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Bachelor of Commerce (B2001) | Level 1 • Part A Core | Monash University

Principles of microeconomics

Course Code: ECC1000 • Module 3 Notes

Module 3: Firm Production, Cost Structures, Profit Maximisation & Market Structures

Chapter 1: Firm Boundaries, Technology and Production Functions

1.1 Inside the Firm: Transaction Costs and Incomplete Contracts

In *The Economy 2.0: Microeconomics*, the firm is not merely a black-box mathematical cost curve; it is a hierarchical institution coordinating specialised production through authority and employment contracts rather than spot market prices. Ronald Coase observed that firms expand when internal administrative coordination saves on market **transaction costs** (search, negotiation, contracting, and quality enforcement). Yet internal coordination faces a distinctive governance challenge: labour contracts are inherently **incomplete**. An employer in Melbourne can contractually specify hours of attendance, Award wages, and general duties, but cannot legally or practically enforce the exact intensity of effort, initiative, or care exercised every minute.

CORE Econ models this relationship as a **principal-agent problem** using the labour-discipline model. Because effort is costly to monitor, firms pay a wage w strictly above the worker's reservation wage w_r (the fallback value of unemployment benefits plus disutility of work), generating an **employment rent**. Fear of losing this rent upon dismissal motivates workers to supply high effort on the firm's best-response curve. Thus, firm productivity depends jointly on engineering technology and internal labour incentives.

1.2 Short-Run Production and Diminishing Marginal Returns

A firm's **production function** maps maximum feasible physical output Q to combinations of inputs—typically labour (L) and capital (K): $Q = f(L, K)$. Microeconomics distinguishes between the **short run**, a time horizon in which at least one input (usually physical capital $\bar{K}$, such as factory floor space or commercial ovens) is fixed, and the **long run**, in which all inputs are freely variable.

Holding capital fixed at $\bar{K}$, short-run output depends on labour L: $Q = f(L, \bar{K})$ (Total Product, TP). Two productivity metrics guide staffing decisions:

$$AP_L = \frac{Q}{L}, \qquad MP_L = \frac{\Delta Q}{\Delta L} = \frac{\partial f(L, \bar{K})}{\partial L}$$

Where:

- AP_L is the **Average Product of Labour** (output per worker).
- MP_L is the **Marginal Product of Labour** (additional output produced by hiring one extra unit of labour, holding capital constant).

Initially, adding workers to a fixed workshop can raise MP_L through task specialisation. Beyond a threshold, however, the **Law of Diminishing Marginal Returns** inevitably sets in: adding successive units of a variable input to a fixed factor yields progressively smaller increments to output ($\partial MP_L / \partial L < 0$). Mathematically, whenever $MP_L > AP_L$, AP_L is rising; whenever $MP_L < AP_L$, AP_L is falling; consequently, the MP_L curve intersects the AP_L curve precisely at the maximum of AP_L.

1.3 Long-Run Production: Isoquants, Isocost Lines, and Returns to Scale

In the long run, both labour and capital vary. An **isoquant** traces all input combinations (L, K) capable of producing a given target output $\bar{Q}$. Analogous to an indifference curve, the magnitude of an isoquant's slope is the **Marginal Rate of Technical Substitution ($MRTS_{L,K}$)**—the quantity of capital the firm can replace with one extra unit of labour while holding output constant:

$$MRTS_{L,K} = -\left.\frac{dK}{dL}\right|_{\bar{Q}} = \frac{MP_L}{MP_K}$$

Where:

- MP_L and MP_K are the marginal products of labour and capital, respectively.

Given competitive input prices—wage rate w per unit of labour and user rental cost r per unit of capital—a firm's total expenditure C defines an **isocost line** $C = wL + rK$, whose slope has magnitude w/r. CORE Econ uses isocost lines to explain why industrial revolutions occurred in high-wage, cheap-coal Britain: firms adopt whichever technology minimises cost at prevailing relative factor prices. Cost minimisation for any target output $\bar{Q}$ requires tangency between the isoquant and the lowest attainable isocost line:

$$MRTS_{L,K} = \frac{w}{r} \iff \frac{MP_L}{w} = \frac{MP_K}{r}$$

Where:

- MP_L/w and MP_K/r measure the extra output obtained per final dollar spent on labour and capital, respectively.

When a firm scales *all* inputs proportionally by a factor $\lambda > 1$, output responds according to the firm's **returns to scale**: **increasing returns to scale** if $f(\lambda L, \lambda K) > \lambda f(L, K)$; **constant returns to scale** if $f(\lambda L, \lambda K) = \lambda f(L, K)$; and **decreasing returns to scale** if $f(\lambda L, \lambda K) < \lambda f(L, K)$.

Worked Example 3.1: Cost-Minimising Input Mix with Cobb-Douglas Technology

Suppose an Australian precision manufacturer produces smart electricity meters according to $Q = 10L^{0.5}K^{0.5}$, facing an hourly wage $w = 40$ and hourly machine rental rate $r = 10$. The firm must produce $\bar{Q} = 200$ meters at minimum cost.
Step 1 (Compute $MRTS_{L,K}$):

$$MP_L = 5L^{-0.5}K^{0.5}, \qquad MP_K = 5L^{0.5}K^{-0.5} \implies MRTS_{L,K} = \frac{MP_L}{MP_K} = \frac{K}{L}$$

Where:

- K/L is the capital-to-labour ratio governing the slope of the isoquant.

Step 2 (Apply Cost-Minimisation Tangency): Set $MRTS_{L,K} = w/r$:

$$\frac{K}{L} = \frac{40}{10} = 4 \implies K = 4L$$

Where:

- Because labour is four times as expensive as capital per unit, the cost-minimising firm operates with four units of capital per unit of labour.

Step 3 (Solve for Optimal (L^*, K^*) and Minimum Cost): Substitute $K = 4L$ into the output constraint $\bar{Q} = 200$:

$$200 = 10L^{0.5}(4L)^{0.5} = 10(2L) = 20L \implies L^* = 10, \qquad K^* = 4(10) = 40, \qquad C_{\min} = 40(10) + 10(40) = 800$$

Where:

- $L^* = 10$ labour hours and $K^* = 40$ machine hours achieve 200 meters at a minimum total cost of \$800 (\$4.00 per meter).

1.4 CORE Econ's Labour-Discipline Model: Employment Rents and Effort Curves

To link production technology with human-resource incentives, CORE Econ formalises the employer–employee interaction as a sequential principal-agent game. The employer sets the hourly wage w, and the worker selects effort $e \in [0, 1]$ per hour along a concave **best-response effort curve** $e(w)$. Paying only the worker's **reservation wage** w_r (hourly unemployment benefit

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plus equivalent disutility value of leisure) yields zero employment rent, so the worker exerts zero discretionary effort because dismissal imposes no financial loss. Raising w above w_r creates a positive hourly **employment rent**:

$$R_{\text{total}} = (w - w_r - c(e)) \cdot H_{\text{unemp}}$$

Where:

- w is the contractual hourly wage paid by the firm.
- w_r is the reservation wage (fallback option).
- $c(e)$ is the hourly disutility of exerting effort e.
- H_{unemp} is the expected duration of unemployment (in hours) if dismissed for shirking.

The firm's objective is to minimise the wage cost per unit of effort, w/e—equivalently, to maximise effort per dollar of wage, e/w. Graphically, isocost lines for effort are rays through the origin with slope e/w. Optimal wage setting occurs where the highest feasible ray (steepest e/w) is tangent to the worker's concave best-response curve $e(w)$:

$$MRS_{\text{firm}} = \frac{e(w^*)}{w^*} = e'(w^*) = MRT_{\text{worker}}$$

Where:

- w^* is the **efficiency wage** maximising effort per dollar.
- $e'(w^*)$ is the marginal slope of the worker's best-response curve at w^*.

Because $w^* > w_r$ strictly exceeds market clearing, involuntary unemployment ($H_{\text{unemp}} > 0$) persists in equilibrium as an endogenous discipline device, explaining why real-world labour markets rarely clear instantaneously through wage cuts.

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Chapter 2: Economic Costs, Revenue and Supply under Perfect Competition

2.1 Accounting Profit Versus Economic Profit

To predict entry, exit, and supply, economists measure **economic profit (π)** as total revenue (TR) minus total *opportunity* costs (explicit outlays plus implicit costs of owner-supplied capital and time). By contrast, financial statements prepared under Australian Accounting Standards (AASB) record **accounting profit** by deducting only explicit monetary expenses and historical depreciation. When a business earns **zero economic profit** ($\pi = 0$), it earns a *normal profit*—its revenue covers all explicit expenses plus the competitive opportunity return its capital and labour could earn elsewhere, giving the owner no incentive to exit the industry.

2.2 Short-Run and Long-Run Cost Curves

In the short run, total cost (TC) splits into **Total Fixed Cost (TFC)**, which does not vary with output Q (e.g., commercial lease, annual council rates), and **Total Variable Cost ($TVC(Q)$)**, which expands with production (e.g., raw materials, casual shift wages). Dividing by output yields unit cost curves, while differentiating TC yields **Marginal Cost (MC)**:

$$TC(Q) = TFC + TVC(Q), \qquad ATC(Q) = \frac{TC(Q)}{Q} = AFC(Q) + AVC(Q), \qquad MC(Q) = \frac{dTC}{dQ} = \frac{dTVC}{dQ}$$

Where:

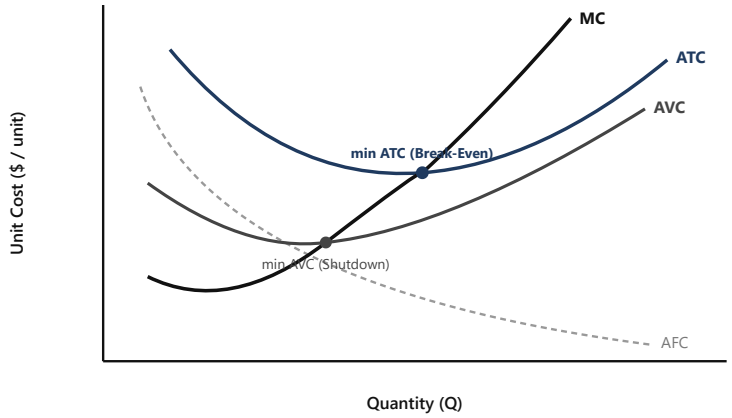
- $AFC(Q) = TFC/Q$ is Average Fixed Cost (strictly decreasing as fixed overhead spreads over more units).
- $AVC(Q) = TVC(Q)/Q$ is Average Variable Cost.
- $ATC(Q)$ is Average Total Cost (typically U-shaped).
- $MC(Q)$ is Marginal Cost, which depends solely on variable cost because $d(TFC)/dQ = 0$.

Because MC measures the cost of the next unit while ATC and AVC measure the average of all prior units, MC pulls the average down whenever $MC < ATC$ and pulls it up whenever $MC > ATC$. Hence, the rising MC curve intersects both AVC and ATC precisely at their respective minimum points. Table 3.1 illustrates a discrete short-run cost schedule for a small Victorian bakery with daily fixed rent $TFC = 120$ dollars, while Figure 3.2 displays the canonical continuous U-shaped average cost geometry.

Output (Q)	TFC ($)	TVC ($)	TC ($)	MC ($/unit)	AFC ($/unit)	AVC ($/unit)	ATC ($/unit)
0	120	0	120	—	—	—	—
1	120	50	170	50	120.00	50.00	170.00
2	120	80	200	30	60.00	40.00	100.00
3	120	120	240	40	40.00	40.00	80.00
4	120	180	300	60	30.00	45.00	75.00
5	120	265	385	85	24.00	53.00	77.00
6	120	380	500	115	20.00	63.33	83.33

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Figure 3.2: Short-Run Cost Geometry (MC Intersects AVC and ATC at Their Minima)



In the long run, the firm selects its optimal plant size so that its **Long-Run Average Cost ($LRAC$)** curve forms the lower envelope of all short-run ATC curves. Over initial output expansion, $LRAC$ typically slopes downward due to **economies of scale** (specialisation of labour, bulk purchasing, geometric container savings where surface area grows slower than volume, and spreading R&D overheads). The lowest output achieving minimum $LRAC$ is the **Minimum Efficient Scale (MES)**. Beyond MES, coordination bottlenecks and bureaucratic layers can generate **diseconomies of scale**, turning $LRAC$ upward.

2.3 Profit Maximisation and Supply in Perfect Competition

In a **perfectly competitive market**, many small firms produce an identical (homogeneous) product with zero barriers to entry or exit and full price transparency (for example, individual Australian grain growers selling feed wheat at global benchmark prices). Each firm is a strict **price-taker** facing a perfectly elastic horizontal demand curve at the prevailing market price P. Consequently, Marginal Revenue ($MR = dTR/dQ$) equals price: $P = AR = MR$.

To maximise profit $\pi(Q) = P \cdot Q - TC(Q)$, the firm sets output where Marginal Revenue equals Marginal Cost (provided MC is rising):

$$\frac{d\pi}{dQ} = P - MC(Q) = 0 \implies P = MC(Q^*)$$

Where:

- P is the exogenous competitive market price.
- $MC(Q^*)$ is marginal cost at the profit-maximising output Q^*.

Two threshold prices govern the competitive firm's short-run and long-run participation:

- **Short-Run Shutdown Rule ($P < \min AVC$):** In the short run, TFC is sunk. Producing $Q^* > 0$ yields operating contribution $(P - AVC) \cdot Q^*$. As long as $P \geq \min AVC$, operating covers all variable costs and contributes toward fixed costs, beating the shutdown loss of $-TFC$. If $P < \min AVC$, every unit sold deepens losses, so the optimal short-run supply is $Q^* = 0$. Thus, the firm's **short-run supply curve** is its MC curve lying on or above $\min AVC$.
- **Long-Run Zero-Profit Equilibrium ($P = \min LRAC$):** If incumbent firms earn positive economic profit ($P > \min ATC$), new firms enter, shifting industry supply rightward and driving P down. If firms incur economic losses ($P < \min ATC$), firms exit, shifting supply leftward and lifting P. In long-run competitive equilibrium, free entry and exit force price to $P^* = \min LRAC$, delivering zero economic profit ($\pi = 0$) and both *productive efficiency* (producing at lowest unit cost) and *allocative efficiency* ($P = MC$).

Worked Example 3.2: Competitive Output, Profit, and Shutdown Threshold

Suppose a competitive firm producing standard solar mounting brackets has the short-run total cost function:

$$TC(Q) = 200 + 10Q + 0.5Q^2$$

Where:

- $TFC = 200$ dollars is daily fixed overhead and $TVC(Q) = 10Q + 0.5Q^2$.
- Q is daily output in brackets.

Step 1 (Derive MC, AVC, and ATC):

$$MC(Q) = 10 + Q, \qquad AVC(Q) = 10 + 0.5Q, \qquad ATC(Q) = \frac{200}{Q} + 10 + 0.5Q$$

Where:

- MC rises linearly from \$10; $\min AVC = 10$ occurs at $Q = 0$ (shutdown price is \$10); minimum ATC occurs where $MC = ATC$:

$$10 + Q = \frac{200}{Q} + 10 + 0.5Q \implies 0.5Q^2 = 200 \implies Q = 20, \qquad \min ATC = 10 + 20 = 30$$

Step 2 (Find Optimum at Market Price $P = 40$): Equate $P = MC$:

$$40 = 10 + Q^* \implies Q^* = 30$$

Where:

- $Q^* = 30$ is the profit-maximising daily output.

Step 3 (Compute Profit): Total revenue is $TR = 40 \times 30 = 1,200$ dollars. Total cost is $TC(30) = 200 + 10(30) + 0.5(30)^2 = 200 + 300 + 450 = 950$ dollars. Economic profit is $\pi = 1,200 - 950 = +250$ dollars per day. If the market price fell to $P = 22$, the firm would produce $Q^* = 12$ ($MC = 22$) and suffer an economic loss of $\pi = 264 - [200 + 120 + 72] = -128$ dollars, yet it should still operate in the short run because $P = 22 > \min AVC = 10$ (losing \$128 is better than shutting down and losing $TFC = 200$).

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Chapter 3: Monopoly, Price-Setting Firms and Price Discrimination

3.1 Sources of Monopoly Power and Natural Monopoly

Unlike price-taking firms, a **monopolist** is the sole seller of a product with no close substitutes, protected by substantial barriers to entry. Those barriers arise from four main sources in the Australian economy: (1) **natural monopoly**, where massive fixed infrastructure costs create declining $LRAC$ across the entire range of market demand (such as regional electricity transmission poles and wires, water distribution networks, or NBN Co's fixed-line access network); (2) **statutory barriers**, including 20-year patents on pharmaceuticals developed by firms such as CSL or government-granted exclusive licences; (3) control of a scarce bottleneck asset (e.g., Sydney Airport); and (4) strong **network externalities** and switching costs in digital platforms.

3.2 Price-Setting Profit Maximisation and the Lerner Index

CORE Econ frames the price-setting firm as optimising over a downward-sloping market demand curve $P(Q)$—the firm's feasible frontier—and convex **isoprofit curves** (loci of (Q,P) combinations yielding equal profit $\pi = (P - ATC)Q$). Profit reaches a maximum where the demand curve is tangent to the highest attainable isoprofit curve, which is algebraically identical to equating Marginal Revenue to Marginal Cost ($MR = MC$). Because a monopolist must lower price on *all* inframarginal units to sell an extra unit (under uniform pricing), MR lies strictly below price:

$$TR(Q) = P(Q) \cdot Q \implies MR(Q) = P + Q\frac{dP}{dQ} = P\left(1 + \frac{1}{\varepsilon_d}\right) = P\left(1 - \frac{1}{|\varepsilon_d|}\right)$$

Where:

- P is the market price charged for quantity Q.
- $\varepsilon_d < 0$ is the price elasticity of market demand at (Q,P).

Setting $MR = MC$ proves two pivotal results: first, a profit-maximising monopolist *always* operates on the elastic segment of demand ($|\varepsilon_d| > 1$, since $MC > 0$ requires $MR = P(1 - 1/|\varepsilon_d|) > 0$); second, the optimal percentage markup over marginal cost—known as the **Lerner Index (L)**—varies inversely with demand elasticity:

$$L = \frac{P_M - MC}{P_M} = -\frac{1}{\varepsilon_d} = \frac{1}{|\varepsilon_d|}$$

Where:

- $L \in [0,1)$ is the Lerner Index of monopoly market power ($L = 0$ under perfect competition where $P = MC$).
- P_M is the monopoly profit-maximising price and MC is marginal cost at Q_M.

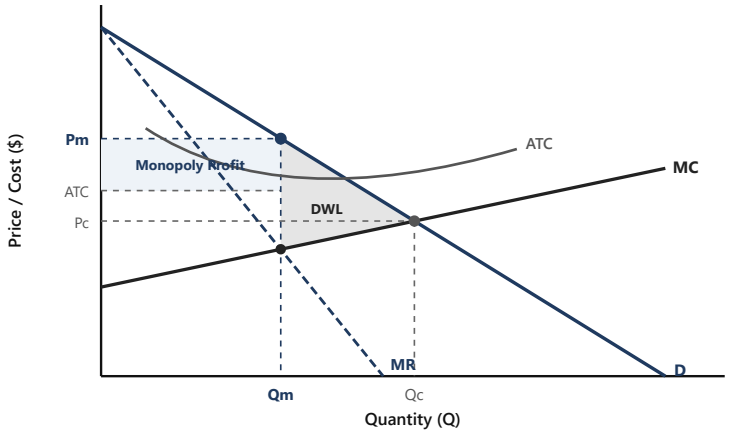
For a linear inverse demand curve $P = a - bQ$, total revenue is $aQ - bQ^2$, so $MR = a - 2bQ$: the MR line shares the exact vertical intercept a and has *twice the slope* of the demand curve.

3.3 Deadweight Loss and Natural Monopoly Regulation

Because the monopolist restricts output to $Q_M < Q_C$ and charges $P_M > MC$, buyers with willingness to pay strictly above marginal cost ($MC < WTP < P_M$) are priced out of the market. Consumer surplus shrinks dramatically; part transfers to the monopolist as monopoly profit, while the unexploited mutually beneficial trades between Q_M and Q_C vanish as **deadweight loss (DWL)**.

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Figure 3.1: Monopoly Pricing, Profit Rectangle and Deadweight Loss (DWL)



For **natural monopolies** where $MC < ATC$ at all relevant outputs, forcing marginal-cost pricing ($P = MC$) achieves allocative efficiency but guarantees chronic financial losses because fixed infrastructure costs go unrecovered. Australian regulators such as the Australian Energy Regulator (AER) and ACCC therefore rely on either **average-cost pricing** ($P = ATC$, zero economic profit), **two-part tariffs** (a fixed daily supply charge plus a low per-kilowatt-hour usage price equal to MC), or revenue-cap CPI-X incentive regulation.

3.4 Price Discrimination

A firm with market power that can prevent arbitrage (resale between buyers) can increase profit by charging different prices to different buyers for the same good—a practice termed **price discrimination**:

- **First-Degree (Perfect) Price Discrimination:** Charging every buyer their exact maximum willingness to pay ($P_i = WTP_i$). Paradoxically, perfect price discrimination eliminates deadweight loss ($Q = Q_C$) because every unit with $WTP \geq MC$ is sold, though the monopolist captures 100 per cent of total surplus ($CS = 0$).
- **Second-Degree Price Discrimination (Versioning / Quantity Tiering):** Offering a menu of packages or volume discounts so buyers self-select according to intensity of demand (e.g., off-peak vs. peak Myki fares in Melbourne, airline cabin classes, or bulk supermarket multipacks).
- **Third-Degree Price Discrimination (Market Segmentation):** Dividing buyers by observable group characteristics (age, student status, geography) and charging higher prices to the segment with *less elastic* demand. Profit maximisation across two segments (Segment 1 and Segment 2) requires $MR_1(Q_1) = MR_2(Q_2) = MC(Q_1 + Q_2)$, implying:

$$\frac{P_1}{P_2} = \frac{1 - 1/|\varepsilon_2|}{1 - 1/|\varepsilon_1|}$$

Where:

- P_1, P_2 are the profit-maximising prices in segments 1 and 2.
- $|\varepsilon_1|, |\varepsilon_2|$ are the absolute price elasticities of demand in each segment ($|\varepsilon_1| < |\varepsilon_2| \implies P_1 > P_2$).

Worked Example 3.3: Monopoly Welfare Loss and Third-Degree Price Discrimination

Part A (Uniform Monopoly vs. Competitive Benchmark): Suppose a patented medical diagnostic device faces inverse market demand $P = 200 - 2Q$ and constant marginal cost $MC = 40$ (zero fixed cost).
Monopoly: $MR = 200 - 4Q$. Equating $MR = MC$ gives:

$$200 - 4Q_M = 40 \implies 4Q_M = 160 \implies Q_M = 40, \qquad P_M = 200 - 2(40) = 120$$

Monopoly profit is $\pi_M = (120 - 40)(40) = 3,200$ dollars, and consumer surplus is $CS_M = \frac{1}{2}(200 - 120)(40) = 1,600$ dollars.
Competitive Benchmark ($P = MC$): Solving $P = MC$ yields $Q_C = 80$ units at $P_C = 40$ dollars ($P = 200 - 2Q_C = 40$).

Deadweight loss under monopoly is:

$$DWL = \frac{1}{2}(P_M - MC)(Q_C - Q_M) = \frac{1}{2}(120 - 40)(80 - 40) = 1,600$$

Where:

- $DWL = 1,600$ dollars represents lost social surplus from underproduction ($Q_M = 40$ vs. $Q_C = 80$).

Part B (Third-Degree Price Discrimination): Now suppose an Australian cinema chain faces constant $MC = 8$ per ticket and separates Adults (A) from Students (S): $P_A = 32 - 0.04Q_A$ and $P_S = 20 - 0.05Q_S$.
Equating $MR_A = MC$ and $MR_S = MC$:

$$32 - 0.08Q_A = 8 \implies Q_A^* = 300,\ P_A^* = 20; \qquad 20 - 0.10Q_S = 8 \implies Q_S^* = 120,\ P_S^* = 14$$

Adults, having less elastic demand at the optimum ($|\varepsilon_A| = \frac{20}{20-8} = 1.67$), pay \$20, while more price-sensitive students ($|\varepsilon_S| = \frac{14}{14-8} = 2.33$) receive a \$14 concession.

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Chapter 4: Monopolistic Competition and Oligopoly

4.1 Spectrum of Market Structures

Most Australian retail, banking, telecommunications, and professional service industries operate neither under pure price-taking competition nor under pure single-firm monopoly, but in the intermediate regimes of **monopolistic competition** and **oligopoly**.

Feature	Perfect Competition	Monopolistic Competition	Oligopoly	Monopoly
Number of Firms	Very many small firms	Many firms	A few dominant firms	One firm
Product Type	Homogeneous	Differentiated (branding, location)	Homogeneous or differentiated	Unique (no close substitutes)
Entry Barriers	None	Low	High (scale, capital, regulation)	Very high / blocked
Strategic Interdependence	None (price-taker)	Minimal	High (rivals react directly)	None (no rivals)
Long-Run Economic Profit	Zero ($P = \min ATC$)	Zero ($P = ATC > MC$)	Can persist ($P > MC$)	Can persist ($P > MC$)

4.2 Monopolistic Competition

In **monopolistic competition**—exemplified by Melbourne suburban cafés, independent bookstores, or boutique hair salons—each firm faces a downward-sloping demand curve because customers perceive differences in quality, ambience, or proximity. In the short run, a successful firm sets $MR = MC$ and may earn positive economic profit ($P > ATC$). Because entry barriers are low, positive profit attracts new entrants whose competing varieties shift incumbent firms' demand curves leftward and make them flatter (more elastic). Entry ceases only in long-run equilibrium when each firm's demand curve is **tangent** to its ATC curve ($P = ATC$, zero economic profit) at an output Q^* strictly to the left of minimum ATC. Thus, monopolistic competition exhibits two structural features: a positive markup ($P > MC$, generating minor deadweight loss) and **excess capacity** ($Q^* < Q_{\min ATC}$), which society trades off against valuable product variety.

4.3 Oligopoly, Concentration Ratios, and Strategic Models

An **oligopoly** features a small number of interdependent firms—such as Australia's major grocery chains (Coles and Woolworths), major domestic banks, or domestic aviation carriers. Market concentration is commonly measured by the **four-firm concentration ratio (CR_4)**—the combined market share of the top four firms—or the **Herfindahl-Hirschman Index (HHI)**:

$$HHI = \sum_{i=1}^{N} s_i^2$$

Where:

- s_i is the percentage market share of firm i ($s_i \in [0, 100]$).
- N is the total number of firms in the industry (HHI ranges from near zero in atomistic competition to 10,000 for a pure monopoly).

The ACCC scrutinises proposed mergers closely whenever post-merger HHI exceeds 2,000 or increases substantially. Because each oligopolist's profit depends directly on rivals' price or output choices, economists model oligopoly through three canonical frameworks:

- **Cournot Quantity Competition:** Firms simultaneously choose output levels (q_1, q_2) assuming rival output is fixed. Each firm maximises profit along its **best-response function** $q_1^*(q_2)$. At the Cournot-Nash equilibrium, output sits strictly

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between monopoly and competitive levels ($Q_M < Q_{\text{Cournot}} < Q_C$) and price sits between P_C and P_M.

- **Bertrand Price Competition:** Firms simultaneously choose prices for a homogeneous product with identical constant MC. Because buyers flock to the lowest price, each firm undercuts any rival price above MC, driving equilibrium immediately to $P_1 = P_2 = MC$ and zero economic profit even with just two firms (the **Bertrand paradox**). Product differentiation or capacity constraints restore positive markups.
- **Stackelberg Sequential Leadership & Collusion:** If Firm 1 moves first and commits to output q_1 before Firm 2 responds along $q_2^*(q_1)$, Firm 1 captures a **first-mover advantage** with higher output and profit than in simultaneous Cournot play. Conversely, if firms form a **cartel** to restrict joint output to Q_M, every member faces an incentive to secretly cheat by expanding output at the high cartel price—making cartels inherently unstable unless deterred by repeated-game punishment (and strictly illegal under Part IV of Australia's *Competition and Consumer Act 2010*).

Worked Example 3.4: Symmetric Cournot Duopoly and HHI Calculation

Part A (Cournot Duopoly): Two competing Australian bottled-water wholesalers, Firm 1 and Firm 2, face inverse market demand $P = 100 - Q$, where $Q = q_1 + q_2$, and identical constant marginal cost $MC = 10$ (zero fixed cost).
Step 1 (Derive Firm 1's Best-Response Function): Firm 1's profit is $\pi_1 = (100 - q_1 - q_2)q_1 - 10q_1 = 90q_1 - q_1^2 - q_1q_2$. Differentiate with respect to q_1 and set to zero:

$$\frac{\partial \pi_1}{\partial q_1} = 90 - 2q_1 - q_2 = 0 \implies q_1^*(q_2) = 45 - 0.5q_2$$

Where:

- $q_1^*(q_2)$ is Firm 1's profit-maximising output given any conjectured output q_2 by Firm 2.

By symmetry, Firm 2's best-response function is $q_2^*(q_1) = 45 - 0.5q_1$.
Step 2 (Solve Cournot-Nash Equilibrium): Substitute $q_2 = q_1$ into q_1^*:

$$q_1^* = 45 - 0.5q_1^* \implies 1.5q_1^* = 45 \implies q_1^* = q_2^* = 30$$

Where:

- Total Cournot market output is $Q^* = 30 + 30 = 60$ units, market price is $P^* = 100 - 60 = 40$ dollars, and each firm earns $\pi_i = (40 - 10)(30) = 900$ dollars (industry profit 1,800 dollars).

Compare benchmarks: a joint cartel/monopoly sets $MR = 100 - 2Q_M = 10$, yielding $Q_M = 45$ (22.5 units each) at $P_M = 55$ dollars and 2,025 dollars total profit (1,012.50 dollars each), while perfect competition yields $Q_C = 90$ at $P_C = 10$ dollars and zero profit.
Part B (HHI Calculation): Suppose an Australian retail market has four firms with market shares 35 per cent, 30 per cent, 20 per cent, and 15 per cent:

$$HHI = 35^2 + 30^2 + 20^2 + 15^2 = 1,225 + 900 + 400 + 225 = 2,750$$

Where:

- $HHI = 2,750$ indicates a highly concentrated market ($HHI > 2,000$).

If Firms 3 and 4 propose to merge into a single firm holding a 35 per cent share, post-merger HHI rises to $HHI_{\text{post}} = 35^2 + 30^2 + 35^2 = 3,350$—an increase of $\Delta HHI = 2 \times 20 \times 15 = 600$ points, triggering formal ACCC merger investigation under section 50 of the *Competition and Consumer Act 2010*.

4.4 Stackelberg Sequential Leadership and Benchmark Synthesis

When one dominant incumbent firm commits to capacity or output *before* rivals act, the strategic environment shifts from simultaneous Cournot competition to a sequential **Stackelberg duopoly**. Solved via backward induction, the leader anticipates the follower's best-response curve $q_2^*(q_1)$ and embeds it directly into the leader's profit function before choosing q_1.

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Worked Example 3.5: Stackelberg First-Mover Advantage vs. Alternative Benchmarks

Using the identical market from Example 3.4 ($P = 100 - q_1 - q_2, MC = 10$), suppose Firm 1 acts as Stackelberg leader and Firm 2 acts as follower along $q_2^*(q_1) = 45 - 0.5q_1$.

Step 1 (Substitute Follower's Best Response into Leader's Demand & Profit):

$$P(q_1) = 100 - q_1 - (45 - 0.5q_1) = 55 - 0.5q_1 \implies \pi_1(q_1) = (55 - 0.5q_1)q_1 - 10q_1 = 45q_1 - 0.5q_1^2$$

Where:

- $P(q_1)$ is the residual inverse demand curve facing the Stackelberg leader once Firm 2 responds optimally.

Step 2 (Maximise Leader's Profit & Solve Equilibrium): Differentiate π_1 with respect to q_1:

$$\frac{d\pi_1}{dq_1} = 45 - q_1 = 0 \implies q_1^S = 45, \qquad q_2^S = 45 - 0.5(45) = 22.5$$

Where:

- $q_1^S = 45$ and $q_2^S = 22.5$ are the Stackelberg leader and follower outputs, giving total output $Q^S = 67.5$ and price $P^S = 100 - 67.5 = 32.50$ dollars.

Leader profit rises to $\pi_1^S = (32.50 - 10)(45) = 1,012.50$ dollars (exceeding Cournot profit of 900 dollars), while follower profit drops to $\pi_2^S = (32.50 - 10)(22.5) = 506.25$ dollars. Table 3.2 synthesises all four market-structure benchmarks for $P = 100 - Q$ and $MC = 10$.

Market Structure	Total Output (Q)	Market Price (P)	Industry Profit (Π)	Consumer Surplus (CS)	Deadweight Loss (DWL)
Cartel / Monopoly	45.0	$55.00	$2,025.00	$1,012.50	$1,012.50
Cournot Duopoly	60.0	$40.00	$1,800.00	$1,800.00	$450.00
Stackelberg Duopoly	67.5	$32.50	$1,518.75	$2,278.13	$253.13
Perfect Competition / Bertrand	90.0	$10.00	$0.00	$4,050.00	$0.00

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