Supply and Demand

Demand: how much consumers will buy at a particular price; describes consumers' willingness to pay (WTP). $\boxed{Q_d = a - b \cdot P}$

Supply: how much producers will provide at a particular price; describes producers' willingness to accept (WTA) / the industry's aggregate marginal cost curve (i.e. Market supply is the sum of the individual firm supply curves). $\boxed{Q_s = c + d \cdot P}$

Remember to always check whether we need to invert a given function! **Competitive Markets**: Individual firms and consumers don't affect prices (i.e. they have no market power and are price takers)

Competitive Market Equilibrium: $\boxed{Q^* = Q_s(P^*) = Q_d(P^*)}$ In these markets, prices are determined by:

- the **"marginal buyer"** $P^* = WTP$: who would leave the market if the price were any higher, and
- the **"marginal seller"** $P^* = WTA$: who would leave the market if the price were any lower

Producer Surplus (PS): = Revenue - Total WTA = Revenue - Total Variable Cost (area below price and above supply.)

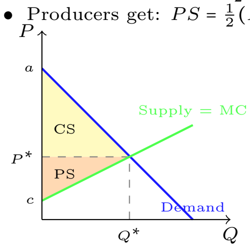
Without market power, firm-level inverse demand curve is perfectly elastic (i.e. horizontal) at the market price. Market sets $\boxed{MR(Q) = P}$. Firm's supply curve is its MC curve. Firm profit **maximized** when: $\boxed{\text{Market } P = MR(Q^*) = MC(Q^*)}$, provided the firm is operating at all. *Not to be confused with the MR discussed in H1 Monopoly Pricing!*

First Welfare Theorem: Competitive markets are **efficient** (i.e. they maximize total surplus = CS + PS).

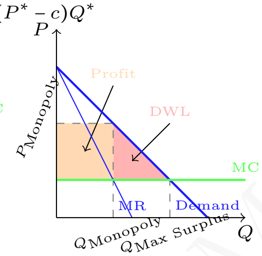
- Assumes no distortions such as market power, info frictions, or *externalities*.
- Under perfect competition, all trades involving consumers who value the good more than the marginal cost associated with producing an additional unit of the good are realized.

Welfare is maximized: by the perfectly competitive outcome when there are not externalities. To maximize total welfare, we want

- Consumers get: $CS = \frac{1}{2}(a - P^*)Q^*$
- Producers get: $PS = \frac{1}{2}(P^* - c)Q^*$



Competitive markets maximize total surplus.



Distortion e.g.: Pricing with market power

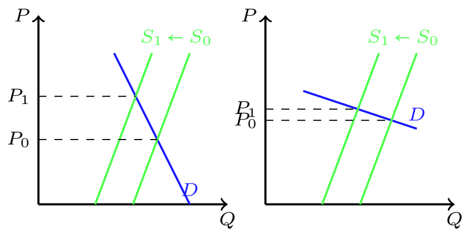
Deadweight Loss (DWL): Lost surplus due to a distortion away from perfect competition.

$\boxed{\text{DWL = CS + PS - TS}}$ i.e. Maximum surplus - Achieved surplus. DWL offers an opportunity to "grow the pie", represents the value proposition for many firms.

In the left graph: DWL will be generated

- if $Q < Q^*$ because there will be consumers that value the product at above the marginal cost
- if $Q > Q^*$ because there will be consumers consuming the product even though their $WTP < MC$

Cost Shock: if one side of the market is highly elastic, then they can avoid shocks (and pass on any taxes / transation fees).

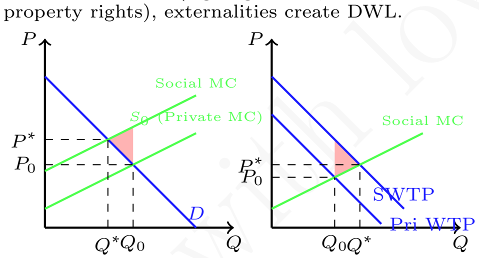


Externalities

Externality: an activity generates it when it imposes a cost or benefit on a third party not involved in the activity. An externality is a **market failure** because the market does not account for the full cost or benefit of the activity – left alone the perfectly competitive market will not maximize welfare.

- **Negative ext.**: costs born by society; e.g. pollution, congestion, noise, contagion. External costs (negative ext.) ⇒ firms produce too much. **Sol.**: tax the product by the externaltiy amount (to shift **up the supply curve**); taxes "internalize" the externality and reduce quantity.
- **Positive ext.**: benefits born by society; e.g. education, vaccines, R&D (ideas). External benefits (positive ext.) ⇒ firms produce too little. **Sol.**: subsidize customers the externaltiy amount (to shift **up the demand curve**)

Without solutions (e.g. regulation, taxes, subsidies, property rights), externalities create DWL.



Tragedy of the Commons: When a resource is held in common, individuals have no incentive to conserve it. This is an example of a negative externality since others' access impairs everyone's use of the resource. Individual will overuse.

Solution: assign property rights, regulate, or tax; joint ventures also allow for collaboration that "internalizes" the externality.

Coase Theorem: If property rights are well-defined and transaction costs are low (or none), the efficient solution occurs regardless of who holds the property rights. Cap and Trade policies set up a market to make this bargaining easier.

Distributional Consequences:

1. the distribution of the burden of the externality,
2. distribution of the costs to correct the externality, and
3. distribution of the burden of externality after policy intervention.

E.g. the R&D market: think of the demand curve originating from the profits that firms here would get from innovating, and thus representing the **private** demand for R&D. The MC curve (supply) represents the private MC of research and development. We will assume that the private MC of R&D equals the social MC. Demand: $Q_{\text{private},d} = 100 - 2P$; supply: $Q_s = \frac{P}{2}$.

1. **Competitive market equilibrium**: $$Q_{\text{private},d} = Q_s \Rightarrow 100 - 2P = \frac{P}{2} \Rightarrow \begin{cases} P^* = 40 \\ Q_s^* = 20 \end{cases}$$
2. **Total amount spent on R&D**: $P^* \cdot Q_s^* = 40 \cdot 20 = 800$
3. Now suppose that not only does the firm paying for the research and development benefit from the R&D, but some of these benefits spillover to other firms. In particular, economists have calculated that every unit of R&D done by a firm benefits other firms by \$30. **What is the society demand for R&D**: Inverse demand curve: $P = 50 - \frac{Q}{2}$. The positive externality implies that the willingness to pay for R&D increases by \$30 everywhere. So the social inverse demand curve (SWTP) is $P = 80 - \frac{Q}{2} \xrightarrow{\text{inverse}} Q_{\text{society},d} = 160 - 2P$
4. **Ways to overcome this positive externality**:
   (a) Implementing patent system to allow the innovating firm to capture more of the benefits of their R&D.
   (b) Subsidizing R&D; esp. for hard, basic science.

Game Theory

Each player's objective is to maximize their payoff, not to beat their opponent.

Situation of strategic interdependence: a firm's best choice depends on what its rivals do and how it expects rivals to react to its actions.

Strategy: a "complete contingent plan" that specifies what a player will do at every possible decision node.

Best response: the strategy with the highest payoff in response to the strategies its rivals can take.

Dominant Strategy: a strategy that is best for a player to follow regardless of the strategies chosen by other players. It's a player's best response to any strategy the other player might choose.

Iterated dominance: sometimes it's possible to narrow things down by eliminating strategies that known never a best choice for rival, and also strategies that are never a best choice for rival if they eliminate the possibility that you will play something that's never a best choice for you ... **E.g.**: guess half of thge median game.

Nash Equilibrium: a set of strategies, one for each player, such that no player has an incentive to change their strategy given what the other players are doing. I.e. each player's strategy is a best response to the strategies chosen by the other players.

Schwab vs E-Trade pricing game:

	Monopoly Price	Lower Price	Lowest Price
Monopoly Price	10, 10	5, 12	0, 9
Lower Price	12, 5	6, 6	2, 8
Lowest Price	9, 0	8, 2	3, 3

- **No dominant strategy** for either firm. All colors would be in one row/column.
- One N.E.: (Lowest Price, Lowest Price). There may be more than one N.E. if both colored!

Bertrand model/trap of price competition: Each firm's best response is to undercut its rival ⇒ N.E. = price = MC (i.e. a price war). **Sol.**: **product differentiation**: when consumers have heterogeneous preferences; can be both horizontal (differentiated by quality; e.g. Coke vs Pepsi) and vertical (differentiated by price; e.g. faster vs slower computers).

Horizontal Differentiation: Linear City/Hotelling Model: Each consumer has a location x and these locations are evenly distributed along a line from 0 to 100. One firm is located at each end of the line, and each firm sells a product that every consumer values at v. (*Note:* We can also allow for vertical differentiation in this model by setting a different v for each firm.)

- Consumers choose where to buy based on price and travel cost; t is the marginal cost of travel.
- To solve this model, we identify the indifferent consumer at location x^*. All consumers with $x \le x^*$ will visit firm 1 (i.e., the firm at location 0) and all consumers with $x \ge x^*$ will visit firm 2 (i.e., the firm at location 100).
  – Consequently, x^* is the *market share* (in percentage terms) for firm 1, and $100 - x^*$ is the market share (in percentage terms) for firm 2.
- The consumer at x^* receives a payoff of $v - (p_1 + tx^*)$ if they buy from firm 1 and a payoff of $v - (p_2 + t(100 - x^*))$ if they visit firm 2. We therefore have: $v - (p_1 + tx^*) = v - (p_2 + t(100 - x^*)) \Rightarrow x^* = 50 + \frac{p_2 - p_1}{2t}$
- **Normalized** demand: $\begin{cases} Q_1(p_1, p_2) = x^* = 50 + \frac{p_2 - p_1}{2t} \\ Q_2(p_2, p_1) = x^* = 50 + \frac{p_1 - p_2}{2t} \end{cases}$
- Profit: $\begin{cases} \Pi_1(p_1, p_2) = p_1\left(50 + \frac{p_2 - p_1}{2t}\right) \\ \Pi_2(p_2, p_1) = p_2\left(50 + \frac{p_1 - p_2}{2t}\right) \end{cases}$
- *Note:* If you are told that there are N consumers evenly distributed along the line, you can compute the actual demand and profits by multiplying these expressions by $N/100$.
- Given the price chosen by its competitor, each firm then **best responds** by choosing a price that maximizes its profits.

Variation of horizontal diff.: two food trucks are located at the endpoints of a "linear city." Truck 1 is located at position 0, and truck 2 is at position 100. The gross value two trucks' products: $v_1 = 300$, $v_2 = 260$. Assume the cost of walking is $t = 1$ per step.

1. Total cost for the 2 products of consumer at position x: Firm 1's product: $300 - p_1 - x$; Firm 2's product: $260 - p_2 - (100 - x) = 160 + x - p_2 \implies$
   - indifferent customer position: $x^*(p_1, p_2) = 70 + \frac{p_2 - p_1}{2}$
   - market shares: $\begin{cases} X_1(p_1, p_2) = 70 + \frac{p_2 - p_1}{2} \\ X_2(p_2, p_1) = 30 - \frac{p_2 - p_1}{2} \end{cases}$
   - profits: $\begin{cases} \Pi_1(p_1, p_2) = p_1\left(70 + \frac{p_2 - p_1}{2}\right) \\ \Pi_2(p_2, p_1) = p_2\left(30 - \frac{p_2 - p_1}{2}\right) \end{cases}$
2. If the two trucks charge identical prices, indifferent consumer: $300 - p - x^* = 160 + x^* - p \Rightarrow x^* = 70$
3. Payoff matrix associated with following price choices: $\begin{cases} p_1 = (110, 160, 210) \\ p_2 = (50, 100, 150) \end{cases}$: Plug prices into $\Pi_1(p_1, p_2)$ and $\Pi_2(p_2, p_1)$ as payoffs

$\downarrow p_1$	$p_2 \rightarrow$ 50	100	150
110	4400, 3000	7150, 3500	9900, 1500
160	2400, 4250	6400, 6000	10400, 5250
210	-2100, 5500	3150, 8500	8400, 9000

4. Only N.E.: $(p_1 = 110, p_2 = 100)$
5. Firm 1 chooses a higher price because firm 1 transfers some of its quality advantage into a greater margin, and some into a larger market share

Why would a company pay to make their product lower quality? 1. By crimping the product designed for the low WTP consumers, we were able to extract more surplus from the high WTP consumers. 2. Ryan Air may be willing to pay to lower its quality so that it doesn't compete as hard with British Airways.

Vertical Differentiation: Vertical City Model: Consumers now have heterogeneous preferences for **quality**. This is captured by a parameter θ, which is evenly distributed along a vertical line from 0 to 1.

- Each firm now chooses a quality level q and a price p.
- A consumer with quality preference θ that buys quality q and at price p receives a payoff of $\theta q - p$.
- Suppose that one firm sets a high price p_H and quality q_H, and the other firm sets a low price p_L and quality q_L.
- We solve this model by identifying **two indifferent consumers:**
  - A consumer with preference for quality θ_L that is indifferent between buying from **the low-quality** firm and not buying anything.
  - A consumer with preference for quality θ_H that is indifferent between buying from **the low-quality and the high-quality** firm.
- The consumer with quality preference θ_L receives a payoff of $\theta_L q_L - p_L$ if they buy from the low-quality firm and a payoff of 0 if they buy nothing. Consequently, we have: $\theta_L q_L - p_L = 0 \implies \theta_L = \frac{p_L}{q_L}$.
- The consumer with quality preference θ_H receives a payoff of $\theta_H q_H - p_H$ if they buy from the high-quality firm and a payoff of $\theta_H q_L - p_L$ if they buy from the low-quality firm. Consequently, we have: $\theta_H q_H - p_H = \theta_H q_L - p_L \implies \theta_H = \frac{p_H - p_L}{q_H - q_L}$.
- Putting everything together: consumers with:
  - $\theta < \theta_L$ will buy nothing.
  - $\theta_L < \theta < \theta_H$ will buy from the low-quality firm.
  - $\theta > \theta_H$ will buy from the high-quality firm.
- **Low-quality firm's market share**: $100(\theta_H - \theta_L)\%$
- **High-quality firm's market share**: $100(1 - \theta_H)\%$
- **Implication:** Increasing the quality of your product offering isn't always a good thing! If your rival is selling a high-quality good, it may be better to sell a lower-quality good.