

# Lecture Note 8: Applying Consumer Theory to Competitive Markets – The United States Sugar Program

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# 1 Applying Consumer Theory to Competitive Markets

- When exchange takes place voluntarily, we generally assume that it makes all participants better off. Otherwise, participants would not have voluntarily engaged in the exchange.
- It's useful to have a dollar metric of the gains from transacting.
- As we've already found in our use of the expenditure function for the food stamps program, this measure is consumer surplus.
- The notion of consumer surplus is critical because although we can readily measure the direct costs of a given project or policy (i.e., building a bridge, imposing a tariff), it's less obvious how we measure the benefits.
- Demand curves allow us to measure these benefits.
- Think of the market demand curve as the set of consumers arrayed in inverse ordering from the person with the highest willingness to pay (WTP) for a good to the person with the lowest WTP.
- Similarly, think of the market supply curve as the set of producers arrayed in order from firm willing to produce at lowest price to firm demanding the highest price to produce a good.
- What market ideally does is match consumers and producers:
  - If a producer is willing to produce at a price less than or equal what a consumer is willing to pay, that transaction will occur.
  - Most consumers will be buying at a price *below* their maximal willingness to pay.
  - Most producers will be selling at a price *above* their lowest willingness to produce.
  - Marginal producer and consumer will be indifferent.
- It is easy to see that when this mechanism works correctly, it maximizes the sum of producer and consumer surplus:
  - All gains from trade are realized.
  - All transactions that benefit both parties occur.
  - No transactions occur that do not benefit both parties.

- It is noteworthy that this metric does not place any greater weight on consumer or producer surplus:
  - If supply is perfectly elastic, all of the surplus is captured by consumers.
  - If demand is perfectly elastic, all of the surplus is captured by producers.
- Why do we want to maximize surplus without any regard for who are the beneficiaries? Isn't there a trade-off between equity and efficiency?
  - Answer: *No*, not in a competitive market. We'll study this issue shortly in general equilibrium theory.
  - But for the moment, take it on faith that we just want to maximize the pie, and we don't need to worry about who gets which slice.
- We often have pretty good data on producers' costs, which should reflect their willingness to produce.
- We often have less meaningful data on consumer's willingness to pay.
- But if we have an estimate of the elasticity of demand, this allows us to extrapolate a great deal of information about consumer surplus. That's because the elasticity is a measure of the slope (or curvature) of the demand curve (something we also saw in the food stamps example).
- We have previously worked with compensated demand curves. For this analysis, we'll use the uncompensated demand curve for *sugar*. Why is that reasonable? Two explanations:
  - We don't have the compensated demand curve (not a great reason)
  - Recall the Slutsky equation:  $\partial d_x / \partial p_x = \partial h_x / \partial p_x - (\partial d_x / \partial I) \cdot x$ . This says that the compensated and uncompensated demand curves don't differ much if  $(\partial d_x / \partial I) \cdot x$  is small. This will be true if the income effect is small *or* if sugar is a small share of consumers' budgets (so, there is very little change in consumers' real income when sugar prices change). The latter is quite likely to be true. Hence, we don't have to worry a great deal about the difference between compensated and uncompensated demand here.
- We're going to apply this reasoning to the system of U.S. Sugar Tariffs to perform a welfare analysis.

- This is a partial equilibrium analysis, using the tools of consumer theory that we have studied so far (plus a little producer theory from 14.01).
- We will leap into general equilibrium analysis in a couple of lectures. But partial equilibrium analysis is plenty powerful, and is sufficient for many applied policy problems – such as this one!
- As we proceed, please keep three points in mind:
  1. Distinguish carefully between *transfers* and *social gains and losses*.
    - If I pay a worker \$5 to do a job, that is *not* a \$5 social gain even though I have ‘generated a job.’
    - Why? This transaction is a \$5 *transfer* from me to the worker.
    - *If* there is a gain, it is because the value that the worker produces for \$5 is worth more than \$5 to me (i.e., consumer surplus) and/or the worker’s alternative use of time was less than \$5 (i.e., producer surplus). There is a gain if the value that the worker produces for me is higher than the cost to the worker of producing it.
  2. A cost is not a benefit.
    - This is a restatement of the above. If I double the wages of all federal employees in the United States government, what is the social benefit of this? To a first approximation, zero. I am simply transferring money from one group of citizens (taxpayers) to another. The social cost, if present, would be due to the dead-weight loss of taxation or the distortions that extra money had on labor supply (and other behavior) of federal workers.
  3. All costs are opportunity costs.
    - In economic reasoning, there is no such thing as *intrinsic value*. The only cost of using a given resource is the value of its alternative to which it could have been put. This is its *opportunity cost*.
    - Why is gasoline so comparatively cheap (less per gallon than Perrier or Dasani!) when it is the staple food of the industrial economy? Simply because it is relatively abundant, so the last gallon isn’t worth much. But if there was a significant reduction in supply, prices could go quite high because the last gallon is very valuable indeed.

- Similarly, diamonds are expensive because at available quantities, people appear to have very high value uses for them (i.e., wedding and engagement rings). If diamonds were as abundant as gasoline, they would presumably be as cheap (and we would use as party favors). (Incidentally, it is likely that diamonds are relatively scarce because of cartelization of the world diamond market by the De Beers Company rather than due to any natural scarcity of supply.)

## 2 Sugar case

### 2.1 Analytics

Using basic competitive theory, we will analyze the efficiency consequences of the U.S. sugar program.

To do this, we need to model the consumer demand curve (to assess consumer surplus) and model the supply curve to assess producer surplus.

With these, we can consider the consequences of the quota system relative to a counterfactual case in which the market was unrestricted.

The deviations from the competitive baseline case can be divided into three components:

1. Transfers. In general, quantity or price distortions will yield some transfers from consumers to producers (or vice versa). These are *not* efficiency losses (though one may still view them as unwarranted windfalls for certain groups).
2. Deadweight losses from inefficient resource allocation. As we'll see in the sugar case, price or quantity quotas may also cause production distortions whereby low cost producers are prevented from producing and high cost producers take their place. In these cases, there is the usual loss in consumer surplus and gain in producer surplus *and* there is also a deadweight loss incurred; real resources are consumed by high-cost producers to make goods that low-cost producers could have made using fewer resources.
3. Deadweight losses from foregone consumption. A price or quantity quota will generally reduce equilibrium consumption below its competitive level. This implies that there are some units of the good that consumers would have been willing to pay for at a price at which producers would have been willing to produce. These thwarted trades are therefore a deadweight loss.

## 2.2 Sources of sugar supply:

1. World sugar supply:
  - Price: perfectly elastic at price \$0.068 per pound
  - Quantity: capped at 3.8 billions pounds
2. U.S. sugar producers:
  - upward sloping from \$0.068 per pound at 1 pound to \$0.22 at 13.2 billion pounds.
  - So  $P_{domestic} = 0.068 + 1.09 \cdot Q$ , where  $Q$  is billion pounds produced.
3. High fructose corn syrup (HFCS) producers:
  - Supply: \$0.15 per pound for 12 billion pounds, infinite cost thereafter (until new plants built).

## 2.3 Demand:

We are given that: elasticity of demand is  $-0.30$  and that domestic demand is 29 billion pounds at \$0.22 per pound.

- Use the functional form

$$Q(P) = KP^{-.30}$$

- Why this functional form?

$$\eta = \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} = -.30KP^{-1.30} \cdot \frac{P}{KP^{-.30}} = -.30,$$

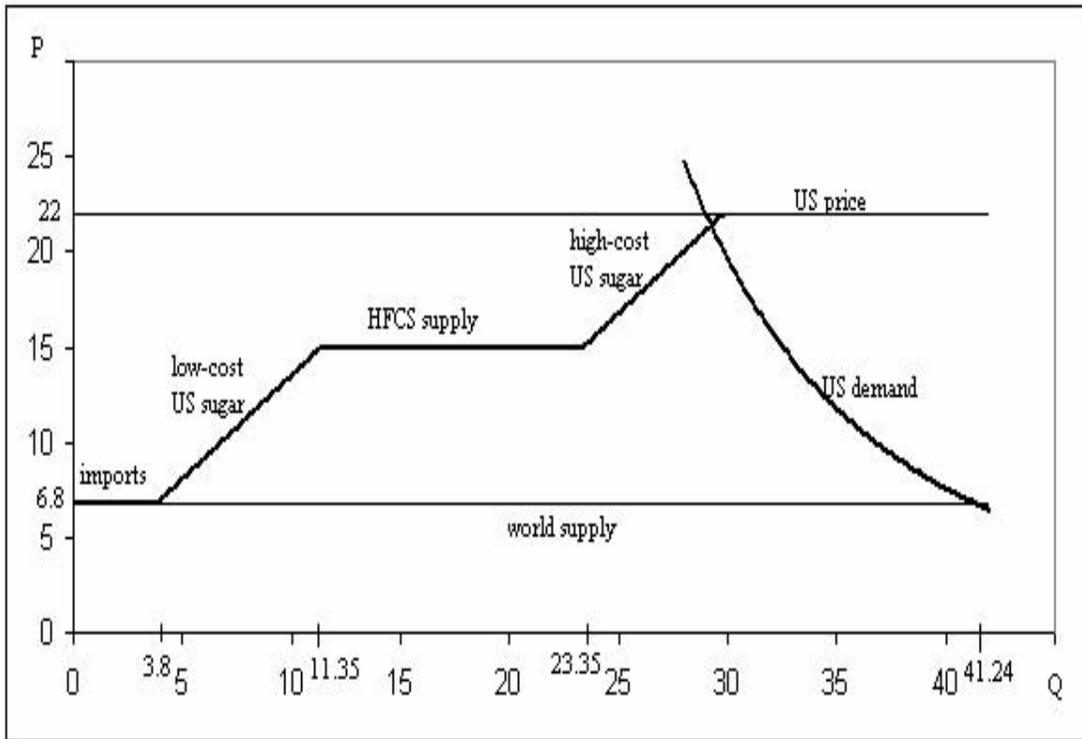
so, this functional form has a constant elasticity.

- Another way to see this:

$$\begin{aligned}\ln Q(P) &= \ln K - .30 \ln P, \\ \frac{\partial \ln Q}{\partial \ln P} &= -0.30\end{aligned}$$

- Applying in this example:

$$\begin{aligned}29 &= K(22)^{-0.30} \\ K &= 29(22)^{0.30} = 73.3 \\ Q &= 73.3(22)^{-0.30}\end{aligned}$$



- What would quantity demanded be at the world price:

$$Q(0.068) = 73.3 \times (6.8)^{-0.30} = 41.2 \text{ billion pounds}$$

## 2.4 Accounting

### 2.4.1 Gains in producer surplus?

- *Why won't gains to producers be identical to corresponding losses for consumers?*

- Foreign producers (Do you want to count these gains? What are the politics that makes this large transfer feasible?)

$$3.8(22 - 6.8)/100 = \$0.58 \text{ billion}$$

This amount is a pure *pure transfer*. Why? There is no distortion involved in taking a chunk of consumer surplus and handing it over to producers. Deadweight losses accrue when consumption is foregone (as it will be) or production decisions are distorted.

– U.S. sugar producers

$$\text{Production Costs } 13.2 \times (6.8 + 0.5(22 - 6.8)) / 100 = \$1.9 \text{ billion}$$

$$\text{Revenue } 13.2(22) / 100 = \$2.9 \text{ billion}$$

$$\text{Gain in Producer surplus} = \$1.0 \text{ billion}$$

– HFCS producers

$$\text{Production costs } 12(15) / 100 = \$1.8 \text{ billion}$$

$$\text{Revenue } 12(22) / 100 = \$2.64 \text{ billion}$$

$$\text{Gain in producer surplus} = \$0.84 \text{ billion}$$

#### 2.4.2 Loss of consumer surplus?

- In the absence of the program, the domestic price of sugar would fall to 6.8 cents per pound. Hence the loss in consumer surplus due to the program is:

$$\int_{6.8}^{22} Q(P) \partial P = \int_{6.8}^{22} 73.3P^{-0.3} \partial P = \left( \frac{73.3}{0.7} \right) P^{0.7} \Big|_{6.8}^{22} = \$5.1 \text{ billion}$$

Note that this area includes the rectangle of lost consumer surplus due to paying higher prices on sugar,  $(22 - 6.8) \times 29$ , and the DWL triangle (which has a non-linear hypotenuse).

- This loss in consumer surplus is composed of two components:
  1. One is a simple transfer from consumers to producers. This is the rectangular area of  $(\$0.22 - \$0.068) \times 29$  billion = \$4.4 billion. Note, however, that some of these transfers are squandered on excess production costs. So, this is not an efficient transfer.
  2. The second loss comes from foregone consumption. In the absence of the sugar program, consumers would consume 41.2 billion lbs of sugar. At the price of \$0.22, they consume only 29 billion pounds. This is a pure DWL, and it's area is  $\$5.1 - \$4.4 = 0.7$  billion.
- If you had just wanted to calculate the loss of consumer surplus inside of the triangle only (the foregone consumption area), you would invert the demand function to obtain willingness to pay at each quantity (so,  $P(Q)$  rather than  $Q(P)$ ). You would integrate

this function over the range of 20 to 41.2 lbs, and subtract off production costs over this range:

$$\begin{aligned} Q &= 73.3(P)^{-0.30} \\ P^{0.3} &= \frac{73.3}{Q} \\ P &= 73.3^{1/.3}Q^{-1/.3} \end{aligned}$$

Willingness to pay in this range is:

$$\begin{aligned} &\int_{29}^{41.24} 73.3^{1/.3}Q^{-1/.3}dQ \\ &= \left( \frac{73.3^{1/.3}}{-0.7/.3} \right) Q^{-.7/.3} \Bigg|_{29}^{41.24} = \$1.53 \text{ bil} \end{aligned}$$

and the production costs are

$$12.24 \times 6.8 = \$0.83 \text{ bil}$$

So the DWL is:

$$DWL = 1.53 - 0.83 = \$0.70 \text{ bil.}$$

### 2.4.3 Net costs and benefits:

- Producer surplus:  $0.58 + 1.00 + 0.84 = \$2.4$  billion
- Consumer surplus:  $-\$5.1$  billion
- Dead weight loss:  $\$2.4 - \$5.1 = \$2.7$  billion
- What accounts for the discrepancy between consumer and producer surplus?
  - As above, one part is the DWL of foregone consumption of \$0.7 billion
  - The other \$2.0 billion is from wasteful resource allocation. The excess production costs of domestic farmers and HFCS producers (relative to the world sugar market price) are their production costs for the 25.2 billion pounds produced minus the cost of obtaining that sugar on the world market:  $\$1.9 + \$1.8 - 25.2 \times \$0.068 = \$1.99$  billion.
- Hence, the loss in consumer surplus is more than twice as large as the gain in producer surplus. Which implies that the deadweight loss of the program is actually slightly *larger* than the gain to producers.

- Notice also that about 25 percent of the gain (0.58 of 2.42 billion) is a pure transfer to foreign producers. The gain to U.S. producers is \$1.84 billion.
- Moreover, about \$0.84 billion of the gain in producer surplus is a transfer *not* to sugar producers but to HFCS producers.

The transfer to domestic sugar producers is only about 1 billion, roughly 20 percent of the loss in consumer surplus.

### 3 Some summary points

#### 3.1 Consider

- At the time the case was written, there were 8,360 sugar farms in the U.S. So this is implicitly a subsidy of

$$(1 \text{ billion})/8,360 = \$120,000 \text{ per farm.}$$

- Also consider that 1,400 farms account for about 50% of all production.

$$(1 \text{ billion} \times 0.5)/1400 = \$357,000 \text{ subsidy per farm for these farms.}$$

- If we counted the loss to consumers per farm, it would be more than twice as large.
- What would be the reaction of farmers if we proposed to open the U.S. to world sugar prices and gave a cash payment of \$120,000 per (former) sugar farm per year?
- How would the High Fructose Corn Syrup producers (e.g., Archer Daniels Midland) feel about this?

#### 3.2 What about Michael Warner of the American Sugarbeet Growers Association?

“In spite of all of the distortions, US sugar farmers are competitive... In my home, the Red River Valley of North Dakota, an independent study by North Dakota State University showed that the sugar industry had an economic impact of one billion dollars. Thirty thousand jobs in that valley rely on the sugar industry... In the debate over price, these folks suggest that I take a reduction of six cents per pound in the loan rate. What does that do? For the American sugarbeet industry it means about a \$300 per acre loss and the end of the domestic industry.” (quoting Michael Warner).

- He points out the \$300 per pound loss in domestic sugar production in North Dakota over  $\frac{1}{4}$  million acres? Is this loss  $\$300 \cdot 250,000$ ? [Depends on the opportunity cost of the land.]
- What about the 30,000 sugar beet farming jobs in North Dakota that Warner stresses? What are the economic losses if these workers are not needed for sugar production? Are they  $30,000 \times \text{Annual Earnings}$ ?
- Is it significant that Mr. Warner counts *both* the loss in crop production of \$300/acre and the loss of jobs of 30,000 workers as costs of eliminating the program?
  - This is clearly double-counting.
  - The workers should be viewed as costs to sugar producers and their wages should be subtracted from the crop production per acre – along with all other variable costs and the opportunity cost of the land – to get a measure of the potential surplus generated by using this land for sugar production.
  - Stated differently, farmers would be delighted to fire all of their workers if they could still get \$300 per acre in direct subsidies. So clearly you can't count both the sugar income and the expense of employing the workers as social benefits.

### 3.3 Further reading:

- Official U.S. government information on the U.S. Sugar Import Program  
<http://www.fas.usda.gov/itp/imports/ussugar.asp>.
- Fascinating book about the Archer Daniels Midland corporation, one of the primary beneficiaries of the U.S. Sugar Program: *The Informant: A True Story*, by New York Times reporter Kurt Eichenwald

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