

Joules to Dollars – Economics: Terms, Tools & Techniques

II. Tools – discounting and net present value

Dynamic analysis – remember, economists tend to be forward-looking with regard to the behavior of firms and individuals

Q: Which is worth more: \$100 today or \$100 tomorrow? Why?

A: \$100 today

- Inflation erodes the purchasing power of money
- Plus, \$100 today represents an opportunity to ‘invest’ ...
- ... earning a rate of return [e.g., interest on savings] ...
- ... and thus increasing your purchasing power in the future

Present Value

- Suppose you put your \$100 in a bank account earning 10% interest annually
- One year from now you’d have \$110 in your account: $100 \times (1 + .10)$
- The **value today** of the \$110 you’d realize a year from now is \$100 [$110 / (1.10)$]
- Suppose you left the money in your bank account for two years, earning 10% interest in each year
- After two years you would have \$121 [$100 \times 1.10 \times 1.10$]
- The **present value** of the \$121 you’d realize in two years is \$100 [$121 / (1.10)^2$]

Net Present Value

- The present value of a one-time net benefit received n years from now is:

$$PV[NB_n] = \frac{NB_n}{(1 + r)^n}$$

- The present value of a stream of net benefits $\{NB_0, NB_1, \dots, NB_n\}$ is:

$$PV[NB_0, \dots, NB_n] = \sum_{i=0}^n \frac{NB_i}{(1 + r)^i}$$

- Where r is the appropriate interest rate

Discounting the Future

- The process of calculating the present value of a future [net] benefit is also known as discounting
- In this context, r is the discount rate
- What about inflation?
- r is the real interest rate: nominal minus inflation

Handout: Colby’s Biomass Facility

III. Techniques – market equilibrium

Analysis of Costs and Benefits

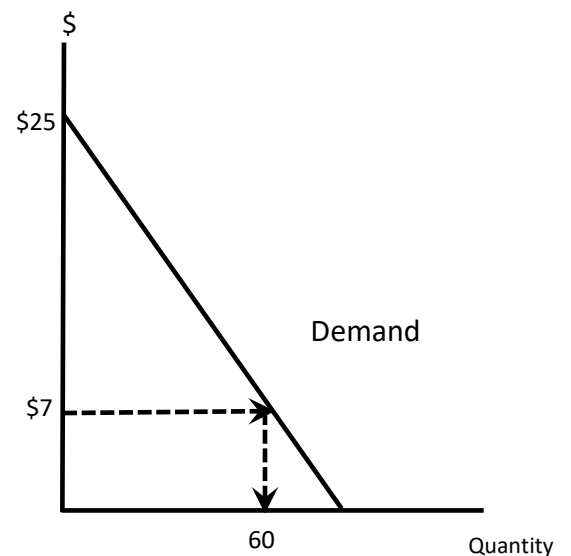
Fuel Price (in dollars)	Fuel Price (dollars per million Btu)
Cord Wood (\$250/cord)	\$11.36
Wood Pellets (\$260/ton)	\$15.64
Natural Gas (\$1.69/therm)	\$16.92
Heating Oil (\$2.94/gallon)	\$21.20
Kerosene (\$3.54/gallon)	\$26.22
Propane (\$2.81/gallon)	\$30.77
Electricity (baseboard) (15-18 cents/kwh)	\$43.94-\$52.75

Governor's Energy Office estimate of current prices

http://www.maine.gov/energy/fuel_prices/index.shtml

Consider the market for wood pellets – equilibrium price is \$15.64/40lb bag (60 bags per pallet; 1.2 tons)

- Assume a linear world
- Typically, people will purchase less of a good or service (including ecosystem services) the higher the price
- Suppose @ \$7/bag you'd buy 60 bags
- But if the price is \$25/bag you wouldn't buy any
- Economists typically use your total willingness to pay to define total benefits
- We add up the amount you're willing to pay for the first, second, ..., fiftieth and sixtieth bags of pellets
- We calculate the area under the demand curve as the total benefit



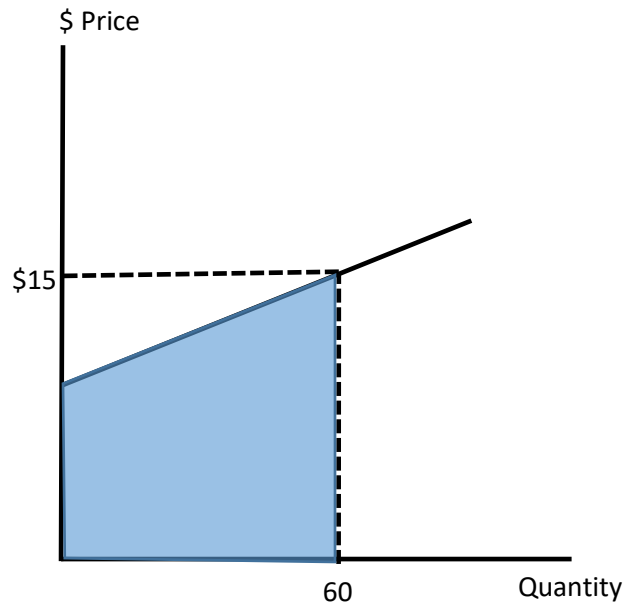
$$\left(\frac{1}{2} \times 60 \times 18\right) + (7 \times 60) = \$960$$

Market Demand

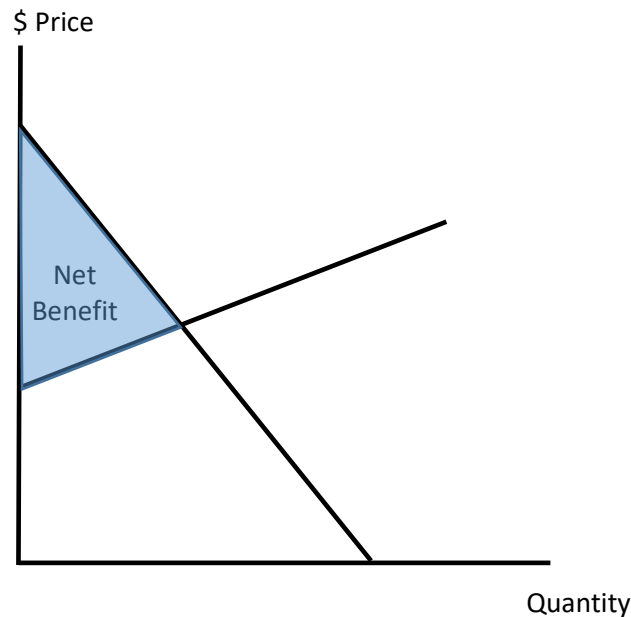
- Market demand curves for consumer goods and services are simply the sum of individual demand curves
- Note that while our theory tells us that demand depends on price: $Q = f(P)$
- We graph the *inverse form* of the demand curve: $P = g(Q)$
- We do this because of an assumption that price adjusts in order to equilibrate demand with supply, i.e., price determines quantity

Total Costs

- Suppose the cost of producing a bag of wood pellets looks like this
- In general, *total cost* will be equal to *variable costs* plus *fixed costs*
- Total *variable cost* is the sum of the *marginal costs*
- Let's assume *zero fixed cost*
- So *total cost* will be the sum of the *marginal costs*



- Net Benefit is the amount by which benefits exceed costs
- The area under the demand curve that lies above the cost (supply) curve

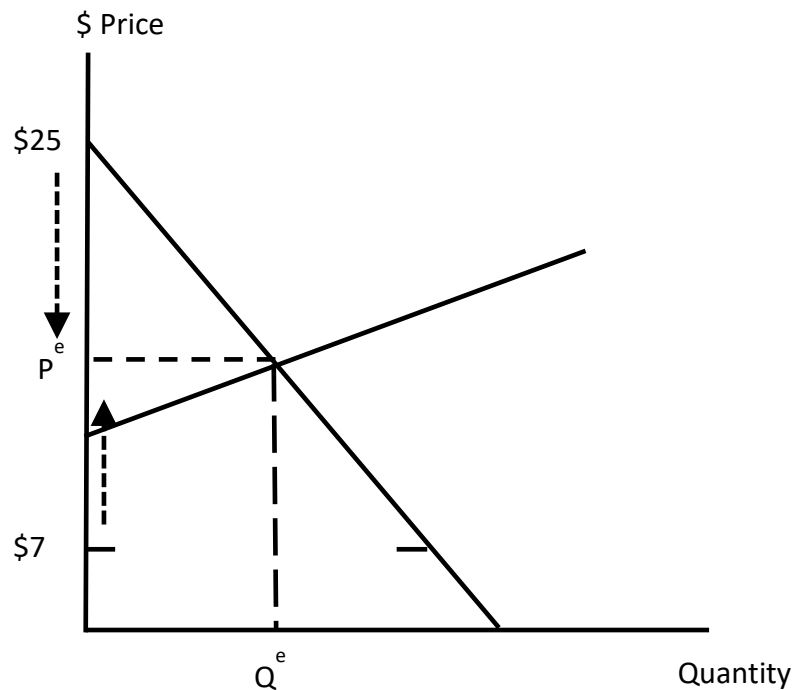


Equilibrium

- Competitive markets
- Price adjusts to bring about a situation in which the quantity demanded equals the quantity supplied
- If the price is too low, we have excess demand
- If the price is too high, we have excess supply

Static equilibrium

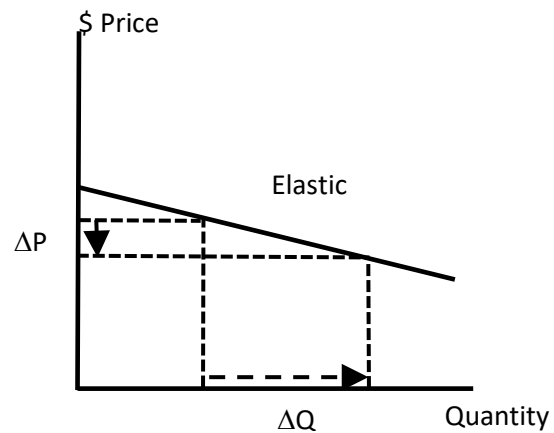
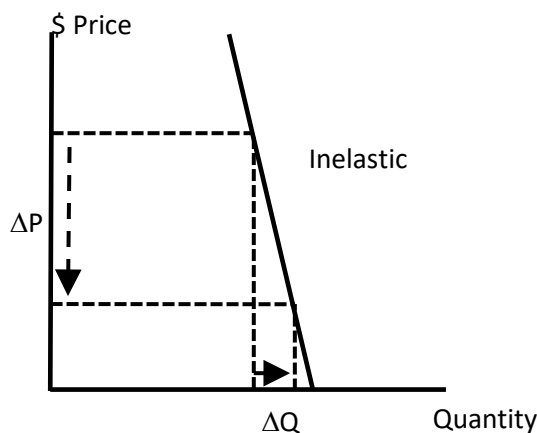
- Notice that no one is willing to supply pellets at \$7 per bag
- At \$7/bag there exists excess demand
- In most situations this will cause an increase in the price of pellets
- Similarly, at \$25/bag there is an excess supply of pellets
- In most situations this will cause a decrease in the price of pellets
- Price will adjust to resolve excess demand and supply



Elasticity

- We measure the responsiveness of demand to changes in price using the elasticity
- We say that a good is inelastic if a change in price has very little effect on demand
- Elastic goods and services are those for which small changes in price have a large impact on the quantity demanded – quantity demanded changes more than the price does (greater than 1.0)
- Unitary elasticity – equi-proportional responses

$$\eta = \frac{\% \Delta Q}{\% \Delta P}$$

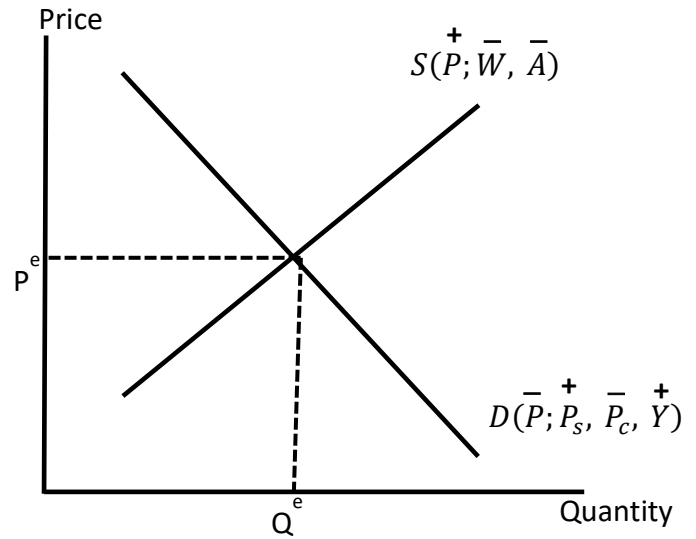


Demand function - determinants

- Price of the good or service
- Price of substitutes & compliments
- Income
- Preferences (stochastic term)

Supply side

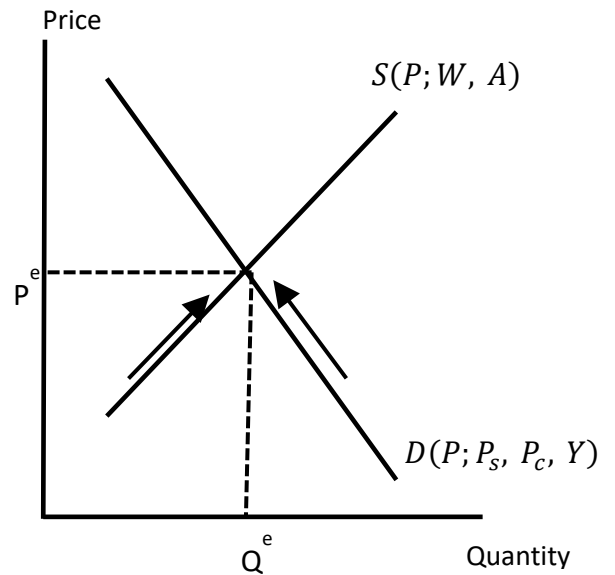
- Price of the good or service
- Factor prices (wages, energy costs)
- Advertising/Marketing
- Unanticipated events (stochastic term)



Key concept

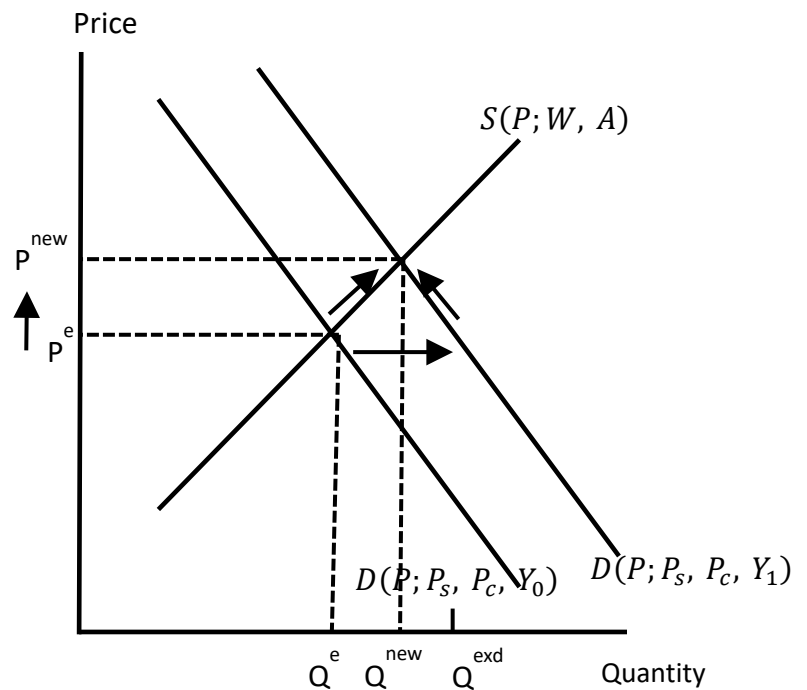
Moving along a curve versus shifts in a curve

- Changes in the quantity demanded of a good or service that result from a change in its price are reflected by re-equilibrating movements along a demand curve
- Similarly, changes in the quantity supplied resulting from changes in the price of a good or service are reflected by movements along the supply curve



Comparative Statics – shifts in the curves

- Change an exogenous variable and see what happens to equilibrium values of our endogenous variables
- Changes in factors determined outside our model will redefine the (P, Q) relationship resulting in a new demand or supply curve
- We draw our demand/supply relationships for pre-determined values of our explanatory variables
- Consider a *ceteris paribus* increase in income from Y_0 to Y_1 – demand curve shifts outward
- At the prevailing price, P^e , there exists excess demand for this good
- This will put upward pressure on the price
- Higher prices attracts more supply – move upward along the supply curve
- And reduces demand – move upward along the new demand curve
- The price will continue to rise until the excess demand is gone and the market reaches a new equilibrium



Algebraic derivation of equilibrium and using calculus to derive the comparative statics solutions

Ecological Economic System Model (handout)