How to Quantify Market Distortions: Some Examples

1 Introduction
This handout will use both equations and graphs to work through three examples of market distortions in order to clarify how you can think about their effects. The first example deals with price supports, the second with price ceilings and the third with externalities.

2 Price Floor: Agricultural Price Supports
Suppose that supply and demand curves for corn in the US are:

\[ Q_D = 3750 - 725P \]
\[ Q_s = 920 + 690P \]

where \( Q \) is millions of bushels and \( P \) is the price per bushel. We would like to know the following:

a What are the equilibrium price and quantity that would prevail in the free market?
b If the government institutes a $2.50 per bushel price support, how much corn will it be forced to purchase? (Note that the price support binds the government to purchasing any excess wheat at $2.50 per bushel. Thus, knowing the government will always buy at this price, farmers will not sell it in the open market for any less.)
c How does this policy affect consumer surplus?

To find equilibrium supply and demand, we equate \( Q_s \) and \( Q_d \) to solve for \( P \) and then recover the optimal quantities:

\[ 3750 - 725P = 920 + 690P \]
\[ 1415P = 2830 \]
\[ P = 2 \]
\[ Q_s \cdot Q_d = 2300 \]

To determine how much the government will purchase at $2.50 we need to calculate excess supply at that price. Thus government’s purchase, \( Q_g \), can be found by subtracting demand from supply at \( P=2.50 \):

\[ Q_g = Q_s - Q_d \]
\[ Q_g = (920 + 690P) - (3750 - 725P) \]
\[ Q_g = 1415P - 2830 \]
\[ if \ P = 2.50 \Rightarrow Q_g = 707.50 \ and \ Q_d = 1937.50 \]

To figure out the change in consumer surplus we need to calculate it both before and after the price support. Before the support is implemented consumer surplus the area under the demand curve and above the equilibrium price, denoted by \( A, B \) and \( D \) in the following graph:
In order to calculate the area of this triangle, we first need to determine the demand curve’s price intercept by solving for $Q_D$ in terms of $P$:

$$Q_D = 3750 - 725P$$

$$P = 517 - 0.0014Q_D$$

The intercept is then 5.17, as shown in the graph. Pre-price support consumer surplus is then just one half the base times the height of triangle $A+B+C$ or:

$$CS_{Pre-Support} = \frac{1}{2}(517 - 2.00)(2300 - 0) = 364550$$

Under the price support, consumer surplus reduces to $A$ and can be calculated as follows:

$$CS_{Post-Support} = \frac{1}{2}(517 - 2.50)(1937.5 - 0) = 2586.56$$

Thus, under the price supports consumers lose $1058.94.

As a test of your understanding, see if you can answer the following questions:

a. What is the change in producer surplus?

b. How does a price support differ from a minimum wage? Would workers be better off with labor price supports?

c. Given the distortion introduced by price supports and minimum wage laws, is the enactment of them by governments irrational?
3 Price Ceiling: Holding Down Local Phone Rates
Suppose the California Public Utilities Commission (PUC) is currently examining excessive peak local cell telephone rates in Los Angeles. The commission has been asked to evaluate a proposal by Ralph Nader to place a $0.10 per minute price ceiling on such rates. Using her well-honed UCLA skills, an MBA at the commission estimates that the demand and supply curves for cellular service are:

\[ Q_D = 1600 - 2400P \]
\[ Q_S = 200 + 3200P \]

where \( P \) is the price per minute of a local cellular call and \( Q \) is millions of minutes per month. We would like to know the following:

a. What are the equilibrium price and quantity that would prevail in the free market?
b. What quantity of minutes will the cellular companies make available under the price ceiling?
c. What will be the likely impact of the ceiling if the PUC imposes a requirement that the cellular companies must maintain the same capacity going forward which exists at the time of the law’s passage? (That is, the PUC realizes that the cellular companies have an incentive under the new law to curtail service in response to the ceiling by limiting the number of cellular telephones available. It imposes the requirement to prevent this.)

To find equilibrium supply and demand, we equate \( Q_S \) and \( Q_D \) to solve for \( P \) and then recover the optimal quantities:

\[ 1600 - 2400P = 200 + 3200P \]
\[ 5600P = 1400 \]
\[ P = 0.25 \]
\[ Q_S \cdot Q_D = 1000 \]

Not surprisingly, at a price ceiling of $0.10, there will be excess demand because:

\[ Q_D = 1600 - 2400(0.10) \]
\[ Q_D = 1360 \]
\[ Q_S = 200 + 3200(0.10) \]
\[ Q_S = 520 \]

Thus, there will be a shortage of 840 million minutes. If the council requires that the cell companies maintain a given number of phones, it is likely that they will try to offset the costs of complying with this requirement by lowering service quality. For example, the quality of existing infrastructure may decline and new signal-enhancing technologies might not be implemented. (Do you see a parallel with rent control? Does this have a marginal analysis interpretation?)

The effects of this policy can be seen in the following graph:
Here, consumer surplus increases from $A+D$ to $A+B$, while producer surplus decreases from $B+C+E$ to $C$. Is this the same result as in the rent control case? What is the economic intuition behind these changes?

As a test of your understanding, can you calculate the changes in producer and consumer surplus caused by the ceiling?

4 Externalities: Pollution at the Paper Mill

Suppose the demand for paper in a particular region served by only one company is:

$$ P = 80 - 0.0005Q_D, $$

where $Q$ is measured in hundred-pound lots and $P$ is price per lot. Further suppose that the firm’s marginal cost function (which equals the supply curve since it is the only producer), is:

$$ P = 20 + 0.0005Q_S. $$

Since there is currently no regulation regarding the dumping of effluent into streams and rivers, such dumping has become a widespread practice in each of the firms’ mills. A local environmental group, however, has estimated the marginal environmental cost associated with paper production to be:

$$ MEC=0.0002Q. $$

We would like to know the following:

- What are the equilibrium price and quantity of paper production assuming that no attempt is made to monitor or regulate the dumping of effluent?
b What are the socially optimal price and output? Why do they differ from the levels in part a? Can the government impose a policy that would bring about the social optimum? What are the difficulties of this approach?
c Sketch a diagram to show the cost to society of allowing the market to act unregulated.

To find the private (antisocial?) equilibrium, we need to equate supply and demand. As a simplification, assume that this is equivalent to setting price (not marginal revenue) equal to marginal cost for the firm. Then, since $Q_s = Q_d = Q$ in equilibrium, we have:

\[ \text{Demand} = \text{Supply} \]
\[ P = MC \]
\[ P_d = P_s \]
\[ 80 - 0.0005Q = 20 + 0.0005Q \]
\[ 0.001Q = 60 \]
\[ Q = 60,000 \]
\[ P = 50 \]

In the socially optimal equilibrium, however, the firm needs to take the cost of its pollution into account. Thus, rather than equating price and marginal cost, as above, the firm needs to equate price with marginal social cost ($MSC$), where $MSC$ is the sum of $MC$ and $MEC$. Thus:

\[ P = MSC \]
\[ P_d = MC + MEC \]
\[ 80 - 0.0005Q = (20 + 0.0005Q) + 0.0002Q \]
\[ 0.0012Q = 60 \]
\[ Q = 50,000 \]
\[ P = 55 \]

Note that the socially optimal paper production is lower than the “antisocial” equilibrium. This difference is due to the firm’s internalization of the costs of pollution. Since the firm is unlikely to impose these costs on itself (why?), one way in which the government can impose them is to make the firm pay a pollution tax on output at the rate of $0.0002 per lot. Such solutions are difficult to implement in the real world, however, because of the difficulty in determining how much damage is actually caused by pollution. Can you think of another policy that might work?

The effects of this internalization can be seen in the following diagram:
By imposing the tax, the government prevents society from incurring $A$, which is the social cost of producing 60,000 rather than 50,000 hundred-pound lots. As shown in the diagram, this cost is not recognized by the firm because it is above the firm’s marginal cost curve.

As a test of your understanding, can you think of a positive externality that would have the opposite effect as pollution? How about an externality that operates between two firms?