ECON 110, Professor Hogendorn

Problem Set 4

1. *ChinaAutoPartsTariff.* Suppose China charges a 25% tariff on imported auto parts.

   Total Chinese imports of auto parts are $5 billion per year. Let the world price of auto parts be $1, and let China's domestic demand curve be $Q(p) = 40.25 - 17p$ (where we measure quantity in billions).

   (a) Draw the effect of the tariff on a graph of the Chinese auto parts market. Show what deadweight losses China causes itself. In words, how do you interpret the deadweight losses?

   (b) Assume that current imports into China of auto parts are 5 billion units. What must be the quantity supplied by Chinese producers?

   (c) Suppose that Chinese auto parts suppliers have a supply elasticity of $\epsilon = 1.2$ and a linear supply curve. What is the change in Chinese producer surplus that results from the tariff?

2. *MexicanFarmers.*

   (a) Suppose that U.S. farmers are willing to supply any amount of corn at $2 per bushel. (Let this be the "world price" of corn.) Suppose that Mexican farmers have supply curve $S(p) = -10 + 10p$. Let Mexican demand for corn be $Q(p) = 50 - 5p$. How many bushels do Mexican farmers produce? How many do Mexican consumers buy? How large are imports from the U.S.?

   (b) Draw a graph of (a).

(c) The North American Free Trade Agreement (NAFTA) allows Mexico to impose a tariff of about 70% on corn imports from the U.S. With the tariff, how much corn do Mexican farmers produce, and how much is imported?

(d) Draw the tariff on your graph, and label the changes in producer and consumer surplus, the tariff revenue, and the deadweight losses.

(e) If the goal is to help Mexican farmers, would the tariff work better if their supply were more elastic? Would the tariff then be better or worse for Mexicans as a whole? (Hint, use your graph and change the slope of the supply curve so that the same tariff causes a larger % increase in supply.)

3. *Lawns.* Grass lawns create a variety of negative externalities, including air and noise pollution from mowing, herbicide and pesticide pollution, water scarcity from irrigation, and destruction of woody plants and shrubs that provide better wildlife habitat and carbon sequestration. The average American household spends around $1200 per year on lawn care (obviously this varies enormously by household, but that's the average). Again using an average, there is about 1/3 acre of lawn per household (lawns are America's biggest and most polluting agricultural "crop").

   (a) Use the data point of price equals $1.2 thousands and quantity equals 0.33, and suppose that the (private) price elasticity of demand for lawn is $|\epsilon| = 1.5$. What is a back-of-the-envelope linear demand curve for lawns? (Let $p = 1.2$, this problem is easier in thousands.)

   (b) Let the supply curve for lawns (really for lawn care products and services) be $S(p) = 0.25 + 0.067p$. What is the equilibrium price, quantity, consumer, and producer surplus from lawns?

(c) Suppose that the negative externalities from lawn *consumption* add up to $400 per acre. What is the social demand curve $Q_s(p)$?

(d) What is the social equilibrium? How much deadweight loss is there? Calculate numerically and show on a graph.

(e) If the government administered a Pigouvian tax by making each household pay $400 per acre of lawn, how much tax revenue would be generated? Calculate numerically and show on a graph.

4. *CoalNaturalGas.* There are two local electricity markets, one called Amherst which uses coal and one called Middletown which uses natural gas.

   Both markets face the same demand curve, which is perfectly elastic at a price of $90 per MWh (megawatt-hour).

   Amherst has an upward-sloping marginal private cost curve given by $MPC(Q) = 10 + 0.1Q$.

   Middletown has an upward-sloping marginal private cost curve of $MPC(Q) = 25 + 0.1Q$.

   (a) Draw two supply-and-demand diagrams for the two markets.

   (b) In Middletown, there are $25 in external costs per MWh due to carbon dioxide (global warming) emissions. Find Middletown's marginal social cost curve and its socially optimal amount of production.

   (c) In Amherst there are $50 in external costs per MWh due to carbon dioxide (global warming) emissions. Use the difference in externalities and costs to show graphically whether Amherst's socially optimal production is larger or smaller than Middletown's.

(d) Suppose the government levied a tax of $50 per MWh on the electricity production in *both* markets. Would this be socially optimal in these two markets? Would it create or remove deadweight loss? Illustrate your answer on two diagrams.

Review Problems only, not to turn in:

5. *Tariff.* Let domestic demand be $q(p) = 60 - 2p$ and supply is $s(p) = p$. Let the world price be 10.

   (a) Under free trade, what is the quantity imported and what is domestic consumer and producer surplus?

   (b) If the government imposes a tariff of $5 per unit imported, how much revenue is generated, and what are the new domestic consumer and producer surpluses? How big is the deadweight loss?

6. *Sugar.* Read the following beginning to an article:

   Michael Schroeder, "Sugar Growers Hold Up Push For Free Trade," *The Wall Street Journal,* February 3, 2004, pg. A13.

   WASHINGTON – The sugar industry – which accounts for less than 1% of all U.S. farm sales but 17% of agriculture's political contributions since 1990 – is proving to be an obstacle to Bush administration efforts to keep the free-trade ball rolling.

   The industry not only is the sticking point in the administration's plans to get congressional backing for a free-trade pact with Central America, but also is gumming up talks toward a free-trade pact with Australia.

   Australia, the world's fourth-largest sugar exporter, wants to sell more sugar to the U.S. in exchange for lowering the tariffs it levies on U.S.-made goods. Australia currently sells the U.S. 87,000 metric tons of sugar a year, less than 1% of the 10 million tons of sugar

consumed in the U.S. Caps on sugar imports long have kept the U.S. price of refined sugar at twice the world market price.

(a) Assume that all U.S. imports of sugar come from Australia for the purposes of this problem, and assume that sugar is subject to a *tariff*. Draw a supply and demand diagram of the U.S. market for sugar, showing the tariff and the amount of imports and sugar consumed. You don't have to draw the diagram perfectly to scale, but try to capture all of the information in the final paragraph above.

(b) Label the effects of the tariff, showing changes in producer and consumer surplus, deadweight losses, etc. With reference to these effects, describe why the sugar industry works hard to maintain the trade barrier and why the government, on behalf of the country in general, is working to end it.

7. *Fatburgers*. There are 400 fatburger consumers and 100 fatburger producers. The price of a fatburger, p, is measured in cents. Each of the 400 consumers has demand curve

$$Q_i(p) = 100 - \frac{p}{4}$$

Each producer has supply curve

$$S_i(p) = 4(p-5)$$

(a) Determine the market supply and demand, find the equilibrium price, and draw on a graph.

(b) The government imposes a per-unit sales tax of t cents per fatburger. Find the new equilibrium price and quantity as a function of t.

(c) Show that the government achieves the maximum possible tax revenue when it sets $t = 197.5$ cents. You will need to find

and maximize the government's revenue as a function of t. Remember that to maximize a function, you look for where the derivative equals 0.

(d) How much does the tax in part (c) reduce consumer surplus and producer surplus, and how much deadweight loss does it cause? Show on a graph as well as giving numerical results.

(e) You have just learned that when people eat fatburgers, it causes significant long-term health problems. Much of the cost of these health problems is paid for by the government rather than the individuals. In fact, careful analysis suggests that the government ends up paying $1.975 in health costs for every fatburger eaten. Show how this information changes the graphical analysis of part (d). (Numerical results are not necessary.)

8. *SiliconValley.* In Silicon Valley, there are many information technology (IT) firms clustered in one place. This is usually attributed to positive externalities in production: when firm produces a product, the skilled workers can exchange ideas with one another, with venture capitalists, and so on. Thus, firms in Silicon Valley are more productive than similar firms elsewhere.

(a) Graph the supply and demand curves for one IT good (e.g. web servers) in Silicon Valley. Show the positive externality in production.

(b) Label the graph to show the external benefits and the deadweight loss in both the free-market and the socially optimal situations.

(c) If the California government were to intervene in this market, what should it do?

Answers to Review Problems:

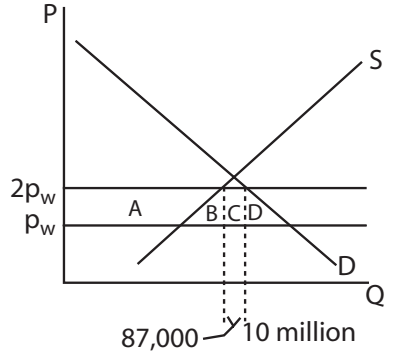
5. *Tariff_a.*

   (a) $q(10) = 60 - 2 \cdot 10 = 40$ and $s(10) = 10$, so imports are 30. The choke price is 30, so consumer surplus is $\frac{1}{2}(30-10)40 = 400$. Domestic producer surplus is $\frac{1}{2}10 \cdot 10 = 50$. Total surplus is 450.

   (b) The price with the tariff is 15, so $q(15) = 60 - 2 \cdot 15 = 30$ and $s(15) = 15$. Imports fall to 15 units, and government revenue is $15 \cdot 5 = 75$. The new consumer surplus is $\frac{1}{2}(30-15)30 = 225$ and the new domestic producer surplus is $\frac{1}{2}15 \cdot 15 = 112.5$. The total surplus is 412.5, so the deadweight loss is 37.5.

6. *Sugar_a.*

   (a)

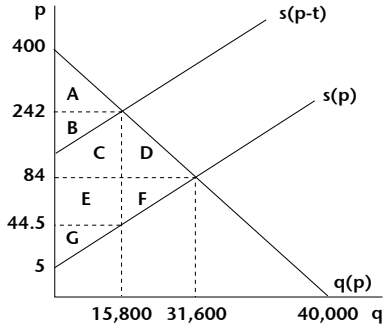


   (b) The effect of the tariff is to reduce consumer surplus by $A + B + C + D$. A is an increase in producer surplus, C is the tariff revenue, and B and D are deadweight losses. The sugar industry gains a great deal from the tariff, since A is quite large, but for the country as a whole the tariff is bad. True, A and C are just transfers between the government's various constituents, but B and D are lost entirely to the U.S. economy. The country as a whole is better off with no tariff.

7. *Fatburgers_a.*

(a) Market demand: $Q(p) = 400q_i(p) = 40,000 - 100p$. Market supply: $S(p) = 100s_i(p) = 400(p-5)$.

$$\begin{aligned} 40,000 - 100p &= 400(p-5) \\ 42,000 &= 500p \\ p &= 84 \\ q(84) &= 31,600 \end{aligned}$$



(b) This is a sales tax, so it is paid by producers and thus shifts the supply curve to $S(p-t)$ in the diagram. The new equilibrium price and quantity is found as follows:

$$\begin{aligned} 40,000 - 100p &= 400(p-t-5) \\ 42,000 &= 500p - 400t \\ p(t) &= 84 + \frac{4}{5}t \\ Q(p(t)) &= 31,600 - 80t \end{aligned}$$

(c) The government's revenue function is $R(t) = tQ(p(t)) = 31,600t - 80t^2$. We can maximize this function by taking the derivative and setting equal to 0:

$$\frac{dR(t)}{dt} = 31,600 - 160t = 0 \Rightarrow t^* = 197.5$$

(d) First, using the formulas from (b) we can find that $p(197.5) = 242$ and $q(p(197.5)) = 15,800$. Then in the graph, we have the

following:

$\Delta CS = -B - C - D$

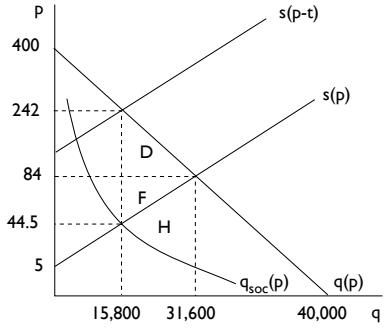
$= -(242-84)15,800 - \frac{1}{2}(242-84)(31,600-15,800) = -3,744,600.$

$\Delta PS = -E - F$

$= -(84-44.5)15,800 - \frac{1}{2}(84-44.5)(31,600-15,800) = -936,150$

$DWL = D + F = \frac{1}{2}(242-44.5)(31,600-15,800) = 1,560,250$

(e) This is a very tricky question! There is actually a negative externality in *consumption* of fatburgers. That means that the social benefit is less than the demand curve. But we don't actually know anything about the shape of the Q_{soc} curve, perhaps it is some nonlinear curve like in the diagram below. All that we know is that at the $Q = 15,800$ point, the negative externality is exactly equal to the sales tax.

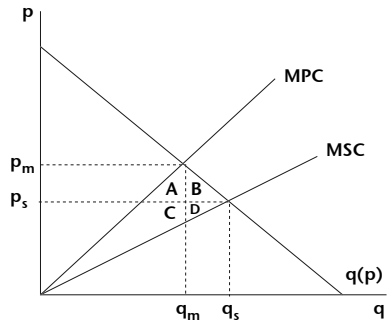


Without the tax, there would be a deadweight loss of area H. There would be too much consumption, and the costs $S(p)$ would exceed the benefits Q_{soc}.

The sales tax corrects for the externality perfectly at the $Q = 15,800$ point. It is not a true Pigouvian tax in the sense that if there were any shifts in the supply curve, it would no longer be optimal. But the supposed deadweight loss of $D + F$ that we found in part (d) turns out not to be a deadweight loss at all. Instead, it turns out that it was private consumer and and producer surplus that was exactly offset by the negative health externality.

8. *SiliconValley_a.*

(a)



(b) Free market: External benefits = $A+C$, Deadweight loss = $B+D$

Social optimum: External benefits = $A+B+C+D$

(c) It could provide a subsidy so that the price of web servers fell to p_s in the graph. This would increase quantity demanded to q_s and correct for the externality.