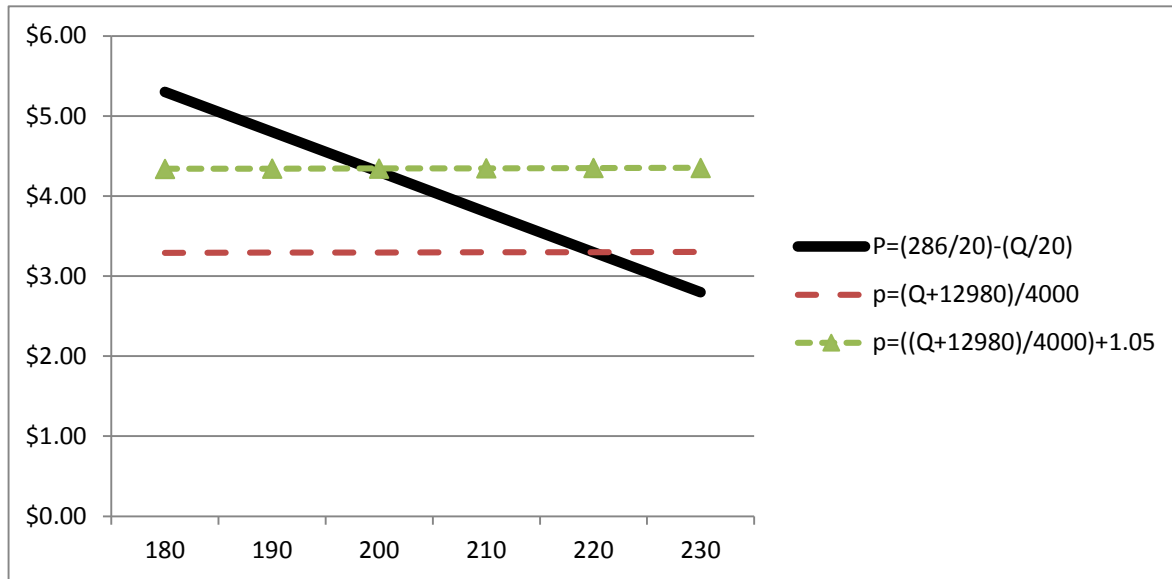
Show each on a graph.

p=2203.30-10*q, ε= -0.0015
P^c=\$4.34
P^s =\$3.29
Q=220 (219.7)
TR=\$231.

Legend:
P=(286/20)-(Q/20)
p=(Q+12980)/4000
p=((Q+12980)/4000)+1.05

supply: p=(Q+12980)/4000,
η=60
P^c=$4.34
P^s =$3.29
Q=199
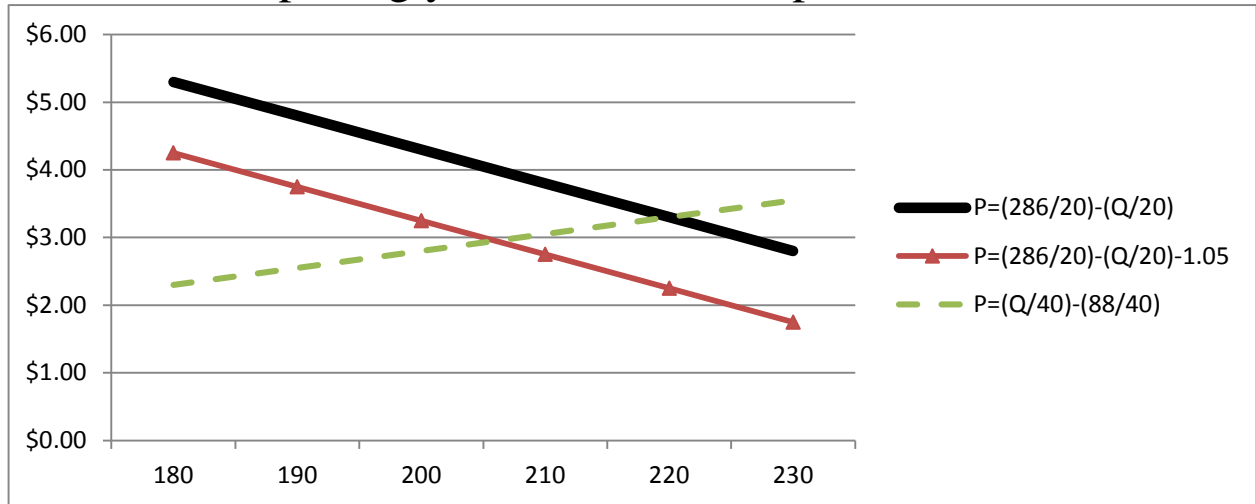TR=209.

In what case do producers bear the entire burden?

The opposite. A price elasticity of demand that is infinite ("flat" demand curve) or a supply elasticity that is zero ("steep" supply curve). Think these through.

Does it matter whether you put the tax on consumers or producers?

Somewhat surprisingly, in the case of a specific tax, no.

If you put the tax on consumers, the lower version of the demand curve reflects the quantity / price schedule after the tax is collected by the government, and the original demand curve reflects the quantity / price paid by consumers when the tax is included.

Take the basic elements of the problem solved before for putting the tax on producers, but now put the tax on consumers.

Solve by algebra.

The specific tax creates a space between the price received by producers and the price paid by consumers. The size of this space is tau. So write:
$P^c-\tau = P^s$

Here, we are given $\tau=1.05$.

$Q^c=286-20*p^c$
$Q^s=88+40*p^s$
$P^c - \$1.05 = P^s$

In equilibrium, Q^c still equals Q^s, so

$286-20*P^c = 88+40*P^s$
$286-20*P^c = 88+40* (P^c - \$1.05)$
$286-20*P=88+40*P-42$

This solves for a consumer equilibrium price of $4.00, and a seller equilibrium price of $2.95. Should be familiar

The suppliers' reaction to the demand curve after the tax has been collected by the government from the consumer takes you to an equilibrium quantity of 206. At this point, the producer gets $2.95 per unit, the consumer pays $4.00 per unit, and the government gets $1.05 per unit and the tax revenue is $216.

That is where we got when we taxed the supplier.

What about the ad valorem tax?

This takes a specific amount per dollar, so for every dollar spent, a certain number of cents goes to the government. Let's say we have a 20% sales tax, so for every $1.00 spent, the producer gets $0.80, the government gets $0.20. In this case, we can call alpha (α) the tax rate and call τ the size of the tax.
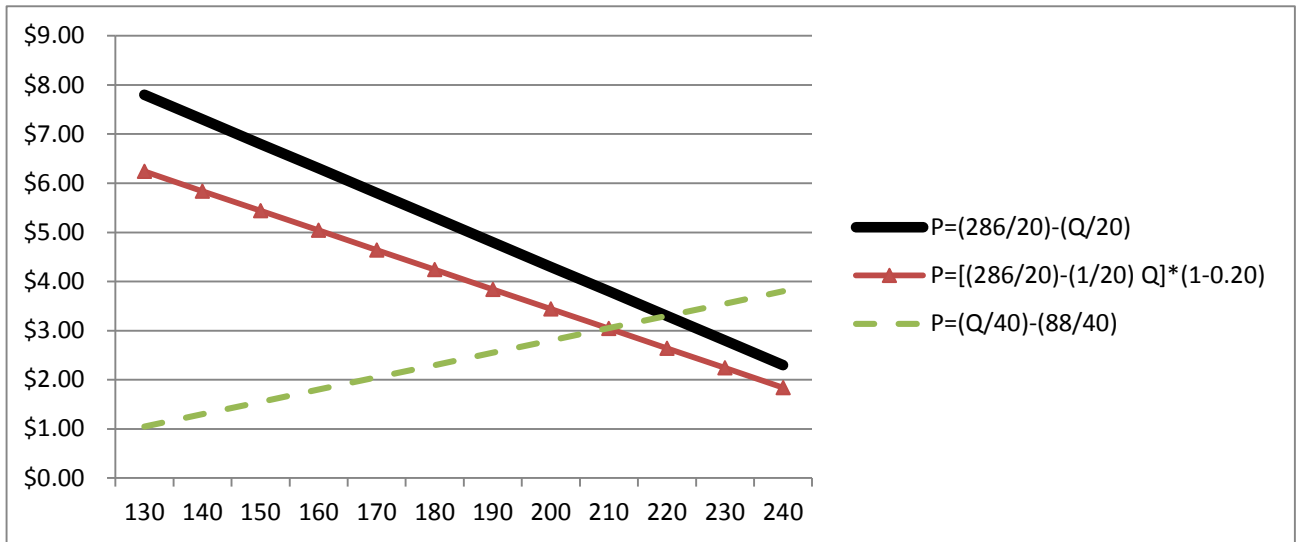Then:
$P^c = \alpha * P^c + (1-\alpha) * P^c$,
where $\tau = \alpha * P^c$ and $P^s = (1-\alpha) * P^c$
so that $P^c = \tau + P^s$

[Note, there is a slight difference I how this policy can be defined. In the US example with a sales tax, we define $p^c = (1+\alpha) \cdot p^s$. This is different from a VAT, that is defined by $p^s = p^c \cdot (1-\alpha)$. We will present the latter here.]

Q	P=(286/20)-(Q/20)	P=[(286/20)-(1/20) Q]*(1-0.20)	τ=(.20)*P	P=(Q/40)-(88/40)
130	$7.80	$6.24	$1.56	$1.05
140	$7.30	$5.84	$1.46	$1.30
150	$6.80	$5.44	$1.36	$1.55
160	$6.30	$5.04	$1.26	$1.80
170	$5.80	$4.64	$1.16	$2.05
180	$5.30	$4.24	$1.06	$2.30
190	$4.80	$3.84	$0.96	$2.55
200	$4.30	$3.44	$0.86	$2.80
210	$3.80	$3.04	$0.76	$3.05
220	$3.30	$2.64	$0.66	$3.30
230	$2.80	$2.24	$0.56	$3.55
240	$2.30	$1.84	$0.46	$3.80

How do you solve one of these by algebra?

This works better if you have the inverse demand curve handy.

Remember $Q^c=286-20P^c$ could be written $P^c =(286/20)-(1/20)Q^c$

The point of this tax is that while that is the price the consumer pays, for the producer, they only get some fraction of this and the government gets the rest.

So if we think about it, the sellers are going to get $P^s=P^c*(1-\alpha)$, which by substitution is $P^s=[(286/20)-(1/20)Q^c]*(1-\alpha)$ which is the equation for the lower version of the demand curve.

To make a long story short, we use the condition that the quantity supplied equals quantity demanded, and we rearrange terms to get:

$286-(20P^s)/(1-.2)=88+40P^s$, $286-25P^s=88+40P^s$,

Without dwelling on the details, we can jump to the answer.
$P^s=\$3.05$,
$P^c=\$3.81$ [To get this from P^s, use the fact that if $P^s =P^c*(1-\alpha)$, $P^c =P^s/(1-\alpha)$, $P^c=\$3.05/.8$]
q=210 [286-(20*\$3.05/.8)=210, 88+40*\$3.05=210]
$\tau =\alpha*p^c=0.2*\$3.81=\$0.76$
TR= \$0.76 per unit *210 units, or \$160.
(some rounding in here if you check the details)

This is algebraically more complicated than the specific tax, but the idea is the same.

The tax creates a condition where the price that the consumer pays and the price that the producer receives differ.

Using the information that the quantity demanded equals the quantity supplied after the tax has been imposed, and the exact nature of the price difference between the price the consumers pay and the price the producers get as a result of the tax, we can solve for post tax equilibrium.

What is the incidence in the ad valorem case?

Well, first, what is the size of the tax?
Consumers pay $3.81 per unit, the producers get $3.05, so $0.76 per unit of Q is the tax.
What is the change in consumers' price? $3.81-$3.30, or $0.51.
Consumer incidence is $0.51/$0.76.
2/3rd of the incidence is borne by consumers.

Recall the specific tax, and contrast the $(\tau/p^c) = (\$1.05 / \$4) = 26\%$ implicit tax rate that came out of the specific tax example with the 20% example used for the ad valorem example here.

If we crank up the tax rate used in our ad valorem example from 20% to 26%, it will take us to the same equilibrium outcome as the specific tax, although other points on the line will differ.

[some rounding going on here]

$\alpha=.26$

$286-(20p)/(1-.26)=88+40p,$

$286-27p=88+40p,$

Sellers price=$2.95,

Consumer price = $4.00

q=206

Tax revenue is $216.

We can get the same outcome with a different kind of tax.

Note the incidence of the tax is the same as well.

Some basic ideas to take away:

Why do we tax?
    Change behavior
    Generate revenue
    Compensate for externalities (more on this later)

The more inelastic demand for a good is, the more taxing it is good at generating revenue.

The more inelastic demand for a good is, the less taxing it is good at changing behavior.

If we want to generate tax revenue without causing much of a change in the equilibrium quantity, tax a relatively inelastic good.

Different taxes forms exist, but under particular conditions we looked at lead to exactly the same outcome.

The relative elasticities of the supply and demand curve play a critical role in determining the incidence, and these elasticities are determined by the nature of the good in question.

If we want to know who bears the greater burden of a given tax, consumers or producers, then we should identify who is the more inelastic party.

The more inelastic party will bear a higher share of the burden.