Lecture Note 8, Part 2: Applying Consumer Theory to Competitive Markets – The United States Sugar Program

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2.2 Estimating consumer demand

We are given the following two pieces of information:

1. The elasticity of market demand for nutritive sweeteners is estimated at $\eta = -0.30$
2. The domestic demand for nutritive sweeteners is 29 billion pounds at \$0.22 per pound.

This is enough information to proceed. To construct the demand curve, we will use the functional form

$$Q(P) = KP^{\eta}$$

Why this functional form? This functional form has constant elasticity (equal to η). Using the definition of an elasticity,

$$\eta = \frac{\partial Q}{\partial P} \cdot \frac{P}{Q},$$

consider the demand elasticity implied by the functional form above:

$$\begin{aligned} \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} &= \eta K P^{\eta-1} \times \frac{P}{KP^{\eta}} \\ &= \eta. \end{aligned}$$

Thus, a demand curve with the functional form $Q(P) = KP^{\eta}$ has a demand of elasticity η.[1]

Plugging in the values supplied above ($Q(22) = 29$, $\eta = -0.30$), we calculate:

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

Using this demand curve, we can calculate the quantity that would be demanded domestically if the U.S. faced the world sugar price:

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

[1] Another way to see this:

$$\begin{aligned} \ln Q(P) &= \ln K + \eta \ln P, \\ \frac{\partial \ln Q}{\partial \ln P} &= \eta \end{aligned}$$

- Parenthetically, it's also interesting to calculate what would consumers be willing to pay if total sugar supply was reduced to 3.8 billion pounds (the import quota only):

$$\begin{aligned} 3.8 &= 73.3P^{-0.30} \\ P &= (73.3/3.8)^{1/0.3} \\ P &= 19,249 = \$192.49/\text{lb} \end{aligned}$$

  In words, the price of sugar would potentially rise to almost $200 per pound if quantities were severely limited. This is high, but it does not strike me as unrealistic. Sugar is inexpensive because it's abundant, not because consumers don't have a strong preference for it. Of course, this calculation is a substantial extrapolation from values that have been observed in the U.S. We're putting a lot of faith in our functional form in making this calculation.

2.3 Estimating the supply curve

As detailed in the reading, there are three main sources of "nutritive sweeteners" to the U.S. market:[2]

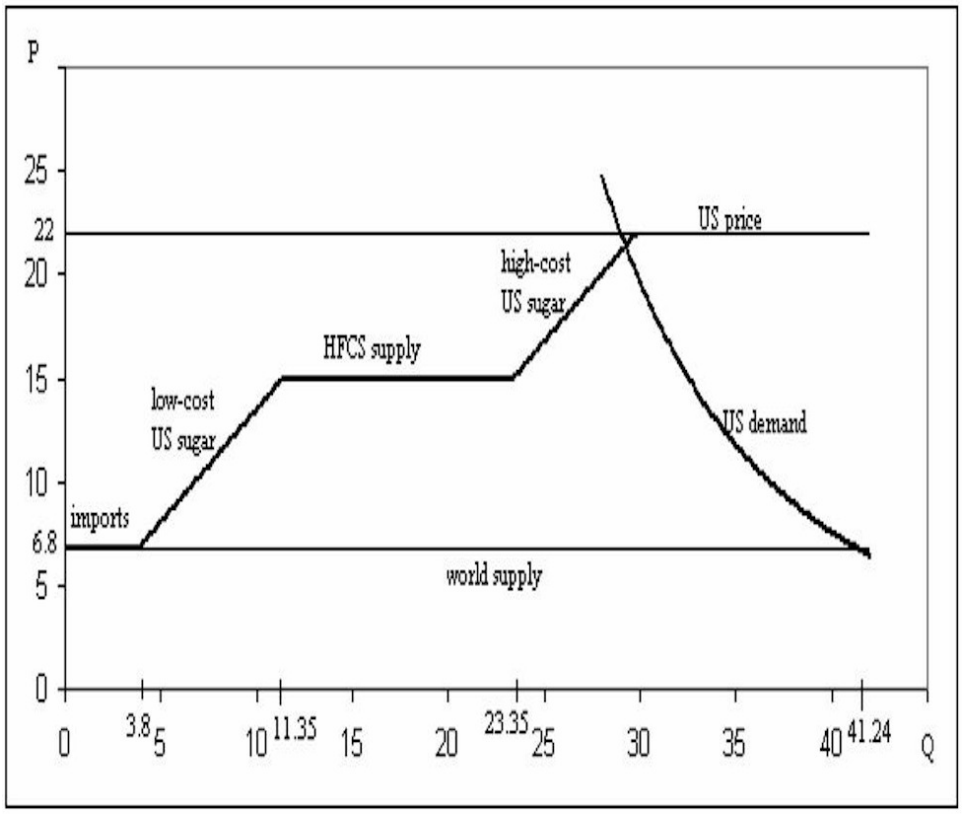
1. World sugar supply:
   - Price: perfectly elastic at price $0.068 per pound
   - Quantity: capped at 3.8 billions pounds
2. U.S. sugar producers:
   - Upward sloping from $0.068 per pound at 1 pound to $0.22 at 13.2 billion pounds.
   - So $P_{domestic} = 0.068 + 0.0115 \cdot Q$, where Q is billion 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]Here's how the US Department of Agriculture defines nutritive sweeteners: "Nutritive and nonnutritive sweeteners enhance the flavor and/or texture of food. Nutritive sweeteners provide the body with calories, while nonnutritive sweeteners are very low in calories or contain no calories at all. They can both be added to food and beverages." Thus, ironically, Nutrasweet is not a nutritive sweetener.

- [Some background on HFCS: HFCS is a perfect substitute for sugar in liquid uses, primarily sweetening soft drinks, but is unusable in applications that require heat (like baking). The technology of HFCS production was perfected in the 1970s, but until the high sugar prices of 1973-74, it was little used. By the mid 1980s, HFCS had all but replaced sugar in its liquid uses, and by 1993, it accounted for 55 percent of total caloric sweetener consumption in the United States.]

We can use this information to construct a supply curve, as you will see in class.

3 Accounting



3.1 Gains in producer surplus?

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

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

This amount is a 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. (What are the politics that makes this large transfer feasible?)

– U.S. sugar producers

$$\begin{aligned} \text{Production Costs } 13.2 \times (6.8 + 0.5\,(22 - 6.8))\,/100 &= \$1.9 \text{ billion} \\ \text{Revenue } 13.2(22)/100 &= \$2.9 \text{ billion} \\ \text{Gain in Producer surplus} &= \$1.0 \text{ billion} \end{aligned}$$

– HFCS producers

$$\begin{aligned} \text{Production costs } 12(15)/100 &= \$1.8 \text{ billion} \\ \text{Revenue } 12(22)/100 &= \$2.64 \text{ billion} \\ \text{Gain in producer surplus} &= \$0.84 \text{ billion} \end{aligned}$$

3.2 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 programmatic imposition of a price of \$0.22 per pound is:

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

- 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 $(\$0.22 - \$.068) \times 29$ billion $= \$4.4$ billion. Note, however, that some of these transfers are squandered on excess production costs. So, part of this transfer is absorbed by the DWL of artificially high producer costs.
2. The second loss comes from foregone consumption. In the absence of the sugar program, consumers would consume 41.2 billion pounds of sugar. At the price of \$0.22, they consume only 29 billion pounds. This is a pure DWL, and its area is $\$5.1 - \$4.4 = 0.70$ billion.

- If you had instead 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 29 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:

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

and the production costs are

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

So the DWL is:

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

3.3 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.

4 Some Summary Points

4.1 How large is the subsidy to sugarbeet growers?

- 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.

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

- 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?

4.2 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 $\$300 \cdot 250,000$?
- 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 $30,000\times$ Annual Earnings?
- Is it legitimate that Mr. Warner counts *both* the loss in crop production of $300/acre *and* the loss of $30,000$ jobs as costs of eliminating the program?

4.3 Further reading

- Official U.S. government information on the U.S. Sugar Import Program
  https://www.fas.usda.gov/programs/sugar-import-program
- 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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