

Appendix 12.1 Demand dependency

This appendix deals with the following question: Under what conditions can we derive a measure of the total economic value of non-market environmental goods solely by examining the household's demand for marketed goods? It turns out that in order to derive the value of environmental goods using such information a price vector must exist at which marginal changes in the level of the environmental good do not affect utility. This property is known as 'demand dependency' and may be a feature of consumer preferences for some environmental goods.

One type of demand dependency, first noticed by Maler (1974), is known as 'weak complementarity'. Weak complementarity describes a situation in which there exists a marketed good with the following property. When the price of the marketed good is so high that its demand falls to zero marginal changes in the level of the environmental good do not affect utility.¹ If a marketed good has this property then the value of the environmental good is equal to the area under the shifting demand curve for the marketed good.

In order to understand better the role of weak complementarity as means of valuing environmental goods start by defining the cost function c as the minimum cost of achieving a given level of utility fixed at u^0 when confronted by price vector p and a level of the environmental good e such that $c=c(p,e,u^0)$. By definition, the derivative of the cost function c with respect to price p is equal to the 'Hicksian' demand curve $h(p,e,u^0)$. Hicksian demand curves are notional demand curves in which income is adjusted to ensure that price changes do not result in the individual moving to a higher or lower level of utility. Because of this adjustment to income, Hicksian demand curves are similar, but not identical, to regular Marshallian demand curves.

$$c_p(p,e,u^0)=h(p,e,u^0) \tag{12.73}$$

Now, by the fundamental theorem of calculus we have

$$c(p^*,e,u^0)-c(p,e,u^0)=\int_p^{p^*} h(p,e,u^0)dp \tag{12.74}$$

¹ Another form of demand dependency is 'weak substitutability'. Weak substitutability means that there exists a commodity such that if the price of that commodity falls to zero then marginal changes in the environmental amenity do not affect utility. Weak substitutability also facilitates the measurement of the economic values of environmental goods (Feenberg and Mills, 1980).

Where p and p^* are two different price vectors. Now differentiate both sides with respect to e , the level of the environmental good, to obtain

$$c_e(p^*, e, u^0) - c_e(p, e, u^0) = \int_p^{p^*} h_e(p, e, u^0) dp \quad (12.75)$$

At this point we are ready to invoke weak complementarity and the idea that there exists a price so high that marginal changes in the level of the environmental good e have no further effect on utility. Let p be the prevailing price of the marketed good and p^* the price at which marginal changes in the level of the environmental good do not affect utility.² The consequence of the assumption of weak complementarity is that the leading term on the left hand side of the equation is equal to zero yielding

$$c_e(p, e, u^0) = - \int_p^{p^*} h_e(p, e, u^0) dp \quad (12.76)$$

Finally, we integrate between the limits of the change in the level of the environmental good

$$c(p, e^1, u^0) - c(p, e^0, u^0) = \int_p^{p^*} h(p, e^1, u^0) dp - \int_p^{p^*} h(p, e^0, u^0) dp \quad (12.77)$$

The left hand side of this expression gives a monetary valuation of welfare change associated with a change in the level of the environmental good from e^0 to e^1 . Throughout we have held fixed the level of utility. If the cost functions and Hicksian demand functions are evaluated at u^0 corresponding to the initial level of utility i.e. prior to the change in the level of the environmental good then this welfare change corresponds to the CS described in section 12.2. If we had instead evaluated the cost functions and the Hicksian utility functions at u^1 the level of utility post change in the level of the environmental good then the welfare measure would correspond to the ES. The right hand side is composed of two terms. The first term is the area under the Hicksian demand curve for the weakly complementary good observed when the environmental good takes the level e^1 whilst the second is the area under Hicksian demand curve when the public good takes the level e^0 . Hence the value of the change in the level of the environmental good is equal to the change in the areas between two Hicksian demand curves between the limits of p and p^* .

Unfortunately all this is in terms of the unobservable Hicksian demand curves. The fact that if weak complementarity holds the area between two shifting Hicksian demand curves is exactly equal to the CS or ES for the environmental change is therefore not of much

² Sometimes this is referred to as the 'choke' price.

immediate use. However, one could hope to determine a Marshallian, uncompensated, demand function for the weakly complementary commodity and thus derive the Marshallian Consumer Surplus (MCS) associated with a change in the level of the environmental good.