

中级微观经济学

Instructed by 邢建炜

VectorPikachu¹ 

¹Peking University

生活试图把我惹毛



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章节 1. Introduction

What do we cover?

- Consumer Theory (Preferences, utility)
- Equilibrium
- Firm technology, Profit maximization
- Firm supply
- Market structure (competition, monopoly, oligopoly)
- Externalities and public goods
- Game Theory
- Information

Problem Set: 15%, Group presentation: 10%, Midterm: 30%, Final: 45%.

我们将主要使用 [Varian \(2014\)](#) 作为教材.

Examples:

- Airfare. Relationship between the ticket price and the departure time. High demand → Charging high price.
- Streaming Media. 2 Strategies: Membership subscription and Individual purchase(Pay-per-view).
- Charity-linked products.
- Urban Green.
- Electric Vehicles. Subsidize the purchase of electric vehicles.

章节 2. Consumer Theory

Economic Modeling:

- Who are the participants?
- Some assumptions:
 - Rational Choice: A person chooses the best alternative available.
 - Equilibrium: The market is in equilibrium.

Consumer Choice. → Preference

Consumers are assumed to choose the best bundle of goods they can afford.

- Best:
- Can afford: Allocated budget.

Consumption Choice Sets A consumption choice set is the collection of *all* consumption choices available to the consumer.

What *constraints* consumption choice?

- Budget
- Time
- Other resource limitations

Consumption Bundle A consumption bundle containing x_1 units of commodity 1, x_2 units of commodity 2 and so on up to x_n units of commodity n is denoted by the vector (x_1, x_2, \dots, x_n) .

Assume commodity prices are p_1, p_2, \dots, p_n .

Budget Constraints

$$p_1 x_1 + p_2 x_2 + \dots + p_n x_n \leq m \quad (2.1)$$

where m is the consumer's (disposable) income.

Budget Set

$$B(p_1, p_2, \dots, p_n, m) \quad (2.2.1)$$

$$= \{(x_1, x_2, \dots, x_n) \mid x_1 \geq 0, x_2 \geq 0, \dots, x_n \geq 0, p_1 x_1 + p_2 x_2 + \dots + p_n x_n \leq m\} \quad (2.2.2)$$

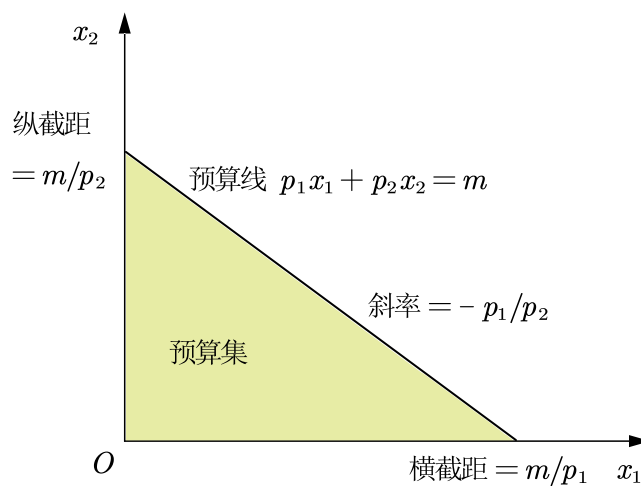


Figure 2.1: Budget Constraints

- Which is affordable? Unaffordable? Just affordable?

If $n = 3$ what do the budget constraints look like?

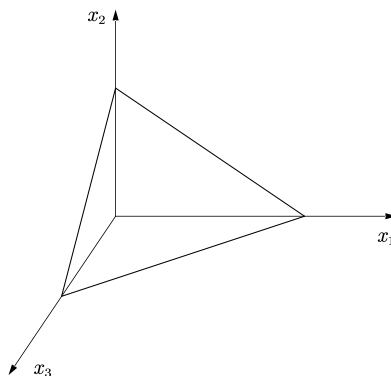


Figure 2.2: 3-dimensional Budget Constraints

In other words, **opportunity cost** of an extra unit of commodity 1 is p_1/p_2 units foregone of commodity 2.

Higher income gives more choice. improve consumer welfare.

enlarging, shrinking

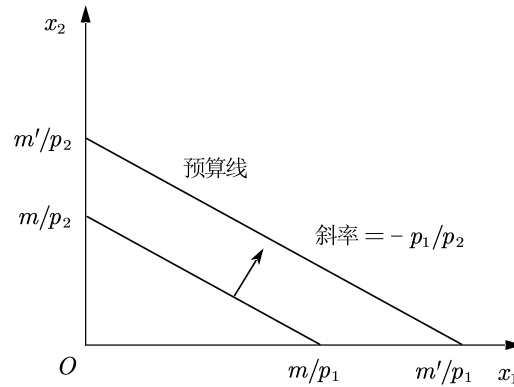


Figure 2.3: Higher Income

Increasing one price pivots the constraint inwards, reduces choice and will make the consumer worse off.

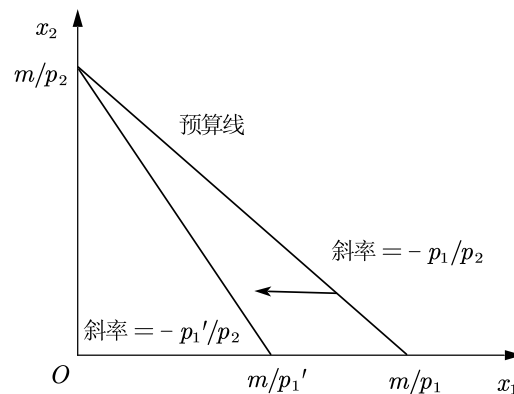


Figure 2.4: Increasing one price

- Q: If the economy is weak and so is consumer demand, what should the policy makers do to stimulate consumption?
- A: Reduce tax rate, sending cash to consumers. PRICE: subsidy.

Price changes: High demand, low supply.

2.1. *Ad Valorem* Sales Tax

Original price: $p \rightarrow$ New price: $(1+t)p$.

A **uniform** sales tax is applied uniformly to all goods.

$$(1+t)p_1x_1 + (1+t)p_2x_2 \leq m \quad (2.3.1)$$

$$\Rightarrow p_1x_1 + p_2x_2 \leq \frac{m}{1+t} \quad (2.3.2)$$

Remark: The tax essentially discount the income. And the equivalent income loss is

$$m - \frac{m}{1+t} = \frac{t}{1+t}m. \quad (2.4)$$

2.1.1. Example: The food stamp program

How does a commodity-specific gift such as a food stamp alters a family's budget constraint?

Suppose $m = 100$, $p_F = 1$ (food), "other goods" $p_G = 1$, the budget constraint is:

$$F + G \leq 100. \quad (2.5)$$

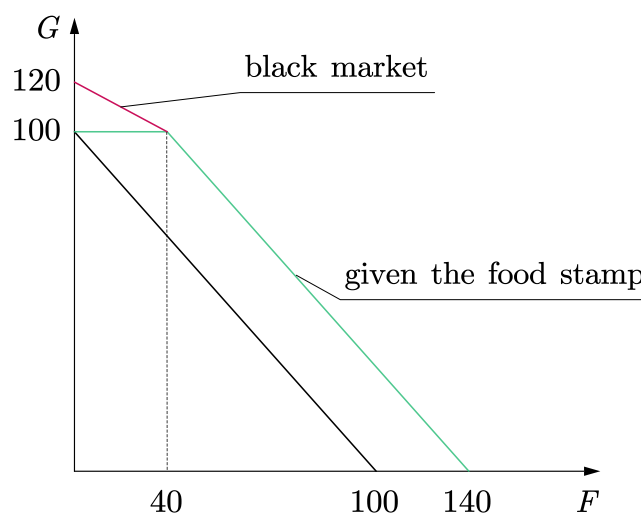


Figure 2.5: The food stamp program

Black market trading makes the budget set even larger. **Black market improve consumer welfare.**

2.2. Relative Price

Numeraire unit of account.

Changing the numeraire changes neither the budget constraint nor the budget set.

Any commodity can be chosen as the numeraire without changing the budget set or the budget constraint.

A straight line: **constant relative price.**

Quantity discounts:

Suppose $p_2 = 1$ is constant and $p_1 = 2$ when $0 \leq x_1 \leq 20$ and $p_1 = 1$ when $x_1 > 20$. The figure is like [Figure 2.6](#).

Q: Is price always positive?

Commodity 1 is stinky garbage. You are paid \$2 per unit to accept it; $p_1 = -2, p_2 = 1$.

$$-2x_1 + x_2 \leq 10 \quad (2.6)$$

Like in [Figure 2.7](#).

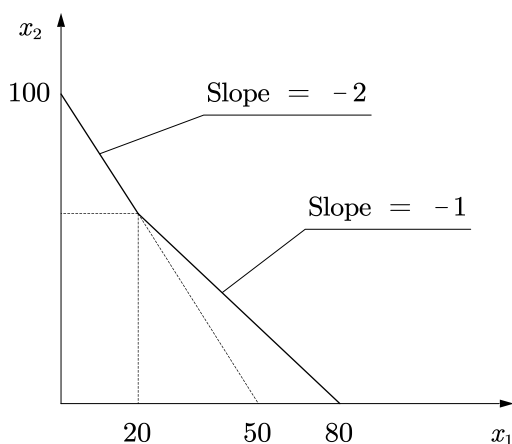


Figure 2.6: Quantity discounts

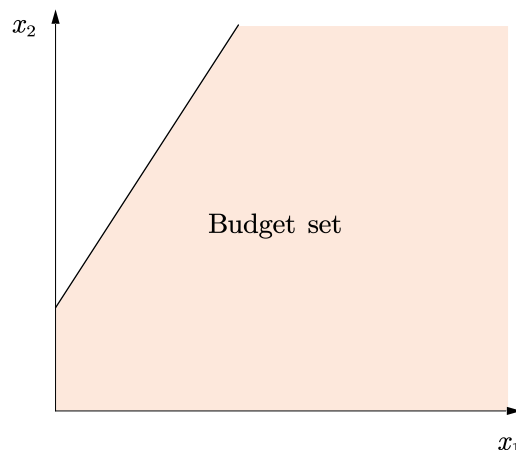


Figure 2.7: Negative prices

e.g.

示例 2.2.1

Why the consumption bundle in Figure 2.7 is unlimited?

双学位: A second degree in economics.

2.3. Multiple Constraints

Food Consumption vs Other Stuff.

- At least 10 units of food must be eaten to survive
- Budget constrained.
- Further restricted by a time constraint.

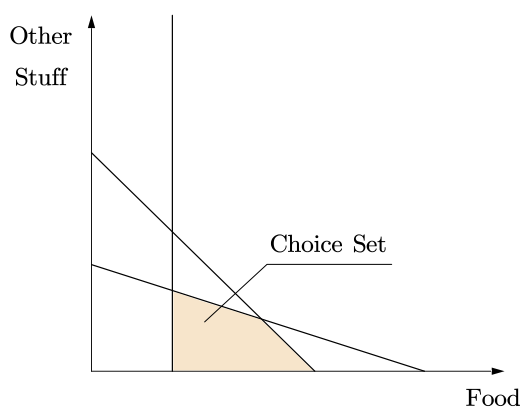


Figure 2.8: Multiple Constraints

章节 3. Preference and Utility

Consumers are assumed to choose the **best** bundle of goods they **can afford**.

Rationality in Economics: A decision maker always chooses its **most preferred** alternative from its set of available alternatives.

3.1. Preference Relations

strict preference x is **more** preferred than y .

weak preference x is **at least as** preferred as y .

indifference x is **exactly** as preferred as y .

They are **ordinal relations**: only **the order** is important.

\succ denotes strict preference. $x \succ y$ iff x is more preferred than y .

\sim denotes indifference. $x \sim y$ iff x is exactly as preferred as y .

\succeq denotes weak preference.

- $x \succeq y$ and $y \succeq x$ imply $x \sim y$.
- $x \succeq y$ and $\neg(y \succeq x)$ imply $x \succ y$.

Assumptions on preference relations:

1. **Completeness**. \forall bundles x and y , either $x \succeq y$ or $y \succeq x$.
2. **Reflexivity**. \forall bundles x , $x \succeq x$.
3. **Transitivity**. $x \succeq y$ and $y \succeq z$ imply $x \succeq z$.

3.2. Indifference Curve

Indifference curve: a set of bundles that are equally preferred.

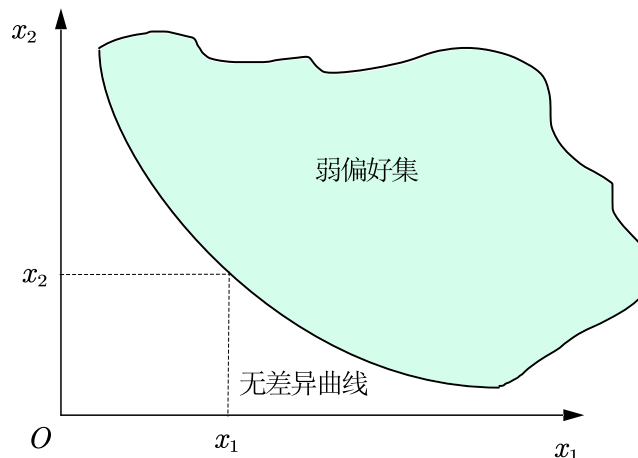


Figure 3.1: Indifference Curve

- $WP(x)$: the set of all bundles that are weakly preferred to x .
- $I(x)$: the set of all bundles that are indifferent to x .
- $I(x) \subseteq WP(x)$.



提示 3.2.1

Indifference curves cannot cross.

Proof: Suppose the intersection of two indifference curves is A . Then A is indifferent to B and C . But B and C are not indifferent to each other.

□

When more of a commodity is always preferred, the commodity is a **good**. If every commodity is a good then indifference curves are negatively sloped.

If less of a commodity is always preferred then the commodity is a **bad**. 1 Good and 1 bad: indifference curves are positively sloped.

3.3. Extreme Cases of Indifference Curves

3.3.1. Perfect Substitutes

If a consumer always regards units of commodities 1 and 2 as equivalent, the commodities are perfect substitutes and only the **total amount** of the two commodities in bundles determines their preference rank-order.

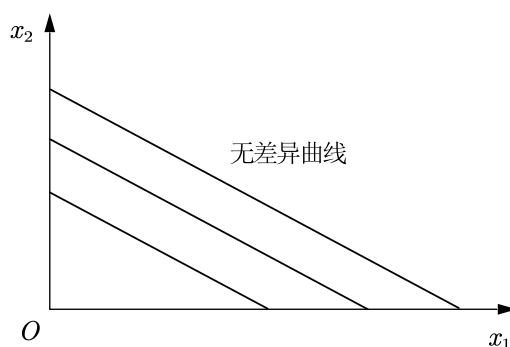


Figure 3.2: Perfect Substitutes

3.3.2. Perfect Complements

Fixed proportions of commodities 1 and 2 are required to provide utility.

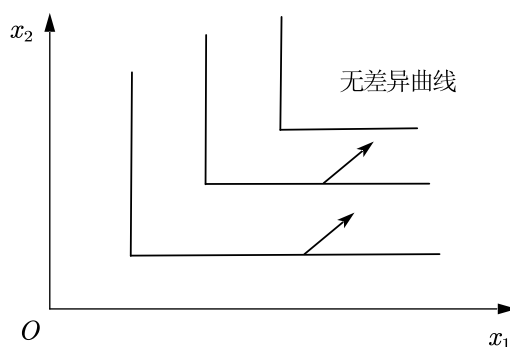


Figure 3.3: Perfect Complements

A L-shaped indifference curve. 45°.

3.3.3. Example: Good and Bad

You like pizzas but hate vegetables. You are only willing to eat an extra unit of vegetable if you get to eat an extra unit of pizza.

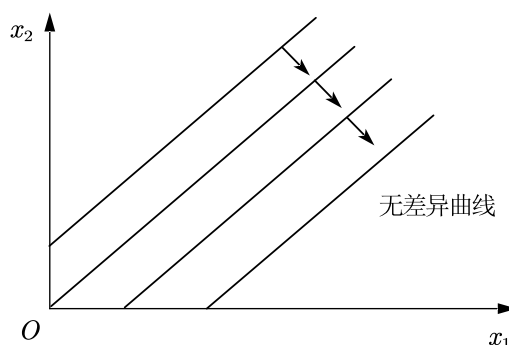


Figure 3.4: Good and Bad

3.3.4. Example: Satiation

You always want to study for 6 hours and workout for 2 hours. Any deviation from it gives you a lower utility level. **Optimal bundle**.

⇒ A satiation point.

3.4. Preferences Exhibiting Satiation

A bundle strictly preferred to any other is a **satiation point** or a **bliss point**.

Why the shape is a circle? Because Any deviation from the satiation point gives you a lower utility level.

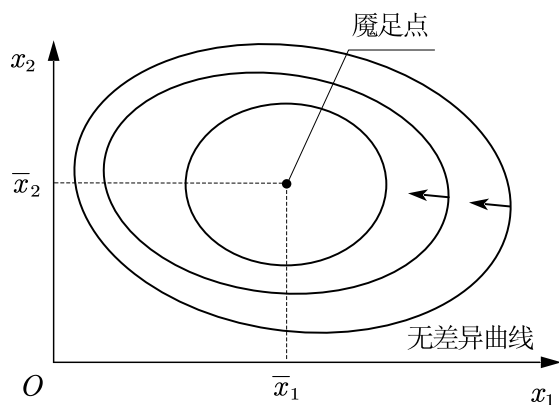


Figure 3.5: Satiation Point

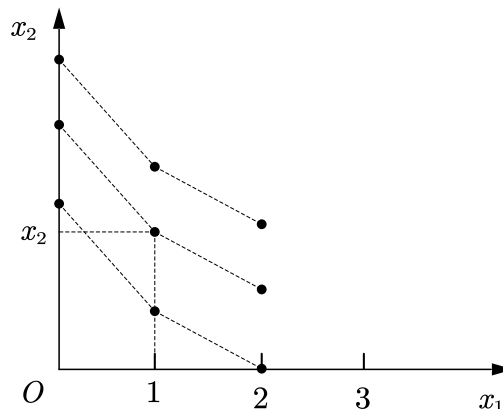


Figure 3.6: Indifferent Curves for Discrete Goods

3.5. Indifferent Curves for Discrete Goods

Like in Figure 3.6.

3.6. Well-Behaved Preferences

1. **Monotonic**. More is better or Less is better. (Satiation is a violation of this.)
2. **Convexity**. Mixtures are preferred to extremes. $\forall 0 < t < 1$,

$$tx + (1 - t)y \succ x = y. \quad (3.1)$$

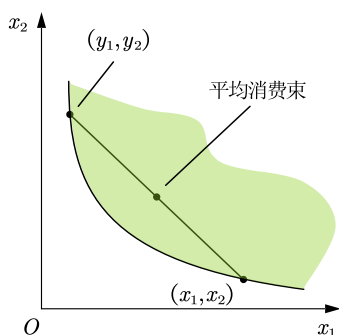


Figure 3.7: Convexity

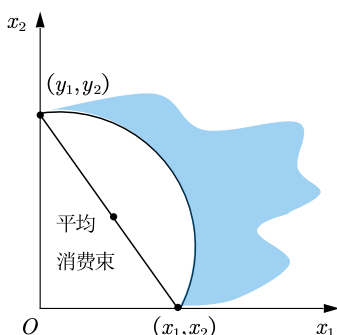


Figure 3.8: Concavity

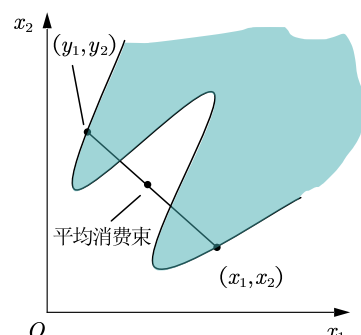


Figure 3.9: Mixture of Convexity and Concavity

For the most part, goods are consumed together. \Rightarrow Convexity.

3.7. Slopes of Indifference Curves

The slope of an indifference curve (at a given point) is its **marginal rate-of-substitution (MRS)**.

$$\text{MRS} = \frac{dx_2}{dx_1} \text{ at } x'. \quad (3.2)$$

Properties:

- Two goods $\Rightarrow \text{MRS} < 0$.
- One good and one bad $\Rightarrow \text{MRS} > 0$.
- Convex $\Leftrightarrow \text{MRS}$ always increases with x_1 .

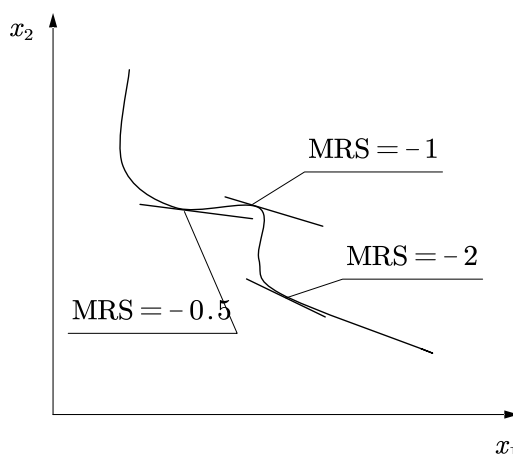


Figure 3.10: Violation of Convexity

3.8. Utility Function

Another way to represent preferences.

We can assign a number to every possible consumption bundle such that more-preferred bundles get assigned larger numbers than less preferred bundles.

The thing can be observed is **the choices** made by the consumer.

- Consumers make choices so as to maximize their utility to make themselves as happy as possible.

Continuity.

$$x' \succ x'' \Leftrightarrow U(x') > U(x'') \quad (3.3.1)$$

$$x' \prec x'' \Leftrightarrow U(x') < U(x'') \quad (3.3.2)$$

$$x' \sim x'' \Leftrightarrow U(x') = U(x'') \quad (3.3.3)$$

Utility is an ordinal concept. The value of utility is not important, only the **order** of the utility values. How much higher doesn't matter.

There is no **unique** utility function representation of a preference relation.

$U(x_1, x_2) = x_1 x_2$, and we can define $V(x_1, x_2) = x_1^2 x_2^2$, preserves the order of the utility values.



提示 3.8.1

U is a utility function represents a preference relation, and f is a strictly increasing function, then $f(U)$ also represents the same preference relation.

3.8.1. Perfect Substitution

$$U(x_1, x_2) = x_1 + x_2. \quad (3.4)$$

The pizza & vegetable example: $U(x_1, x_2) = x_1 - x_2$.

3.8.2. Perfect Complements

e.g. Left and right shoes, pencils and erasers, fries and ketchup, game consoles and games.

$$U(x_1, x_2) = \min\{x_1, x_2\}. \quad (3.5)$$

3.8.3. Quasi-linear Utility Function

Def

定义 3.8.1

A utility function of the form

$$U(x_1, x_2) = f(x_1) + x_2 \quad (3.6)$$

is linear in just x_2 and is called a **quasi-linear utility function**.

3.8.4. Cobb-Douglas Utility Function

Def

定义 3.8.2

A utility function of the form

$$U(x_1, x_2) = x_1^a x_2^b \quad (3.7)$$

is called a **Cobb-Douglas utility function**.

Well-behaved.

3.9. Marginal Utility

E.g. consider $U(x_1, x_2) = x_1^{1/2} x_2^2$, then

$$MU_1 = \frac{\partial U}{\partial x_1} = \frac{1}{2} x_1^{-1/2} x_2^2, \quad (3.8.1)$$

$$MU_2 = \frac{\partial U}{\partial x_2} = 2 x_1^{1/2} x_2. \quad (3.8.2)$$

Totally differentiating this identity gives

$$\frac{\partial U}{\partial x_1} dx_1 + \frac{\partial U}{\partial x_2} dx_2 = 0. \quad (3.9)$$

$$\Rightarrow \frac{dx_2}{dx_1} = -\frac{\partial U / \partial x_1}{\partial U / \partial x_2}. \quad (3.10)$$

This is the **MRS**.

3.9.1. MRS for Quasi-linear Utility Function

$$\frac{\partial U}{\partial x_1} = f'(x_1), \quad \frac{\partial U}{\partial x_2} = 1. \quad (3.11.1)$$

$$\Rightarrow \text{MRS} = \frac{dx_2}{dx_1} = -\frac{\partial U / \partial x_1}{\partial U / \partial x_2} = -f'(x_1). \quad (3.11.2)$$

MRS does not depend on x_2 . So the slope of indifference curves for a quasi-linear utility function is constant along any line for which x_1 is constant.

3.9.2. Monotonic Transformation & MRS

If $V = f(U)$, we have

$$\text{MRS} = -\frac{\partial V / \partial x_1}{\partial V / \partial x_2} = -\frac{f'(U) \times \partial U / \partial x_1}{f'(U) \times \partial U / \partial x_2} = -\frac{\partial U / \partial x_1}{\partial U / \partial x_2}. \quad (3.12)$$

So MRS is **unchanged** by a positive monotonic transformation.

e.g.

示例 3.9.1

Linda's preferences over magazines (M) and books (B) are given by:

$$U(M, B) = 3M^{\frac{2}{3}} + 6B^{\frac{2}{3}}. \quad (3.13)$$

Are Linda's preferences convex or not?

章节 4. Choice and Demand

A decision maker chooses its most preferred alternative from those available to it.

4.1. Rational Constrained Choice

To find the bundle in the budget set that is on the **highest** indifference curve.

Since preferences are well-behaved, (more is preferred to less), we can focus on the bundles that line on the budget line.

The Rational Constrained Choice is:

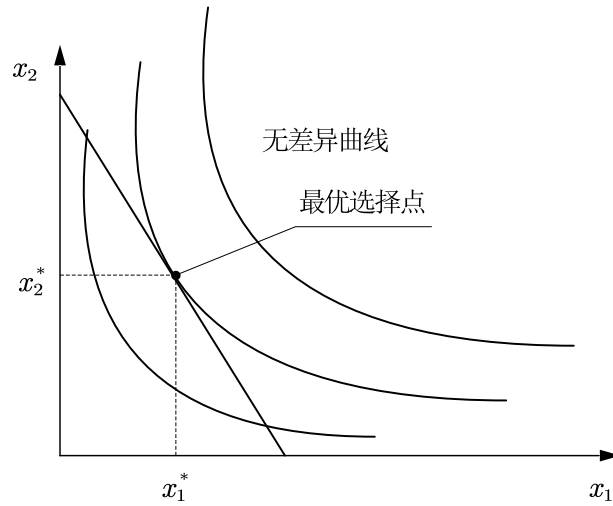


Figure 4.1: Rational Constrained Choice

(x_1^*, x_2^*) is the most preferred bundle on the budget line.

Ordinary Demand Ordinary demands will be denoted by $x_1^*(p_1, p_2, m)$ and $x_2^*(p_1, p_2, m)$.

The most preferred affordable bundle is the consumer's **ORDINARY DEMAND** at the given prices and budget.

$x_1^* > 0$ and $x_2^* > 0 \Rightarrow$ the demand bundle is **INTERIOR**. 注: *interior*, 内部的

If buying (x_1^*, x_2^*) costs m , then the budget is **exhausted** since

$$p_1 x_1^* + p_2 x_2^* = m. \quad (4.1)$$

所以, in Figure 4.1, (x_1^*, x_2^*) is interior and exhausts the budget.

The slope of the indifference curve at (x_1^*, x_2^*) is equal to the slope of the budget line.

1. the budget is exhausted:

$$p_1 x_1^* + p_2 x_2^* = m \quad (4.2)$$

2. the slope of the budget constraint $-\frac{p_1}{p_2}$ and the slope of the indifference curve containing (x_1^*, x_2^*) are equal at (x_1^*, x_2^*) .

4.2. Computing Ordinary Demands

Suppose that the consumer has Cobb-Douglas preferences:

$$U(x_1, x_2) = x_1^a x_2^b. \quad (4.3)$$

Then

$$MU_1 = \frac{\partial U}{\partial x_1} = a x_1^{a-1} x_2^b, \quad (4.4.1)$$

$$MU_2 = \frac{\partial U}{\partial x_2} = b x_1^a x_2^{b-1}. \quad (4.4.2)$$

So the MRS is

$$MRS = -\frac{\partial U / \partial x_1}{\partial U / \partial x_2} = -\frac{a x_1^{a-1} x_2^b}{b x_1^a x_2^{b-1}} = -\frac{a x_2}{b x_1}. \quad (4.5)$$

这将会得到:

$$x_2^* = \frac{bp_1}{ap_2}x_1^*. \quad (4.6)$$

接着联立 Equation (4.2), 得到:

$$x_1^* = \frac{am}{(a+b)p_1}, x_2^* = \frac{bm}{(a+b)p_2}. \quad (4.7)$$

4.3. Corner Solutions

If either $x_1^* = 0$ or $x_2^* = 0$, then the ordinary demand (x_1^*, x_2^*) is at a **corner solution** to the problem.

4.3.1. the Perfect Substitutes Case

Examples of Corner Solutions – the Perfect Substitutes Case

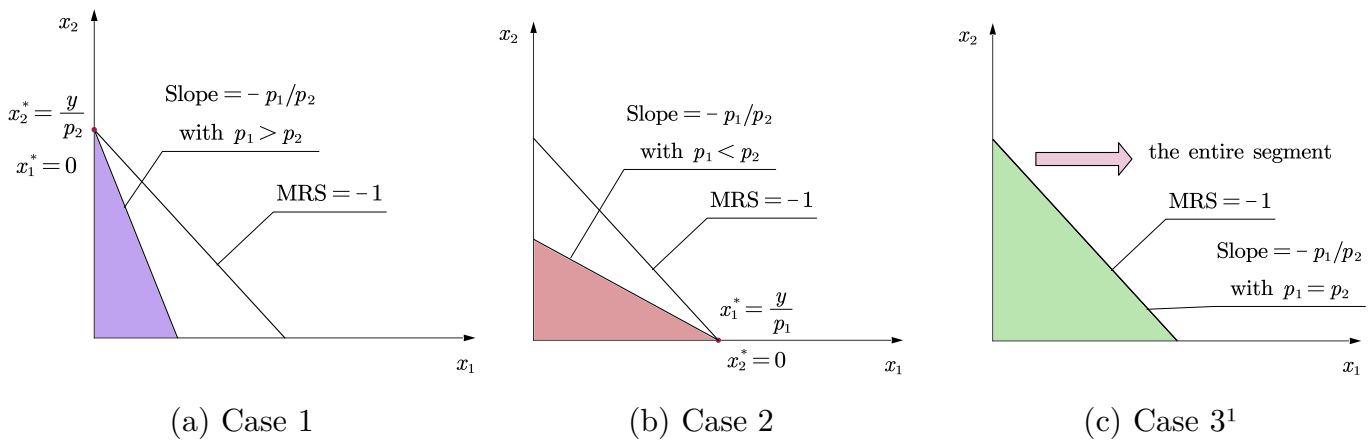


Figure 2: the Perfect Substitutes Case

4.3.2. Non-Convex Preferences

Examples of Corner Solutions – Non-Convex Preferences

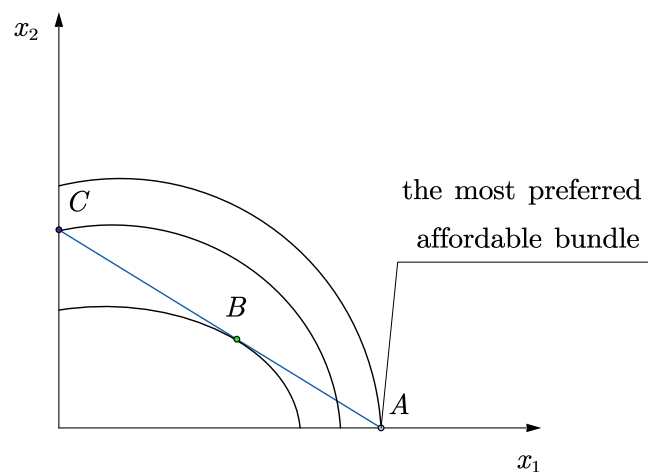


Figure 4.3: Non-Convex Preferences

4.4. 'Kinky' Solutions

¹All the bundles in the constraint are equally the most preferred affordable when $p_1 = p_2$.

kinky: 奇怪的

4.4.1. Perfect Complements Case

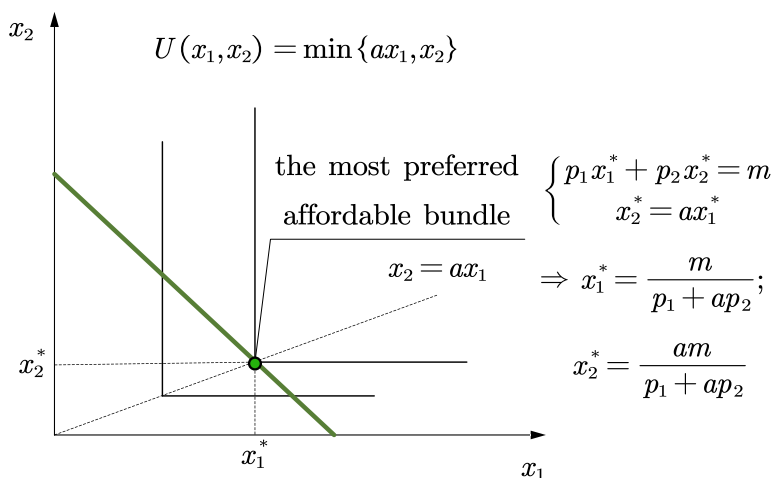


Figure 4.4: Perfect Complements Case

4.5. Properties of Demand Functions

Comparative statics analysis(静态分析) of ordinary demand functions:

- How do ordinary demands $x_1^*(p_1, p_2, y)$ and $x_2^*(p_1, p_2, y)$ change as p_1 , p_2 and income y change?

4.5.1. Own-Price Changes

Fixed p_2 and y .

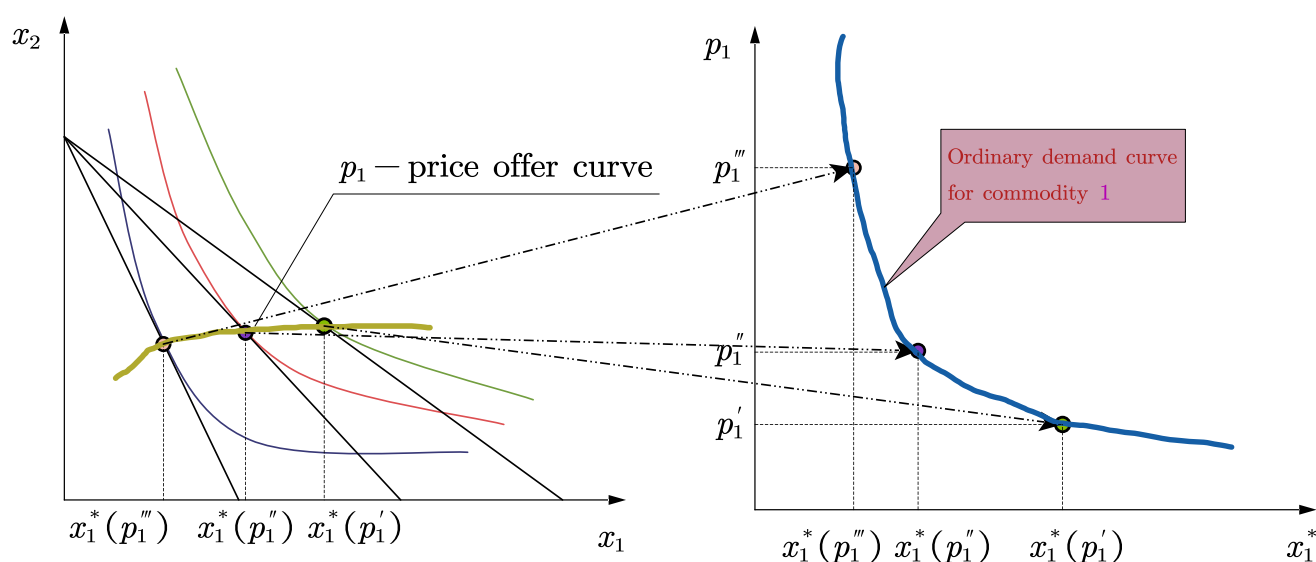


Figure 4.5: p_1 -price offer curve & Ordinary demand curve for commodity 1

The curve containing all the utility-maximizing bundles traced out as p_1 changes, with p_2 and y constant, is the p_1 -price offer curve. 实际上是 x_2^* 关于 x_1^* 的函数.

The plot of the x_1 -coordinate of the p_1 -price offer curve against p_1 is **the ordinary demand curve for commodity 1**.

4.5.1.1. Cobb-Douglas preferences

What does a p_1 -price offer curve look like for Cobb-Douglas preferences?

$$x_1^*(p_1, p_2, y) = \frac{a}{a+b} \times \frac{y}{p_1}, \quad (4.8.1)$$

$$x_2^*(p_1, p_2, y) = \frac{b}{a+b} \times \frac{y}{p_2}. \quad (4.8.2)$$

这里的 p_1 -price offer curve 是一条平线, 而 Ordinary demand curve for commodity 1 是一个反函数的图象.

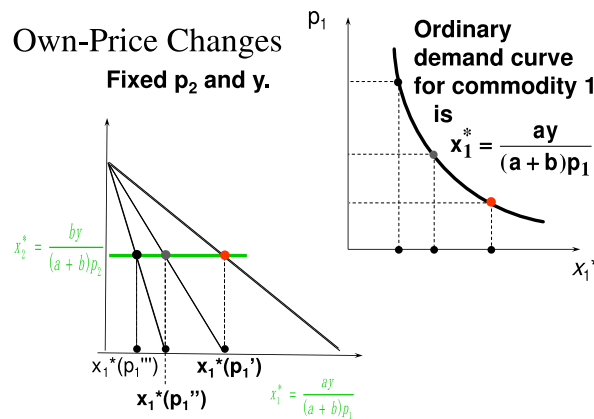


Figure 4.6: p_1 -price offer curve for Cobb-Douglas preferences

4.5.1.2. Perfect Complements

What does a p_1 -price offer curve look like for a perfect-complements utility function?

$$x_1^*(p_1, p_2, y) = \frac{y}{p_1 + p_2}, \quad (4.9.1)$$

$$x_2^*(p_1, p_2, y) = \frac{y}{p_1 + p_2}. \quad (4.9.2)$$

所以就有:

$$x_2^* = x_1^*. \quad (4.10)$$

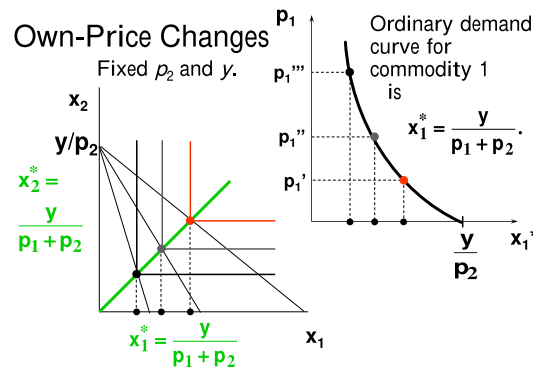


Figure 4.7: p_1 -price offer curve for a perfect-complements utility function

4.5.1.3. Perfect Substitutes

首先我们写出 Ordinary demand:

$$x_1^*(p_1, p_2, y) = \begin{cases} 0 & \text{if } p_1 > p_2 \\ y/p_1 & \text{if } p_1 < p_2 \end{cases} \quad (4.11.1)$$

$$x_2^*(p_1, p_2, y) = \begin{cases} 0 & \text{if } p_1 < p_2 \\ y/p_2 & \text{if } p_1 > p_2 \end{cases} \quad (4.11.2)$$

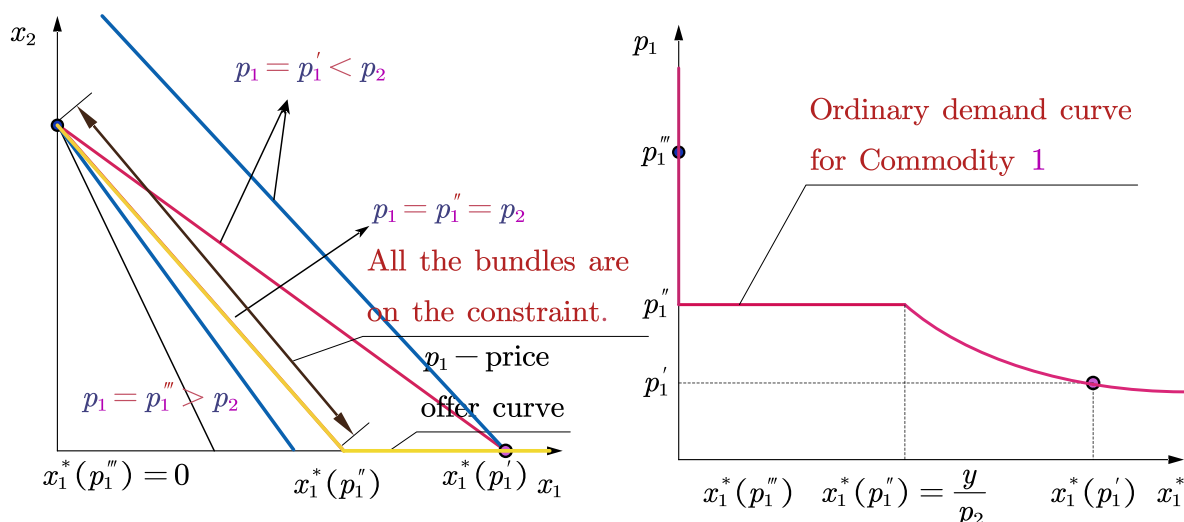


Figure 4.8: p_1 -price offer curve for a perfect-substitutes utility function

4.6. Inverse Demand

Inverse Demand: At what price for commodity 1 will the consumer buy x_1 units of commodity 1?

Cobb-Douglas:

$$x_1^* = \frac{ay}{(a+b)p_1} \rightarrow p_1 = \frac{ay}{(a+b)x_1^*}. \quad (4.12)$$

Perfect Complements:

$$x_1^* = \frac{y}{p_1 + p_2} \rightarrow p_1 = \frac{y}{x_1^*} - p_2. \quad (4.13)$$

4.7. Income Changes

Income Offer Curve:

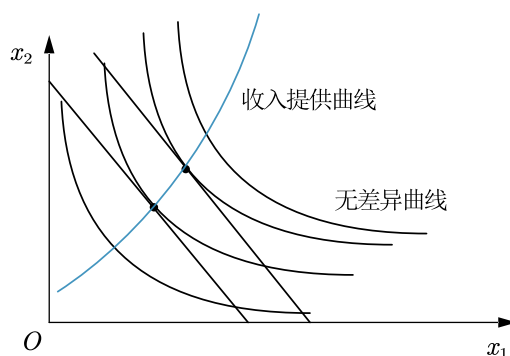


Figure 4.9: Income Offer Curve

A plot of quantity demanded against income is called an **Engel curve**.

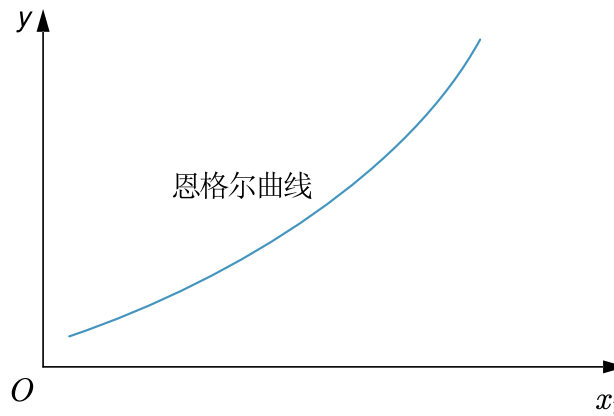


Figure 4.10: Engel Curve

Cobb-Douglas:

$$x_1^* = \frac{ay}{(a+b)p_1}; x_2^* = \frac{by}{(a+b)p_2}. \quad (4.14.1)$$

$$\Rightarrow y = \frac{(a+b)p_1}{a} x_1^*; y = \frac{(a+b)p_2}{b} x_2^*. \quad (4.14.2)$$

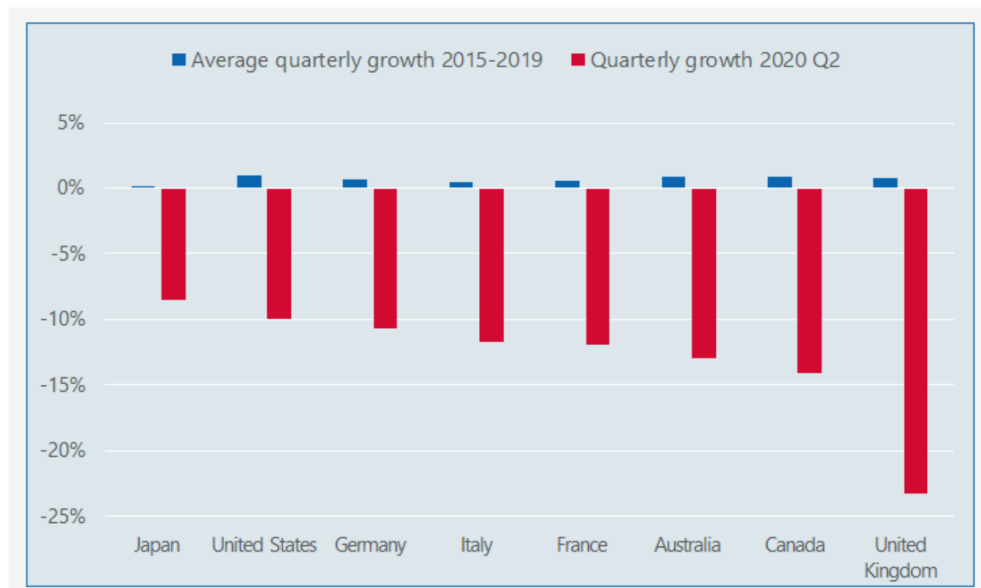
Perfectly-Substitutable Preferences: 在假设 $p_1 < p_2$ 等情况下讨论.

Perfectly-Complementary Preferences:

$$x_1^* = x_2^* = \frac{y}{p_1 + p_2}. \Rightarrow y = (p_1 + p_2)x_1^* = (p_1 + p_2)x_2^*. \quad (4.15)$$

4.8. Discussion

The Covid outbreak resulted in significant decline in household spending.



Source: OECD Statistics Directorate

Figure 4.11: Significant decline in household spending

- How to achieve a swift recovery of consumption post-Covid?
- Could you use the tools we have learned to support your reasoning?

4.8.1. Stimulating Tools

刺激工具有:

- Vouchers(代金券): XX yuan to spend on retail or service outlets
- Shopping Coupons(消费券): x-yuan off if purchasing y-yuan or more.

4.9. Homotheticity

Homotheticity(齐次性): A consumer's preferences are homothetic if and only if

$$(x_1, x_2) \prec (y_1, y_2) \Leftrightarrow (kx_1, kx_2) \prec (ky_1, ky_2) \quad (4.16)$$

for every $k > 0$.

That is, Consumer's preferences only depend on the **ratio** of good 1 to good 2.

Quasilinear preferences are **not homothetic**.

$$U(x_1, x_2) = f(x_1) + x_2. \quad (4.17)$$

4.10. Normal and Inferior

Does the demand for a good always increase as the **income** increases?

Normal good: the demand for a normal good would increase when income increases.

Inferior good: an increase in income results in a reduction in its consumption (low-quality good).

4.11. Ordinary Goods, Giffen Goods

Does the demand for a good always increase as **its own price** reduces?

A good is called **ordinary** if the quantity demanded of it always increases as its own **price** decreases.

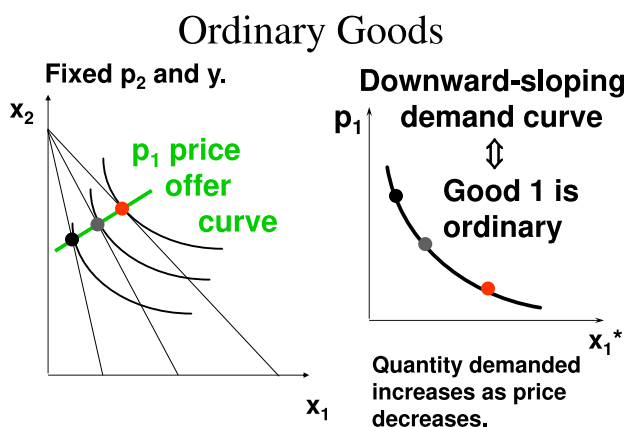


Figure 4.12: Ordinary Goods

If, for some values of its own price, the quantity demanded of a good rises as its own-price increases then the good is called **Giffen**. 价格增加, 需求也增加, 称为吉芬商品.

The income effect of the price change more than offsets the substitution effect (will discuss more later).

4.12. Cross-Price Effects

$p_2 \uparrow$

- demand for commodity 1 \uparrow , then commodity 1 is a **substitute** for commodity 2.
- demand for commodity 1 \downarrow , then commodity 1 is a **complement** for commodity 2.

References

Varian, H.R. (2014) *Intermediate Microeconomics: A Modern Approach*. 9th ed. New York: W.W. Norton & Company.