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

Principles of microeconomics

Course Code: ECC1000 • Module 2 Notes

Module 2: Consumer Choice Theory, Preferences, Budget Constraints & Behavioural Economics

Chapter 1: Preferences, Utility and Indifference Curves

1.1 Axioms of Rational Consumer Choice

While supply-and-demand curves describe market outcomes at the aggregate level, **consumer choice theory** builds the microeconomic foundations of individual demand. Rather than assuming all shoppers perform explicit calculus at supermarket checkouts, neoclassical consumer theory posits that consumers hold stable, internally consistent preferences over bundles of goods and services, denoted $A = (x_A, y_A)$ and $B = (x_B, y_B)$, and select the most preferred bundle they can afford. Standard rational preference orderings rest on four core axioms:

- **Completeness:** Given any two bundles A and B, the consumer can always compare them and declare either $A \succ B$ (A is strictly preferred to B), $B \succ A$, or $A \sim B$ (indifference).
- **Transitivity:** Preferences are logically consistent: if $A \succsim B$ and $B \succsim C$, then $A \succsim C$. Intransitive preferences would render a consumer vulnerable to money-pumping cycles and preclude a well-defined optimum.
- **Monotonicity (Non-satiation):** For desirable goods ("more is better"), if bundle A contains at least as much of every good as bundle B and strictly more of at least one good, then $A \succ B$.
- **Strict Convexity (Diminishing Marginal Rate of Substitution):** Averages are preferred to extremes. If $A \sim B$, then any weighted combination $\lambda A + (1-\lambda)B$ with $\lambda \in (0,1)$ is strictly preferred to A and B. Balanced consumption of housing and groceries beats starving in a mansion or living outdoors with excess food.

1.2 Ordinal Utility and Functional Forms

When preferences satisfy completeness, transitivity, and continuity, they can be represented by a numerical **utility function** $U(x,y)$ assigning higher real numbers to preferred bundles: $A \succ B \iff U(A) > U(B)$. Crucially, modern microeconomics employs **ordinal utility** rather than cardinal utility: only the *ranking* of bundles carries behavioural meaning, not the absolute numerical differences. Any strictly increasing monotonic transformation $V(x,y) = f(U(x,y))$ (such as taking a natural logarithm $\ln U$ or adding a constant) preserves the identical preference ordering and generates identical demand choices.

Four utility specifications recur throughout ECC1000 and applied economic modelling:

Preference Type	Utility Function $U(x,y)$	Indifference Curve Shape	Marginal Rate of Substitution (MRS)
Cobb-Douglas	$U(x,y) = x^{\alpha}y^{\beta}$ ($\alpha, \beta > 0$)	Smooth, strictly convex, asymptotic to both axes	$MRS_{x,y} = \frac{\alpha}{\beta} \cdot \frac{y}{x}$ (diminishing)
Perfect Substitutes	$U(x,y) = ax + by$ ($a, b > 0$)	Downward-sloping straight lines	$MRS_{x,y} = \frac{a}{b}$ (constant)

Preference Type	Utility Function $U(x,y)$	Indifference Curve Shape	Marginal Rate of Substitution (MRS)
Perfect Complements	$U(x,y) = \min\{ax, by\}$	L-shaped (right-angled) with vertices on $ax = by$	Zero on horizontal arm, ∞ on vertical arm, indeterminate at the kink
Quasi-Linear	$U(x,y) = v(x) + y$ ($v'(x) > 0, v''(x) < 0$)	Vertically parallel convex curves	$MRS_{x,y} = v'(x)$ (independent of y)

1.3 Properties of Indifference Curves and the Marginal Rate of Substitution

An **indifference curve** traces all combinations (x,y) yielding the same constant level of utility $\bar{U}$. Under the standard axioms, indifference maps exhibit four geometric properties: (1) curves are downward-sloping when both goods are desirable, because increasing x requires reducing y to hold utility constant; (2) curves further from the origin represent higher utility levels (monotonicity); (3) indifference curves can never intersect, as intersection violates transitivity combined with monotonicity; and (4) indifference curves are bowed inward (convex to the origin).

The absolute value of the slope of an indifference curve at any bundle is the **Marginal Rate of Substitution ($MRS_{x,y}$)**—the maximum amount of good y a consumer is willing to give up to acquire one additional unit of good x while remaining equally satisfied. Taking the total differential of $U(x,y) = \bar{U}$ gives:

$$dU = MU_x\,dx + MU_y\,dy = 0 \implies MRS_{x,y} = -\frac{dy}{dx} = \frac{MU_x}{MU_y}$$

Where:

- $MU_x = \partial U/\partial x$ is the marginal utility of good x (extra utility from an infinitesimal increase in x, holding y constant).
- $MU_y = \partial U/\partial y$ is the marginal utility of good y.
- $MRS_{x,y}$ is the subjective rate of substitution of y for x (units of y per unit of x).

Notice that although MU_x and MU_y individually depend on the cardinal scaling of U, their ratio MU_x/MU_y is completely invariant to positive monotonic transformations. As a consumer moves downward and rightward along a strictly convex indifference curve (consuming more x and less y), $MRS_{x,y}$ declines: the consumer becomes progressively less willing to sacrifice scarce units of y for abundant units of x.

Worked Example 2.1: Marginal Utilities and Diminishing MRS

Suppose a Melbourne commuter has preferences over weekly rideshare trips (x) and café meals (y) represented by the Cobb-Douglas utility function:

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$$U(x,y) = x^{0.4}y^{0.6}$$

Where:

- x is the number of rideshare trips per week ($x > 0$).
- y is the number of café meals per week ($y > 0$).

Step 1 (Compute Marginal Utilities): Partially differentiate $U(x,y)$ with respect to each good:

$$MU_x = 0.4x^{-0.6}y^{0.6}, \qquad MU_y = 0.6x^{0.4}y^{-0.4}$$

Where:

- MU_x and MU_y are the partial derivatives $\partial U/\partial x$ and $\partial U/\partial y$.

Step 2 (Compute $MRS_{x,y}$): Take the ratio MU_x/MU_y:

$$MRS_{x,y} = \frac{0.4x^{-0.6}y^{0.6}}{0.6x^{0.4}y^{-0.4}} = \frac{2}{3}\cdot\frac{y}{x}$$

Where:

- $MRS_{x,y}$ gives the number of café meals the commuter is willing to sacrifice for one extra rideshare trip.

Step 3 (Evaluate Diminishing MRS): At bundle $A = (4, 12)$, $MRS_{x,y} = \frac{2}{3}(12/4) = 2.0$ meals per trip. Moving down the same indifference curve ($U = 4^{0.4}12^{0.6} \approx 7.735$) to bundle $B = (10, 6.51)$, $MRS_{x,y} = \frac{2}{3}(6.51/10) \approx 0.434$ meals per trip. Willingness to trade meals for rideshare trips falls sharply as rideshare trips become abundant.

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Chapter 2: Budget Constraints and Optimal Consumer Choice

2.1 The Budget Line and Relative Prices

Preferences dictate what a consumer *wants* to buy; the **budget constraint** dictates what the consumer *can afford*. Given exogenous nominal income (or weekly budget) M and market prices P_x and P_y, the affordable consumption set consists of all non-negative bundles (x, y) satisfying $P_x x + P_y y \leq M$. Assuming non-satiation, the consumer spends the entire budget on the boundary line, which rearranges into slope-intercept form as:

$$y = \frac{M}{P_y} - \left(\frac{P_x}{P_y}\right) x$$

Where:

- M is nominal income (budget) in Australian dollars.
- P_x and P_y are the unit prices of goods x and y.
- M/P_y and M/P_x are the real purchasing power intercepts in units of y and x.
- P_x/P_y is the magnitude of the budget line's slope, measuring the market opportunity cost of good x in terms of forgone units of good y.

An increase in income M (holding prices constant) shifts the budget line outward in parallel, expanding the feasible set without altering the relative price P_x/P_y. A uniform proportional inflation that doubles P_x, P_y, and M simultaneously leaves the budget constraint completely unchanged—demonstrating the absence of money illusion. By contrast, a fall in P_x alone leaves the vertical intercept M/P_y fixed while rotating the horizontal intercept M/P_x outward, flattening the budget line.

Real-world Australian policies often produce kinked or piecewise-linear budget constraints. For instance, an energy bill rebate or a capped Child Care Subsidy creates a horizontal or kinked segment over an initial threshold, whereas progressive overtime pay or tiered electricity tariffs alter the slope P_x/P_y beyond a cutoff quantity. Similarly, an in-kind voucher (e.g., a $100 NSW or Victorian voucher restricted solely to cultural venues) shifts the budget constraint horizontally up to the voucher amount, creating a vertical kink at the free threshold.

2.2 Tangency Condition and Corner Solutions

The rational consumer chooses (x^*, y^*) to reach the highest attainable indifference curve subject to the budget constraint. At an **interior optimum** $(x^* > 0, y^* > 0)$ with smooth convex preferences, the indifference curve must be strictly tangent to the budget line. Intuition confirms why: if $MRS_{x,y} > P_x/P_y$, the consumer values one more unit of x more highly (in forgone y) than the market charges for it, so shifting expenditure from y to x raises utility. Conversely, if $MRS_{x,y} < P_x/P_y$, shifting expenditure from x to y raises utility. Gains from reallocation vanish only when:

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$$MRS_{x,y} = \frac{P_x}{P_y} \iff \frac{MU_x}{P_x} = \frac{MU_y}{P_y}$$

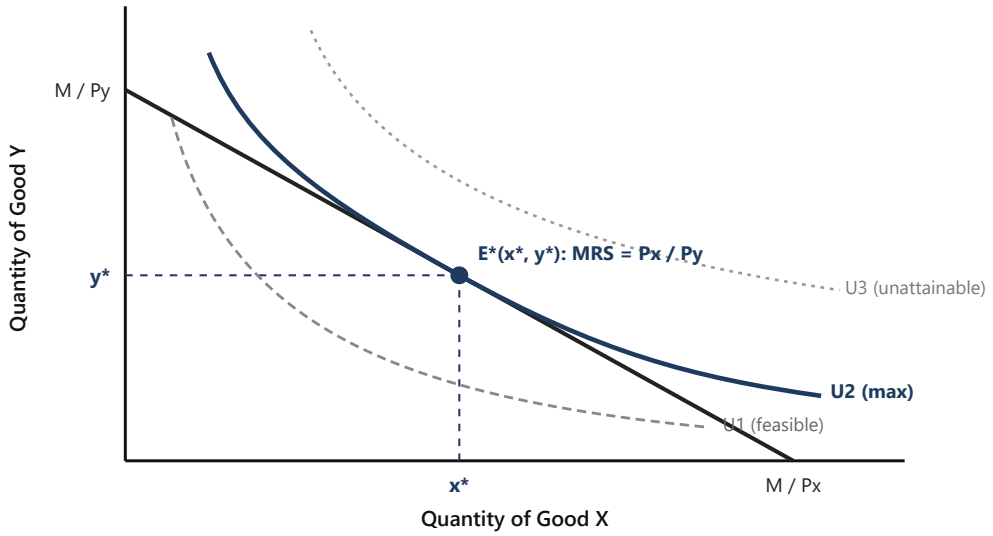
Where:

- MU_x/P_x is the marginal utility per dollar spent on good x ("bang for the buck").
- MU_y/P_y is the marginal utility per dollar spent on good y.

This equimarginal principle states that at the optimal bundle, the final dollar spent on every purchased good yields identical incremental utility. Note two essential exceptions where tangency fails: first, for **perfect complements** ($U = \min\{ax, by\}$), the optimum always sits at the L-shaped vertex where $ax = by$ on the budget line; second, for **perfect substitutes** ($U = ax + by$) or steep non-convex preferences, the consumer typically selects a **corner solution** spending the entire budget on whichever good yields the higher marginal utility per dollar ($a/P_x > b/P_y \implies x^* = M/P_x, y^* = 0$).

Figure 2.1 illustrates the geometric tangency at $E^*(x^*, y^*)$, where the highest reachable indifference curve U_2 kisses the budget line without crossing it, whereas lower curve U_1 intersects the budget line at two sub-optimal bundles and higher curve U_3 lies outside the feasible budget set.

Figure 2.1: Optimal Consumption Bundle at Budget-Indifference Tangency



Worked Example 2.2: Solving for the Optimal Consumption Bundle

Suppose a university student in Clayton allocates a weekly entertainment and dining budget of $M = 120$ between cinema tickets (x, priced at $P_x = 20$) and café lunches (y, priced at $P_y = 15$). Preferences follow $U(x, y) = x^{0.4}y^{0.6}$, for which Example 2.1 established $MRS_{x,y} = \frac{2}{3} \cdot \frac{y}{x}$.
Step 1 (Apply the Tangency Condition): Set $MRS_{x,y} = P_x/P_y$:

$$\frac{2y}{3x} = \frac{20}{15} = \frac{4}{3} \implies 2y = 4x \implies y = 2x$$

Where:

- $y = 2x$ defines the consumer's income-expansion ray along which marginal utility per dollar is equalised.

Step 2 (Substitute into the Budget Constraint): The budget line is $P_x x + P_y y = 20x + 15y = 120$. Substituting $y = 2x$:

$$20x + 15(2x) = 120 \implies 50x = 120 \implies x^* = 2.4$$

Where:

- $x^* = 2.4$ is the optimal number of cinema tickets per week (or 12 tickets over 5 weeks).

Step 3 (Solve for y^* and Verify Expenditure Shares): $y^* = 2(2.4) = 4.8$ café lunches per week. Expenditure on x is $P_x x^* = 20 \times 2.4 = 48$ dollars (exactly 40 per cent of $M = 120$), and expenditure on y is $P_y y^* = 15 \times 4.8 = 72$ dollars (exactly 60 per cent of $M = 120$). This confirms a hallmark property of Cobb-Douglas utility: optimal budget shares equal the normalized utility exponents $\alpha/(\alpha + \beta)$ and $\beta/(\alpha + \beta)$, independent of prices.

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Chapter 3: Income Effects, Substitution Effects and Labour-Leisure Choice

3.1 Deriving Demand and Engel Curves

Tracing optimal bundles as nominal income M rises (with prices fixed) traces the **income-consumption path**, from which we extract the **Engel curve** relating x^* to M. If x^* rises with M, good x is *normal*; if x^* falls as M rises (because the consumer substitutes toward higher-quality alternatives), good x is *inferior*. Similarly, varying P_x (with M and P_y fixed) traces the **price-consumption path**, from which we directly read the individual's downward-sloping demand curve $x^*(P_x)$.

3.2 Income and Substitution Effects of a Price Change

When the price of good x falls from P_x^1 to P_x^2, the consumer alters consumption of x for two conceptually distinct reasons, known as the **Hicks-Slutsky decomposition**:

1. **Substitution Effect (SE):** Holding purchasing power (real utility) constant at the initial level U_1, the fall in P_x makes good x cheaper relative to good y. Because MRS diminishes along a convex indifference curve, the consumer moves along U_1 to a flatter tangent slope P_x^2/P_y, substituting toward x and away from y. By the convexity of preferences, the own-price substitution effect is *always* negative with respect to price: a price fall always raises x via SE ($\Delta x_{SE} > 0$).
2. **Income Effect (IE):** The fall in P_x also increases the consumer's real purchasing power, shifting the consumer from U_1 to a higher indifference curve U_2 at the new relative price. For a **normal good**, higher real income increases demand ($\Delta x_{IE} > 0$), reinforcing the substitution effect and guaranteeing a downward-sloping demand curve. For an **inferior good**, higher real income reduces demand ($\Delta x_{IE} < 0$), opposing the substitution effect.

$$\Delta x_{\text{Total}} = \Delta x_{SE} + \Delta x_{IE}$$

Where:

- $\Delta x_{\text{Total}} = x(P_x^2, M) - x(P_x^1, M)$ is the observed total change in quantity demanded.
- Δx_{SE} is the compensated substitution change along the initial indifference curve (Hicks) or through the initial bundle (Slutsky).
- Δx_{IE} is the pure purchasing-power shift between the compensated bundle and the final bundle.

In the rare theoretical case of a **Giffen good**, a staple good is so strongly inferior and absorbs such a large share of a poor household's budget that the negative income effect outweighs the positive substitution effect ($|\Delta x_{IE}| > \Delta x_{SE}$), causing quantity demanded to fall when price falls (an upward-sloping demand curve).

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3.3 The CORE Econ Labour-Leisure (Free-Time) Choice Model

CORE Econ applies the identical constrained-optimisation apparatus to labour supply. Suppose a worker has 24 hours per day to divide between **free time (t)** and **paid work ($h = 24 - t$)** at an hourly wage w, plus non-labour income y_0 (e.g., government family benefits or investment dividends). Daily consumption expenditure c is constrained by:

$$c = w(24 - t) + y_0 \implies c + wt = 24w + y_0$$

Where:

- c is daily consumption spending in dollars (price normalised to 1).
- t is daily hours of free time ($t \in [0, 24]$), whose opportunity cost per hour is the wage w.
- $M_{\text{full}} = 24w + y_0$ is "full income"—the maximum consumption attainable if the worker worked all 24 hours.

Here the feasible consumption frontier has slope $-w$ ($MRT_{t,c} = w$). Maximising utility $U(t, c)$ requires setting $MRS_{t,c} = w$: the worker chooses free time until the subjective marginal value of an extra hour of leisure equals the market wage. When the hourly wage w rises, two opposing forces act on free time t: the **substitution effect** raises the opportunity cost of leisure, inducing the worker to take less free time and work more hours; the **income effect** makes the worker richer for every hour already worked, inducing the worker to consume more free time (since leisure is a normal good) and work fewer hours. At low wages, the substitution effect typically dominates (upward-sloping labour supply); at high wages, the income effect can dominate, generating a **backward-bending individual labour supply curve**—explaining why average annual working hours in Australia and Western Europe fell substantially over the twentieth century even as real wages surged.

Worked Example 2.3: Slutsky Decomposition of a Price Decrease

Suppose a household has budget $M = 160$, faces initial prices $P_x^1 = 8$ and $P_y = 4$, and holds Cobb-Douglas utility $U(x, y) = x^{0.5}y^{0.5}$ (yielding Marshallian demands $x = \frac{M}{2P_x}$ and $y = \frac{M}{2P_y}$). Now P_x falls to $P_x^2 = 4$.

Step 1 (Initial and Final Bundles):
Initially, $x_1 = \frac{160}{2(8)} = 10$ and $y_1 = \frac{160}{2(4)} = 20$.
After the price cut, $x_2 = \frac{160}{2(4)} = 20$ and $y_2 = \frac{160}{2(4)} = 20$. Total change in x is $\Delta x_{\text{Total}} = 20 - 10 = +10$ units.

Step 2 (Slutsky Compensated Income & Substitution Effect): Under Slutsky compensation, adjust income to M' so the original bundle $(10, 20)$ remains just affordable at the new prices ($P_x^2 = 4, P_y = 4$):

$$M' = P_x^2 x_1 + P_y y_1 = 4(10) + 4(20) = 120$$

Where:

- $M' = 120$ is the Slutsky-compensated nominal budget holding initial purchasing power constant.

At budget $M' = 120$ and new prices, the compensated demand for x is $x_s = \frac{120}{2(4)} = 15$ units.

Step 3 (Separate SE and IE):

$$\Delta x_{SE} = x_s - x_1 = 15 - 10 = +5, \qquad \Delta x_{IE} = x_2 - x_s = 20 - 15 = +5$$

Where:

- $\Delta x_{SE} = +5$ is the pure relative-price substitution response.
- $\Delta x_{IE} = +5$ is the pure purchasing-power expansion (confirming x is a normal good).

Together, $+5 + 5 = +10$ units accounts for the entire observed demand increase.

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Chapter 4: Behavioural Economics, Bounded Rationality and Policy Nudges

4.1 Departures from Neoclassical Rationality

Standard consumer theory assumes unbounded cognitive calculation, perfect willpower, and pure self-interest. Empirical psychology and experimental economics—pioneered by Herbert Simon, Daniel Kahneman, Amos Tversky, and Richard Thaler—demonstrate systematic, predictable departures from this benchmark along three dimensions:

- **Bounded Rationality:** Human attention, working memory, and computational capacity are scarce. Rather than solving global optimisation problems, agents rely on mental shortcuts (**heuristics**) and "satisficing" rules that work well in routine settings but generate systematic errors in complex financial or probabilistic choices.
- **Bounded Willpower:** Individuals frequently act against their own long-run plans—procrastinating on superannuation consolidation, overspending on buy-now-pay-later credit, or failing to cancel unused subscriptions.
- **Bounded Self-Interest (Social Preferences):** As CORE Econ documents extensively through Ultimatum Game, Dictator Game, and Public Goods experiments, real people exhibit altruism, reciprocity, and **inequality aversion**. In Australian and international Ultimatum Game trials, responders routinely reject positive monetary splits below 20–30 per cent of the endowment to punish unfair offers, contradicting narrow self-interest.

4.2 Heuristics, Framing, and Prospect Theory

Kahneman distinguishes fast, automatic, intuitive thinking (**System 1**) from slow, deliberative, analytical reasoning (**System 2**). Because System 1 dominates everyday choices, several cognitive biases shape market outcomes:

- **Anchoring:** Arbitrary initial reference numbers (such as inflated "recommended retail prices" next to sale tags) distort willingness-to-pay judgments.
- **Availability Heuristic:** Agents judge event probabilities by how vividly examples come to mind rather than statistical base rates, leading to over-insurance after dramatic natural disasters and under-insurance for chronic risks.
- **Framing and Status Quo Bias:** Logically equivalent descriptions elicit opposite choices depending on whether outcomes are framed as gains or losses, and consumers disproportionately retain pre-selected defaults.

To replace Expected Utility Theory for risky choices, Kahneman and Tversky developed **Prospect Theory**. Instead of evaluating final wealth levels, agents evaluate changes Δx relative to a **reference point** using an S-shaped value function $v(\Delta x)$ that is concave over gains (risk aversion in gains), convex over losses (risk seeking to avoid sure losses), and roughly twice as steep for losses as for equivalent gains—a property called **loss aversion**:

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$$v(\Delta x) = \begin{cases} (\Delta x)^{\alpha} & \text{if } \Delta x \geq 0 \\ -\lambda(-\Delta x)^{\beta} & \text{if } \Delta x < 0 \end{cases}$$

Where:

- $\Delta x = x - x_0$ is the outcome deviation from the decision-maker's reference point x_0.
- $\alpha, \beta \in (0, 1)$ capture diminishing sensitivity to gains and losses (empirical median ≈ 0.88).
- $\lambda > 1$ is the loss-aversion coefficient (empirically $\lambda \approx 2.25$, meaning a \$100 loss hurts more than twice as much as a \$100 gain pleases).

4.3 Intertemporal Choice, Present Bias and Time Inconsistency

Standard economic models assume exponential discounting, where utility at future period t is weighted by δ^t ($\delta \in (0, 1)$). Because the discount ratio between period t and $t + 1$ is always δ, exponential discounters are **time consistent**: plans made today remain optimal tomorrow. However, empirical choice experiments reveal **present bias**, captured by Laibson's quasi-hyperbolic (β-δ) discounting model:

$$U_0 = u_0 + \beta \sum_{t=1}^{T} \delta^t u_t$$

Where:

- u_t is instantaneous utility experienced in period t.
- $\delta \in (0, 1)$ is the standard long-run exponential discount factor per period.
- $\beta \in (0, 1)$ is the short-run present-bias parameter (if $\beta = 1$, the model collapses to standard exponential discounting).

When $\beta < 1$, the agent values today disproportionately relative to *any* future date, creating **time inconsistency**: from today's perspective, saving next month looks attractive (both next month and the month after are discounted by β, so their relative weight is just δ); when next month arrives, immediate consumption suddenly receives weight 1 against $\beta\delta$, tempting the agent to defer saving again. **Naive** agents fail to anticipate this preference reversal and perpetually procrastinate, whereas **sophisticated** agents recognise their present bias and adopt **commitment devices**—such as illiquid superannuation accounts, automatic payroll deductions, or binding savings lockboxes.

4.4 Libertarian Paternalism and Australian Policy Nudges

Thaler and Sunstein coined **libertarian paternalism** to describe choice-architecture interventions ("nudges") that steer boundedly rational agents toward welfare-improving decisions while preserving complete freedom to opt out without material financial penalty. Australia has been an international leader in embedding behavioural economics in regulation and public administration through the Behavioural Economics Team of the Australian Government (BETA) and state behavioural units:

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- **Default Superannuation (MySuper):** Because status quo bias and present bias discourage active fund selection, Australian employers automatically enrol workers into regulated low-fee MySuper default funds unless the employee actively opts into an alternative, dramatically boosting retirement wealth compared to opt-in systems.
- **ATO Tax Compliance & Social Norms:** Timely SMS reminders and letters highlighting that "9 out of 10 Australians pay their tax on time" leverage social norms and salience to lift on-time lodgement without increasing audit penalties.
- **ACL & ASIC Drip-Pricing Bans:** Under the Australian Consumer Law (*Competition and Consumer Act 2010*), regulators prohibit hidden mandatory surcharges ("drip pricing") in airline and ticketing checkouts because shrouding fees exploits bounded attention and anchoring.

Worked Example 2.4: Exponential vs. Present-Biased Decision Making

Suppose an employee decides whether to complete an annoying 1-hour voluntary superannuation salary-sacrifice form that imposes an immediate effort disutility of -12 utils when completed, in exchange for a future retirement tax-saving benefit worth $+20$ utils next period. Assume long-run discount factor $\delta = 0.95$. Compare a time-consistent agent ($\beta = 1$) with a present-biased agent ($\beta = 0.5$):

Step 1 (Planning Today to Complete the Form Tomorrow): Both periods are in the future, so the present-biased agent discounts both by β:

$$U_{\text{plan}}^{\text{PB}} = 0 + 0.5\,[0.95(-12) + 0.95^2(20)] = 0.5\,[-11.40 + 18.05] = +3.325 > 0$$

Where:

- $\delta u_1 = 0.95(-12)$ is the discounted effort cost in period 1 and $\delta^2 u_2 = 0.95^2(20)$ is the discounted benefit in period 2.

Both the exponential discounter ($U_{\text{plan}}^{\text{Exp}} = +6.65$) and the present-biased agent plan to submit the form tomorrow.

Step 2 (Evaluating the Choice When Tomorrow Arrives): Now the effort cost occurs immediately (weight 1), whereas the $+20$ benefit sits one period ahead:

For the exponential discounter ($\beta = 1$): $U_{\text{now}}^{\text{Exp}} = -12 + 0.95(20) = -12 + 19 = +7.0 > 0$ (completes the form as planned).

For the present-biased agent ($\beta = 0.5$):

$$U_{\text{now}}^{\text{PB}} = -12 + 0.5(0.95)(20) = -12 + 9.5 = -2.5 < 0$$

Where:

- $\beta\delta = 0.5 \times 0.95 = 0.475$ is the effective immediate-to-next-period discount factor under present bias.

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Because $-2.5 < 0$, the present-biased agent reverses her plan and procrastinates—demonstrating why automatic opt-out enrolment in MySuper outperforms purely voluntary opt-in registration.

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