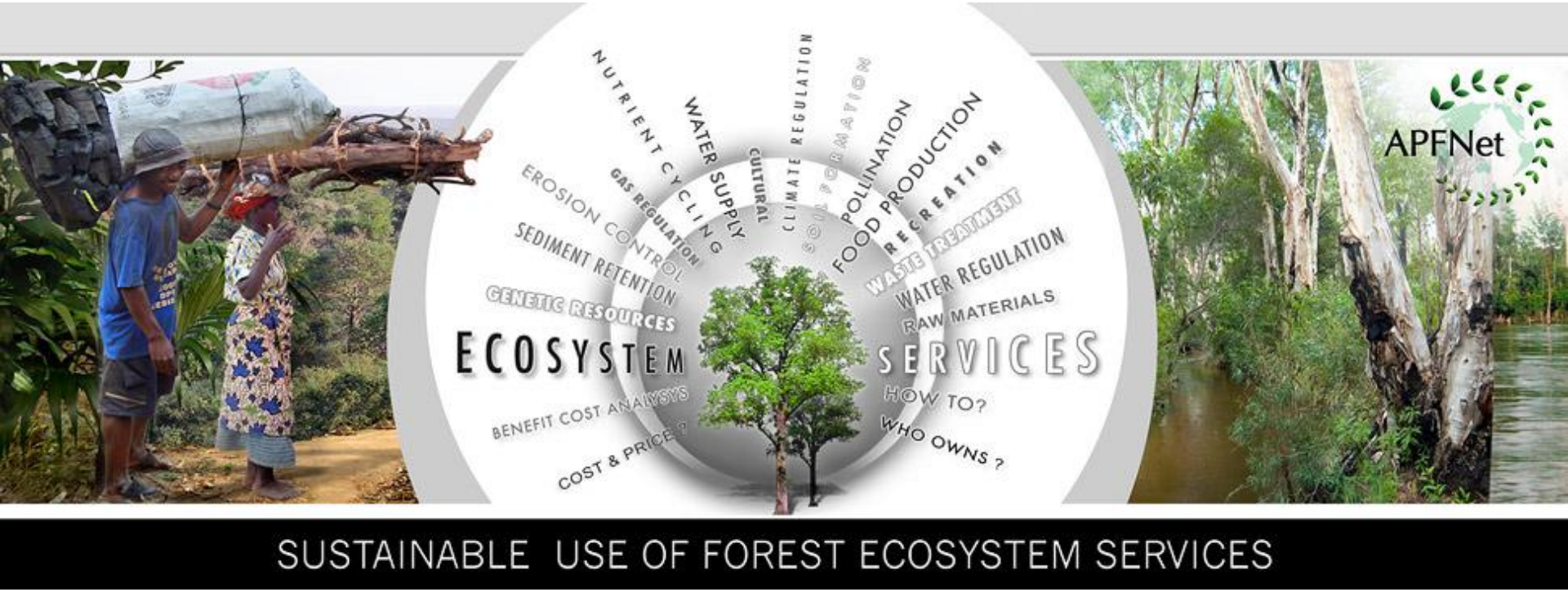


SUSTAINABLE USE OF FOREST ECOSYSTEM SERVICES

UTILITY THEORY AND WELFARE ECONOMICS

Learning Outcomes

At the end of the presentation, participants should be able to:

1. Explain the concept of utility and welfare economics
2. Describe the measurement of welfare change

Outline

- General background
- Utility theory
- Measure of welfare change

General Background

Utility Theory

- Utility – is the term used in welfare economics to mean happiness, or satisfaction or benefit or welfare that a consumer gets from a given market
- For example, If an individual prefers good A to good B, then good A gives more utility than good B.
- It is an important concept in economics because it represents satisfaction experienced by the consumer of a good or services.
- An individual's welfare is represented by his or her utility level
- Utility levels cannot be observed directly. This is the difficulty of welfare economics
- Economists have devised ways of representing and measuring utility in terms of economic choices that can be measured.
- Economists consider utility to be revealed in people's willingness to pay different amounts for different goods.
- It is assumed that the action of an individual operates under prevail market situation.
- For most ecosystem services, market are not readily available and market price is seldom exist.

- For the basic theory, the consumer will react to price or income changes can all be derived from an ordinal system – by ranking the alternatives
- When dealing with public choices, however, it would be helpful to measure the utility

Individual preferences and demand

- individuals consume environmental resources because they can provide satisfaction or well-being. This satisfaction is known as utility
- What affects utility? (Or satisfaction)
- For two market goods, X_1 and X_2, the utility function of an individual is given by the following utility function:

  $U=U(X_1,X_2)$ → *[Note: refer to graph of utility or indifference curve]*
- Consumption of goods and services (for example priced and non-priced goods) is shown by utility function,

  $u = u(x,s,k)$

  x = goods (priced)

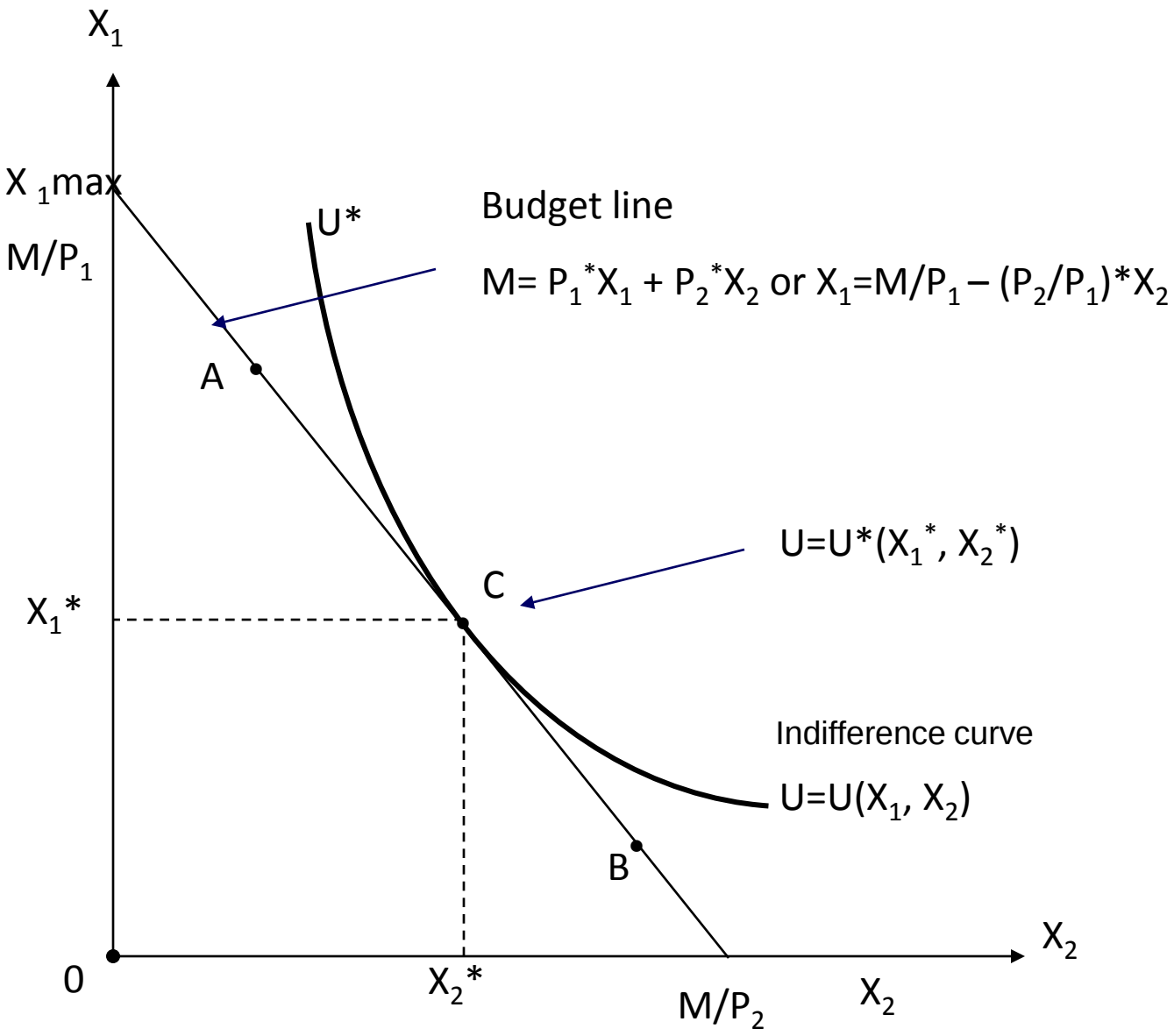
  s = environmental services (non-priced, for example forest)

  k = customs and law (property rights of resource use)
- Economists assume that individuals will maximize utility subject to prices of goods and services and income constraints, i.e. $M = P_1 + P_2$ where P_1 is price of X_1 and P_2 is price of X_2. Since s and k are not priced, they are not included in the budget constraint.
- This utility is known as indirect utility function

Utility Functions

- A preference relation that is complete, reflexive, transitive and continuous can be represented by a continuous utility function.
- Continuity means that small changes to a consumption of good cause only small changes to the preference level.
- An indifference curve contains equally preferred bundles.
- Equal preference $\Rightarrow$ same utility level.
- Therefore, all bundles in an indifference curve have the same utility level.
- Utility function and indifference curve can be shown in the following graph

Utility maximisation



- First, we consider utility function of two market goods, X_1 and X_2
- The individual is maximizing utility and subject to budget constraints.
- Preferences do not explain all of consumer behavior.
- Budget constraints also limit an individual's ability to consume in light of the prices they must pay for various goods and services.
- Assume the two goods have market price, P_1 is market price for X_1, and P_2 is market price for X_2.
- Individual income is given by M. Assume all income is spent on these products:
  $P_1 * X_1 + P_1 X_1 = M$
- This is known as budget line
- Budget line can be represented by a graph. In the diagram it is referred as: $X_1 = M/P_1 - (P_2/P_1) * X_2$

We can represent the budget line in mathematical form by solving the budget line equation:

$$M = P_1 * X_1 + P_2 * X_2$$

$$P_1 * X_1 = M - P_2 * X_2$$

$$X_1 = \frac{M - P_2 * X_2}{P_1} = \frac{M}{P_1} - \frac{P_2}{P_1} * X_2$$

$$a = \frac{M}{P_1}, \qquad b = -\frac{P_2}{P_1} \ (slope)$$

The budget line indicates all combinations of two commodities for which total money spent equals total income.

Budget Constraints

- The Budget Line
  - As X_1 moves along a budget line from the intercept, the consumer spends less on X_1 and more on X_2.
  - The slope of the line measures the relative cost of X_1 and X_2 .
  - The slope is the negative of the ratio of the prices of the two goods, i.e. $-(P_2/P_{1)}$
  - The slope indicates the rate at which the two goods can be substituted without changing the amount of money spent.

Budget Constraints

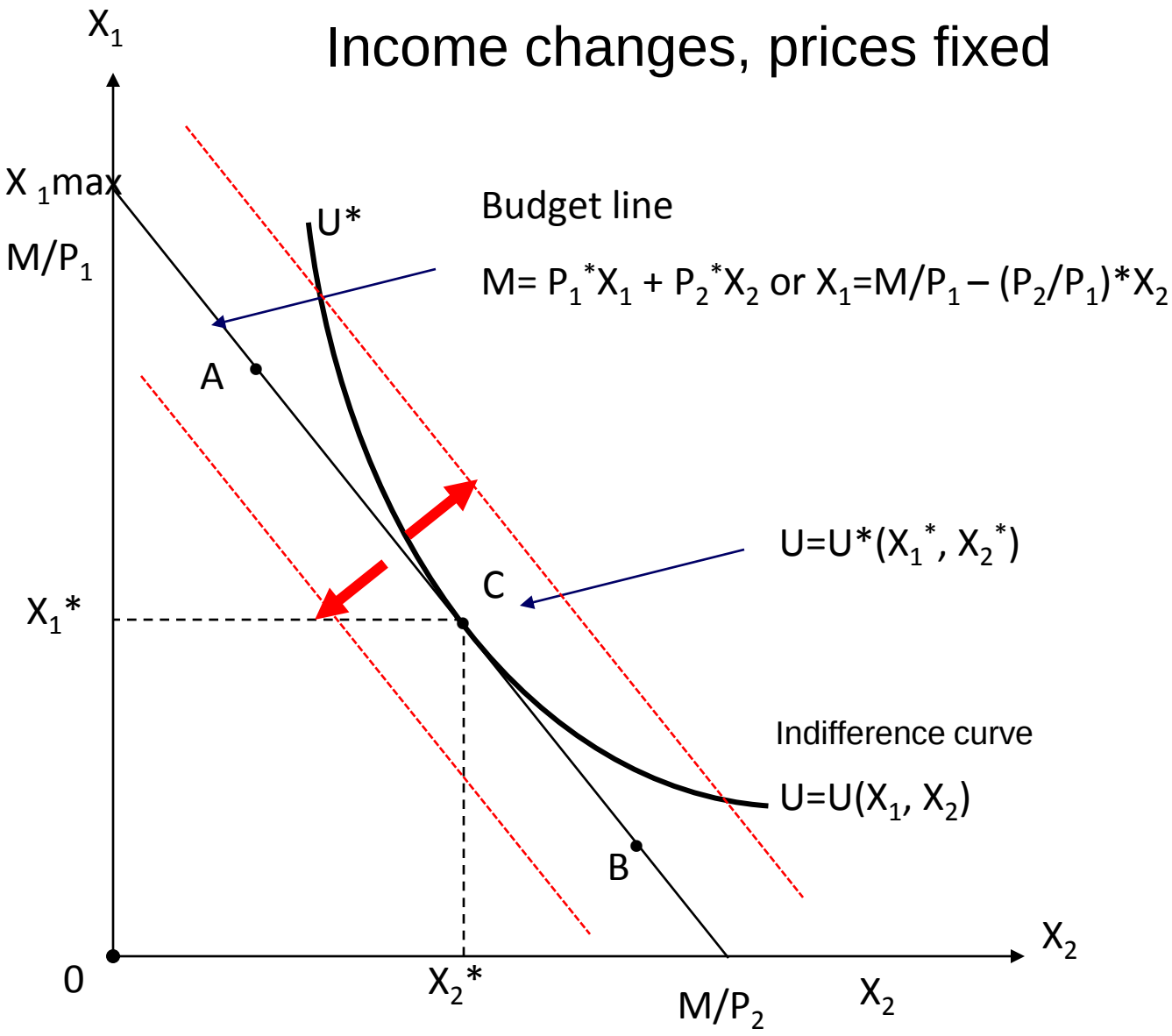
- The Budget Line
  - The vertical intercept (M/P_1), illustrates the maximum amount of X_1 that can be purchased with income M.
  - The horizontal intercept (M/P_2), illustrates the maximum amount of X_2 that can be purchased with income M.

Budget Constraints

- The Effects of Changes in Income and Prices
  - Income Changes
    - An increase in income causes the budget line to shift outward, parallel to the original line (holding prices constant).
    - A decrease in income causes the budget line to shift inward, parallel to the original line (holding prices constant).

Utility maximisation

Income changes, prices fixed

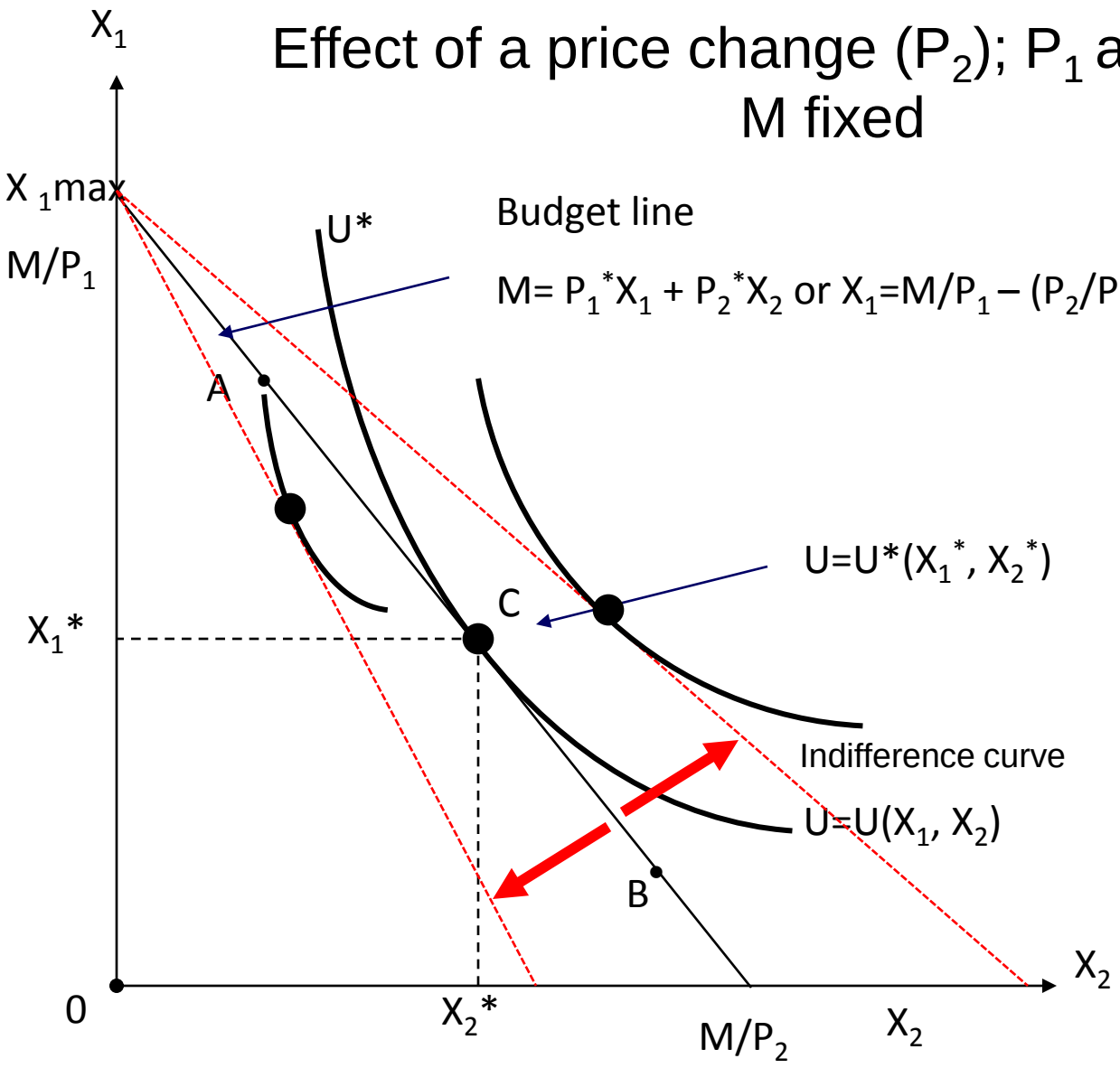


Budget Constraints

- The Effects of Changes in Income and Prices
  - Price Changes
    - If the price of one good increases, the budget line shifts inward, pivoting from the other good's intercept.
    - If the price of one good decreases, the budget line shifts outward, pivoting from the other good's intercept.
    - If the two goods increase in price, but the *ratio* of the two prices is unchanged, the slope will not change.

Utility maximisation

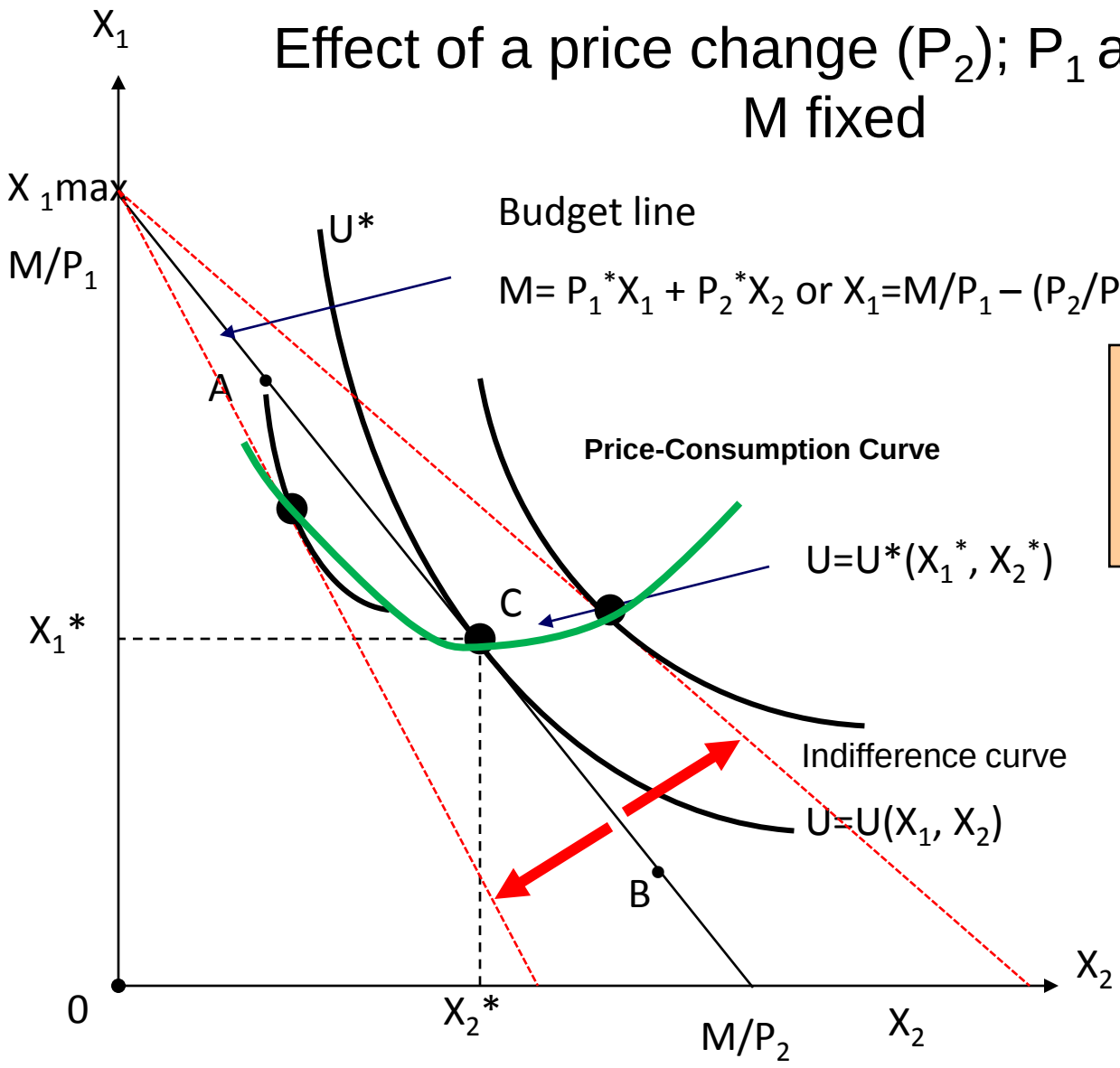
Effect of a price change (P_2); P_1 and income M fixed



Three separate indifference curves are tangent to each budget line.

Utility maximisation

Effect of a price change (P_2); P_1 and income M fixed



The price-consumption curve traces out the utility maximizing market basket for the various prices for food.

- Using the consumer theory or known as 'household production function' we can write our problem as follows:

  Max $U=U(X_1,X_2)$ subject to: $P_1X_1 + P_2X_2 = M$
- Solving the above problem, we obtain:

  $X_1=(P_1, P_2,M)$
- This enable us to define indirect utility function for price and unpriced goods and services:

  $U = U(P, S, K,M)$
- Why is utility function important? Because it provides common framework for valuing benefits
- e.g., If p or s changes, we can value by looking at change in U
- What is the great limitation of this approach?
- Cannot observe or estimate utility function, instead of utility, we observe P, X, M

Hicksian welfare measure

- If we cannot measure utility directly and cardinally, may be we can measure it indirectly and ordinally.
- i.e. May be we can develop some other measures that consistently reflects the direction and relative magnitude of differences in utility
- The change in income, M, necessary to maintain utility to some fixed, reference level when some variables in the indirect utility function changes (generally, P or S)
- It sounds promising, because
  1. We don't need to observe the utility, we just need to be sure that it is unchanging from reference level.
  2. We can observe income (i.e., money), but:
     - We are restricting to value changes, not absolute levels. The implication is that we cannot calculate total value, but we can calculate changes in forest value (e.g., relative to some other land use)

Hicksian welfare measure

- So, what is appropriate level of reference?
- When change occurs, we have the level of utility before the change and after the change. For example:

  $U_0 = U(P_0, S_0, K, M_0)$

  $U_1 = U(P_1, S_1, K, M_1)$
- which one should be choosen? We can choose either U_0 or U_1
- if we choose U_0, this is known as hicksian compensating variation: $U_1 = U(P_1, S_1, K, M_1\text{-hc})$
- hc is the hicksian compensating:
  - "amount of income, paid or received, that would leave an individual at the initial level of utility, u_0, if the change occurs."
- If hc > 0, change must be beneficial, and hc is termed willingness to pay (WTP): individual would be willing to pay to obtain change.
- If hc < 0, change must be costly, and hc is termed willingness to accept (WTA): individual must be compensated to accept the change.

Hicksian welfare measure

- If we choose U_1, hicksian equivalent variation:

  $U_1 = U(p_0, s_0, k, M_0\text{-}he)$
- he is the hicksian equivalent:
  - "amount of income, paid or received, that would leave an individual at the final level of utility, U_1, if the change does not occur."
- If he > 0, change must be costly, and he is termed willingness to pay (WTP): individual would be willing to pay to avoid change.
- If hec < 0, change must be beneficial, and he is termed willingness to accept (WTA): individual must be compensated to forgo the change.
- The role of valuation: seeks to estimate WTP or WTA

- Resource economists generally prefer:
  1. WTP: reflects budget constraints
  2. HC: compare prospective change to status quo
- Question: will change make us better or worse off?
- Benefit-cost analysis is based on hicksian compensating (HC)

Consumer surplus (CS)

- For priced goods, we know p (price) and x (quantity)
- The relationship is: X = f(P), *ceteris paribus.* Thus, is there an easy way to measure WTP?
- If maximize utility function subject to income constraint, inverse demand curve, i.e.,

  P = P(X, S, K, M)

  X = quantity demanded
- The inverse demand curve gives WTP for marginal unit, with income (m) held constant
- Consumer surplus is the difference between WTP and market price
  - surplus: value is not equal expenditure. For example, if we were to value a protected are or a forest recreational area, we shouldn't look at tourism expenditures, rather at consumer surplus or simply surplus.
- Generally, we consider changes: i.e., we need go through price increase.
- Question: what does CS measure?

Consumer surplus (CS)..cont'd

- Utility is not held constant, and this means that CS may sometimes fail to provide a consistent, ordinal measure of welfare change
- however, CS is more easily measured than HC or he
- it is generally true that:
- -HE > CS > HC
- we can use formulas to convert CS to HE or HC. The results are that the differences are small. However in some cases, it is large, due to:
  1. Demand is very sensitive to income changes
  2. Good accounts for large share of budget

Producer surplus (PS)

- In certain cases, the change in income might be significant. For instance, environmental change such as flooding caused by deforestation, might reduce crop yields and thus farmers income. In this situation:
- Change in income might reflect farmers' WTP to avoid flooding
- Producer surplus (PS) is a means of accounting these. It should be noted that, production costs: is
  - variable: if change level of output, change level of use of inputs. For example, labour and logs input in a sawmill
  - fixed: if change level of output, don't change level of use of inputs. For example, administrative staff and building.
- It should be noted that:
  - production surplus = total revenue - total variable costs
    = fixed costs + profits
- the assumption is that variable inputs can be employed elsewhere, so they are not relevant in determining income impacts.

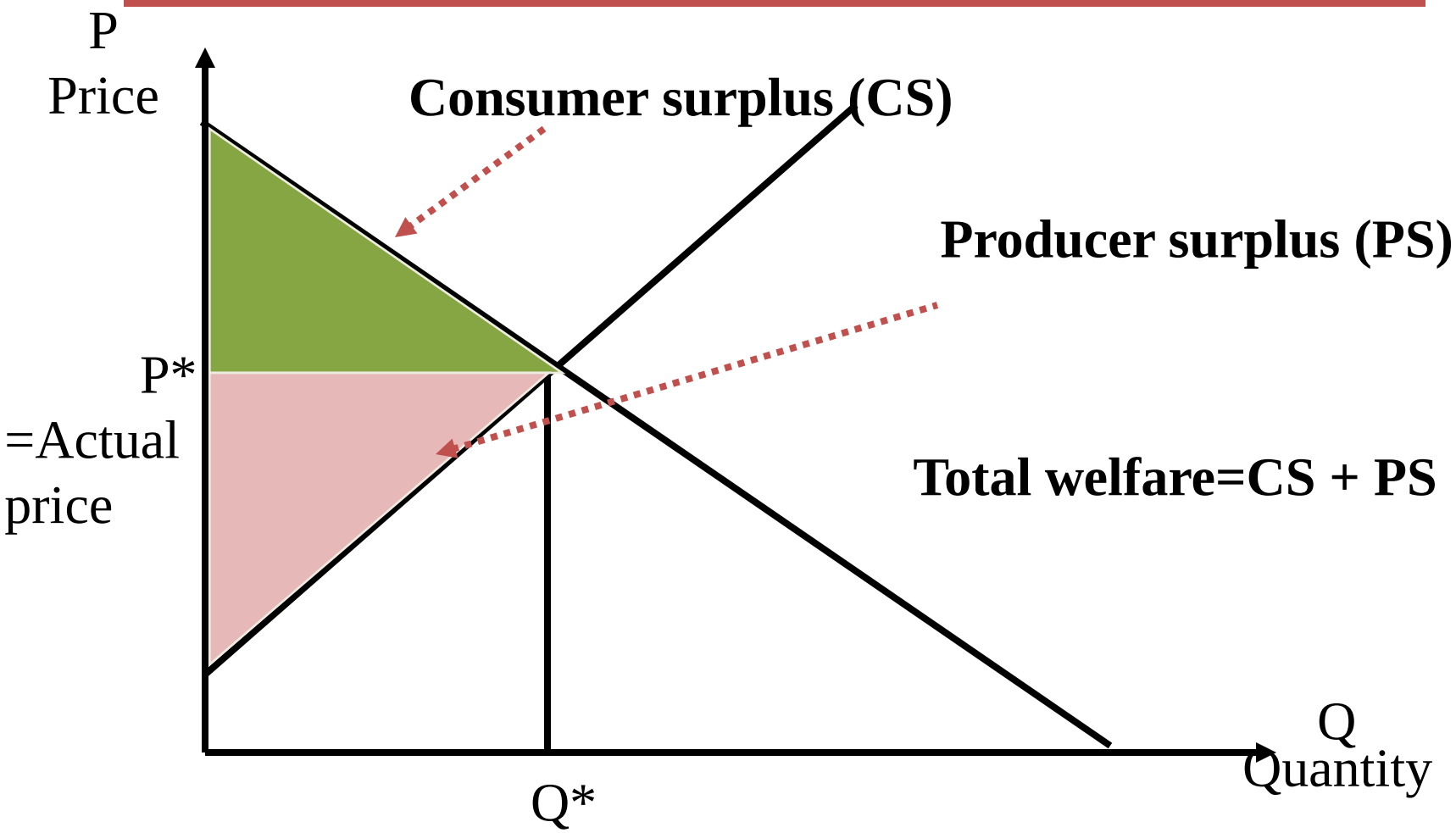
- Another interpretation is the "rent" to fixed factors of production (e.g. rent for land, wage for labour, dividend for capital)
- It is therefore, the producer surplus is the difference between marginal (variable) costs (=supply curve) and market price

  Note that surplus: value is not equal to revenue
- For instance, if we want to value forest as timber supply, we shouldn't look at sales revenue from logs, but rather at surplus (fixed costs plus stumpage value) – we use residual value technique to value timber rent
- generally, we consider changes in price (increase)

Net social surplus

- sum of producer and consumer surplus
- We also should consider an upward shift in supply curve
- For example: the effects of deforestation-induced flooding on consumer surplus and producer surplus of downstream agriculture and other activities

Producer and consumer surplus



Valuation

- taxonomy: valuation methods seek to estimate economic surpluses for goods and services that are unpriced or have distorted prices
- ideally we want to calculate Hicksian Compensating (HC) or Hicksian Equivalent, but in practice we usually estimate consumer surplus (CS) and producer surplus (PS)
- The taxonomy is based on whether we can infer the economic surplus (PS) from the price of some other goods.

Approaches

Normally we have two approaches:

1. **Indirect approach**

   In this approach, price of some other goods can be used, for instance production function approach

   - Based on actual behaviour that reflects utility maximization
   - we need to have a functional relationship between unpriced and priced good. Generally can do this for use values
   - usually we get consumer surplus or producer surplus, and we must convert these to hc or he
   - several methods can be used: productivity change, travel cost method

Approaches

2. Direct approach

In this approach, we use price of other goods that cannot be used

- Observations based on actual choices
- People are maximizing utility
- Data obtained reveal willingness-to-pay
- we need a hypothetical market to get people to estimate WTP or WTA.

- Example: contingent valuation method (CVM)
- We can do this for use values, but is only method for option, quasi-option, and existence values
- For example: we ask sample of people how much WTP to preserve tropical forests. This can be done using CVM.
- We can estimate of hc or he directly

The methods used under each this approach is given in the following table

Approach	Observed behavior	Hypothethical
Direct	Direct observation Competitive market price Simulated market	Direct hypothetical Bidding game Willingness-to-pay
Indirect	Indirect observation Travel cost method (TCM) Hedonic price Damage cost avoided Referendum voting	Indirect hypothetical Contingent ranking Contingent activity Contingent referendum

Welfare Measures for Changes in Prices

Welfare measures

- Changes in forest ecosystem services quality can affect individual welfare through various means
  - Changes in the price paid (i.e. price of timber)
  - Changes in quantities or qualities of nonmarket goods (e.g. water quality, recreation)
  - Changes in price received for factors of production
  - Changes in the risks
- The first two relate to consumer theory and preference (focus in this presentation)
- They are relevant because changes in forest ecosystem services quality affect people indirectly through price effects. This will affect individual's welfare
- Thus, all costs take the form of reductions in utility of individuals

Welfare measures

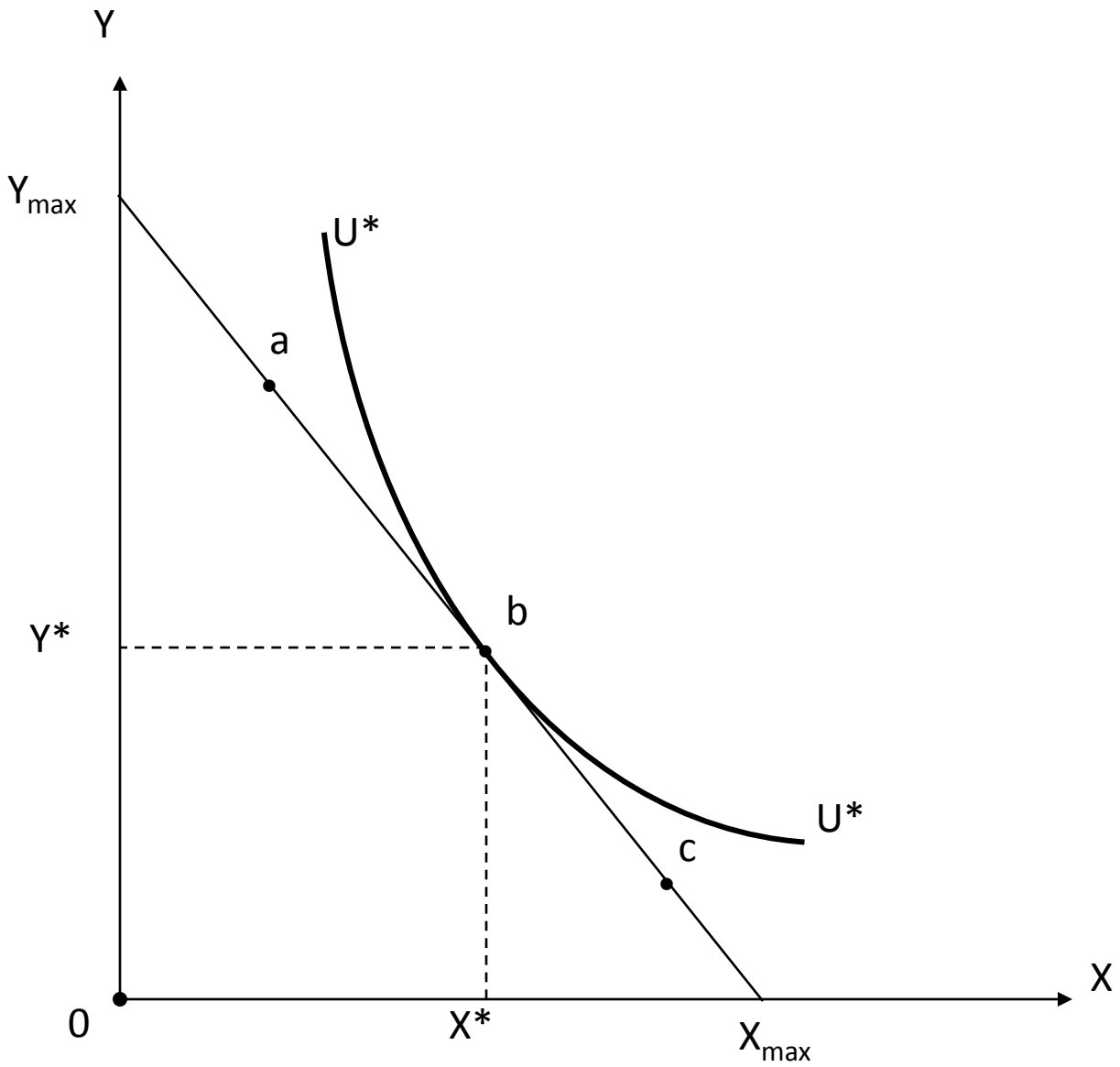
Questions

- How to define an acceptable monetary measure of changes in economic welfare for an individual
- How changes in welfare would be measured (theory and practices)
- Ho any measure of welfare changes for individuals might be used to make judgment about social policies affecting many individuals)

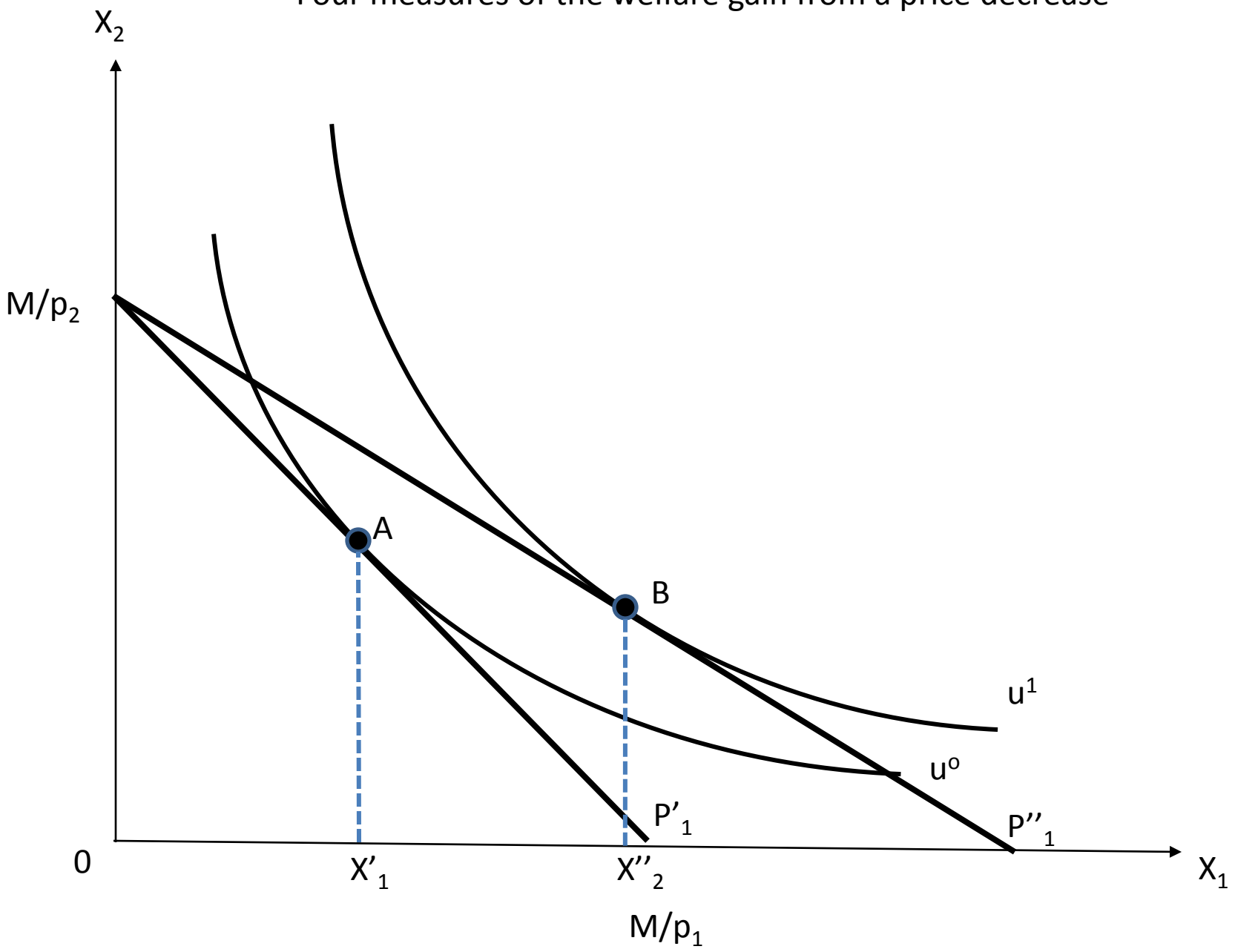
Welfare measure for price changes

- We consider the simplest case on only two goods and the welfare gain associated with a nonmarginal decrease in price of one of these goods
- 2 types of measures of this welfare change
  - Change in ordinary consumer surplus (area under the ordinary Marshalian demand curve)
  - Change in Hicksian demand curve, underlying individual preference mapping

Figure 4.8 Utility maximisation.

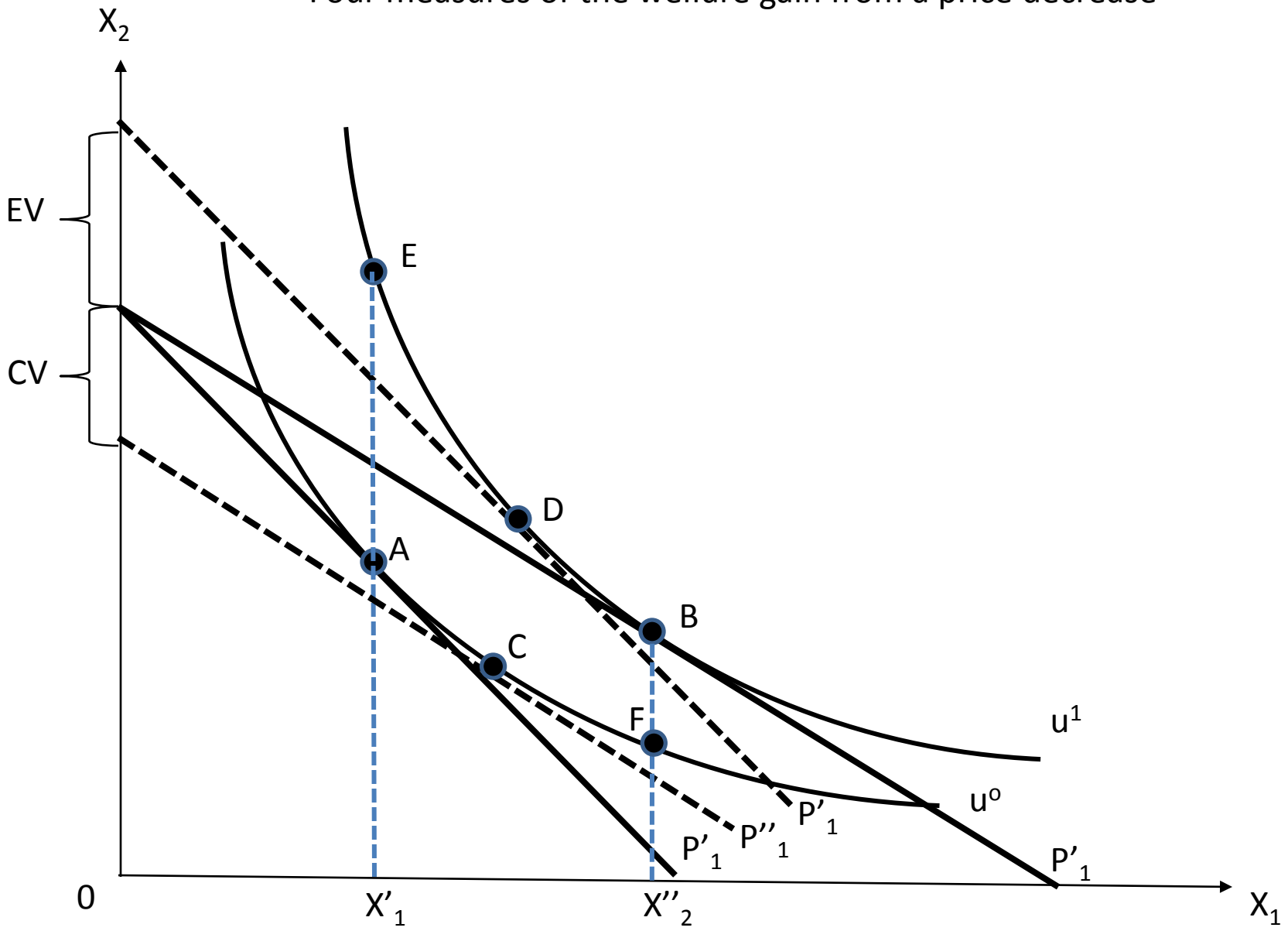


Four measures of the welfare gain from a price decrease

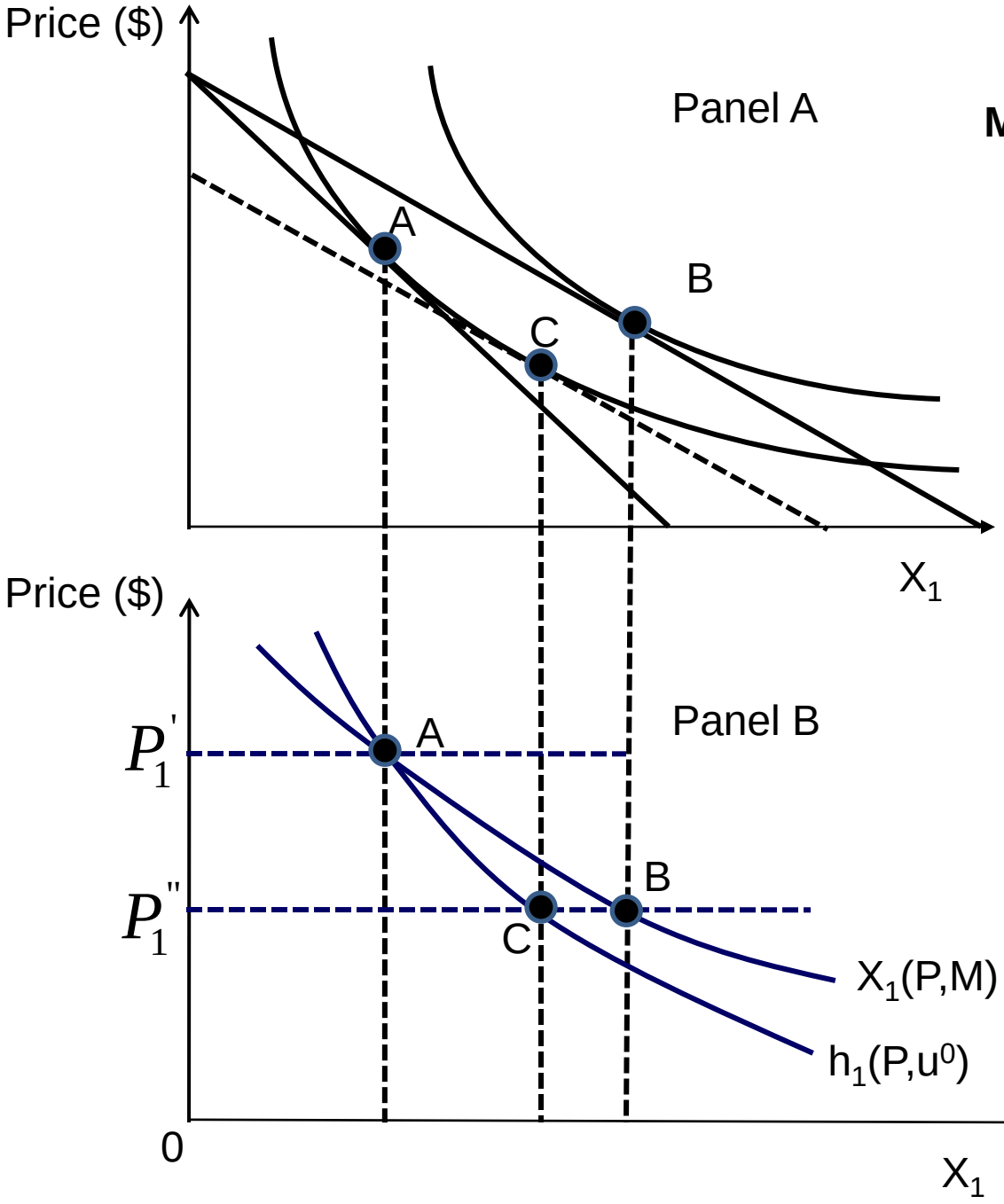


Source: Freeman, 1993

Four measures of the welfare gain from a price decrease



Source: Freeman, 1993



Marshalian surplus

Panel A

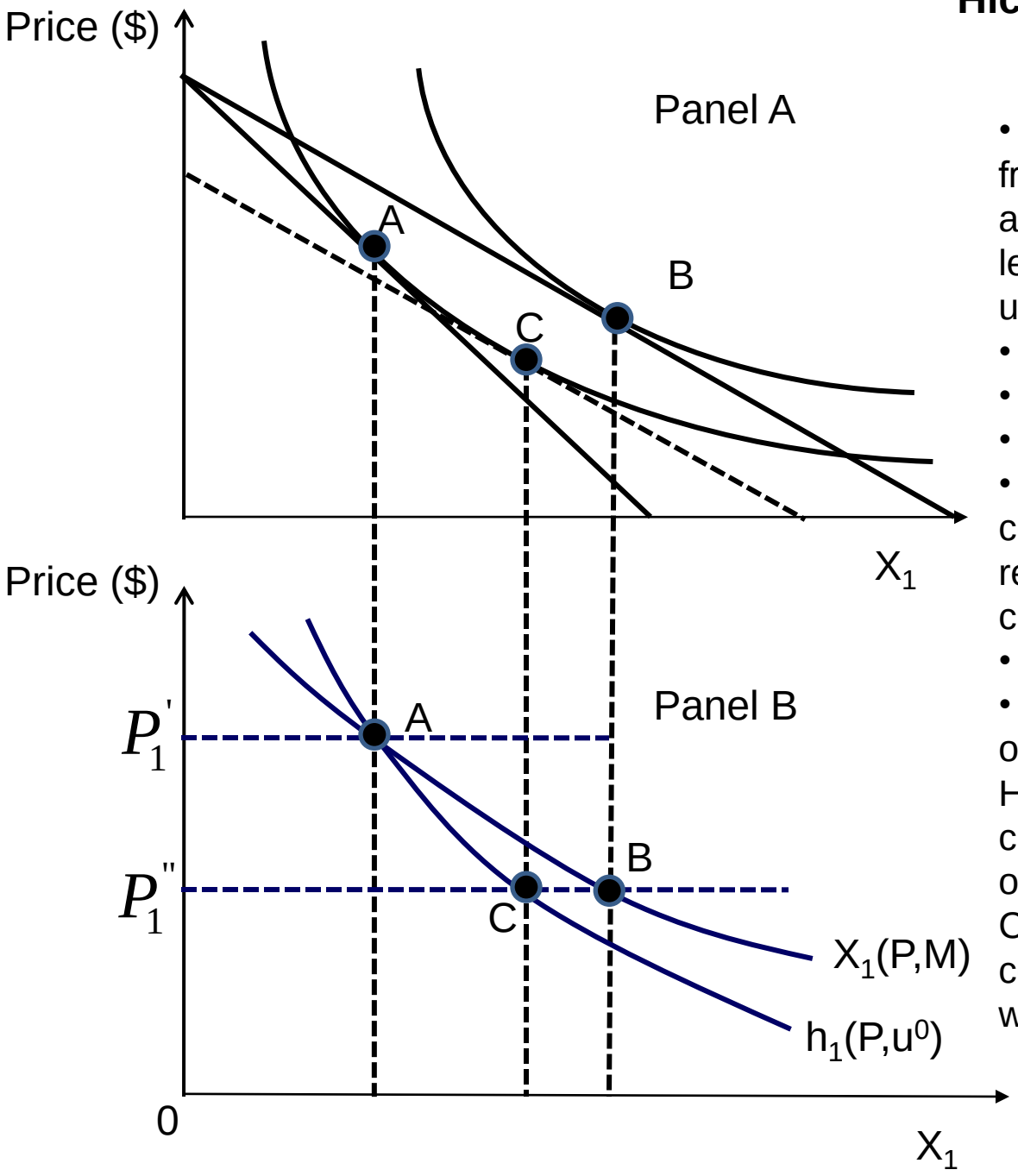
- Price of good X_1 falls from P' to P"
- Original equilibrium –point A
- New equlibrium at point B

Panel B

- Ordinary demand curve –points A and B (price of good X_2 and income constant)
- Marshalian suplus associated with consumption of good at given price is area under demand curve
- Change in surplus for a change in price
- The change is: P_1'ABP$_1$"

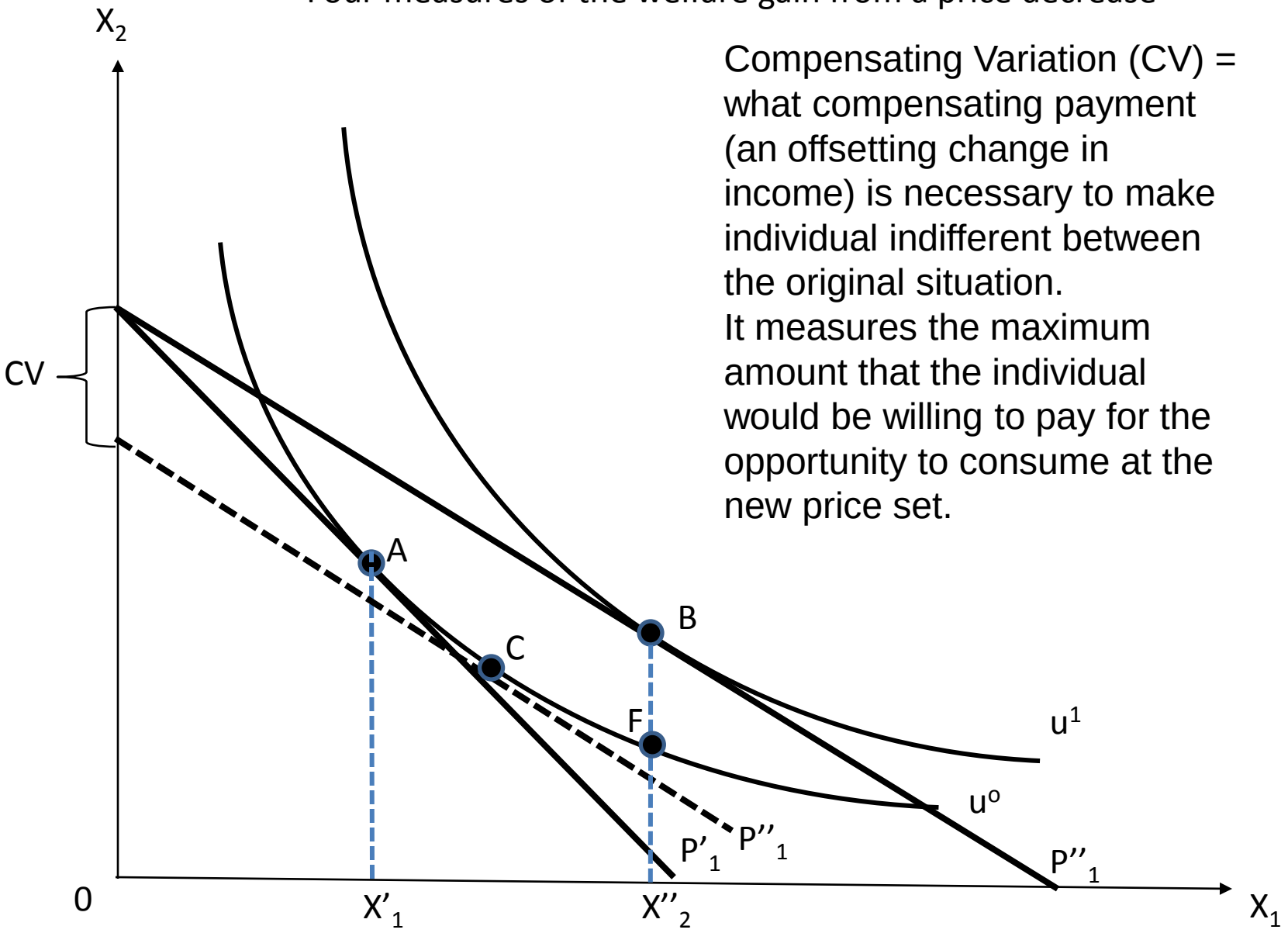
Marshalian surplus can be interpreted as the utility change converted to monetary units by a weighting factor – marginal utility of income

Hicksian surplus



- Suppose price of good X_1 falls from P' to P"; income is taken away from individual so that utility level remains at initial utility level u^0
- Equilibrium at point C (Panel A)
- Point C is plotted in Panel B
- In Panel B:
- Points A – C are Hicks - compensated demand curve → reflects substitution effect of the change in relative prices
- It s less price-elastic
- Difference between Marshalian ordinary demand curve and Hicks-compensated demand curve is the main considerations of Equivalent variation, Compensating variation and consumer surplus measure of welfare change

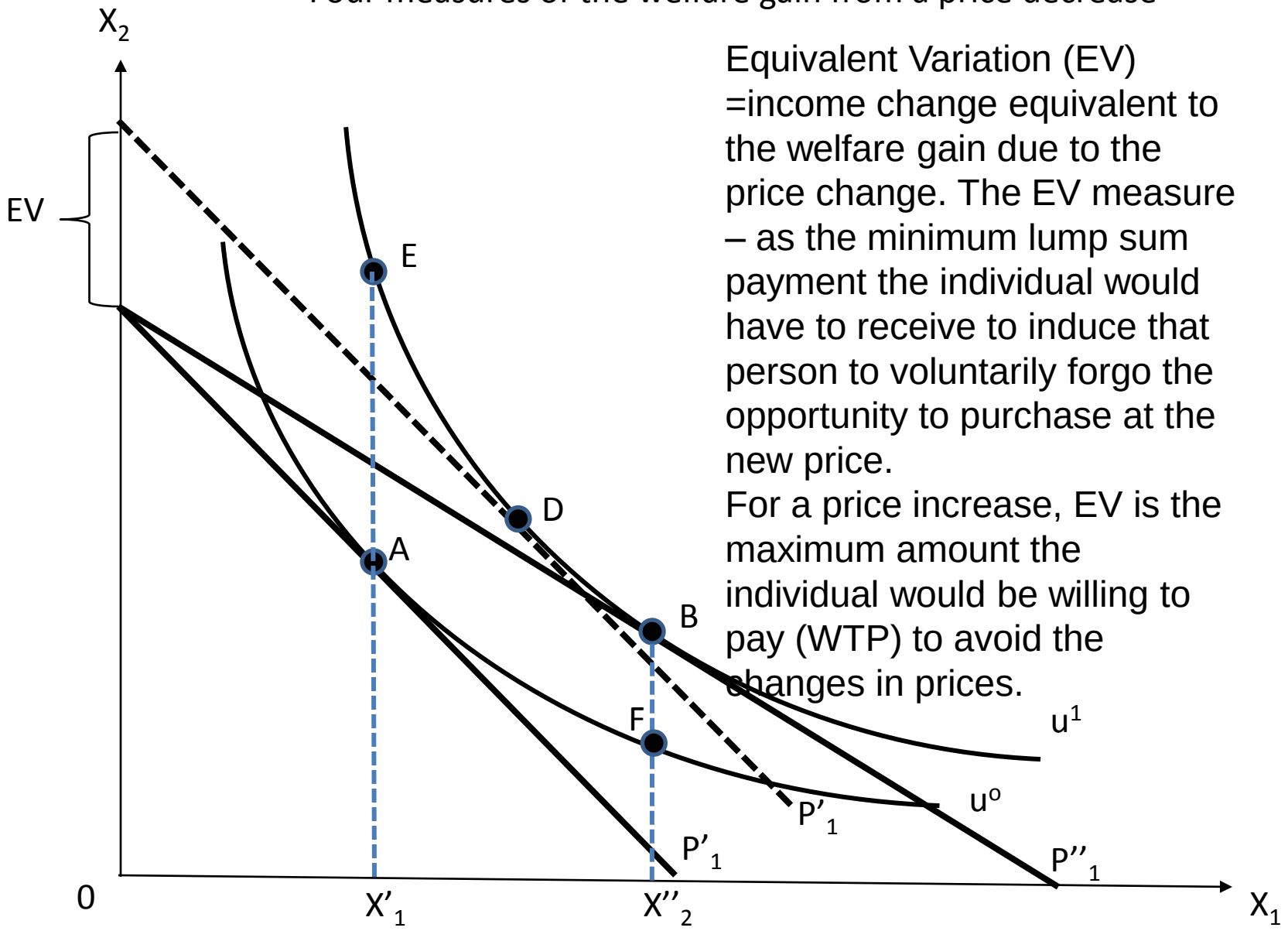
Four measures of the welfare gain from a price decrease



Compensating Variation (CV) = what compensating payment (an offsetting change in income) is necessary to make individual indifferent between the original situation.
It measures the maximum amount that the individual would be willing to pay for the opportunity to consume at the new price set.

Source: Freeman et al. (2014)

Four measures of the welfare gain from a price decrease



Equivalent Variation (EV) =income change equivalent to the welfare gain due to the price change. The EV measure – as the minimum lump sum payment the individual would have to receive to induce that person to voluntarily forgo the opportunity to purchase at the new price.

For a price increase, EV is the maximum amount the individual would be willing to pay (WTP) to avoid the changes in prices.

Source: Freeman, 1993