EEP 101 **Chapter 20: Environmental Services** **David Zilberman**
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TOPICS:

Categories of environmental services
Targeting and policy design
The Role of Correlation
Scale Effects
Market Effects and Slippage
Organizational structure and environmental services
Multi-Objectives
Political Economic Considerations
Information Considerations
Inhabitants' Rights

Categories of environmental services

There are several categories of environmental services. Some useful typologies and partition of environmental services include:

Pollution prevention, conservation, and amenity creation activities.

Producers, in particular farmers, have established de facto rights to conduct certain activities that have negative environmental effect. These include application of chemicals that may harm water quality, fish and wild life, tillage practices that lead to soil erosion and build up of silt, and excessive irrigation that lead to water logging. Farmers may be paid to modify their activities and engage in sustainable practices.

Many environmental services scheme are established to conserve resources, life styles, ecosystems etc. These include payment for preservation of forest resources and wetland, purchasing of "development rights" near cities to slow urban sprawl, payment to peasants to continue and plant and or raise traditional varieties and species, etc.

A third category of policies aims at natural resources restoration and built up. They include payment for clean up activities, planting of forests, restoration of wetlands etc.

Purchase of resources (or resource services) vs. payment for activities

Some environmental services purchase resources or resource services. For example, producers may be paid for their water that will be used instead for, say, improving wetland or fishery conditions. Farmers may be paid for not farming their land and instead will be planted with cover crops or trees. Forest communities will be paid for not harvesting their forests etc. Another set of policies will pay producers for modifying their production activities. These are "working lands" programs that may pay farmers for desirable tillage practices, for instance not using certain chemicals, etc.

Targeting and policy design

A key issue in the design of an environmental service purchasing land is the determination of what to buy and how much to pay. Several considerations affect the "targeting" decisions.

(1) Heterogeneity –There are differences in both environmental quality and cost of resources in different locations. For example, consider the case where we want to stop farming in a region so that native plants can be restored. The lands may vary, both in terms of agricultural productivity and in value of environmental products. These variations are reflected in the amount of purchasing funds willing to offer land at various locations.

Suppose these are landowners in a region and let $n = 1...N$ be an indicator of an owner. Assume constant benefit and profit per acre of each unit, but benefits may vary across units. Let b_n be benefit per acre of unit in that it has A_n acres. Let π_n be profit per acre of the n-th unit. Let this unit be order according to their π_n / b_n ratio. So that unit with $n = 1$ has the lowest cost of providing benefits. We can now construct the supply curve for benefits depicted below in Figure 1 on the next page.

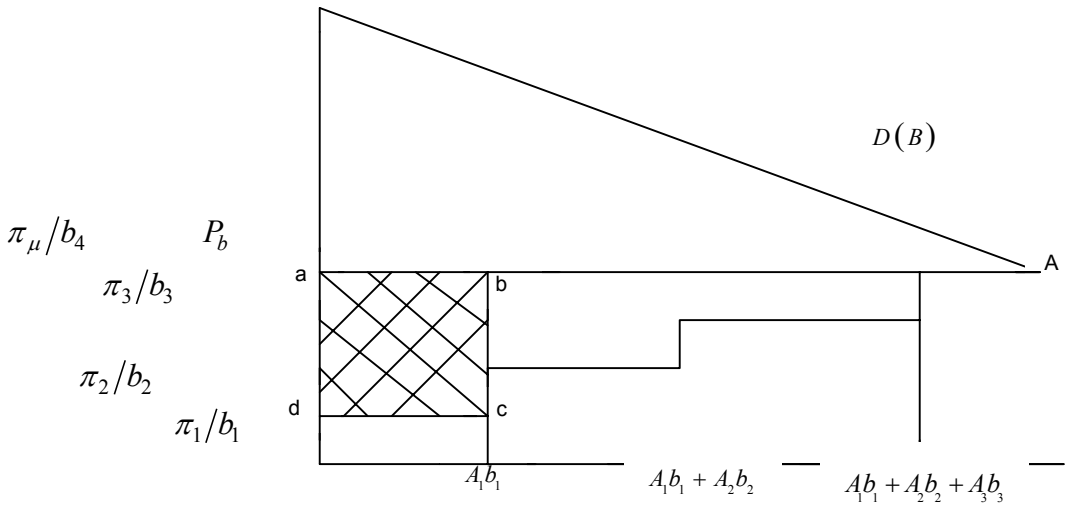

$D(B)$
π_μ / b_4
P_b
π_3 / b_3
π_2 / b_2
π_1 / b_1
a
b
c
d
A
$A_1 b_1$
$A_1 b_1 + A_2 b_2$
$A_1 b_1 + A_2 b_2 + A_3 b_3$

Figure 1

Assume that society has a utility of environmental benefit $V(B)$. The marginal benefit curve $V(B)\frac{\partial V}{\partial B} = D(B)$ in a demand for benefits. Social optimism occurs at a point like A in Figure 1 when the demand intersects supply. That will yield P_B - social cost for environmental benefits.

Under the optimal solution we will have a price P_B, so that all units with $P_B b_n < \pi_n$ will be purchased for conservation. All the units with $P_B b < \pi_n$ will continue production, and that may be a marginal unit n^x when $P_B b_{n^*} < \pi_{n^*}$ that will be partially conserved.

The optimal policy can be carried out in two ways:

(1) Offer farmers $P_B b_n$ for conservation. This solution equivalent to the competitive market solution and units will accrue rent. In Figure 1 unit 1 will gain the area *abcd* under this arrangement.
(2) The regulation should behave as discriminating monopsony and offer the farmer units he wants to purchase π_n per acre. In this case, the government (or buying agency) captures all the surplus of the transaction.

In a case when an agency has a limited budget and knows both b_n and π_n, it will maximize benefit by ranking lands according to their b_n/π_n ratio, paying these ongoing rents and capturing the entire surplus. Such an approach may anger farmers because price per unit of benefits vary and they don't capture rent of environmental amenity.

The Role of Correlation

Suppose the b_n and π_n are correlated. In the case of negative correlation, $(b = b_1)$ is associated with low so that π/b_1 is much smaller than π_n/b_1 and supply of benefit is rather steep.

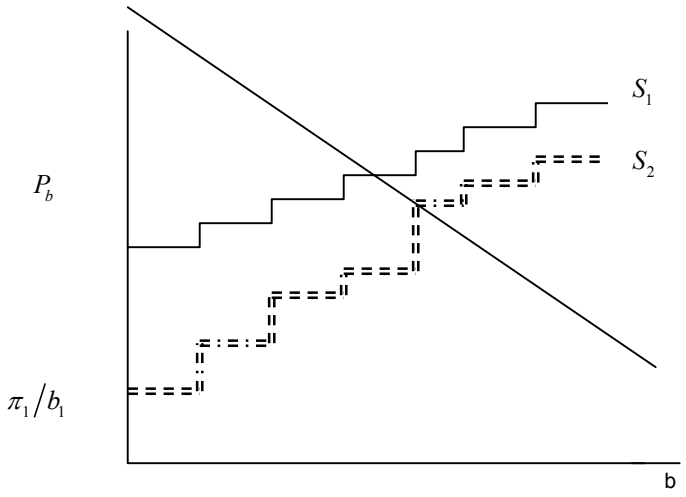


Figure 2

In the case with positive correlation, the π_n / b_n ratio may not vary much $(S = S_2)$. Even when the price of the amenities is the same-the difference is distributional. Outcomes between market and discriminatory monopsony solutions are substantial. Landowners will loose much more from the discriminatory solution when correlation is negative. If the correlation is negative and the purchasing fund is discriminatory, it will reach the optimal solution by targeting the deepest land. In this case, the benefit maximizing solution also maximizes land purchased.

If there is a positive correlation, in some cases it may be optimal to target the highest quality land (that will be the most expensive). But if the relative difference is profits between high and low utility, lands is much higher than difference in benefits. Again the optimal solution is to target the lower quality land. If the lands are $A_1 A_2 A_3 A_4$ (Figure 3) it is worth targeting the highest quality reports A_4. But if they are $B_1 B_2 B_3 B_4$ benefit maximization suggest targeting the lowest quality plots B_1.

Scale Effects

Frequently the design of a reserve requires minimum space to enable movement of wildlife and diversity of conditions and opportunity. Therefore, the value of reserves and targeting opportunities depend on a greater confirmation. Suppose we have 4 fields**.** The first three are connected and the fourth separate. On the next page we have rent and environmental benefits under various conditions.

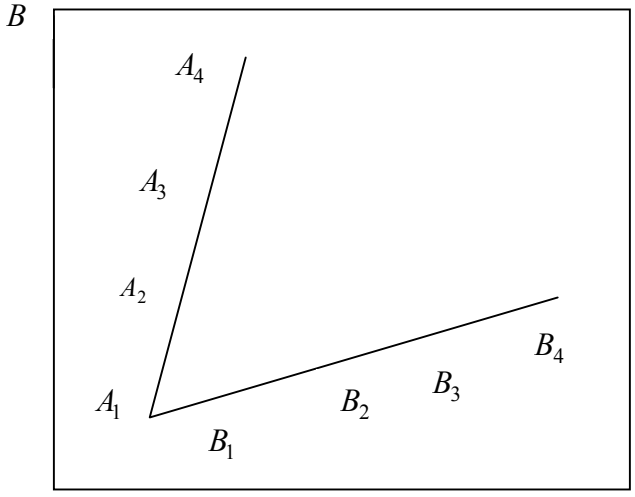


Figure 3

Field No.	1	2	3	4
π_i	2	2	3	4
b_i (if used alone)	2	3	6	7

Benefits of (1 & 2) 8

Integration (1& 2 &3) 15

So lets consider optimal choice:

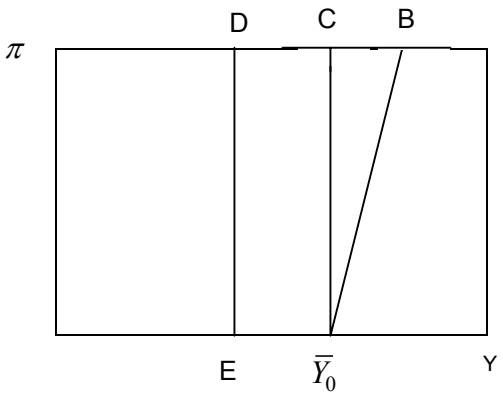
Budget	**Choice**
2	2
3	3
4	1&2
5	2 & 3
6	2 & 4
7	1 & 2 & 3

Even though unit 4 has a higher ration of benefit/dollars than 1 and 2, individually the complimentarity between these units lead to their selection under a variety of budgets ahead of it.

Market effects and Slippage

Thus far we assumed that the industry providing environmental services is small and that the program doesn't affect price. But large land retirement programs may affect supply and thus affect prices substantially. Now assume that y_n produce is output of the n-th firm. Its cost per acre is C_n and thus, $\pi_n = PY_n - C_n$. If this has a result of a purchasing fund prices will increase profitability change and that has to be taken into account in the design.

Suppose now that $C_n = C.$ Figure 4 depicts a set of firms in the industry in the $b \quad y$ space. The initial price, before the purchasing fund firms is P_0, and at $\overline{Y}_0, P_0 Y_0 = C.$ Before the purchasing fund is introduced firms with $Y < \overline{Y}_0$ were not operating.



So the land with y smaller than $\overline{Y}_0$ was idle and provided environmental amenities. Now suppose that a payment scheme is introduced and only firms that are in operation are entitled to join. The firm in the region $Y_0 DC$ joins the

Figure 4

conservation program and then supply declines. But then firms in the region $\overline{Y}_0 C_0 DE$ find it profitable to operate and their activities reduce environmental services. This counter productive effect is called slippage. The payment for environmental services caused agents that had "good" behavior to engage in counter productive behavior. In some cases, slippage effect may dominate the direct effect of a conservation program.

In situations like ours the incentive has to be designed to counter possible slippage, by paying firms in the area $\overline{Y}CDE$ in Figure 3, not to modify this behavior. Another form of slippage occurs when farmers or producers are conducting a desirable behavior because its profitable before the conservation program is introduced and then they realize that others are paid for the same activities. They may reverse their behavior to be entitled for payment in the future. For example, farmers that may engage in low tillage and realize that the others that were engaged in traditional tillage are paid a significant amount to switch to low tillage may revert to traditional tillage (and thus, release green house gases) to be entitled to the environmental services payment. Design of environmental services payment has to take such behavior into account and pay a good player so they won't revert and become a bad one.

Organizational Structure and Environmental Services

The design of environmental services programs has to take into account issues of implementation, transaction costs, monitoring, and enforcement. Generally, a central organization (Federal government, the United nations) or an international donor, control the fund and set the broad objective of the program but implementation requires detail knowledge of local conditions. Therefore,

environmental services programs may be supported by a hierarchical structure where a local agency will negotiate with the producers on the specification of amenity provisions. Especially when it comes to restoration programs, participants have a high degree of freedom and generally provide the agency a proposal about what type of environmental services they want to provide, as well as a request for funding. For example, when a program is supposed to reduce soil erosion participants have to then develop a plan on how to address soil erosion on their land. In cases where participation and environmental services programs include stoppage of production and modification of the landscape the tenant will include a rent for the diverted land and partial payment for the improvement of the land to provide the environmental amenity.

In cases where many small participants provide environmental services they may establish a cooperative, or collective action group that will represent them in their dealings with government agencies that finance the program. For example, in the case of soil carbon sequestration, farmers in Iowa cooperated together to sell rights of sequestered carbon to organizations in Canada. The buyer doesn't know the individual producer and the group is responsible for providing the environmental amenity. This type of solution may apply in many other cases where a local entity may represent farmers that would be willing to sell environmental services.

Either the buyer of the environmental amenity, or the seller, may take insurance against possibilities that the provisions of the environmental amenity will stop or decline in the future. This is especially the case if the buyers of a certain party may monitor the provision of the amenities over time.

Concern about the appropriate performance of a program that provides an environmental services may lead to extensive monitoring of its activities. Monitoring may be quite expensive. The use of remote sensing to monitor compliance is very promising. When that is not possible there may be quite infrequent inspections because of the high cost of monitoring. Producers may attempt to violate the agreement, especially when the monitoring is infrequent. Random checks on behavior can provide one avenue for improving performance. Furthermore, it has to be associated with imposing the use of penalties against contract violations.

Multi-Objectives

Environmental services programs have several objectives, for example, to improve water quality, preserve native plants, preserve ecosystems, etc. One approach to meeting these objectives is to establish individual funds for the purpose of pursuing objectives individually. Another approach is to have one

multi-objective fund that ranks land parcels according to their overall contributions and select the one with the most benefits per dollar. This integrated approach is preferable from the perspective of environmental quality, given that policymakers are capable of providing weights to different objectives. In many cases, however, it is very difficult to provide weights and several programs are being introduced. Farmers may prefer the latter approach because programs may outbid themselves when purchasing lands with high environmental amenities.

In reality, we view both public and private sector funds for environmental services. In many cases private funds are targeted to specific objectives because it appeals to donors who have a particular interest, for example, preservation of biodiversity or a specific species of fish. Public funds are more diversified and tend to be multi-objective. An important area of research is determining how to expand the amount of resources spent on conservation funds. One possibility is providing matching funds to the private sector's contributions to private funds. The rational behind this is that conservation funds provide public goods, and many people may not contribute because of free-rider considerations. Thus, the matching contribution is one way to compensate free-rider problems. In reality, a tax exemption for contributions to environmental purchasing funds is a form of matching contributions.

Political Economic Considerations

Targeting criteria and rules of operation of environmental services programs affect various groups of society in different ways. Clearly, if the objective is to improve environmental benefits, programs should be designed to maximize benefits subject to budget constraints, and participants should be selected according to the environmental benefits/economic cost ratio. Sometimes the program is managed so it is targeted to maximize acreage purchased given the budget. In this case, the programs purchase lands with the lowest quality. This scheme is most desirable from the perspective of landowners, since the budget is spent on the lowest quality land and they are left to use the higher quality lands to earn their income. These programs are also desirable from a farmer's perspective because they entail the highest revenue per acre, which reduces the cost of land preparation for farming.

Programs that target lands of the highest environmental quality regardless of cost may not be favored by farmers since they require the lowest numbers of acres and have the highest land preparation cost, and some of the land that remains for farming may not be very productive.

One of the main issues in managing and designing conservation programs is that they may be used as a mechanism for transferring income to certain groups such as farmers. Therefore, targeting that aims to maximize acreage can be an indicator that programs actually aim to subsidize farming.

Indeed, many of the environmental services programs in developed countries are farm-support programs in disguise. Efforts to transfer them to genuine environmental programs encounter political and economic problems because areas that may provide the most benefits have not been supported in the past. Thus, traditional beneficiaries of this program may suffer from a redirection and object to it. One practical solution to this problem is to increase the budget of the environmental services program to emphasize targeting new money to meet genuine environmental needs.

Information Considerations

Assessment of gains from environmental programs suggests that in many cases involvement of a relatively small amount of acres may provide much of the benefits. Babcock et al. shows that less than 40 percent of the land enrolled in the CRP may provide more than 80 percent of the benefits. Therefore, it is crucial to have appropriate information about the distribution of environmental benefits. Similarly, there is significant disparity in cost and value of lands enrolled in programs, and policymakers need more accurate information on the rents and cost of production to obtain the best deal.

Obtaining information on the yield potential under various ecological and climatic conditions as well as the cost of production is important for policymakers when both offering rents to participants and asking for bids. Programs often require management of lands and significant investment, and agencies that design programs need to assess the technical feasibility and cost of proposals. Part of the challenge in establishing environmental services programs is being able to build an infrastructure that will provide technical assistance to farmers and landowners in designing and managing their conservation program. In some cases, extension and public sector agencies may initially help with the technical support and provide training to establish private sector expertise in conservation activities.

Most of the informational challenges in management of environmental services programs involve monitoring and inspection. In general, the programs are land intensive and benefits per acre are minimal. Thus, monitoring may be expensive because it requires coverage of a large size of land. One way to reduce monitoring is the use of remote sensing technologies (e.g., satellite information

can detect whether forests have been cut). Another useful method is developing random inspection programs.

An alternative approach is to emphasize payment schemes based on performance. For example, a plan that pays farmers for soil carbon sequestration should not require a large initial payment when farmers make a commitment to stop plowing and use low tillage. Instead, rents should be paid annually according to benefits incurred by environmental services during the year. In some cases, however, programs should provide significant initial sums to cover fixed costs. To reduce the moral hazard of not following through, the initial payment should cover part of the fixed cost of investment, and the rest should be paid over time. In many cases, investments in environmental services also benefit the farmers directly, and in this case the government should pay only part of the cost.

Inhabitants' Rights

Some of the most significant environmental services programs are in developing countries where international donors pay for the preservation of biodiversity. In many cases the payments go to the central government, and the local people who are denied the opportunity of economic growth and utilization of resources are not compensated for their loss. The main challenge is to develop transfer schemes to ensure that the benefits of conservation will go to the endogenous people and individuals who own and live on the land where development is restricted.