

CHAPTER 5: DYNAMIC EFFICIENCY AND SUSTAINABLE DEVELOPMENT

- In previous chapters, we have developed two specific means for identifying environmental problems:
 - o The first, static efficiency, allows us to evaluate those circumstances where time is not a crucial aspect of the allocation problem
 - o The second, more complicated criterion, dynamic efficiency, is suitable for those circumstances where time is a crucial aspect
- They are useful not only in identifying environmental problems and ferreting out their behavioural sources, but also in providing a basis for identifying types of remedies
- These criteria even help design optimal policy instruments for restoring some sense of balance between the economy and the environment
- In a general sense, the efficiency criteria are designed to prevent wasteful use of environmental and natural resources
 - o We might care, for example, not only about the value of the environment (size of the pie), but also how this value is shared (the size of each piece to recipients)
 - o In other words, fairness or justice concerns should accompany efficiency considerations
- We begin by considering a specific, ethically challenging situation – the allocation of a depletable resource over time

A Two-Period Model

- Dynamic efficiency balances present and future uses of a depletable resource by maximizing the present value of the net benefits derived from its use; this implies a particular allocation of the resource across time
- If the allocation is not temporally interdependent, then the static efficiency criterion is sufficient
- According to the dynamic efficiency criterion, the efficient allocation is the one that maximizes the present value of the net benefit
 - o The present value of the net benefit is simply the sum of the present values in each of the two periods
- The present value in the first period would be that portion of the geometric area under the demand curve that is over the supply curve
- The present value in the second period is that portion of the area under the demand curve that is over the supply curve from the origin to the number of units produced multiplied by $1/(1+r)$
- The dynamically efficient allocation of this resource has to satisfy the condition that the present value of the marginal net benefit from the last unit in Period 1 equals the present value of the marginal net benefit in Period 2

FIGURE 5.1 The Allocation of an Abundant Depletable Resource: (a) Period 1 and (b) Period 2

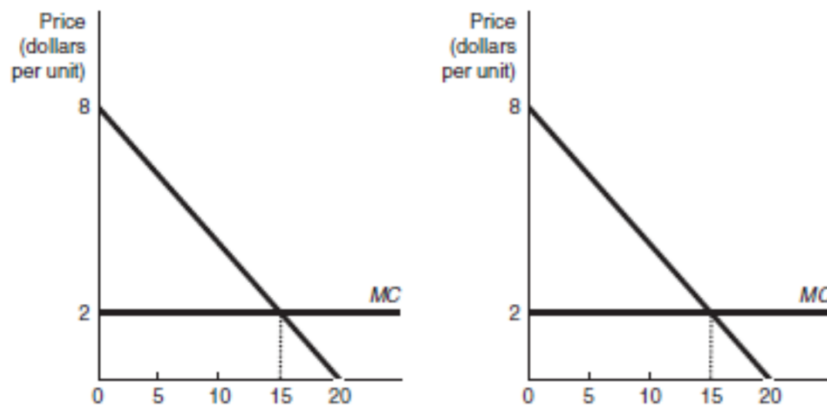
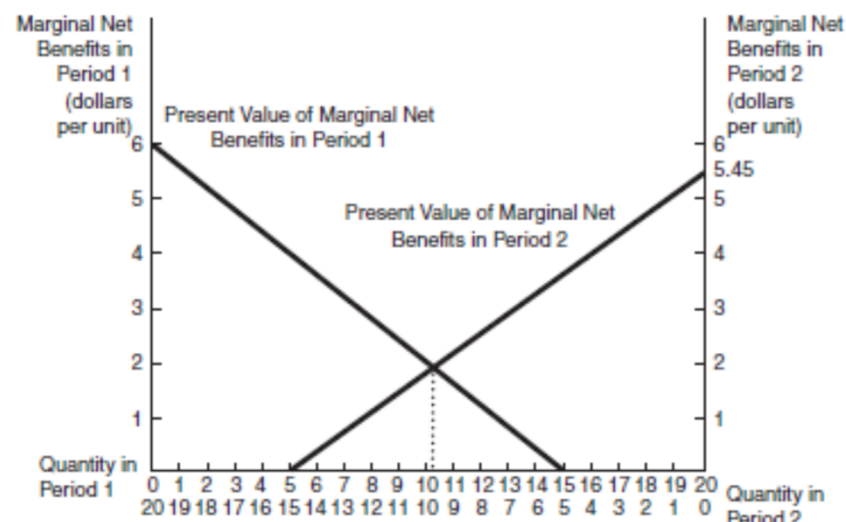


FIGURE 5.2 The Dynamically Efficient Allocation



- The zero axis for the Period 2 net benefits is on the right, rather than the left side; therefore, increases in Period 2 are recorded from right to left
 - o Any point on that axis picks a unique allocation between the two periods
- The present value of the marginal benefit curve for Period 2 intersects the vertical axis at a different point than does the comparable curve in Period 1
 - o This intersection is lower because the marginal benefits in the second period need to be discounted (multiplied by $1/(1+r)$ to convert them into present value form since they occur 1 year later)
 - o Note that larger discount rates would rotate the Period 2 marginal benefit curve around the point of zero net benefit toward the right-hand axis
- The efficient allocation is now readily identifiable as the point where the two curves representing present value of marginal net benefits cross
- The total present value of net benefits is then the area under the marginal net benefit curve for Period 1 up to the efficient allocation plus the area under the present value of the marginal net benefit curve for period 2 from the right-hand axis up to its efficient allocation
- Intertemporal scarcity imposes an opportunity cost that we henceforth refer to as the marginal user cost
 - o When resources are scarce, greater current use diminishes future opportunities

- The marginal user cost is the present value of these forgone opportunities at the margin; to be more specific, uses of those resources, which would have been appropriate in the absence of scarcity, may no longer be appropriate once scarcity is present
- Failure to take the higher scarcity value of a resource into account in the present would lead to inefficiency due to the additional cost resulting from the increased scarcity imposed on the future; this additional marginal value created by scarcity is the marginal user cost
- Whereas in the absence of scarcity, the price would equal only the marginal cost of extraction, with scarcity, the price would equal the sum of marginal extraction cost and marginal user cost
- In an efficient market, the marginal user cost for each period is the difference between the price and the marginal cost of extraction
- Thus, while the present value of marginal user cost is equal in both periods, the actual marginal user cost rises over time
- Both the size of the marginal user cost and the allocation of the resource between the two periods is affected not only by the degree of scarcity, but also by the discount rate
 - The larger the discount rate, the greater the amount of rotation required
- The implication is clear: the amount allocated to the second period would be necessarily smaller with larger discount rates
- Higher discount rates tend to skew the resource extraction toward the present because they give the future less weight in balancing the relative value of present and future resource use

Defining Intertemporal Fairness

- This is a particularly difficult issue because, in contrast to other groups for which we may want to ensure fair treatment, future generations cannot articulate their wishes, much less negotiate with current generations
- One way to derive general principles of justice is to place all people into an original position behind a “veil of ignorance”
 - Because these members are prevented by the veil of ignorance from knowing the generation to which they will belong after the rules are defined, they will not be excessively conservationist or excessively exploitative
- The sustainability criterion suggests that, at a minimum, future generations should be left no worse off than current generations
 - In essence, earlier generations are at liberty to use resources that would thereby be denied to future generations as long as the wellbeing of future generations remains just as high as that of all previous generations
 - On the other hand, diverting resources from future use would violate the sustainability criterion if it reduced the wellbeing of future generations below the level enjoyed by the preceding generations