




Consumer Behavior:
Advanced topics
EE311

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Agenda

- Hicks and Slutsky substitution effect
- Finding consumer surplus from ICs
- Revealed Preferences
- Index numbers
- Duality


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Hicks and Slutsky substitution effect

- To calculate the substitution effect, we need to compensate the consumer for the change in real income.
- The substitution effect defined earlier compensate the income change until the consumer receives the **same level of utility**.
 - This is called **Hicks substitution effect**.
- But we cannot measure utility, so Hicks substitution effect is not observable.

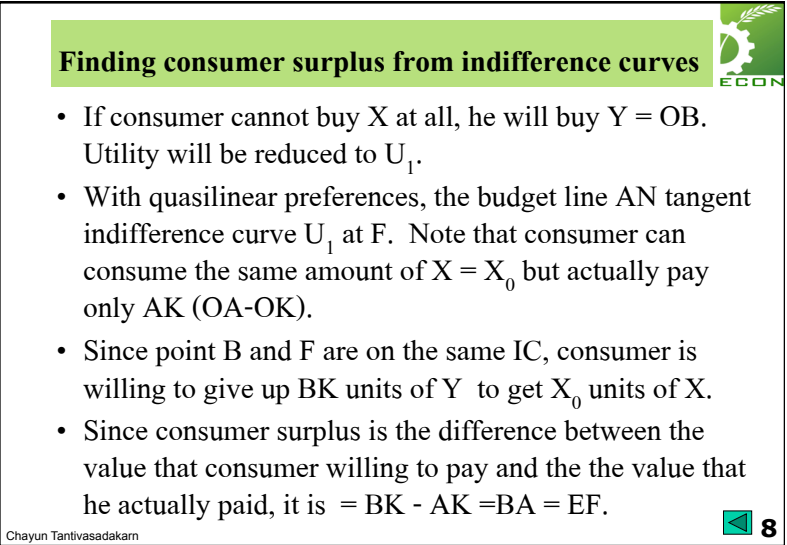
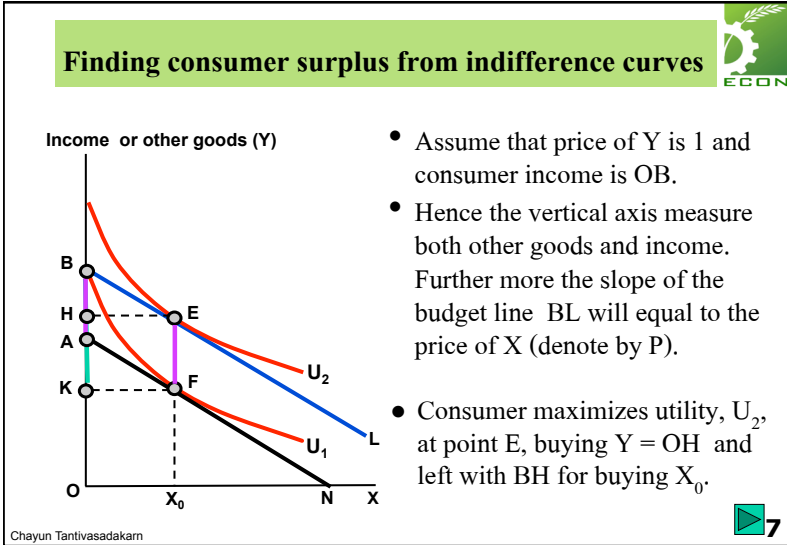
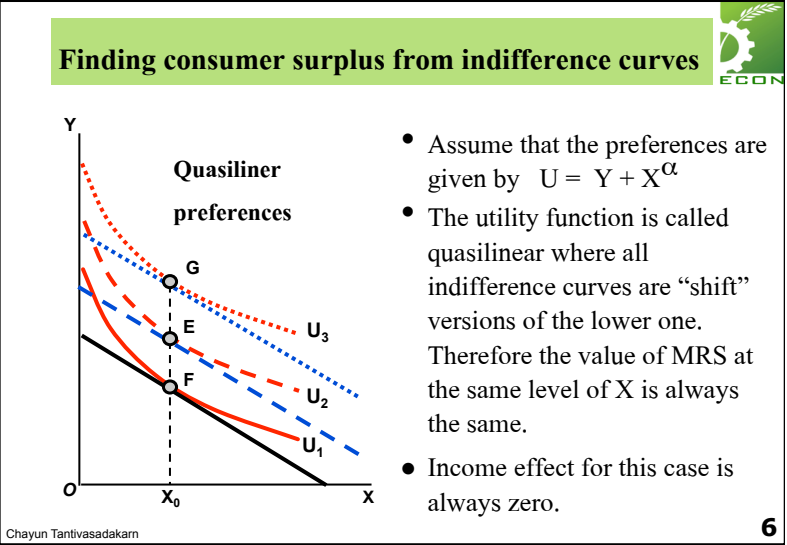
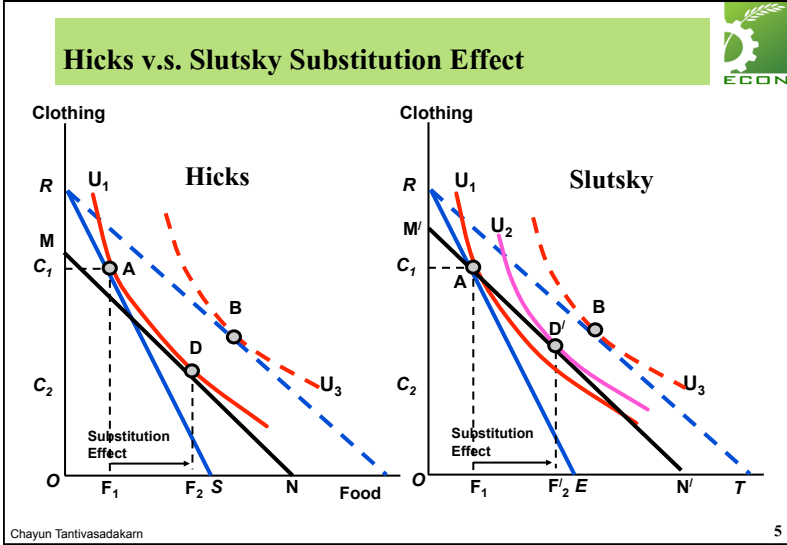
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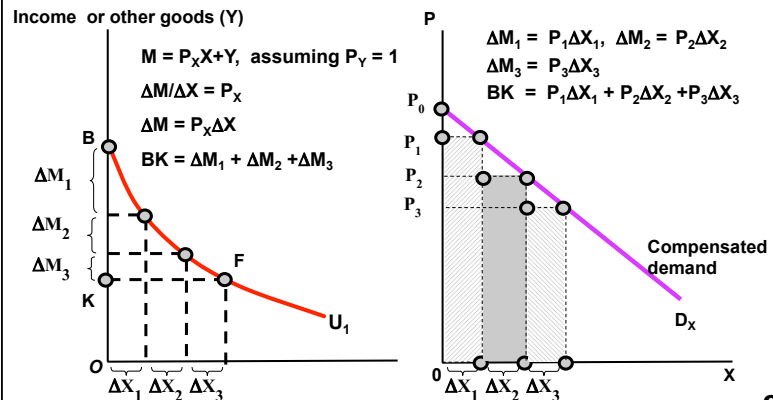
Hicks and Slutsky substitution effect

- The alternative way is to compensate the income change until the consumer can **consume exactly the same bundle**.
 - This is called **Slutsky substitution effect**.
- With this new budget, at the new relative prices, the consumer will choose a new optimal bundle which is observable.

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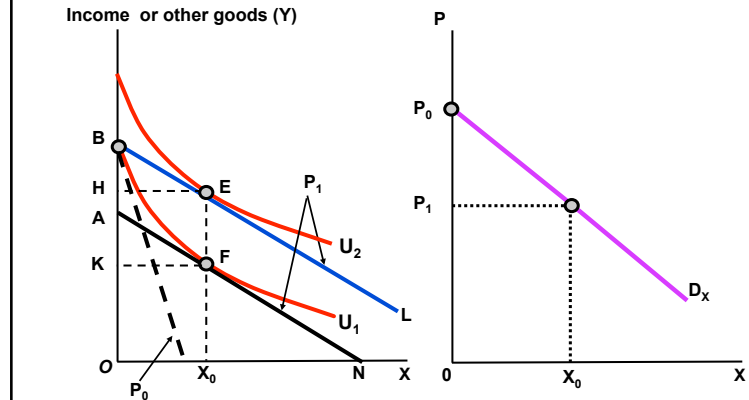


Finding consumer surplus from indifference curves



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Finding consumer surplus from indifference curves



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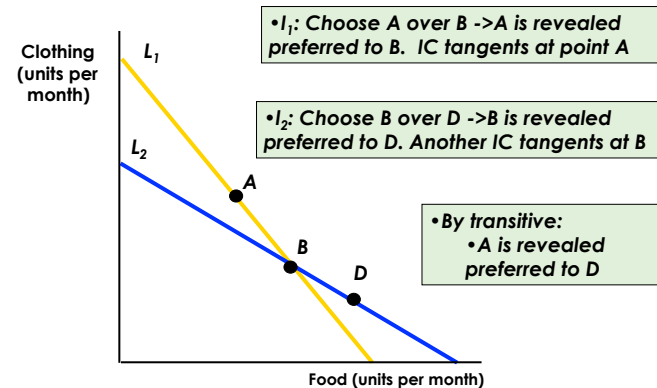
Revealed Preferences

- According to the theory, for given preferences, a consumer will choose bundle of goods subject to the budget constraint.
- In reality, preferences are unknown.
- But if we know the choices a consumer has made, we can determine what their preferences are if we have information about a sufficient number of choices that are made when prices and incomes vary.
- [Read Varian, Ch. 7 - 8]

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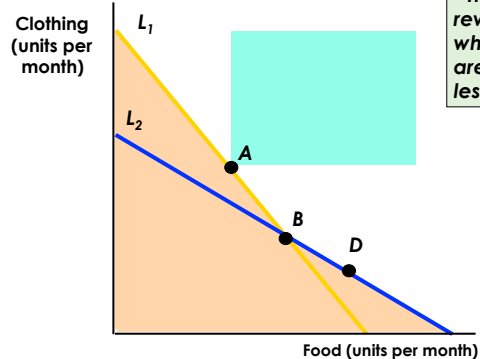
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Revealed Preferences – Two Budget Lines



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Revealed Preferences – Two Budget Lines

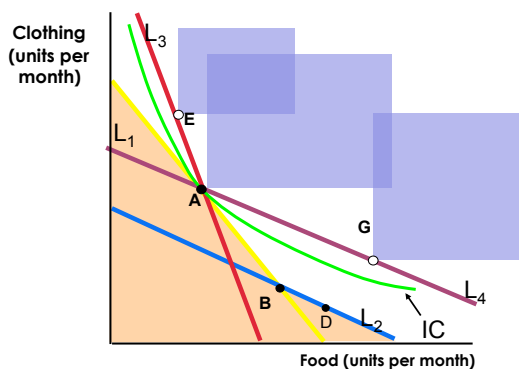


•The pink areas are revealed prefer to A while the yellow areas are revealed less prefer to A.

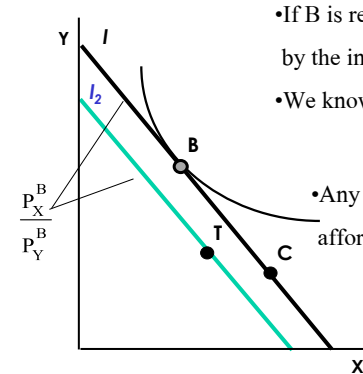
Revealed Preference

- As you continue to change the budget line, individuals can tell you which basket they prefer to others.
- The more the individual reveals, the more you can discern about their preferences
- Eventually you can map out an indifference curve

Revealed preferences and the construction of an IC



Reveal preference condition



•If B is revealed prefer to any bundle affordable by the income I.

•We know that

$$P_X^B X^B + P_Y^B Y^B = I$$

•Any other bundle, such as T or C, is affordable by income I, hence

$$P_X^B X^T + P_Y^B Y^T \leq I$$

Reveal preference condition

$$P_X^B X^B + P_Y^B Y^B = I$$

$$P_X^B X^T + P_Y^B Y^T \leq I$$

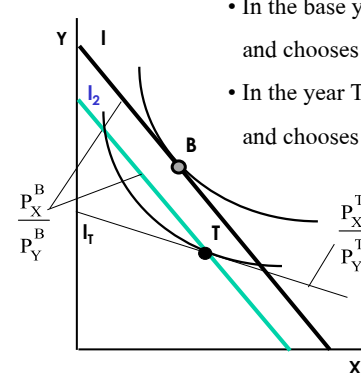
$$P_X^B X^B + P_Y^B Y^B \geq P_X^B X^T + P_Y^B Y^T$$

- For a given income I , if a consumer chooses bundle B , the expenditure for B must be greater than or equal to the expenditure for any other bundle.
- If the expenditure for bundle B is greater than or equal to the expenditure for bundle T and the consumer chooses B , B must be preferred to T .

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Reveal preference condition



- In the base year, consumer is facing budget line I and chooses bundle B .
- In the year T , consumer is facing budget line I_T and chooses bundle T .

- If we know that $P_X^B X^B + P_Y^B Y^B \geq P_X^B X^T + P_Y^B Y^T$ B must be preferred to T or the consumer is worse off in period T compared to B .

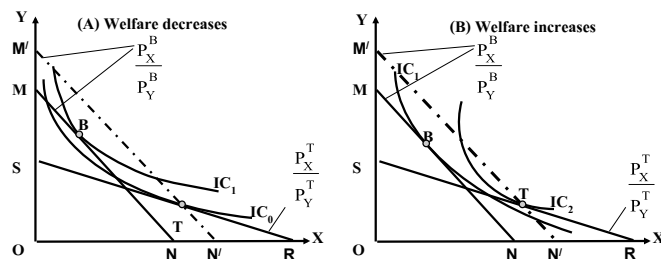
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Reveal preference condition

- However, we cannot conclude anything if

$$P_X^B X^B + P_Y^B Y^B < P_X^B X^T + P_Y^B Y^T$$



- This is because bundle T is not affordable in period B

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Index numbers

- We may construct quantity indexes of price indexes to estimate welfare change from period B to period T .

| Period | Prices | Quantities |
|------------------|----------------|------------|
| Base (B) | P_X^B, P_Y^B | X^B, Y^B |
| Present time (T) | P_X^T, P_Y^T | X^T, Y^T |

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Quantity Indexes

$$I_Q = \frac{w_X X^T + w_Y Y^T}{w_X X^B + w_Y Y^B}$$

- where I_Q is a general form of quantity index; w_i is the weight for each good i .
- One possible weight is the price.
- **Laspeyres** uses the base period price in the past, **Paasche** uses the current period price.

Quantity Indexes

- **Laspeyres** uses the base period prices P^B as weights to construct **Laspeyres Quantity Index**

$$L_Q = \frac{P_X^B X^T + P_Y^B Y^T}{P_X^B X^B + P_Y^B Y^B} = \frac{\sum P_i^B Q_i^T}{\sum P_i^B Q_i^B}$$

- **Paasche** uses the period T prices P^T as weights to construct **Paasche Quantity Index**

$$P_Q = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^T X^B + P_Y^T Y^B} = \frac{\sum P_i^T Q_i^T}{\sum P_i^T Q_i^B}$$

Quantity Indexes

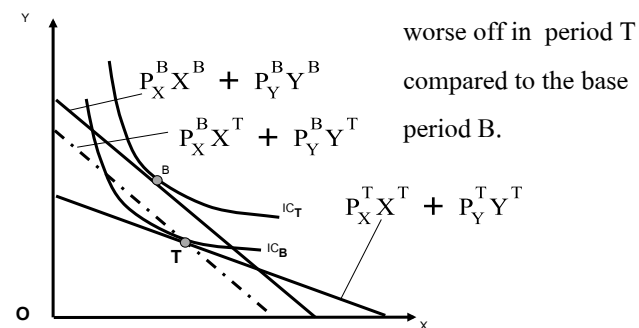
1) If L_Q is less than or equal to 1

$$L_Q = \frac{P_X^B X^T + P_Y^B Y^T}{P_X^B X^B + P_Y^B Y^B} \leq 1$$

$$P_X^B X^T + P_Y^B Y^T \leq P_X^B X^B + P_Y^B Y^B$$

- This is a reveal preference condition.
- Consumers choose B over T when both are affordable
-> **worse off in period T compared to the base period B.**

L_Q is less than or equal to 1



Quantity Indexes

2) If L_Q is greater than 1

$$L_Q = \frac{P_X^B X^T + P_Y^B Y^T}{P_X^B X^B + P_Y^B Y^B} > 1$$

$$P_X^B X^T + P_Y^B Y^T > P_X^B X^B + P_Y^B Y^B$$

- This is **not** a revealed preference condition.
- It only tells that bundle T is not affordable in period B.
- **Inconclusive** about the welfare change.



Quantity Indexes

3) If P_Q is greater than or equal to 1

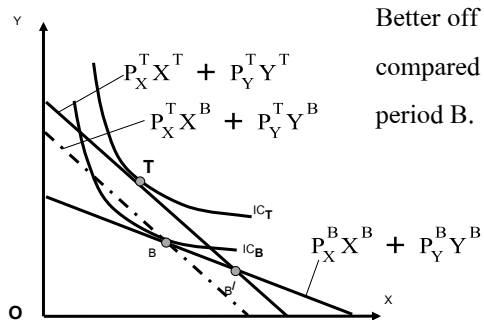
$$P_Q = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^T X^B + P_Y^T Y^B} \geq 1$$

$$P_X^T X^T + P_Y^T Y^T \geq P_X^T X^B + P_Y^T Y^B$$

- This is a reveal preference condition.
- Consumers choose T over B when both are affordable -> **Better off in period T compared to the base period B.**



P_Q is greater than or equal to 1



Better off in period T compared to the base period B.



Quantity Indexes

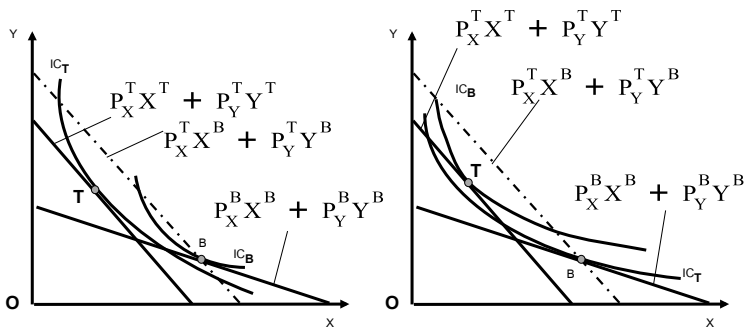
4) If P_Q is less than 1

$$P_Q = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^T X^B + P_Y^T Y^B} < 1$$

$$P_X^T X^T + P_Y^T Y^T < P_X^T X^B + P_Y^T Y^B$$

- This is **not** a revealed preference condition.
- Inconclusive about the welfare change.

Inconclusive when $P_Q < 1$



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Price Indexes

$$I_p = \frac{w_X P^T + w_Y P^T}{w_X P^B + w_Y P^B}$$

- Where I_p is a general form of quantity index, w_i is the weight for each good i .
- One possible weight is the quantity.
- **Laspeyres** uses the base period quantity in the past,
- **Paasche** uses the current period quantity.

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Price Indexes

- **Laspeyres** uses the base period quantity Q^B as weight to construct

Laspeyres Price Index

$$L_p = \frac{P_X^T X^B + P_Y^T Y^B}{P_X^B X^B + P_Y^B Y^B} = \frac{\sum_i P_i^T Q_i^B}{\sum_i P_i^B Q_i^B}$$

- **Paasche** uses the period T quantity Q^T as weight to construct

Paasche Price Index

$$P_p = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^T + P_Y^B Y^T} = \frac{\sum_i P_i^T Q_i^T}{\sum_i P_i^B Q_i^T}$$

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Price Indexes

- We cannot simply compare the price index with 1 as in the case of the quantity index.
- For instance if $P_p > 1$, this means

$$P_X^T X^T + P_Y^T Y^T > P_X^B X^T + P_Y^B Y^T$$

- This is not a reveal preference condition because the price on both sides are not the same.

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Price Indexes

- To solve the problem we need to construct another index to help, called expenditure index.

$$M = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^B + P_Y^B Y^B} = \frac{\sum P_i^T Q_i^T}{\sum P_i^B Q_i^B}$$

- It is the ratio between the actual expenditure in period T and the actual expenditure in the base period.

Price Indexes

1) If L_P is less than or equal to M

$$L_P = \frac{P_X^T X^B + P_Y^T Y^B}{P_X^B X^B + P_Y^B Y^B} \leq \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^B + P_Y^B Y^B} = M$$

$$P_X^T X^B + P_Y^T Y^B \leq P_X^T X^T + P_Y^T Y^T$$

- This is the same as $P_Q > \text{or} = 1$.
- Consumers choose T over B when both are affordable -> **Better off in period T compared to the base period B.**

Price Indexes

2) If L_P is greater than M

$$L_P = \frac{P_X^T X^B + P_Y^T Y^B}{P_X^B X^B + P_Y^B Y^B} > \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^B + P_Y^B Y^B} = M$$

$$P_X^T X^B + P_Y^T Y^B > P_X^T X^T + P_Y^T Y^T$$

- This is the same as $P_Q < 1$.
- Inconclusive** about the welfare change.

Price Indexes

3) If P_P is greater than or equal to M

$$P_P = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^T + P_Y^B Y^T} \geq \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^B + P_Y^B Y^B} = M$$

$$P_X^B X^B + P_Y^B Y^B \geq P_X^B X^T + P_Y^B Y^T$$

- This is the same as $L_Q < \text{OR} = 1$
- Consumers choose B over T when both are affordable -> **worse off in period T compared to the base period B.**

Price Indexes

4) If P_p is less than M

$$P_p = \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^T + P_Y^B Y^T} < \frac{P_X^T X^T + P_Y^T Y^T}{P_X^B X^B + P_Y^B Y^B} = M$$

$$P_X^B X^B + P_Y^B Y^B < P_X^B X^T + P_Y^B Y^T$$

- This is the same as $L_Q > 1$
- Inconclusive about the welfare change.

Cost-of-Living Indexes

- Social security payments can be adjusted to compensate for inflation.
- The inflation rate is calculated from the Consumer Price Index (CPI) based on Laspeyres price index.
- Should we increase the payments equal to the rate of increase of the CPI?

Cost-of-Living Indexes

- Laspeyres price index
 - Amount of money at current year prices that an individual requires to purchase a bundle of goods/services chosen in a base year divided by the cost of purchasing the same bundle at base-year prices

$$L_p = \frac{P_X^T X^B + P_Y^T Y^B}{P_X^B X^B + P_Y^B Y^B} = \frac{\sum P_i^T Q_i^B}{\sum P_i^B Q_i^B}$$

Cost-of-Living Indexes

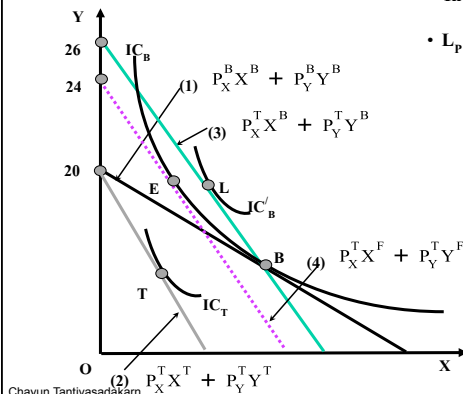
- The Laspeyres price index assumes that consumers do not alter their consumption patterns as prices change
- Tend to overstate the true cost of living index
- Using the CPI to adjust retirement benefits will tend to overcompensate most recipients requiring greater government expenditure

Laspeyres price index overstates the cost of living

Assuming that $P_Y = 1$, Y axis also measure income. • The expenditure in period B is (1) = 20.

• In period T price of X increases.

- $L_P = \frac{\text{old bundle at new prices}}{\text{old bundle at old prices}}$
- The income needed to compensate is only (4) - (2) = 24 - 20 = 4.
- The income implies by L_P is (3) - (2) = 26 - 20 = 6.
- Consume at L instead of E.
 - $L_P = (3)/(1) = 26/20 = 1.3$
 - True cost-of-living index = (4)/(1) = 24/20 = 1.2
- > over estimate



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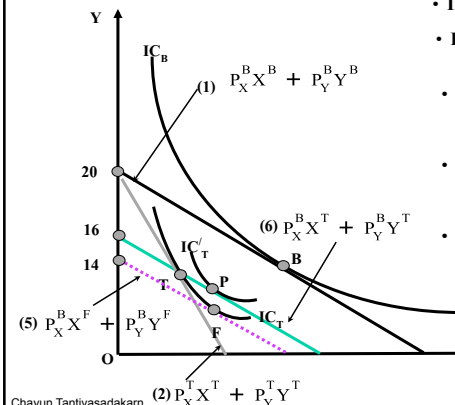
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Paasche price index understates the cost of living

Assuming that $P_Y = 1$, Y axis also measure income. • The expenditure in period B is (1) = 20.

• In period T price of X increases.

- $P_P = \frac{\text{new bundle at new prices}}{\text{new bundle at old prices}}$
- The income needed to compensate should be (1) - (5) = 20 - 14 = 6.
- The income implies by P_P is (1) - (6) = 20 - 16 = 4.
- Consume at P instead of F.
 - $P_P = (2)/(6) = 20/16 = 1.25$
 - True cost-of-living index = (2)/(5) = 20/14 = 1.43
- > under estimate



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Fisher Ideal Price Index

- To solve the over and under estimate problems of both indices, Irving Fisher has proposed the Fisher Ideal Price Index

$$F_P = \sqrt{L_P \cdot P_P}$$

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Duality

- There exists a dual relationship between two optimization problems.

$$\text{Max } U(X,Y) \text{ subject to } I = P_X X + P_Y Y \quad (1)$$

$$\text{Min } P_X X + P_Y Y \text{ subject to } U(X,Y) = U^* \quad (2)$$

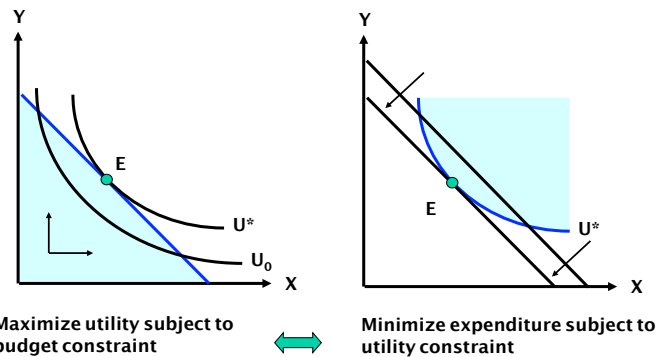
where U^* is the utility level attained from (1)

- Solving either problem will give the same optimum value of X^* and Y^* .

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Duality



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Duality: example

- Max $U = XY$ subject to $I = 20$, $P_X = P_Y = 1$
- Since $I = P_X X + P_Y Y$,

$$Y = (I - P_X X) / P_Y = 20 - X$$
- Substitute this into U to get $U = X(20 - X) = 20X - X^2$
- $dU/dX = 20 - 2X = 0$

$$\rightarrow X^* = 10, Y^* = (20 - 10) = 10$$

$$U^* = (10)(10) = 100$$

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Duality: example

- Min $E = P_X X + P_Y Y$ subject to $U^* = 100 = XY$, $P_X = P_Y = 1$
- Since $Y = 100/X$
- Substitute this into E to get $E = P_X X + 100P_Y/X = X + 100/X$
- $dE/dX = 1 - 100/X^2 = 0$

$$\rightarrow X^* = 10, Y^* = 100/10 = 10$$

$$E^* = 10 + 10 = 20 = I \text{ in the first problem}$$

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Duality

- The optimal expenditure function from the second problem is useful because it is observable.
- We can collect expenditure data to estimate expenditure function and get the Hicksian demand function.
- It is possible to prove that the derivative of the expenditure function is the Hicksian demand function which gives an accurate measurement for consumer surplus.

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