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Can payments for ecosystem services schemes mimic markets?

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ABSTRACT

A Payments for Ecosystem Services (PES) scheme can be understood as a mechanism that performs the role of a 'market' for Ecosystem Services (ES) in circumstances where such a market would otherwise fail to develop. We investigate the potential for and limits of PES schemes to act in lieu of competitive markets and propose a PES scheme design that mimics markets. This is achieved by applying their underpinning concepts of demand and supply to the determination of 'market clearing' prices, while reducing transaction costs of buyer and supplier engagement through the involvement of agents. The proposed design combines economic valuation techniques to estimate ES demand with a novel tendering process that allows the estimation of individual marginal cost curves of potential ES suppliers. Supply actions and ES are linked through 'conversion factors' derived from biophysical models that act as environmental production functions. Demand and supply so estimated enable the determination of a 'market clearing' price which, when offered to suppliers, provides static and dynamic incentives for cost-effective supply. Mutually beneficial exchange between buyers and suppliers, as is facilitated under the PES scheme design, improves resource use efficiency while allowing both the buyers and the suppliers to secure surpluses.

1. Introduction

Ecosystems provide a range of services that include provisioning (e.g. food and fibre), regulation (e.g., flood and storm protection), cultural services (e.g. recreation and tourism) and support of the systems that maintain life on earth (Millennium Ecosystem Assessment, 2005a, 2005b). With growing levels of wealth internationally and associated increases in the levels of environmental awareness, demand for these so-called Ecosystem Services (ES)[1] has been increasing. However, there has been no resultant commensurate increase in the supply of ES as would be expected if markets were functioning to coordinate the plans of those who want ES with those who have the capacity to provide them. Instead, with natural resources under profit-motivated, development pressure, the supply of a range of ES is in decline (Millennium Ecosystem Assessment, 2005a, 2005b).

This failure of markets to coordinate ES supply with ES demand through exchange, indicates that transaction costs faced by potential buyers and suppliers are in excess of the gains that each party expects to enjoy from trading.[2] Transaction costs are defined as 'the resources used to define, establish, maintain and transfer property rights' (McCann et al., 2005, p.530), and may include, but are not limited to, the costs of defining the rights to the ES to be exchanged, searching for trading partners, and negotiating and closing contracts (e.g. Bromley, 1991; Kasper, 1998).

There are several ways in which transaction costs can be sufficiently large as to preclude market exchange. The costs of negotiating an exchange may be prohibitively high when large numbers of globally dispersed buyers attempt to buy ES from a large number of potential suppliers. Transaction costs are also driven up by uncertainties faced by buyers and suppliers. Such uncertainties arise when property rights to ES are poorly defined and defended (Coggan et al., 2010), as is the case when they embody the characteristics of public goods[3] or

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[1] This article used the term 'ecosystem services' defined as 'the benefits people obtain from ecosystems []' (Millennium Ecosystem Assessment, 2005a, 2005b, p.27). An overview of alternative definitions and suggested differences between the terms 'ecosystem services' and 'environmental services' is provided by Derissen and Latacz-Lohmann (2013). The PES scheme proposed in this article is generally applicable to any non-marketed ecosystem service for which a cause-effect relationship between supply actions and ecosystem service (quantified as a production function) can be estimated.

[2] This reasoning follows Coase (1960) who discussed the impact of transaction costs on efficiency and distributional effects of market transactions.

[3] Public goods are characterized by non-excludability and indivisibility: 'Non-excludability refers to a circumstance where, once the resource is provided, even those who fail to pay for it cannot be excluded from enjoying the benefits it confers. Consumption is said to be indivisible when one person's consumption of a good does not diminish the amount available to others' (Tietenberg and Lewis, 2009, p.76).

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common-pool resources.[4] Property rights may be poorly defined because the cause-effect relationships between supply actions (e.g. pollution control upstream) and produced ES (e.g. water quality downstream) are not well established. Buyers then bear the risk of making payments for actions that do not yield the ES demanded. Equally, suppliers bear the risk of performing supply actions that may not produce the ES purchased by the buyers, and hence may not get paid. Uncertainties may also occur because of complexities in excluding ES users who do not pay. 'Free-riding' – benefiting from the ES without paying – may then predominate amongst users. Suppliers then bear all the costs of providing the ES without receiving compensating revenues from sales.

Facing domestic and international pressure to counteract the decline in ES supply relative to ES demand, governments have introduced policies that involve public sector intervention to expand supply. Typically these policies have involved the regulation of private sector activities that have caused the decline in supply. Examples include the imposition of limits on emissions to the atmosphere and water bodies. The public sector has also become a direct supplier of ES. For example, governments own and manage National Parks as sources of ES. Over the last decade, governments have also initiated the development of Payments for Ecosystem Services (PES) schemes designed to stimulate the supply of ES that are not bought and sold in markets.

One way a PES scheme can stimulate the supply of non-marketed ES is for it to be designed to address the main driver of market failure: prohibitively high transaction costs. Transaction costs can be reduced through the involvement of agents external to the exchange. As a result, exchange in otherwise non-marketed ES may become mutually beneficial to buyers and suppliers. In such an exchange, prospective suppliers have an incentive to supply ES if the financial or in-kind payments received outweigh their supply costs; prospective buyers have an incentive to purchase ES if the benefits they enjoy outweigh the payments they make.

Agents may be government departments, non-governmental organisations, research organisations or private entities. For example, research organisations may lower transaction costs by providing scientific knowledge that enables an adequate definition and defence of property rights to ES. This may be achieved through the estimation of cause-effect relationships (production functions) between supply actions and ES outputs so that direct negotiations between suppliers and buyers become feasible. Government departments may lower transaction costs by defining and defending property rights to ES, or through compulsory taxation that 'forces' buyers (those who pay for ES supply and enjoy the generated benefits) to purchase ES to address free-riding. In other cases, linking globally dispersed demand to large numbers of potential suppliers may be achieved by supporting the determination, collection and distribution of payments through a government agency, a private agency or a donor acting as a 'broker'. Finally, agents may also provide funds for the design, implementation and maintenance of a PES scheme.

The first aim of this paper is to review examples of PES schemes that have attempted to embed elements of markets forces into their design. The second aim is to introduce a PES scheme that is designed to mimic competitive market for otherwise non-marketed ES. Mimicking the efficiency and incentive properties of a competitive market offers the opportunity to increase supply to match demand. Despite market failure being a driver for the undersupply of ES, market principles offer the potential to be part of the solution.

The proposed PES scheme design is based on the estimation of (1) bio-physical models (production function) that link supply actions with ES outcomes, (2) non-market valuation techniques that enable the estimation of buyers' marginal benefits (demand) functions for ES outcomes, and (3) a novel tender format that allows the estimation of individual marginal costs (supply) functions associated with suppliers' actions to produce ES.[5]

These elements are then used to determine the efficient level of ES supply and the 'market clearing' price per unit of ES that allows both buyers and suppliers to earn a surplus.[6] The opportunity to earn a surplus provides incentives for suppliers and buyers to engage in exchange and thus match supply with demand. Suppliers face both static and dynamic incentives encouraging cost-effective supply, with the dynamic component encouraging marginal costs reductions over time through innovation.

To our knowledge, such a PES scheme has not been developed to date.

The remainder of the paper is structured as follows. Section 2 provides a brief overview of market principles relevant to PES schemes and reviews past and current schemes in the light of these principles. Section 3 details the proposed PES scheme design that applies competitive market principles, and discusses the limits of such a design. Section 4 closes with some conclusions.

2. Market principles and payments for ecosystem services schemes

The aim of this section is to provide a brief outline of the main principles of undistorted, competitive markets[7,8], discuss their relevance for PES schemes and review examples of existing PES schemes in the light of competitive market principles. Despite the fact that competitive markets are stylised models, incorporating their underlying principles into PES scheme designs promises improvements in cost-effectiveness (supplying ES at minimum cost) and economic efficiency (generating a social net benefit through ES supply).

Buyers and suppliers in competitive markets are price-takers. Neither has the power to influence the market price, which is treated as given. At a given market price, buyers purchase the quantity of output that maximises their consumer surplus, whereas suppliers choose the quantity of supply that maximises their producer surplus. In the short run,[9] suppliers have the opportunity to earn economic profits,[10] with lower cost suppliers earning a higher economic profit than higher cost suppliers. The market price and hence the quantity that is bought and sold in the market are determined by the interaction between market demand and market supply. Market demand is the horizontal (rival goods) or vertical (non-rival goods) sum of individual buyers' marginal benefit functions (assuming negligible income effects). Market supply is the horizontal sum of individual suppliers' marginal cost functions.

[4] Common-pool resources are characterized by non-excludability and divisibility: '[D]ivisibility means that the [consumption] of part of the resource by one [person] subtracts it from the amount available to [others]' (Tietenberg and Lewis, 2009, p.74).

[5] The proposed design is not relevant for PES schemes which are based on direct negotiations between buyers and suppliers such as the scheme initiated by the water bottling company Vittel (Nestlé Water) (Perrot-Maître 2006). In such cases, an actual ES market exists. Information on demand and supply is generated through market transactions without the need to estimate marginal benefits and marginal costs using economic techniques such as non-market valuation or tenders.

[6] Buyers and suppliers have the opportunity to earn consumer and producer surpluses, respectively: 'Consumer surplus [is] a [monetary] measure of the extent to which a consumer benefits from participating in a [market] transaction' (Frank, 2003, p.156) and 'Producer surplus [is] the [monetary] amount by which a [supplier] benefits by producing a profit-maximizing level of output' (Frank, 2003, p.385).

[7] This section outlines generally accepted principles of micro-economic theory. For more details see, for example, Mas-Colell et al. (1995) and Frank (2003).

[8] The proposed PES scheme is based on observed demand and supply and underpinned by a positivistic approach to the issue of behavioural hypotheses.

[9] 'Short run [is] the longest period of time during which at least one of the inputs used in a production process cannot be varied' (Frank, 2003, p.299).

[10] '[E]conomic profit is defined as the difference between total revenue and total cost, where total cost includes all costs – both explicit and implicit – associated with resources used by the [supplier]' (Frank, 2003, p.370).