CH 5 More on the analysis of consumer behavior

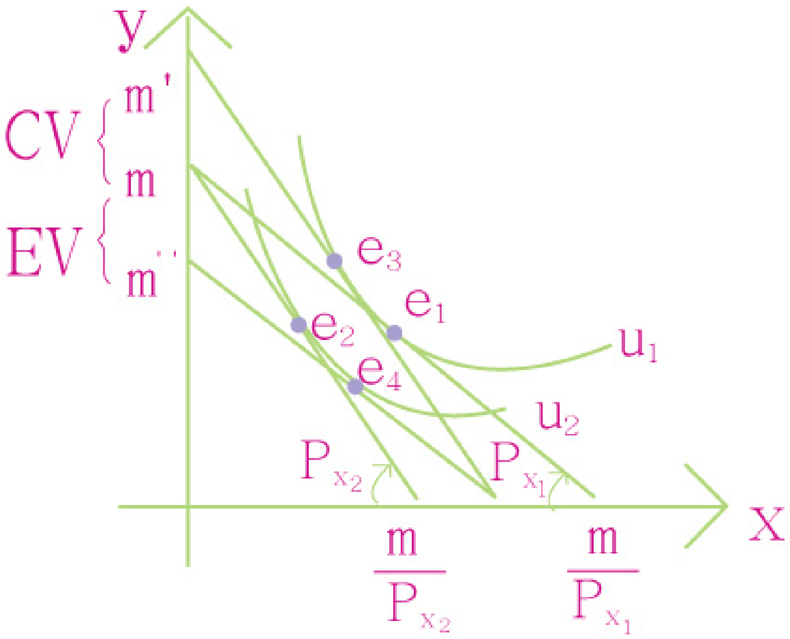


Figure74：

An increase in the price of X, P_x↑

$P_{x_1} \rightarrow P_{x_2}$, $P_{x_2} > P_{x_1}$

Assume $P_y = 1$ and m are fixed.

$m' = e(P_{X_2}, P_y, u_1)$ $\quad m = e(P_{X_1}, P_y, u_1) = e(P_{X_2}, P_y, u_2)$

$m'' = e(P_{X_1}, P_y, u_2)$

CV= $e(P_{X_2}, P_y, u_1) - m = e(P_{X_2}, P_y, u_1) - e(P_{X_2}, P_y, u_2)$

distance between u_1 and u_2 in terms of new prices

EV= $e(P_{X_1}, P_y, u_2) - m = e(P_{X_1}, P_y, u_2) - e(P_{X_1}, P_y, u_1)$

distance between u_2 and u_1 in terms of old prices

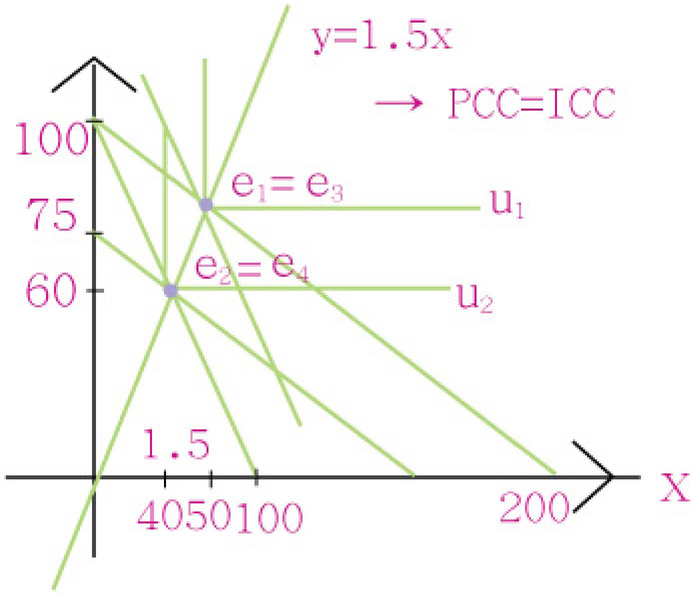


Figure70：

EX: *X* &*Y* are perfect complement.

u(x,y)= $min\{\frac{x}{2},\frac{y}{3}\}$

(P_{x_1}, P_y, m)=(0.5,1,100)
(P_{x_2}, P_y, m)=(1,1,100)

most efficient x,y ratio: $\frac{x}{2}=\frac{y}{3}$ => y=1.5x

e_1 satisfies $\begin{cases} y=1.5x \\ 0.5x+y=100 \end{cases}$ => $\begin{cases} x=50 \\ y=75 \end{cases}$

$u(x,y)= min\{\frac{x}{2},\frac{y}{3}\}$ => $u_1 = 25$

e_2 satisfies $\begin{cases} y=1.5x \\ x+y=100 \end{cases}$ => $\begin{cases} x=40 \\ y=60 \end{cases}$

$u(x,y)$= $\min\{\frac{x}{2},\frac{y}{3}\}$ => $u_2 = 20$

since $e_3 = e_1 = (50,75)$ => m'=1*50+1*75=125
CV=125-100=25
since $e_4 = e_2 = (40,60)$ => m''=0.5*40+1*60=80
EV=80-100=-20

- **ordinary demand functions**

  max x,y $(\min\{\frac{x}{2},\frac{y}{3}\})$

s.t. $P_x x + P_y y = m$

$$\begin{cases} \frac{x}{2} = \frac{y}{3} \\ P_x x + P_y y = m \end{cases} \Rightarrow \begin{cases} y=1.5x \\ P_x x + P_y y = m \end{cases}$$

$P_x x + 1.5xP_y = m$

$(P_x + 1.5P_y)x = m$

$x^* = \frac{m}{P_x+1.5P_y} = \frac{2m}{2P_x+3P_y}$

$y^* = \frac{1.5m}{P_x+1.5P_y} = \frac{3m}{2P_x+3P_y}$

- **Indirect utility function**

$V(P_x, P_y, m) = u(x^*, \ y^*) = \frac{m}{2P_x+3P_y}$

- **Compensated demand functions**

$\min_{x,y} \ P_x x + P_y y$

s.t. $\min\{\frac{x}{2}, \frac{y}{3}\} = u$

$$\frac{x}{2} = \frac{y}{3} = u \Rightarrow \left.\begin{matrix} x^h = 2u \\ y^h = 3u \end{matrix}\right\} \text{ independent of } P_x, P_y$$

- **Expenditure function**

$e(P_x, P_y, u) = P_x x^h + P_y y^h = P_x \cdot 2u + P_y \cdot 3u = (2P_x + 3P_y)u$

$u_1 = V(P_{x_1}, P_y, m) = V(0.5,1,100) = \frac{100}{2*0.5+3*1} = 25$

$u_2 = V(P_{x_2}, P_y, m) = V(1,1,100) = \frac{100}{2*1+3*1} = 20$

CV= $e(P_{X_2}, P_y, u_1)$-m = e(1,1,25)-100 = (2*1+3*1)*25-100=25

EV= $e(P_{X_1}, P_y, u_2)$ –m= e(0.5,1,20)-100=(2*0.5+3*1)*20-100=-20

EX:

$u(x.y)=x^2y$

$(P_{x_1}, P_y, m)=(0.5,1,90)$

$(P_{x_2}, P_y, m)=(1,1,90)$

- **ordinary demand functions**

  max x,y x^2y

  s.t. $P_x x + P_y y = m$

  $$x^* = \frac{2}{2+1}\frac{m}{P_x} = \frac{2}{3}\frac{m}{P_x}$$

  $$y^* = \frac{1}{2+1}\frac{m}{P_y} = \frac{1}{3}\frac{m}{P_y}$$

- **Indirect utility function**

  $$V(P_x, P_y, m) = x^{*2}y^* = (\frac{2}{3}\frac{m}{P_x})^2(\frac{1}{3}\frac{m}{P_y})$$

  $u_1 = V(0.5,1,90)=432000$ $\quad x_1 = 120, y_1 = 30$

  $u_2 = V(1,1,90) = 108000$ $\quad x_2 = 60,\ y_2 = 30$

- **Compensated demand functions**

  min x,y $P_x x + P_y y$

  s.t. $x^2y = u$

  Foc $MRS_{xy}=\frac{P_x}{P_y}$ ①

  $x^2y=u$ ②

  LHS of ① $MRS_{xy}=\frac{Mu_x}{Mu_y} = \frac{2xy}{x^2} = \frac{2y}{x}$

  ① => $\frac{2y}{x} = \frac{P_x}{P_y}$ => $y=\frac{P_x x}{2P_y}$

  ② => $x^2\frac{P_x}{2P_y}x = u$

  $$\frac{P_x}{2P_y}x^3 = u$$

  $$x^3 = \frac{2P_y}{P_x}u$$

  $$x^h = \sqrt[3]{\frac{2P_y}{P_x}u}$$

  $$y^h = \frac{P_x}{2P_y}\sqrt[3]{\frac{2P_y}{P_x}u} = \sqrt[3]{\frac{P_x^2}{4P_y^2}u}$$

- **Expenditure function**

$e(P_{X_1,}P_y,u_2)= P_x x + P_y y \ = \ P_x\sqrt[3]{\frac{2P_y}{P_x}}u + P_y\sqrt[3]{\frac{P_x^2}{4P_y^2}}u \ = \ \sqrt[3]{2P_x^2P_y u} + \sqrt[3]{0.25P_x^2P_y u}$

$e(P_{X_2,}P_y,u_1)= e(1,1,432000)=\sqrt[3]{864000} + \sqrt[3]{108000}$

$= \ \sqrt[3]{2^3 * 108000} + \sqrt[3]{108000}$

$= 3\sqrt[3]{108000}= 90\sqrt[3]{4}$

$e(P_{X_1,}P_y,u_2)= e(0.5,1,108000) = \ \sqrt[3]{0.5 * 108000} + \sqrt[3]{\frac{1}{16}108000}$

$= 30\sqrt[3]{2} + 15\sqrt[3]{2} \ = 45\sqrt[3]{2}$

$CV=90\sqrt[3]{4} - 90$

$EV=45\sqrt[3]{2} - 90$

$(P_{x_1}, P_y, m) \ \rightarrow x^*, y^*$ old equilibrium

$V(P_{x_1}, P_y, m)= u(x^*, y^*)=u_1$

$(P_{x_2}, P_y, m) \rightarrow x', y'$ new equilibrium

$V(P_{x_2}, P_y, m)= u(x', y')=u_2$

$e(P_x, P_y, u)$ is the expenditure function

min x,y $P_x x + P_y y$ (x^h, y^h) compensated demand function

s.t. $u(x,y)= u$ $x^h = x(P_x, P_y, u)$

$y^h = y(P_x, P_y, u)$

$e(P_x, P_y, u)= P_x x^h + P_y y^h$

$e(P_{X_1,}P_y,u_2)$ $e(P_{X_1,}P_y,u_1)=m$

$e(P_{X_2,}P_y,u_1)$ $e(P_{X_2,}P_y,u_2)=m$

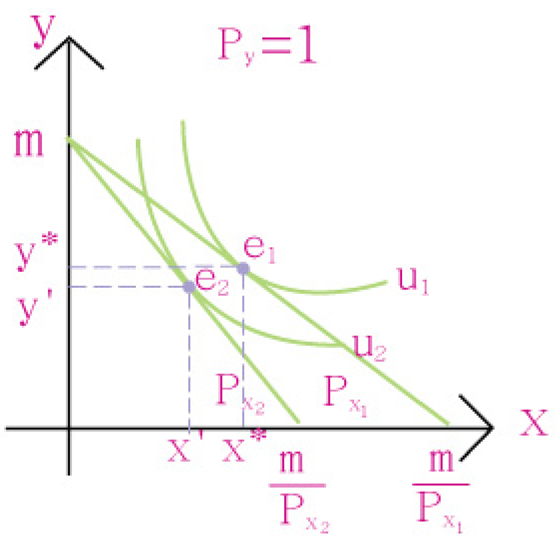


Figure71：

結論： $CV= e(P_{X_2,}P_y,u_1)-m= e(P_{X_2,}P_y,u_1)- e(P_{X_2,}P_y,u_2)$

$EV= e(P_{X_1,}P_y,u_2) -m= e(P_{X_1,}P_y,u_2) - e(P_{X_1,}P_y,u_1)$

EX:

$u(x,y)=\sqrt{x}+y$

$\max_{x,y} \quad \sqrt{x}+y$

s.t. $\quad P_x x + P_y y = m$

$$\left.\begin{aligned} &\text{Foc } MRS_{xy}=\frac{P_x}{P_y} \quad ① \\ &P_x x + P_y y = m \quad ② \end{aligned}\right\} x^*, y^*$$

$$① \text{ LHS } MRS_{xy}=\frac{Mu_x}{Mu_y}=\frac{\frac{1}{2}x^{-\frac{1}{2}}}{1}=\frac{1}{2}x^{-\frac{1}{2}}=\frac{1}{2x^{0.5}}$$

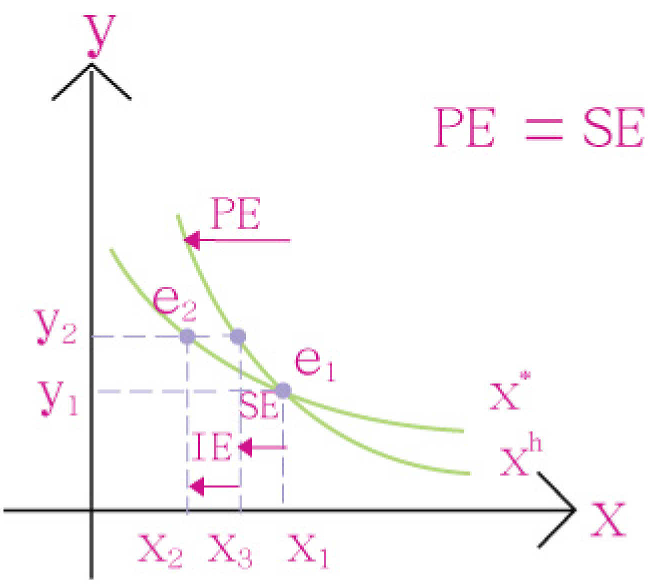
$$① \rightarrow \frac{1}{2x^{0.5}}=\frac{P_x}{P_y} \rightarrow x^*=\frac{P_y^2}{4P_x^2}$$

note that in the process of finding compensating demand function,

we have the FOC:

$$\left.\begin{aligned} &MRS_{xy}=\frac{P_x}{P_y} \quad ① \\ &\sqrt{x}+y=u \quad ②' \end{aligned}\right\} \Rightarrow \begin{matrix} x^h \\ y^h \end{matrix}$$

$$① \Rightarrow x^h=\frac{P_{y^2}}{4P_{x^2}} \qquad x^*=x^h$$



PE = SE + IE

In this example, $x_2 = x_3$

=>PE = SE, there is no income effect.

Ｆigure72：

② => $P_x \cdot \frac{P_{y^2}}{4P_{x^2}} + P_y y = m$

$$P_y y = m - \frac{P_{y^2}}{4P_{x^2}}$$

$$y^* = \frac{m}{P_y} - \frac{P_y}{4P_x}$$

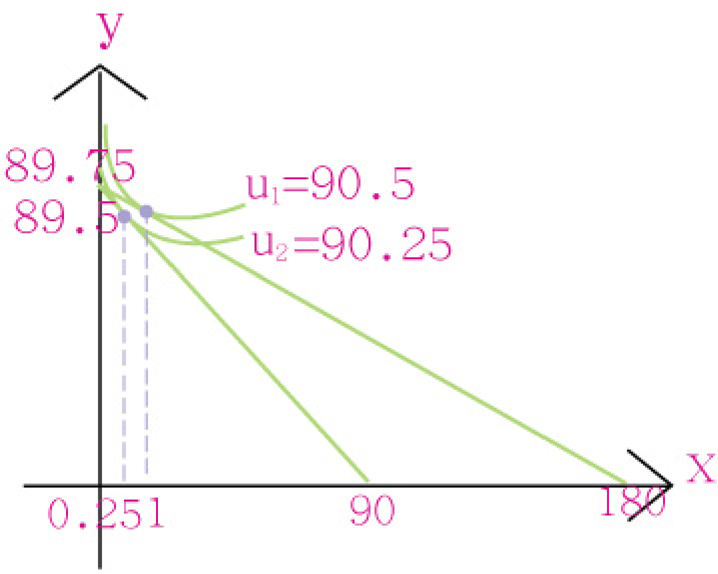


Figure73：

$P_{x1} = 0.5$, $P_y = 1$, $m = 90$

$P_{x2} = 1$, $P_y = 1$, $m = 90$

$$V(P_x, P_y, m) = \sqrt{\frac{P_{y^2}}{4P_{x^2}}} + \frac{m}{Py} - \frac{P_y}{4P_x}$$

$$= \frac{P_y}{2P_x} + \frac{m}{Py} - \frac{P_y}{4P_x}$$

$$= \frac{m}{Py} + \frac{P_y}{4P_x}$$

$u_1 = V(P_{x1}, P_y, m) = V(0.5, 1, 90) = 90.5$

$x^* = 1$, $y^* = 89.5$

$u_2 = V(P_{x2}, P_y, m) = V(1, 1, 90) = 90.25$

$x' = 0.25$, $y' = 89.75$

$e(P_x, P_y, u) = ?$

$\min_{x,y}\ P_x x + P_y y$

s.t. $\sqrt{x} + y = u$

$$\left.\begin{array}{l} \text{FOC.}\quad MRS_{xy} = \frac{P_x}{P_y} \quad ① \\ \sqrt{x} + y = u \quad ②' \end{array}\right\} \Rightarrow \begin{array}{l} x^h \\ y^h \end{array}$$

① => $x^h = x^* = \frac{P_{y^2}}{4P_{x^2}}$ $\quad u$不影響

②' => $\frac{P_y}{2P_x} + y = u$

$$y^h = u - \frac{P_y}{2P_x}$$

$$e(P_x, P_y, u) = P_x \cdot \frac{P_{y^2}}{4P_{x^2}} + P_y(u - \frac{P_y}{2P_x})$$

$$= \frac{P_{y^2}}{4P_x} + P_y u - \frac{P_{y^2}}{2P_x}$$

$$= P_y u - \frac{P_{y^2}}{4P_x}$$

CV = $e(P_{x2}, P_y, u_1) - m$

$= e(1, 1, 90.5) - m$

= (90.5 – 0.25) – 90 = 0.25

EV = $e(P_{x1}, P_y, u_2) - m$

= $e(0.5, 1, 90.25) - m$

= (90.25 – 0.5) – 90 = -0.25 $\qquad$ CV = -EV

∗ quasi-linear function

quasi –linear in y utility function

$u(x, y) = y + f(x)$

CV = -EV

∗ Quasi-linear utility function

$u(x, y) = y + f(x)$

given $u(x, y) = u_1$

an indifference curve

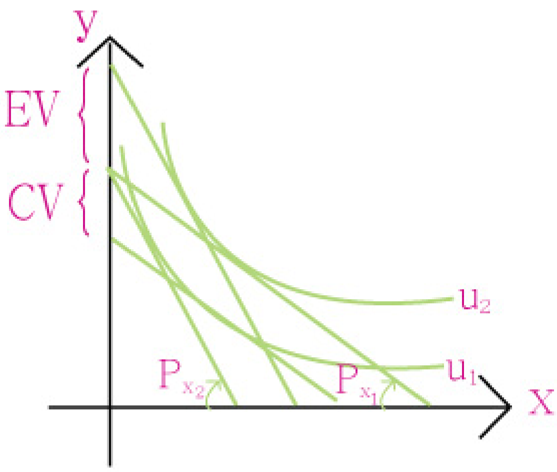
$\{(x, y) | \, u(x, y) = u_1\}$

$=\{(x, y) | \, y + f(x) = u_1\}$

$=\{(x, y) | \, y = u_1 - f(x)\}$

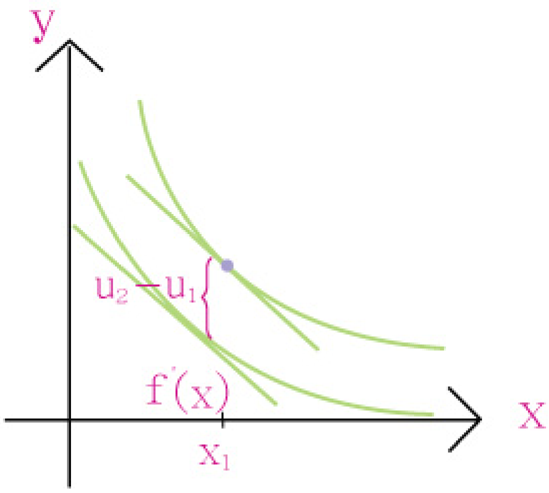
$u(x, y) = u_2$

another indifference curve $\quad \{(x, y) | \, y = u_2 - f(x)\}$



Ｆigure74 :Equivalent variation(EV) and compensating variation(CV)

the vertical distance between those two difference curve
(suppose $u_2 > u_1$)
$y_2 - y_1 = u_2 - u_1$ (f(x) canceled)



Ｆigure75 :

given a X

$$MRS_{xy} = \frac{MU_x}{MU_y} = \frac{f'(x)}{1} = f'(x) \quad \text{no y}$$

⇨ given a X, f(x) = MRSxy is independent of Y.
Since MRSxy = f'(x)

From the FOC, $MRS_{xy} = \frac{P_x}{P_y}$

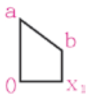
$f'(x) = \frac{P_x}{P_y}$ => $x^* = x^h$ is a function of P_x and P_y

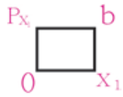
(no m, no income effect)

PE = SE

IE = 0

∗Consumer Surplus, CS

A consumer is willing to pay  for X_1 units of X_1 units of X

The consumer pays $Px_1 * X_1$ for X_1 units of X 

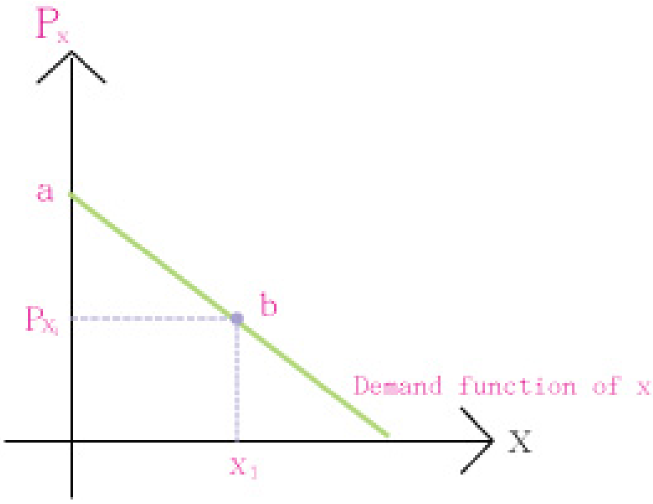
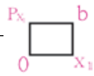
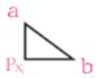


Figure76 :

CS = −  =  $= \int_0^{X_1} P_x\, x dx - P_{x1}X_1$

an increase of price of X from P_{x1} to P_{x2}, $P_{x2} > P_{x1}$

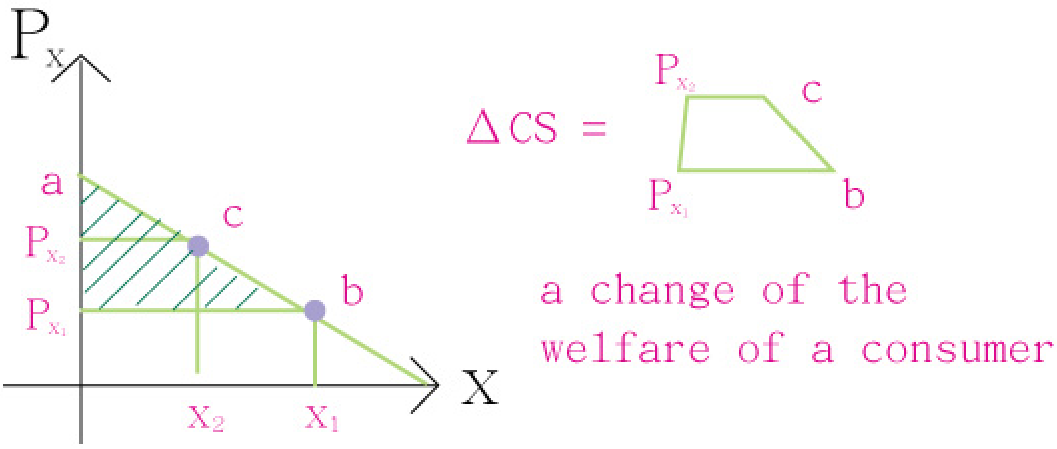


Figure77 :Change in consumer surplus with an increase of price of x

∗Relationship among CV, EC & ΔCS

a ~ b ~ c ~ d

$(0, y_0) \sim (1, y_1) \sim (2, y_2) \sim (3, y_3)$

the consumer is willing to pay $(y_0 - y_1)$

for the 1st unit of X

2nd $(y_1 - y_2)$

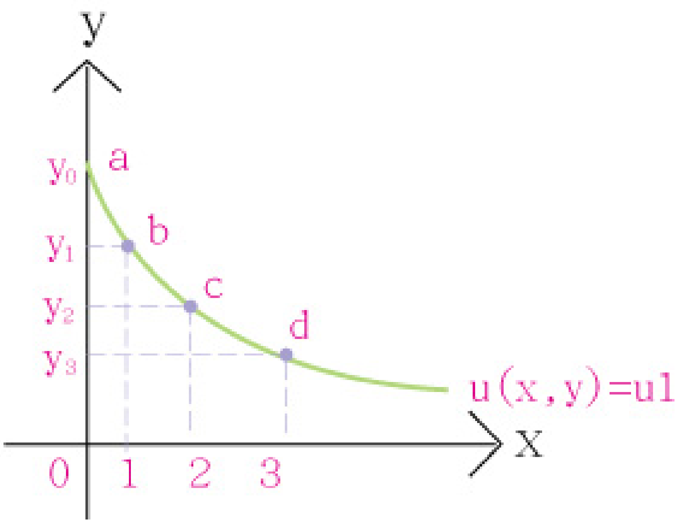


Figure78 :

P_y = 1, y :other expenditure.

MRSxy at x=1 $= y_0 - y_1$

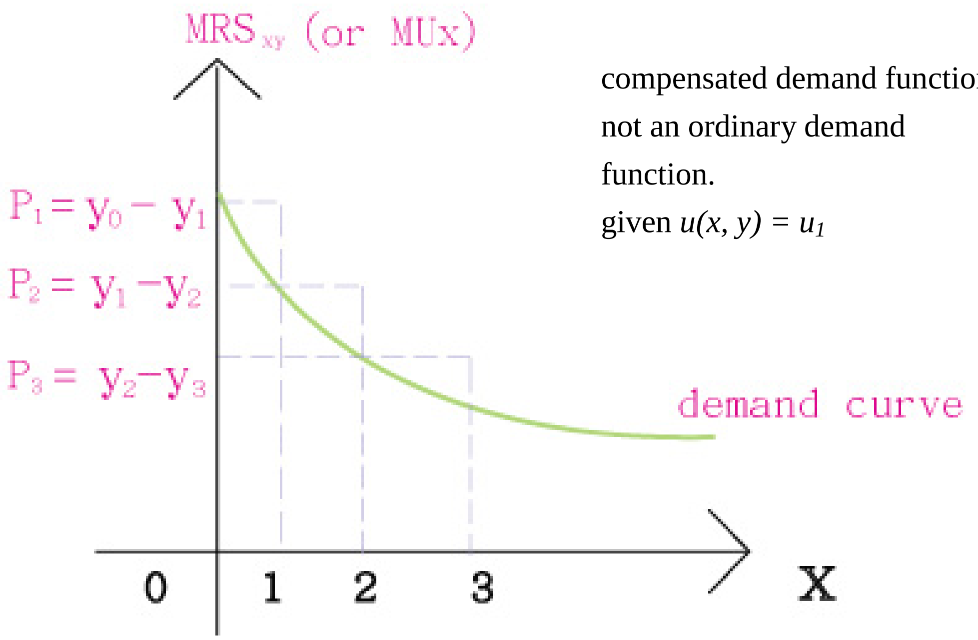
at x=2 $= y_1 - y_2$

at x=3 $= y_2 - y_3$

in equilibrium, $MRS_{xy} = \frac{P_x}{P_y}$

$P_y = 1$ => $MRS_{xy} = P_x$

(or MVx)



compensated demand function.
not an ordinary demand function.
given $u(x, y) = u_1$

Figure79：

$\Delta CS =$?

base on X^*

ΔCS base on $x^h(u_1) =$? CV

ΔCS base on $x^h(u_2) =$? EV

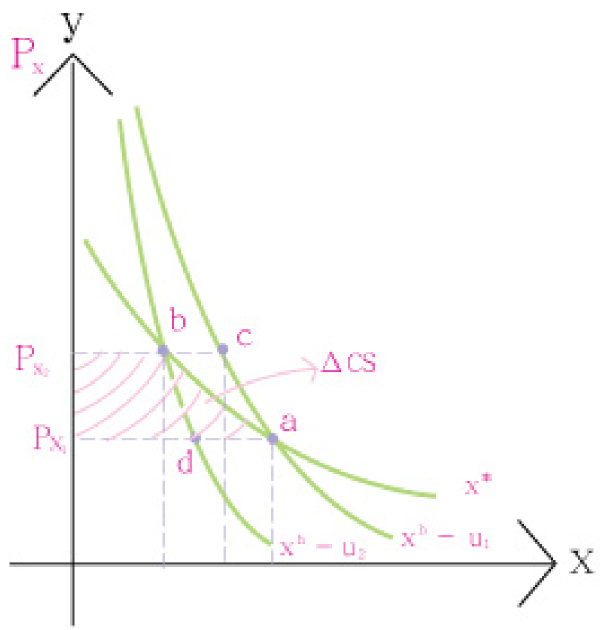


Figure80：

結論: $P_{x1} \rightarrow P_{x2}$, $P_{x2} > P_{x1}$

X is normal => CV > ΔCS > EV

Quasi-linear u(x, y) => CV = ΔCS = EV

＊Revealed Preference

The theory of revealed preference.

Bundle (x_1, y_1) is revealed preferred to bundle (x_2, y_2)

if ① both bundles are affordable/

② (x_1, y_1) is chosen (but not (x_2, y_2))

$$(①P_x x_1 + P_y y_1 \geq P_x x_2 + P_y y_2)$$

＊The principle of the revealed preference.

Suppose a consumer is rational and (x_1, y_1) is revealed preferred to (x_2, y_2), then (x_1, y_1) must be preferred to (x_2, y_2)

(Axiom)

The weak axiom of revealed prefernence. (WARP)

Suppose「(x_1, y_1) is revealed preferred to (x_2, y_2)」 statement A

then「(x_1, y_1) cannot be revealed preferred to (x_2, y_2)」 statement B

statement A is true => according to the principle of the revealed preference,

we have $(x_1, y_1) > (x_2, y_2)$

statement B is true =>

an inconsistency in the consumer’s preference.

EXAMPLE

某人將全部所得用於買 A 物及 B 物。

當 A 物價格 P_A 為 2 元，而 B 物價格也為 2 元時,他以 80 元的所得購買 20 單位的 A 物，當 $P_A = 4$, $P_B = 2$ 時，他以 120 元的所得購買 25 單位的 A 物。請問其消費行為是否符合經濟理性？ 試加比較說明之。

(Definition) (x_1, y_1) is revealed preferred to (x_2, y_2)

if (1) both (x_1, y_1) and (x_2, y_2) are affordable

(2) (x_1, y_1) is chosen

if (x_1, y_1) is chosen at (P_{x1}, P_{x2}), $P_x x_1 + P_y y_1 \geq P_x x_2 + P_y y_2$

The principle of the revealed preference

If consumer is rational

⇨ Then (x_1, y_1) is revealed preferred to (x_2, y_2)

implies (x_1, y_1) is preferred to (x_2, y_2)

(x_1, y_1) is revealed preferred to (x_2, y_2)

then (x_2, y_2) cannot be revealed preferred to (x_1, y_1)

$P_{x1}x_1 + P_{y1}y_1 \geq P_{x1}x_2 + P_{y1}y_2$ and (x_1, y_1) is chosen

at (P_{x2}, P_{y2}), (x_2, y_2) is chosen, but not (x_1, y_1)

$$P_{x2}x_1 + P_{y2}y_1 \geq P_{x2}x_2 + P_{y2}y_2$$

Example

(a) $(P_{x1}, P_{y1}) = (20, 1)$ $(x_1, y_1) = (2, 40)$ $m_1 = 80$

$(P_{x2}, P_{y2}) = (20, 4)$ $(x_2, y_2) = (3, 25)$ $m_2 = 160$

(b) $(P_{x1}, P_{y1}) = (20, 1)$ $(x_1, y_1) = (3, 20)$ $m_1 = 80$

$(P_{x2}, P_{y2}) = (20, 4)$ $(x_2, y_2) = (2,30)$ $m_2 = 160$

sol.

(a) $P_{x1}x_1 + P_{y1}y_1 = 20 * 2 + 1 * 40 = 80$

$P_{x1}x_2 + P_{y1}y_2 = 20 * 3 + 1 * 25 = 85$

=>(x_1, y_1) is not revealed preferred to (x_2, y_2) …(1)

$P_{x2}x_2 + P_{y2}y_2 = 20 * 3 + 4 * 25 = 160$

$P_{x2}x_1 + P_{y2}y_1 = 20 * 2 + 4 * 40 = 200$

=> (x_2, y_2) is not revealed preferred to (x_1, y_1) …(2)

(1), (2) => doesn't violate the WARP.

sol.

(b) $P_{x1}x_1 + P_{y1}y_1 = 20 * 3 + 1 * 20 = 80$

$P_{x1}x_2 + P_{y1}y_2 = 20 * 2 + 1 * 30 = 70$

=>(x_1, y_1) isrevealed preferred to (x_2, y_2) …(1)

$P_{x2}x_2 + P_{y2}y_2 = 20 * 2 + 4 * 30 = 160$

$P_{x2}x_1 + P_{y2}y_1 = 20 * 3 + 4 * 20 = 140$

=> (x_2, y_2) is revealed preferred to (x_1, y_1) …(2)

(1), (2) => violate the WARP.

a not RP to b
b not RP to a — WARP ok!

c RP to d
d RP to c — violate to WARP

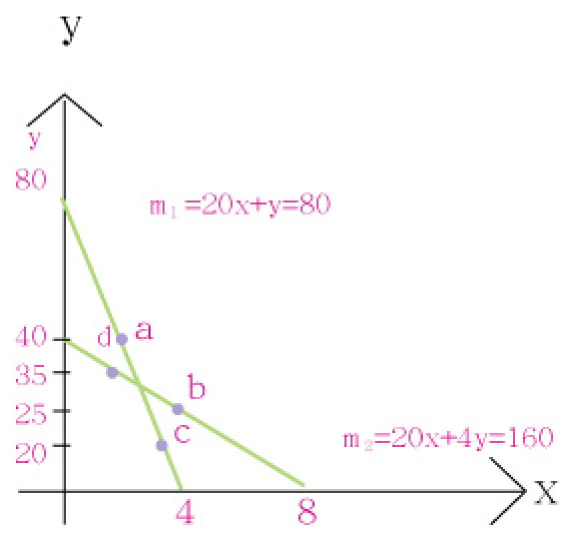


Figure81:

at (P_{x1}, P_{y1}), e is chosen

f is affordable, e is RP to f

at (P_{x2}, P_{y2}), f is chosen

e is not affordable, f is not RP to e

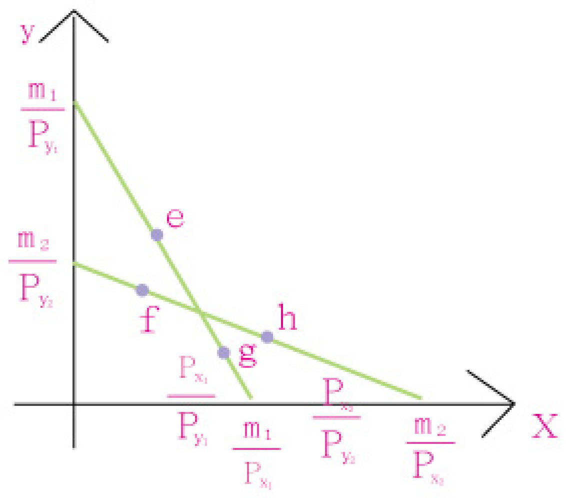


Figure82：

=>e, f don't violate WARP

at (P_{x1}, P_{y1}), g is chosen

h is not affordable, g is not RP to h

at (P_{x2}, P_{y2}), h is chosen

g is affordable, h is RP to g h>g

=>g, h don't violate WARP

(a, b)
(a, c) ok!

(a, d) not
(a, e) ok

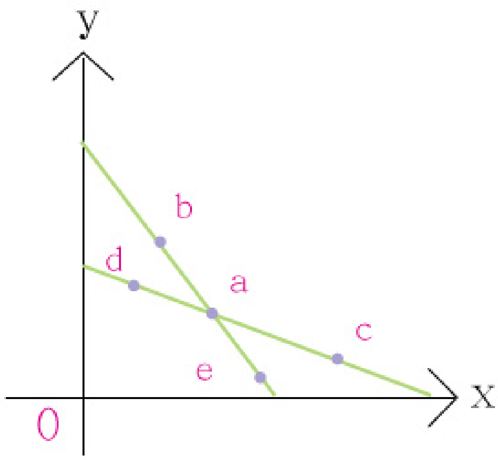


Figure83：

Income is fixed at m

at (P_{x1}, P_{y1}) the consumer chooses a

at (P_{x2}, P_{y2}) the consumer chooses b

a→b price effect of a decrease in price of X

(P_{x1}→P_{x2}, $P_{x2} < P_{x1}$)

Figure89：

How to decompose PE into SE and IE?

slutsky substitution effect.

If a consumer would have chosen c' after a slutsky income subsidy, note that at P_{x1}, P_y, and m, a and c' are affordable, a is chosen

=>a is RP to c'

at P_{x2}, P_y, and m, a and c' are both affordable, c' is chosen

=>c' is RP to a

check a, c is OK with WARP

At (P_{x1}, P_y, m), a is chosen but c is not affordable

=> a is not RP to c.

At (P_{x2}, P_y, m), c is chosen ,a and c are both affordable

=> c is RP to a

=> doesn't violate WARP

$P_x\downarrow$, slutsky substitution effect

$a \to c$

$x_3 > x_1$ (X is cheaper, X substitutes for Y)

After slutsky subsidy,

$$\underbrace{P_{x2}x_1 + P_{y2}y_1}_{\text{original bundle } a \text{ is affordable at new price}} = \underbrace{P_{x2}x_3 + P_{y2}y_3}_{c \text{ is chosen after slutsky subsidy}} = m' \ \ldots ①$$

=>c is RP to a

a cannot RP to c => c is not affordable at (P_x, P_y)

$$m = P_{x1}x_1 + P_{y1}y_1 > P_{x1}x_3 + P_{y1}y_3 \ \ldots ②$$

①-②

$$(P_{x2} - P_{x1})x_1 + (P_{y2} - P_{y1})y_1 > (P_{x2} - P_{x1})x_3 + (P_{y2} - P_{y1})y_3$$

$$(P_{x2} - P_{x1})(x_3 - x_1) + (P_{y2} - P_{y1})(y_3 - y_1) < 0$$

$$P_{y2} = P_{y1} = P_y \quad fixed$$

$$\Rightarrow (P_{x2} - P_{x1})(x_3 - x_1) < 0$$

$$\Rightarrow P_{x2} < P_{x1} \quad \Rightarrow x_3 - x_1 > 0$$

$$x_3 > x_1$$

∗ Tax

Tax on gasoline (X)

$\$t$ tax on each unit of X

$P_x \to P_x + t$ =>equilibrium $e_1 \to e_2$

consumer is worse off

e_1 is revealed pregerred to e_2

(e_1& e_2 are affordable before imposing a $\$t$ unit tax)

$\$t^* X$ => a tax return to the consumer

=>new equilibrium e_3

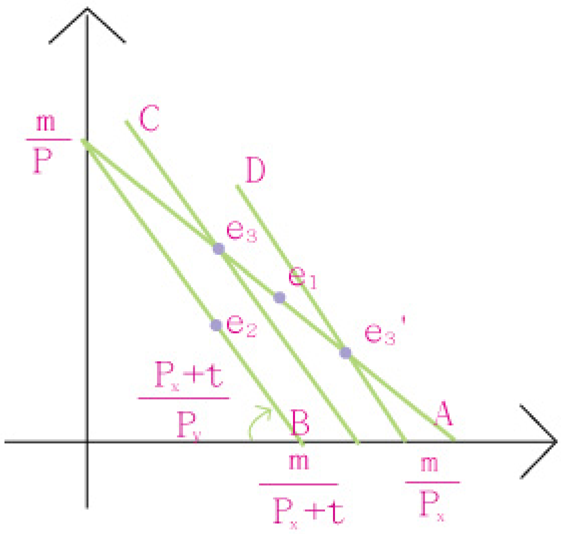


Figure84：

A: $P_x x + P_y y = m$

B: $(P_x + t)x + P_y y = m$

The budget line after tax return: $(P_x + t)x + P_y y = m + tx$

$=> P_x x + P_y y = m$ same as A

new income: m' = m + tx

new price: $P_x + t$ & P_y

slope of the budget line (after tax and tax return)

$=> \frac{P_x + t}{P_y}$ (a steeper budget line)

$(P_x + t)x + P_y y = m + tx$ => both e_1 and e_3 are affordable at $(P_x$

=> e_1 is revealed preferred to e_3

=>consumer is worse off at e_3

Suppose new equilibrium were at e_3'

the new budget line is D.

the expenditure of e_1 at $(P_x + t)$ is less than m'

=> e_3' is revealed preferred to e_3 (both are on A, and e_1 is chosen before tax)

Based on new budget line C

- ⇨ e_1 is not affordable after tax and tax return
- ⇨ e_3 is not revealed preferred to e_1

conclusion: X↓ after a tax and tax return

e_3必在 e_1 左上方

＊Price Index and welfare

based period : 0

current period : t

at period 0 : P_{x0}, P_{y0}

X_0, Y_0

at period t : P_{xt}, P_{yt}

X_t, Y_t

Compare welfare between periods 0 and t

the consumer is better off in period 0 ((X_0,Y_0) is RP to X_t,Y_t)

if $P_{x0}x_0 + P_{y0}y_0 > P_{x0}x_t + P_{y0}y_t$ …(1)

the consumer is better off in period t ((X_t,Y_t) is RP to X_0,Y_0)

if $P_{xt}x_t + P_{yt}y_t > P_{xt}x_0 + P_{yt}y_0$ …(2)

$$m_t = P_{xt}x_t + P_{yt}y_t$$

$\frac{mt}{(1)}$ Paasche price index 巴氏指數

$$\frac{P_{xt}x_t+P_{yt}y_t}{P_{x0}x_0+P_{y0}y_0} \le \frac{P_{xt}x_t+P_{yt}y_t}{P_{x0}x_t+P_{y0}y_t}$$ price index weighted by current consumption bundle

$\text{Index}_p \ge \frac{m_t}{m_0} \Rightarrow$ the consumer is better off in period 0.

$\frac{(2)}{m_0}$ Lasperes price index 拉氏指數

$$\frac{P_{x_t}x_t + P_{y_t}y_t}{P_{x_0}x_0 + P_{y_0}y_0} \ge \frac{P_{x_t}x_0 + P_{y_t}y_0}{P_{x_0}x_0 + P_{y_0}y_0}$$ price index weighted by based period consumption bundle

CPI is one of Lasperes price index

$Index_L \le \frac{m_t}{m_0} \Rightarrow$ the consumer is better off in period t.