Chapter 10
Partial Equilibrium Competitive Model

We will study how price is arrived at in a single market (Partial Equilibrium).
Market Demand and Elasticity

- Up to now we have considered **individual** demand. Now we will consider **market** demand.
- Market demand is **simply the horizontal sum of the individuals’ demands**.
- Each individual’s (j) demand for good $x_i$ is
  $$x_{i,j} = x_{i,j}(P_1, \ldots, P_n, I_j)$$
  j is the individual; $j = 1 \ldots m$
  i is the good; $i = 1 \ldots n$
- All consumers have **different** $I_j$’s and different utility-function parameters but face the **same** prices $(P_1, \ldots, P_n)$.

Total
$$X_i = \sum_{j}^m x_{i,j}(P_1, \ldots, P_n, I_j)$$
Assuming linear demand functions:

\[ x_{1,1} = a + bP_1 + cP_2 + dI_1 \]

\[ + (x_{1,2} = e + fP_1 + gP_2 + hI_2) \]

Graphically

\[ X_1 = x_{1,1} + x_{1,2} = (a+e) + (b+f)P_1 + (c+g)P_2 + dI_1 + hI_2 \]

Market demand for \( X_1 \) for two individuals in the market.

For a particular price, distance 1 + distance 2 = distance 3.
• When individual demand curves shift, so does the market demand curve, although when only one individual’s demand curve shifts, market demand may not shift perceptibly.

• Sometimes movements are unambiguous because all individual demand curves move in the same direction.

• However, in other cases, movements in individual demands may be in different directions, because for different individuals a good may be normal or inferior and/or it may be a gross substitute or a gross complement for another good.

• Which way will D move? Existence of income effects and relationships between goods over many individuals may make market demand respond ambiguously. Preferences may also be different across individuals.
Own-Price Elasticity of Demand

\[ e_{Q,P} = \frac{\partial Q_D(P, P', I)}{\partial P} \cdot \frac{P}{Q_D} \], where \( P' \) is prices of other goods.

\( e_{Q,P} \leq 0 \) except for Giffen good.

- \( e_{Q,P} < -1 \rightarrow \) Elastic
- \( e_{Q,P} = -1 \rightarrow \) Unit elastic
- \( e_{Q,P} > -1 \rightarrow \) Inelastic

Many economists think about elasticities in absolute value terms, so they reverse the operators (e.g., > becomes <), but we will view them as above.
Cross-Price Elasticity of Demand

\[ e_{Q,P'} = \frac{\partial Q}{\partial P'} \cdot \frac{P'}{Q} \]

Gross Substitutes  \( e_{Q,P'} > 0, \quad P' \downarrow \Rightarrow Q_D \downarrow \)

Gross Complements  \( e_{Q,P'} < 0, \quad P' \downarrow \Rightarrow Q_D \uparrow \)

We don’t usually refer to cross-price elasticity as being “elastic” or “inelastic”. 
Income Elasticity of Demand

\[ e_{Q,I} = \frac{\partial Q_D (P, P', I)}{\partial I} \cdot \frac{I}{Q_D} \]

- \( e_{Q,I} \geq 0 \) for normal goods \( \left( \frac{\partial Q_D}{\partial I} \geq 0 \right) \)
- \( e_{Q,I} > 1 \) for luxury goods \( \left( \frac{\partial Q_D}{\partial I} < 0 \right) \)
- \( e_{Q,I} < 0 \) for inferior goods

Empirically, the composite good, food, is a normal good. Some individual foods may be inferior depending on income level.
• In price determination, we generally divide lengths of run into:
  
  - **Very short run**: Changes in quantity are not possible.
  - **Short run**: Existing firms can change their quantity by changing variable inputs, but firms will not enter or exit the industry, and at least one input is fixed (fixed costs).
  - **Long run**: Firms may enter and exit the industry and all inputs are variable.
Very Short-Run Pricing

- **Market period** – Firms cannot change the quantities they produce. The good is already produced and in the market place, and cannot be stored. For example, fresh fish or strawberries must be sold soon after harvest.

- Price simply rations the quantity supplied among consumers.
- Price will adjust to clear the market.
Short-Run Pricing

We will assume a Perfectly Competitive Industry (Pure Competition). The assumptions are:

– A large number of small firms exist in the industry, each producing the same homogeneous product with the same technology and costs,
– Each firm attempts to maximize profit,
– Each firm is a price taker: It assumes that its actions have no effect on market price.
– Information is perfect: Prices are assumed to be known by all market participants,
– Transactions are costless: Buyers and sellers incur no costs in making exchanges.

Are these assumptions realistic? Why do we make these assumptions?
Each firm in the industry has a supply curve as shown in the last chapter; \( q \) depends on \( P, v, \) and \( w \) (\( v \) and \( w \) are fixed, while \( q \) varies with \( P \)).

- The number of firms is fixed.
- \( q \) produced by each firm is variable. They can change \( q \) by changing the variable input levels.
- They cannot change the fixed inputs.
- Market supply curve is the horizontal sum of the SMC curves of all firms in the industry.

\[
Q_S(P, v, w) = \sum_{i=1}^{n} q_i(P, v, w).
\]
Industry Supply Function and Elasticity of Supply

The market S curve will be positively sloped because each firm's SMC is positively sloped (increasing SMC is the SOC).

\[ e_{S,P} = 0 \text{(perfectly inelastic)} \]

\[ e_{S,P} = 1 \text{(unit elastic)} \]

\[ e_{S,P} \text{ large (elastic)} \]

\[ e_{S,P} = \infty \text{(perfectly elastic)} \]

\[ e_{S,P} \text{ small (inelastic)} \]

\[ e_{S,P} = \frac{\partial Q_S}{\partial P} \frac{P}{Q_S} \geq 0 \]

- If S is linear and passes through 0, \( e_{S,P} = 1 \) (unit elastic).
- If S is linear with a positive price intercept, \( e_{S,P} > 1 \) (elastic) throughout.
- If S is linear with a negative price intercept, \( 0 < e_{S,P} < 1 \) (inelastic) throughout.
- The above holds at a particular point on a nonlinear supply curve if a line tangent to the curve at that point has an intercept that is equal to, greater than, or less than zero, respectively.
Market supply and demand curves interact to determine the market price \( P \).

\[
Q_D(P_1, P', I) = Q_S(P_1, v, w)
\]

Trace logical sequence for constructing graphs: 1) Individual \( d \) curve, 2) \( \sum d = D \), 3) Firm’s SMC, 4) \( \sum SMC = S \), 5) Solve S and D simultaneously to determine \( P_1 \), 6) At \( P_1 \), \( q_1 \) is produced by firm, 7) At \( P_1 \), \( q' \) is consumed by individual, and 8) and \( \pi > 0 \) can occur in the short run.

\( P_1 \) is the equilibrium between the costs of firms and the demands (preferences) of individuals.

Price acts as a signal to producers, and price acts as a signal to consumers.

The equilibrium price is the price where \( Q_D = Q_S \). Both suppliers and demanders are doing as they wish, given the conditions (prices, costs, income, preferences, and technology).

Suppose the individual (only one) has an increase in \( d \). Market \( P \) and \( Q \) will change by only an imperceptible amount because \( D \) will not change significantly.

Suppose the firm (only one) has an increase in SMC. Market \( P \) and \( Q \) will change by only an imperceptible amount because \( S \) will not change significantly (SAC' is not shown in graph).

**Price does not change when demand for one consumer changes or short-run marginal cost for one firm changes because each firm and consumer account for only a very small amount of the market (see assumptions).** Only quantity produced or consumed for the one firm or consumer changes.
Suppose demands for many individuals change:

$\pi > 0$ can occur in the short run.

A new short-run equilibrium is established because Market D increases to $D'$. $S$ does not shift because in the short run the number of firms in the industry does not increase.
Shifts in Market Short-run Supply and Demand Curves

Referring to $QS = S(P)$ and $QD = D(P)$:

Demand shifters:
- Change in income (changes the budget constraint),
- Change in prices of substitutes or complements (changes the price ratios between goods),
- Change in preferences (changes the shape of the indifference curves by changing the utility function),

Supply shifters:
- Change in input prices (changes $v$ and/or $w$, so input price ratio changes),
- Change in technology (changes the shape of the isoquant by changing the production function),
- Change in prices of competitive outputs,
Effects of shifts in S or D depend on shape of the other curve (mostly slope).

With elastic D, a change in S has little effect on P but a large effect on Q.

With inelastic D*, a change in S has a large effect on P but little effect on Q.

With an inelastic D curve (D*), changes in costs change P a lot, but result in only small changes in Q. U.S. agriculture is in this situation. Decreases in costs of production (SMC) cause relatively large decreases in output prices as supply increases.

Could also look at the effects of the elasticity of supply on P and Q caused by shifts in D. In agriculture, supply is inelastic, so changes in demand cause relatively large changes in price. In the U.S., changes in D are relatively minor compared with changes in S.
A Mathematical Model of S and D Equilibrium

- \( QD = D(P, \alpha) \) where \( \alpha \) is set of demand shifters
- \( QS = S(P, \beta) \) where \( \beta \) is set of supply shifters
- \( QD = QS \) in equilibrium
- Take the total differential of each functions:
  
  \[ dQD = D_P dP + D_\alpha d\alpha \]
  
  \[ dQS = S_P dP + S_\beta d\beta \]

  and

  \[ dQD = dQS \]

  Depends on shift caused by \( \alpha \) or \( \beta \)

  where \( D_P = \frac{\partial D}{\partial P} < 0 \), \( S_P = \frac{\partial S}{\partial P} > 0 \), \( D_\alpha = \frac{\partial D}{\partial \alpha} \Leftrightarrow 0 \), \( S_\beta = \frac{\partial S}{\partial \beta} \Leftrightarrow 0 \)

We can use this model to look at the effects on equilibrium \( P \) and \( Q \) of changes in \( \alpha \) and \( \beta \).
If $\alpha$ changes while $\beta$ is constant ($d\beta = 0$):

\[ D_P dP + D_\alpha d\alpha = S_P dP + S_\beta 0 \quad \text{Setting } dQD = dQS. \]

\[ D_P dP - S_P dP = -D_\alpha d\alpha \]

\[ dP(D_P - S_P) = -D_\alpha d\alpha \]

\[ dP = \frac{-D_\alpha d\alpha}{D_P - S_P} \quad \text{or} \quad \frac{dP}{d\alpha} = \frac{D_\alpha}{S_P - D_P} \]

Because $D_P$ is negative and $S_P$ is positive, the denominator will be positive. **Thus, $dP/d\alpha$ has the same sign as $D_\alpha$.**

So the equilibrium $P$ will change in the **same direction** as the sign of $D_\alpha$. $\alpha$ may be income, preferences, or prices of complements or substitutes.
• If \( d\alpha = 0 \) and \( d\beta \neq 0 \), then \( D_\alpha d\alpha = 0 \), so
\[
D_P dP - S_P dP = S_\beta d\beta
\]
\[
dP(D_P - S_P) = S_\beta d\beta
\]
\[
dP \frac{(D_P - S_P)}{S_\beta} = d\beta \quad \text{or} \quad \frac{dP}{d\beta} = \frac{S_\beta}{(D_P - S_P)}
\]

Because \( D_P \) is negative and \( S_P \) is positive, the denominator will be negative. Thus, \( dP/d\beta \) has the opposite sign as \( S_\beta \).

So the equilibrium \( P \) will change in the opposite direction as the sign of \( S_\beta \). \( \beta \) may be the price of an input, technology, or the price of a competing product.
Multiply the above equations by $\frac{\alpha}{P}$ or $\frac{\beta}{P}$:

**Demand**

\[
\frac{dP}{d\alpha} \cdot \frac{\alpha}{P} = \frac{D_\alpha}{S_p - D_p} \cdot \frac{\alpha}{P}
\]

\[
e_{P,\alpha} = \frac{D_\alpha \alpha}{(S_p - D_p)P}
\]

Multiply both top and bottom by $1/Q$.

\[
e_{P,\alpha} = \frac{D_\alpha \alpha/Q}{(S_p - D_p)P/Q}
\]

**Supply**

\[
\frac{dP}{d\beta} \cdot \frac{\beta}{P} = \frac{S_\beta}{D_p - S_p} \cdot \frac{\beta}{P}
\]

\[
e_{P,\beta} = \frac{S_\beta \beta}{(D_p - S_p)P}
\]

\[
e_{P,\beta} = \frac{S_\beta \beta/Q}{(D_p - S_p)P/Q}
\]

$\beta$ might be an input price ($w$)

\[
e_{Q,\alpha} \leftarrow \text{ Might be income elasticity of D.}
\]

\[
e_{Q,\alpha} = \frac{e_{Q,\alpha}}{e_{S,\alpha} - e_{Q,P}} \text{ Price elasticity of demand.}
\]

\[
e_{S,\beta} \leftarrow \text{ Price elasticity of supply.}
\]

These expressions can be manipulated to calculate one type of elasticity from the others that have been estimated econometrically.
Long-Run Pricing in Pure Competition

• In the long run, all inputs are variable and firms may enter and exit the industry.
• Each firm will operate at its most efficient plant size (SAC) at the low point on its AC curve.
• Long-run cost curves are used for decision-making.
In the long run, there are no fixed costs. Any price below $P_1$ will cause exits from the industry because firms earn an economic loss and any price above $P_1$ will cause entries into the industry because firms earn an economic profit. These graphs depict long-run equilibrium where $P=MR=AR=d=SMC=MC = \text{Min SAC}=\text{Min AC}$
• If the price is at \( P_2 > SAC \), economic profit exist because SAC accounts for opportunity costs of all inputs; thus, any \( P > SAC \) reflects returns greater than opportunity costs. Economic profit attracts new firms. New firms expand SS, causing P to decline. New firms continue to enter until SS increases enough to cause P to decline enough to reduce economic profit to zero at \( P_1 \).

• Same could be done for \( P < P_1 \) causing firms to exit, SS to decrease, and P to rise to \( P_1 \).

• Entry and exit will lead to a long-run equilibrium with no economic profit. \( P_1 \) is the only viable price in the long run.

• If all firms have identical cost curves, then everyone earns exactly zero profit. Thus, all firms will produce at the low point on \( AC = MC = P = MR = SAC = SMC = AR = d \).

• \( P_1 = SMC \) means the firm earns maximum profit! \( P = \min SAC = \min AC \) means profit = 0, so no entry or exit. Returns exactly equal opportunity costs, and products are produced at minimum cost.

• Self interest (maximum profit) meets the discipline of competition (0 profit)!
Constant, Increasing, and Decreasing Cost Industries

1. **Constant Cost** – Entry or exit of firms does not affect input costs.
2. **Increasing Cost** – Entry (or exit) increases (or decreases) input costs.
3. **Decreasing Cost** – Entry (or exit) decreases (or increases) input costs.

In the long run, the MC curve does not relate specifically to the long-run supply curve as in the case of short-run supply relating to the SMC curve. Rather, it is the MC = MR = P intersection at minimum AC that shows how Q responds to P. The emphasis is on minimum AC.
**Constant Cost:** Industry is a relatively small employer of inputs, which implies the cost curves remain fixed as entry and exit occur.

Start at long-run equilibrium, $P_1$, $q_1$, and $Q_1$. Now $D$ increases to $D'$, causing $P$ to rise to $P_2$, causing $q$ to increase to $q_2$, causing $Q$ to increase to $Q_2$. The price rise creates short-run economic profits, causing firms to enter the market, causing supply to increase from $SS$ to $SS'$ because as firms enter, costs of firm remain unchanged. The increase in supply causes $P$ to fall to $P_3 = P_1$, causing $q$ to decrease to $q_3 = q_1$, and $Q$ to increase to $Q_3$. The new long-run equilibrium is $P_3 = P_1$, $q_3 = q_1$, and $Q_3$. $Q_3$ is larger than $Q_1$ because there are more firms. The **Long Run Supply** curve is $LRS$. It shows how $Q$ responds to $P$ in the long run with all inputs and $n$ (number of firms) variable. Perfectly elastic $LRS$ (horizontal).

No matter what happens to $D$, $P_1$ price will prevail in the long run. Only the number of firms changes to change $Q$ in the long run.
Increasing Cost: As firms enter (exit) the market, input costs increase (decrease) because of increasing (decreasing) demand for inputs.

Start at long-run equilibrium, $P_1$, $q_1$, and $Q_1$. Increase $D$ to $D'$, causing $P$ to increase to $P_2$, yielding economic profits, causing firms to enter the industry, causing supply to increase toward $SS'$. But simultaneously as firms enter the industry, $SMC$ and $AC$ increase to $SMC'$ and $AC'$, causing supply to decrease. Supply increases because of more firms but decreases because more firms cause costs to increase. The rising cost structure meets increasing $SS$ at a higher long-run equilibrium price of $P_3$ (higher than $P_1$) and industry output of $Q_3$. So, a price rise to $P_3$ leads to an increase in quantity to $Q_3$, giving a positively sloped long-run supply curve. $q_3$ does not necessarily equal $q_1$. It depends on the cost structure of the firms.
Decreasing Cost: Decreasing costs may result from a larger pool of trained labor, better infrastructure, economies of size among input suppliers as the industry grows larger (n increases) (eg., the computer industry).

Start at long-run equilibrium, P₁, q₁, and Q₁. Increase D to D₁, causing P to increase to P₂, yielding economic profits, causing firms to enter the industry, causing supply to increase toward SS’. But simultaneously as firms enter the industry, SMC and AC decrease to SMC₁ and AC₁, causing supply to increase even further. Supply increases because of more firms and increases because more firms cause costs to decrease. The declining cost structure is overtaken by increasing SS at a lower long-run equilibrium price of P₃ (lower than P₁) and industry output of Q₃. So, a price fall to P₃ leads to an increase in quantity to Q₃, giving a negatively sloped long-run supply curve. With the cost structure graphed here, q₃ does not equal q₁, but they could be equal. It depends on the cost structure of the firms.
Long-Run Supply Elasticity

- The LRS curve incorporates all adjustments that occur within the firm and in the industry outside the firm (e.g., changing cost structure).

\[ e_{LS,P} = \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} \approx \frac{\% \Delta Q}{\% \Delta P} \] \( \Delta Q \) is a long-run adjustment to \( \Delta P \).

- \( e_{LS,P} \) may be negative (decreasing cost) as well as positive (increasing cost) or infinity (constant cost). LRS will be more elastic than SS.

Changes in the number of firms

A new equilibrium implies a change in the number of firms in the industry.

If \( Q_0 \) is initial industry equilibrium output and \( q_0^* \) is the optimal firm output, then the number of firms in the industry is \( n_0 = Q_0 / q_0^* \).

If the \( \Delta D \) causes \( Q \) to rise to \( Q_1 \), then \( n_1 = Q_1 / q_1^* \) and the change in \( n \) is \( \Delta n = n_1 - n_0 = Q_1 / q_1^* - Q_0 / q_0^* \). In the constant cost industry case, \( q_1^* = q_0^* \), so \( \Delta n = \frac{Q_1 - Q_0}{q_0^*} \), so \( \Delta n \) is a function of \( \Delta Q \) only.
In the increasing and decreasing cost industry cases, $q_1^*$ may not equal $q_0^*$, implying a change in optimal firm size. Eg., With an increase in D for an increasing cost industry or increase in input cost as initial stimulus, could have either of the following.

We could do the same for a decreasing cost industry for a decrease in cost as the initial stimulus; just switch $q_1^*$ and $q_0^*$ around on the graph. Even for a constant cost industry, changes in input costs (as the initial stimulus) may obviously result in a different $q^*$ at the new equilibrium Q.
Producer Surplus in Long Run, Ricardian Rent, and Capitalization of Rents

**Producer surplus** is the extra return producers make by making transactions at the market price over and above what they would earn if nothing were produced. Graphically it is similar to short-run producer surplus; the area above the long-run supply curve below the market price.

In the long run, profits are zero at the market price, so who receives the gain? Producer surplus goes to the owners of the inputs in the form of higher input prices.

For a constant-cost industry, returns to inputs are independent of the level of output; producer surplus is zero.

For an increasing-cost industry, input prices are bid up as output increases, so returns to inputs increase; producer surplus is positive. Input prices must increase to attract more and more highly productive resources to the industry. Vice versa for decreasing-cost industry.

**Ricardian rents** are profits earned by firms (low cost firms) with resources that are more productive than needed to earn zero profit at the market price (eg., crop land). These profits can persist in the long run.

**Capitalization of rents** simply means that input prices increase to reflect the present value of future profits earned by the input (eg., more productive land earns higher profits, so land price will be higher for more productive land than for less productive land). Therefore, future profits are said to be capitalized into the price of input. Producer surplus goes to owners of the inputs that cause an upward sloping long-run industry supply curve.