The Abdus Salam International Centre for Theoretical Physics

Fondazione Eni Enrico Mattei

The Beijer International Institute of Ecological Economics - The Royal Swedish Academy of Sciences

1st Teaching Workshop on Environmental Economics

for the Middle East and North Africa

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Valuation Approches

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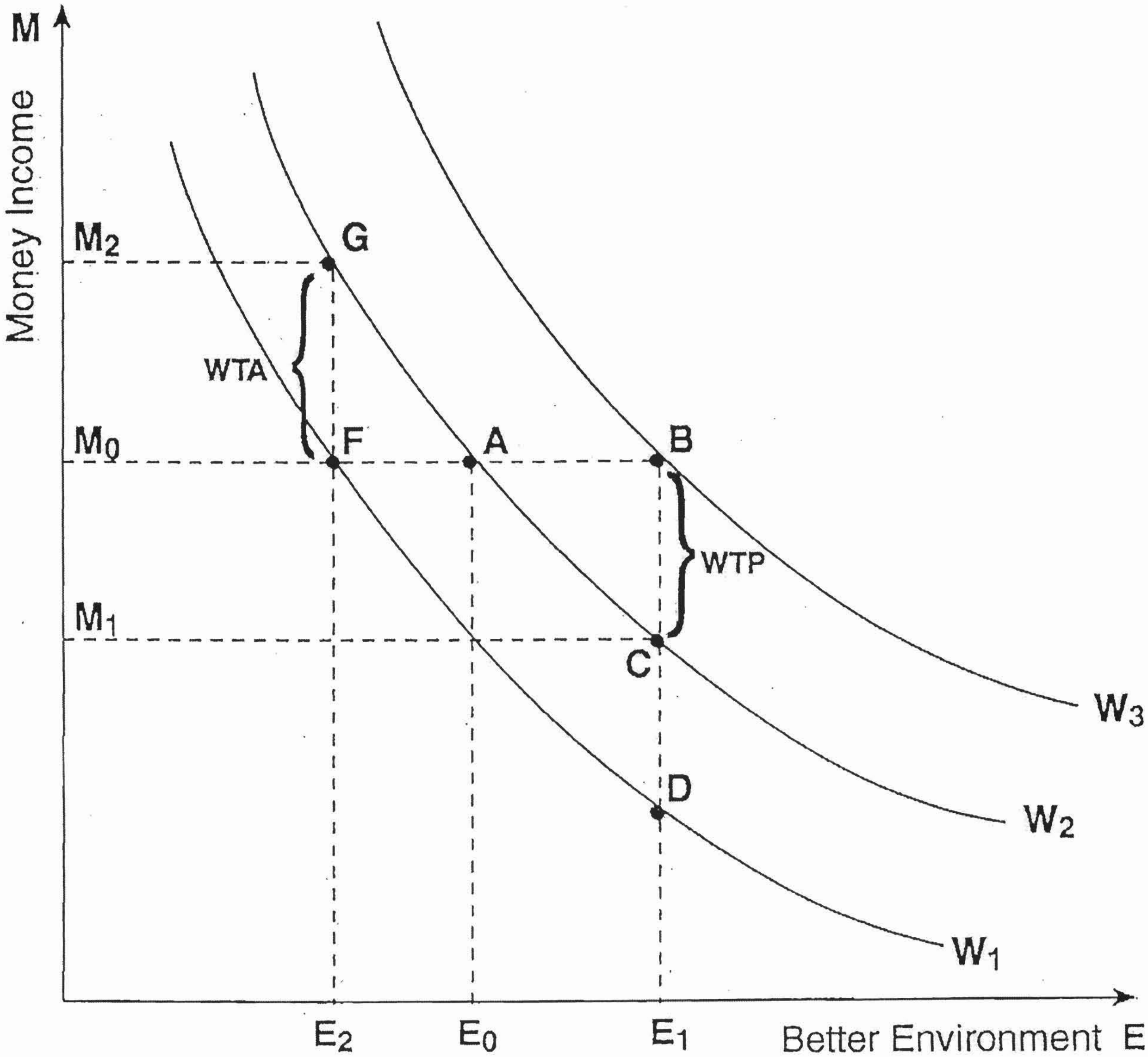


Figure 1: Translating preferences into monetary values

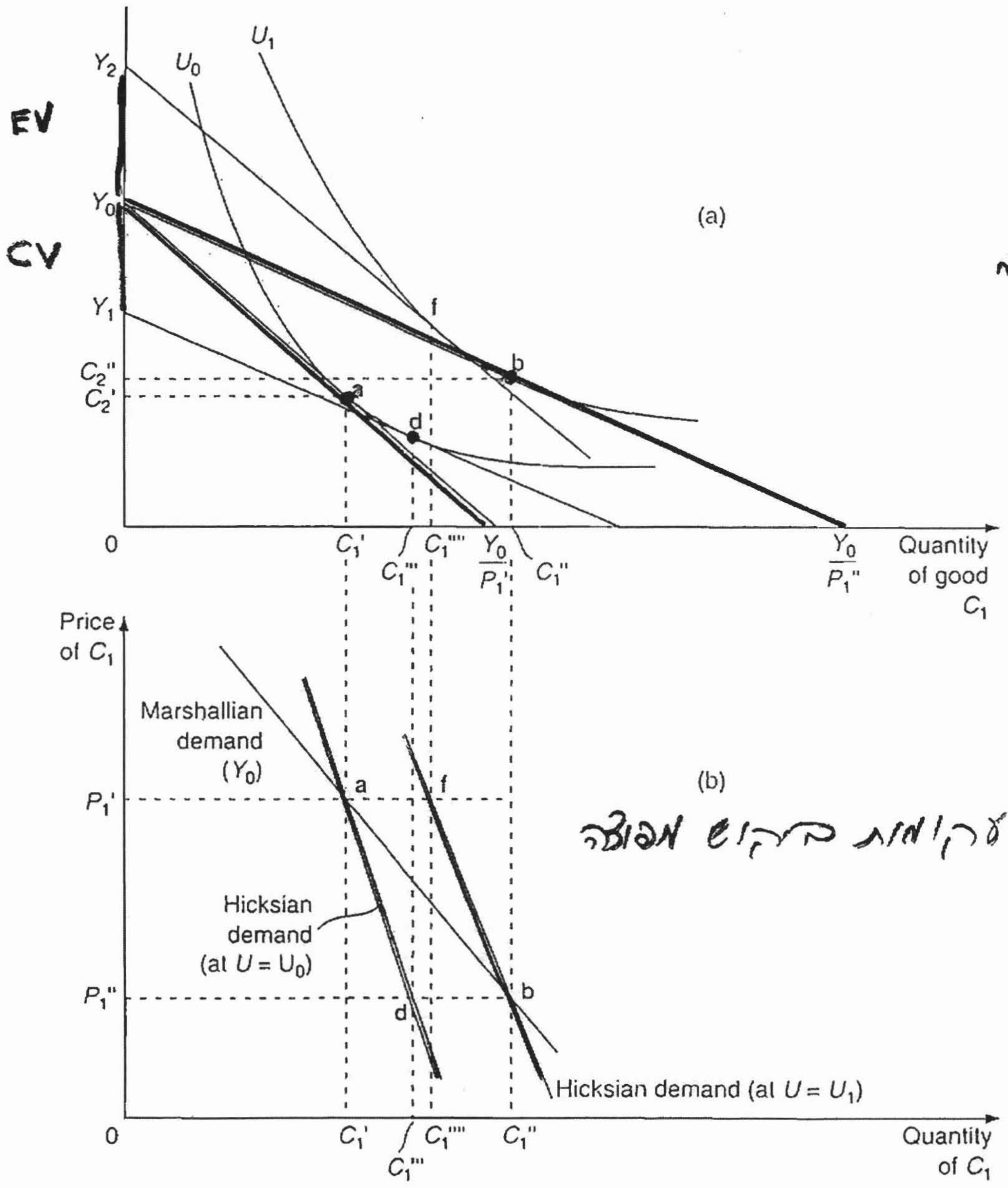


Figure 14.3 (a) The compensating variation of a price fall. (b) Hicksian and Marshallian demands.

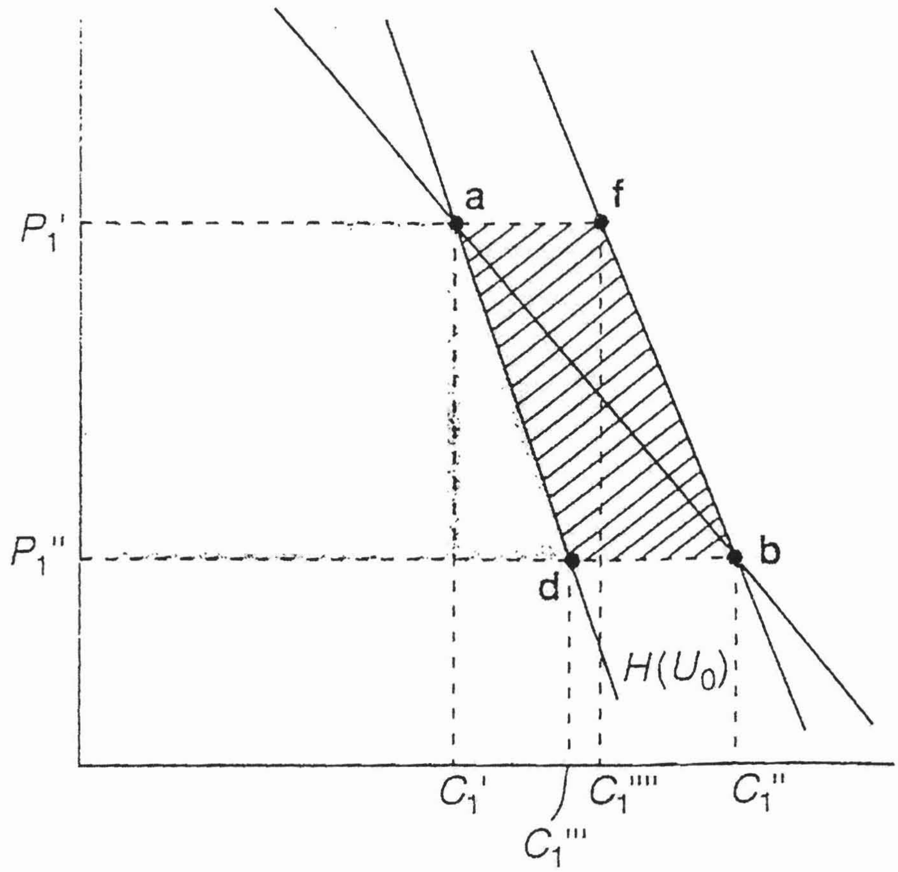
ירידה במחיר { מצב התחלתי / מצב סופי

$P_1' \rightarrow P_1''$

$C_1' - C_1'''$ התחלפה

$C_1''' - C_1''$ הכנסה

גורם



For a fall in the price of C_2:

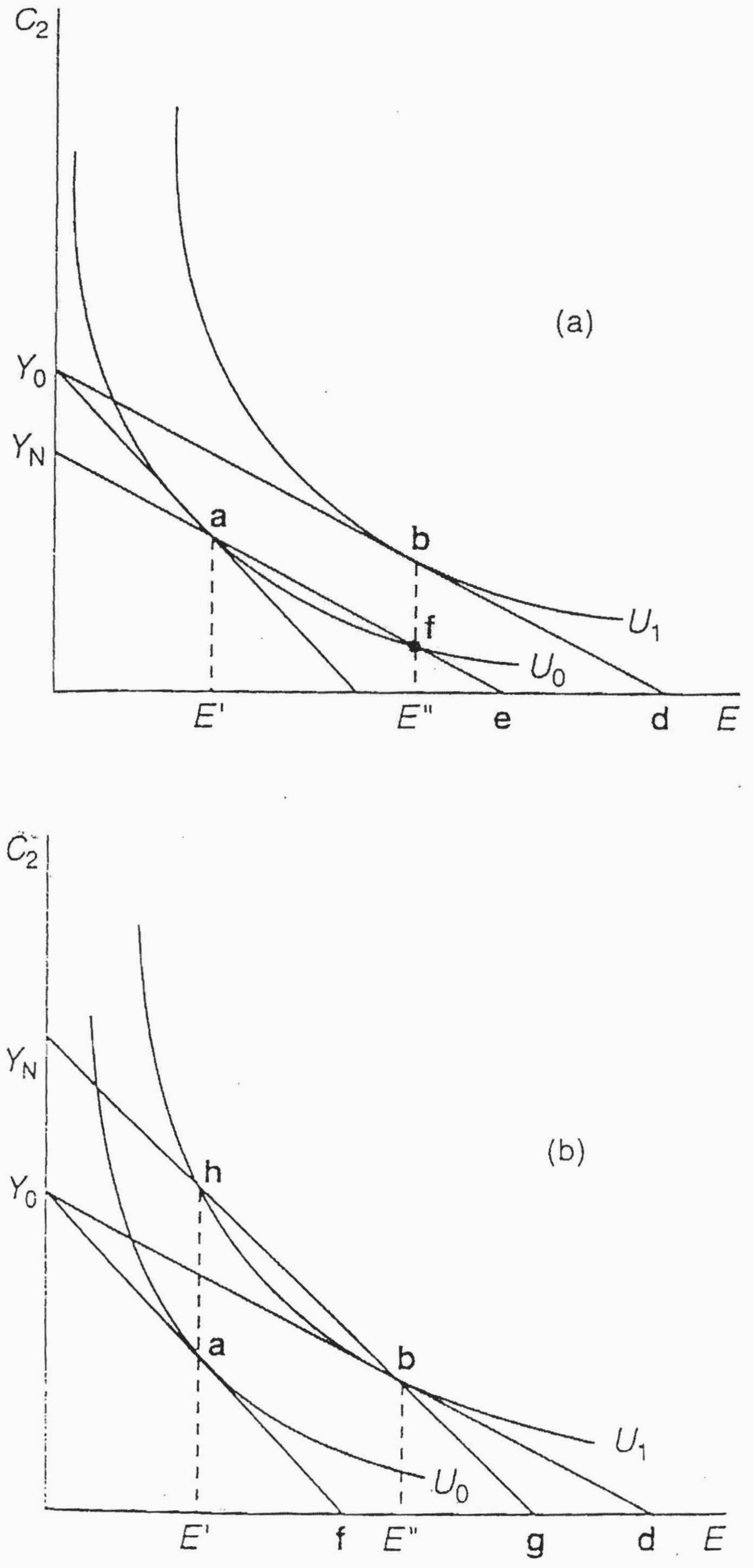
$$CV = \int_{P_1''}^{P_1'} H(U_0)\, dP = \text{shaded area}$$

$$EV = \int_{P_1''}^{P_1'} H(U_1)\, dP = \text{shaded area} + \text{hatched area}$$

Figure 14.4 Compensating variation and equivalent variation.

Table 14.2 Monetary measures for price change effects.

	CV	EV
Price fall	WTP for the change occurring	WTA compensation for the change not occurring
Price rise	WTA compensation for the change occurring	WTP for the change not to occur



igure 14.5 Equivalent and compensating surplus.

Table 14.3 Monetary measures for environmental quality changes.

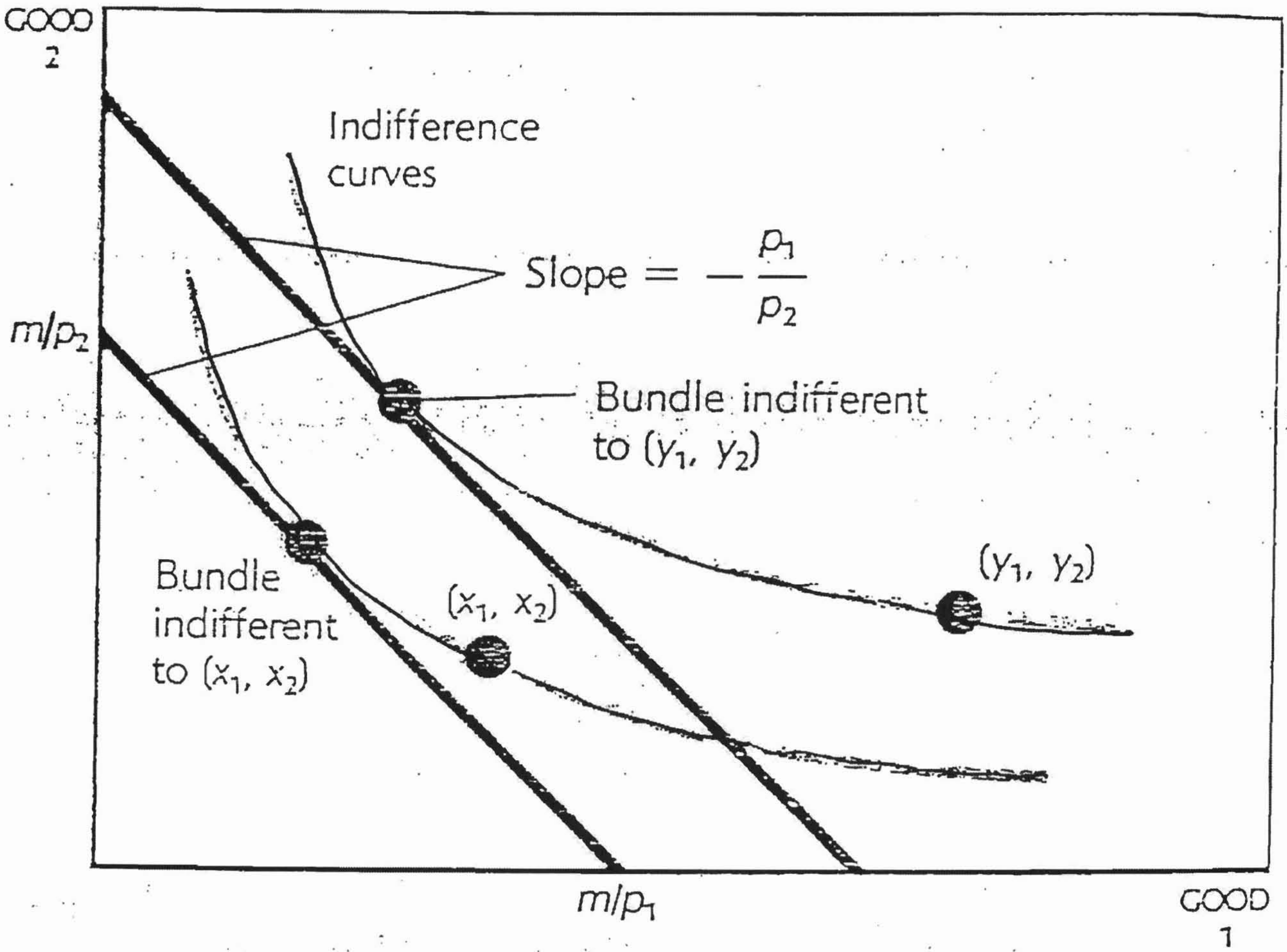
	CS	ES
Improvement	WTP for the change occurring	WTA compensation for the change not occurring
Deterioration	WTA compensation for the change occurring	WTP for the change not to occur

Money Metric Utility Function

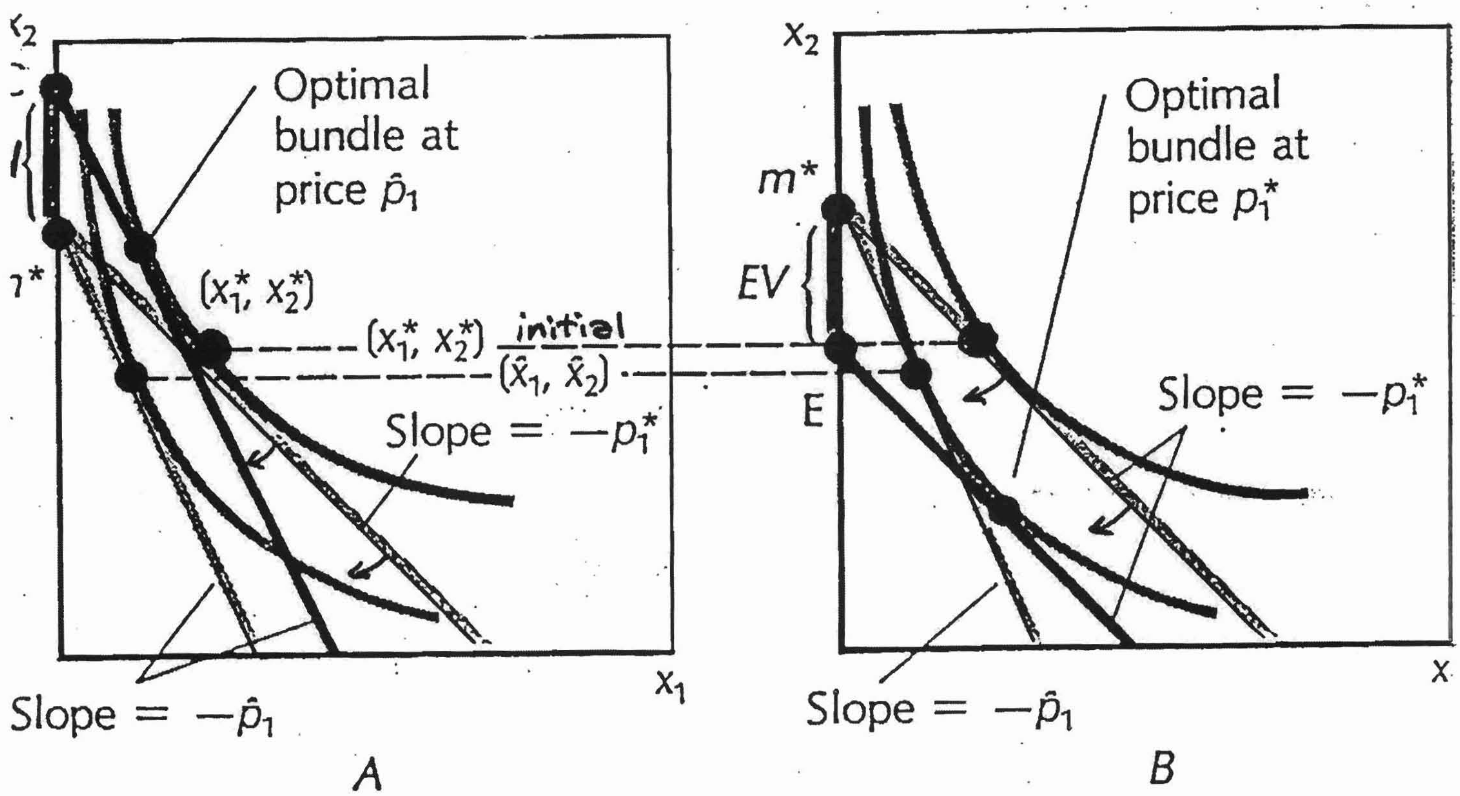
$$m(p_1, p_2, x_1, x_2)$$

The amount of money that a consumer would need at prices (p_1, p_2) to be as well-off as he would be consuming the bundle (x_1, x_2).

In ***some*** sense, it represents the monetary value of the consumption bundle (x_1, x_2) to the consumer.



The money metric utility function. The vertical intercept times p_2 measures the amount of money necessary at prices (p_1, p_2) to purchase a bundle that is just as good as (x_1, x_2) according to this consumer's preferences.



The compensating and the equivalent variations. Panel A shows the compensating variation (CV) and panel B shows the equivalent variation (EV).

Compensating Variation: **measures the change in income that will just *compensate* the consumer for the posited change (in price or quantity) - and will restore him to his *original* indifference curve *after* the change had taken place.**

Equivalent Variation: **measures the change in income that is *equivalent* (in utility terms) to the posited change - and will move him to the final indifference curve *in lieu* of that change.**

$u = u(x_1, x_2) = x_1^{1/2} x_2^{1/2}$ $\quad a = 1/2$

$p^0 = (p_1^0, p_2^0) = (1, 1)$

$m = 100$

$p_1 \uparrow \longrightarrow p_1 = 2$

Demand: $x_1 = x_1(p_1, p_2, m) = m/2p_1 \quad \left(\frac{1/2 \cdot m}{p_1}\right)$

$x_2 = x_2(p_1, p_2, m) = m/2p_2 \quad \left(\frac{1/2 \cdot m}{p_2}\right)$

$\Rightarrow x_1^0 = 50 \quad x_2^0 = 50$

$x_1' = 25 \quad x_2' = 50$

CV: At $p' = (2,1)$ $\quad x' = (m/4, m/2)$

At $p^0 = (1,1)$ $\quad x^0 = (50, 50)$

$\left(\frac{m}{4}\right)^{1/2}\left(\frac{m}{2}\right)^{1/2} = 50^{1/2} 50^{1/2}$

$m = 100\sqrt{2} \cong 141 \Rightarrow$ **CV = 41**

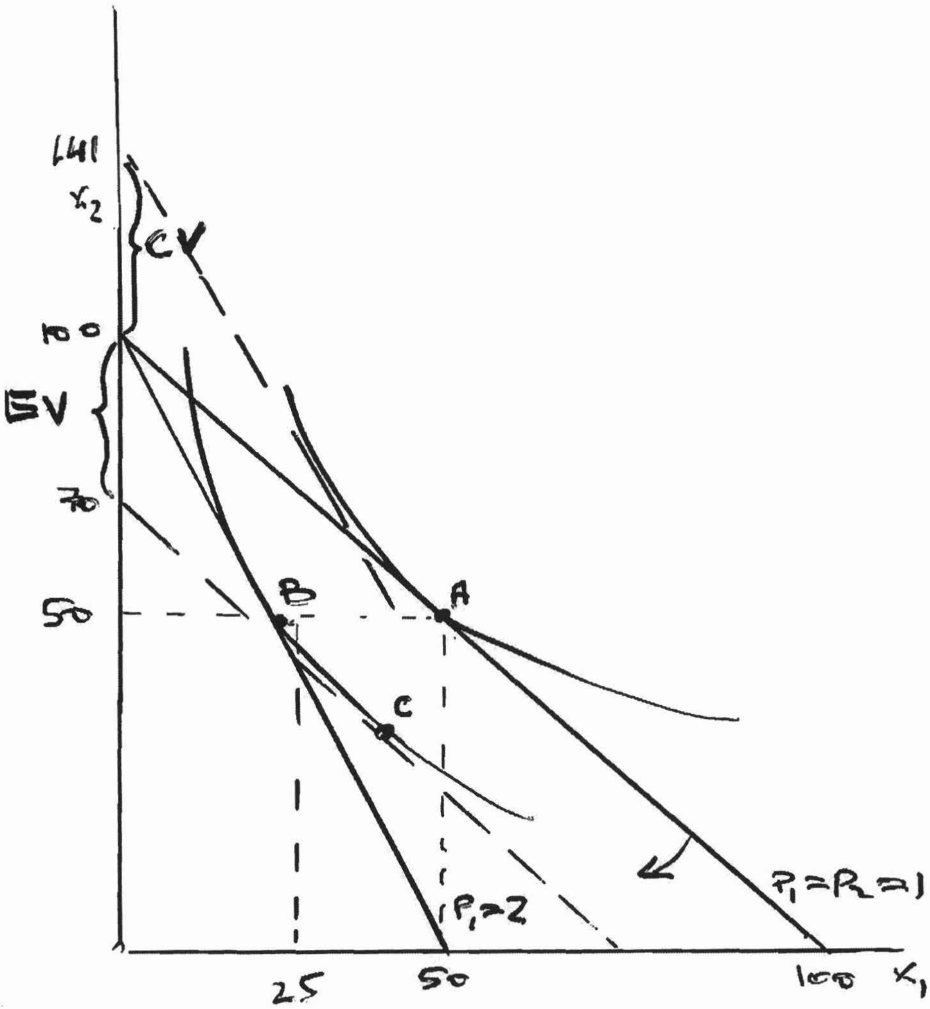
EV: $\left(\frac{m}{2}\right)^{1/2}\left(\frac{m}{2}\right)^{1/2} = 25^{1/2} 50^{1/2}$

$m = 50\sqrt{2} = 70$ **EV = 30**

$\rightarrow$ money metric utility:

$m(\cdot) = \left(\frac{p_1}{a}\right)^a \left(\frac{p_2}{1-a}\right)^{1-a} x_1^a \cdot x_2^{1-a} = \left(\frac{2}{1/2}\right)^{1/2}\left(\frac{1}{1/2}\right)^{1/2}\left[50^{1/2} \cdot 50^{1/2}\right]$

$= 100\sqrt{2}$



141
x_2
CV
100
EV
70
50
B
A
C
$P_1=2$
$P_1=P_2=1$
25
50
100
x_1

From Theory to Measurement

The exploitation of possible relationships between environmental goods and private goods leads to several empirical techniques for estimating environmental and resource values.

These techniques have the following characteristics:

1. They are consistent with the basic theory of demand and consumer preferences;
2. They provide a ,means for estimating the indirect utility function, the expenditure function, or the compensated demand function for the environmental service;
3. They are practical in the sense of imposing realistic data and computational requirements.

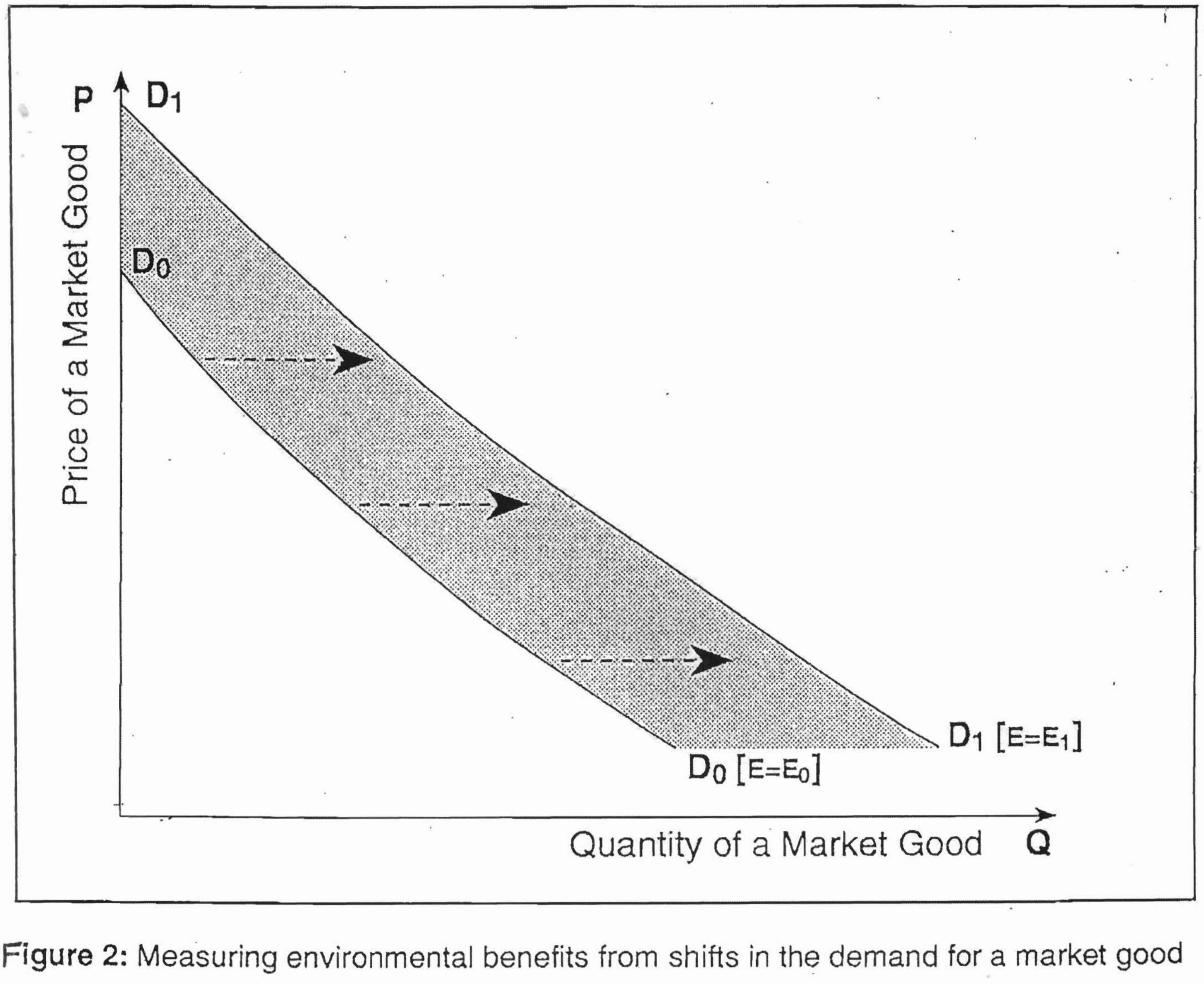


Figure 2: Measuring environmental benefits from shifts in the demand for a market good

Environmental Quality as a Factor Input

When E is a factor of production, changes in E lead to changes in production costs which in turn affect the price and quantity of output or the returns to other factors of production, or both.

The benefits of changes in E can be inferred from these changes in *observable* market data.

Assume that x is produced with a production function

$$x = x(k, l, \ldots, E)$$

where k and l are capital and labor, and where $\delta x/\delta E > 0$.

From these production function we can derive the cost function:

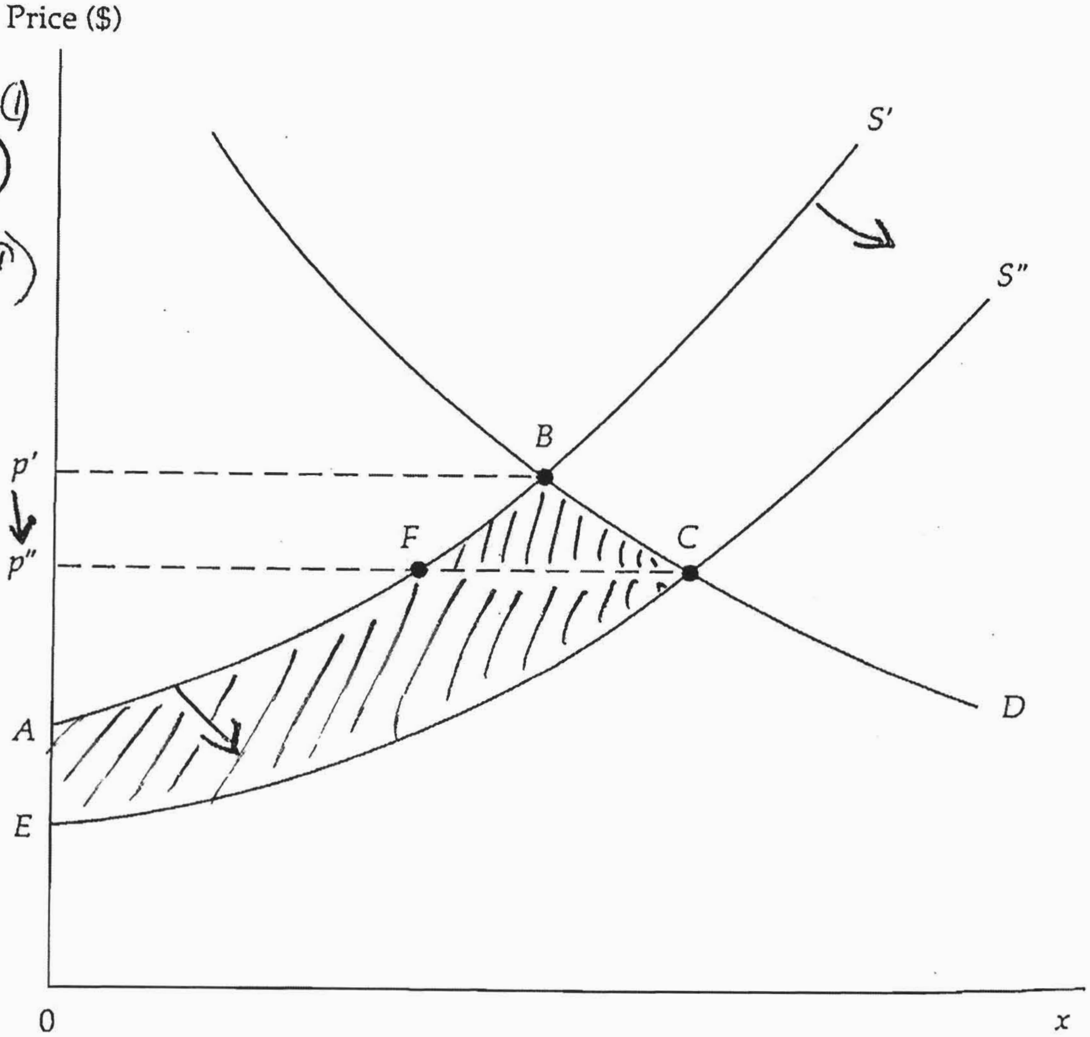
$$C = C(p_k, p_l, x, E)$$

the *MC* function, and the market *supply function* for x.

$\Rightarrow$ A change in E will cause a shift in the supply and factor demand curves, leading to (1) changes in the price of x to consumers, and (2) changes in the incomes received by owners of factor inputs used in the production of x.

E as a factor input in production

(1) תועלת לצרכנים (ΔS)
BCp''
p'BFp'' (קיטון עודף יצרן)
נטו: BCF
(2) גידול בעודף יצרן: p''CE
p''FA (כולל קודם)
AFCE
סה"כ גידול בתועלת: (עודף יצרן + צרכן):
ABCE



The welfare measure when q affects the production of x

HOUSEHOLD HEALTH PRODUCTION MODEL

Household produce "health", H, using market goods (z) and a nonmarket (environmental) good, Y, as inputs in the production process.

$$\text{Max } U = U(x,H) \quad \text{s.t. } p_x x + p_z z = M$$

H = H(z,Y) - The health production function

Note: * The state of health, H, and *not* the nonmarket good, Y, enters the utility function.

*** Y and z are substitutes.**

⇒ *If* the production function H(·) is known, the WTP for Y (associated with a *non-compensated* demand function for the nonmarket good) can be calculated from the *observed* market demand functions for z.

<u>Environmental Quality as a Direct or indirect Argument in the Individual Utility Function</u>

Consider an individual maximizes the utility function

$$u = u(X, E)$$

subject to the budget constraint

$$\Sigma p_i x_i = M$$

where *X* is a vector of private goods, and *M* is money income.

The individual takes *E* as given and does not have to pay a price for this "imposed" quantity.

Note: We assume here that the individual *perceives at least the effects of changes in E on his/her well-being.*

The solution to this problem yields a set of *ordinary* demand functions

$$x_i = x_i(p_1,\ldots,p_n, M, E)$$

The *dual* to the utility maximization problem can be stated as:

Minimize expenditure $\Sigma p_i x_i$, subject to a given utility level, u^0.

The solution to this problem gives the *expenditure function*

$$e(p_1,\ldots,p_n, E; u^0) = M$$

where

$$\delta e/\delta p_i = h_i(p_1,\ldots,p_n, E; u^0)$$

that is, the *Hick-compensated demand function* for x_i.

Similarly,

$$-\delta e(p_1,\ldots,p_n, E; u^0)/\delta E = w_E(p_1,\ldots,p_n, E; u^0) \quad (1)$$

is the *Hick-compensated demand function* for E, or the *marginal willingness to pay* for a change in E, w_E.

If the value of the derivative $\delta e/\delta E$ can be inferred from observed data, then we have a point estimate of the *MWTP* for E. If this derivative can be estimated as a function of E, then we have the *MWTP* function (or demand schedule) for E. Then we also can obtain the benefit to the individual of a non-marginal increase in the supply of E:

$$W = -\int_{E1\text{-}E2} \delta e(p_1,\ldots,p_n, E; u)/\delta E \qquad \int_{E_1}^{E_2}$$

$$= e(p_1,\ldots,p_n, E_1; u) - e(p_1,\ldots,p_n, E_2; u) \qquad (2)$$

which is either a *Compensating Surplus (CS)* or an *Equivalent Surplus (ES)* depending on the level of utility at which this expression is evaluated.

THE COST OF ILLNESS METHOD (COI)

Measures the *total economic costs* which morbidity imposes on society = *Direct Cost* + *Indirect Cost*

Direct Costs = **The value of resources devoted to the treatment of illness:**

(a) hospital care
(b) nursing home care
(c) home health care
(d) services of physicians, dentists, and other care specialists
(e) medication
(f) eye glasses, etc.

Indirect costs = **measure the value of lost productivity due to illness**

<u>*Not* included</u>:

- **Disutility of illness and psychological costs (pain, suffering, anxiety)**
- **Defensive expenditures**

$\Rightarrow$ **COI $\neq$ WTP**

Prevalence Basis: **All costs associated with all cases of the disease in a given time period.**

Incidence Basis: **All discounted costs associated with *new* cases of a disease, from the onset of illness until recovery or death occurs.**

THE CONTINGENT VALUATION METHOD (CVM)

Respondents are asked for their *maximum WTP* or *minimum WTA*, by being presented with *hypothetical* situations describing

(a) how a change in morbidity will be accomplished

(b) how payment would be made.

***Payment Mechanisms*:**

(a) Open Maximum-WTP/minimum-WTA questions

(b) Iterative bidding

(c) Payment cards

(d) Referendum-type questions

***Data Sources*: Primary - Sample surveys**

***Biases*:**

- Strategic misrepresentation of preferences

- Unfamiliarity with the commodity

- Vehicle bias

- Starting point bias

***Two approaches* to empirical estimation:**

(1) Assessing WTP for improvements in health

(2) Valuing reductions in air pollution (implicit estimation of dose-response function