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The Devil in the Detail: A Practical Guide on Designing Payments for Environmental Services

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ABSTRACT

Payments for environmental services (PES) have become a popular approach to address environmental degradation. However, evidence on its effectiveness is scarce and rather mixed. PES is not a panacea, but there are many cases where PES can be a promising tool. Yet, poor PES design translates into poor performance of the instrument. PES design is a complex task; the devil is in the detail of a number of PES design features. The purpose of this paper is to provide guidance in dealing with this complexity through a comprehensive review of PES design that is accessible to both academics and practitioners. Practitioner guidelines on deciding whether PES is the best approach and for selecting among alternative design features are presented. PES design has to start from a careful understanding of the specific ecological and socio-economic context. We now know a lot about which design features are best suited to which context. It is time to put these insights into practice.

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1 Introduction

Payments for environmental services (PES) have become a popular approach to address environmental degradation. While rigorous impact assessments of conservation policies are scarce (Baylis *et al.*, 2016), the few that have been conducted on PES show mixed evidence on actual performance (Naeem *et al.*, 2015; Pattanayak *et al.*, 2010; Samii *et al.*, 2014). PES is clearly not the best approach under all circumstances. Where PES is the most suitable approach, designing a PES scheme is a complex task that is often underestimated. In designing a successful PES scheme, it is not sufficient to organize funding. The devil is in the detail of a number of PES design features.

Although some recent studies have highlighted the importance of specific aspects of PES design and some common design flaws (Hanley and White, 2013; Kinzig *et al.*, 2011; Naeem *et al.*, 2015; Sattler and Matzdorf, 2013; Wunder *et al.*, 2014), there is to my knowledge no systematic review synthesizing the lessons learned on the complete range of PES design features. The purpose of this paper is to provide such a review in a manner accessible to both academics and practitioners. Practitioner's guides on deciding whether PES is the best approach and for selecting among alternative design features are presented. Section 2 briefly introduces the basic concept of PES and explains when it may be an appropriate policy approach. Section 3, the core of this paper, presents a comprehensive review of PES design features and key design lessons. The insights of sections 2 and 3 are summarized in visual decision guides. Section 4 highlights open questions. Section 5 concludes.

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2 PES Basics

2.1 Definition and Concept

Considerable debate has centered on the definition of PES (Tacconi, 2012; Wunder, 2015). Proposed definitions range from rather narrow (Wunder, 2005, 2015) to rather broad (Muradian *et al.*, 2010). For the purpose of this paper I consider PES as *a positive economic incentive where environmental service (ES) providers can voluntarily apply for a payment that is conditional either on ES provision or on an activity clearly linked to ES provision.* The basic idea of PES is illustrated in Figure 1. The starting point is a situation where a land use or land use practice (activity A) reduces the provision of environmental services, and where an alternative activity (B) prevents the loss in environmental services, but implies reduced profits for landholders (ES providers). Assuming that the gain in environmental services from switching to activity B exceeds the loss in profits, activity B is socially desirable.[1]

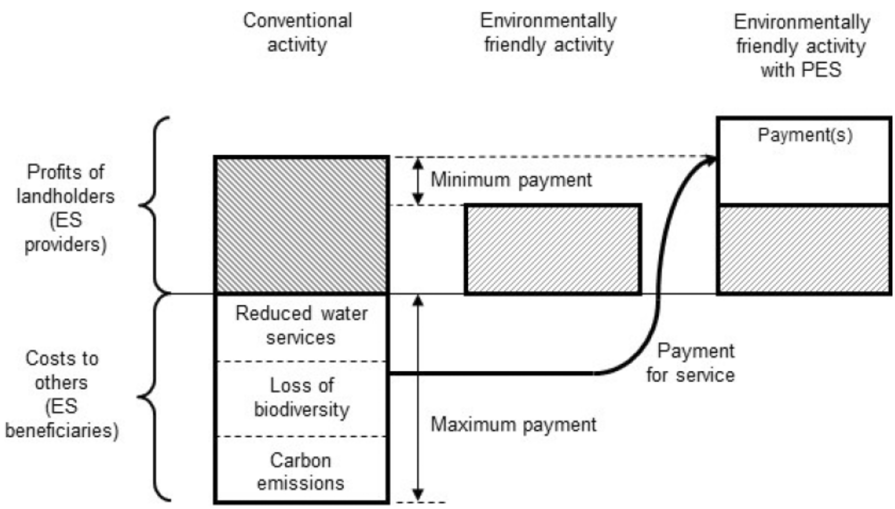

Figure 1: The Logic of PES (adapted from Engel *et al.*, 2008).

[1]In practice, the link between a land use or land use practice and the provision of environmental services is not always fully understood, and the degree of complexity and knowledge about this link differs for different environmental services (Naeem *et al.*, 2015).

PES can translate at least part of the societal benefits from increased ES provision into a payment to ES providers (for example, landholders), so that their total profits from the socially desirable activity become higher than under the conventional activity.[2]

2.2 Appropriateness of PES As a Policy Approach

As illustrated in Figure 1, PES is primarily an approach for addressing environmental externalities in situations where the societal benefits from ES provision exceed the costs to ES providers (Engel *et al.*, 2008; Wunder, 2005, 2015). Yet, environmental degradation may also be due to other problem sources such as insecure property rights, lack of awareness, credit market imperfections, poverty, commons dilemmas, or subsidies on environmentally damaging activities.[3] In these cases, respectively, securing property rights, awareness building, credit policies, poverty alleviation, community-based management, and elimination of counterproductive subsidies are more appropriate solution approaches. In practice, a combination of problem sources is often present and requires a policy mix, which may or may not involve PES.

PES is, however, not the only approach to address externalities. Environmental taxes, tradable permits, and command-and-control approaches such as ambient or emission standards are often more appropriate because they implement a polluter-pays principle (Sterner, 2011). PES by contrast implements a 'steward rewarded' or 'beneficiary pays' principle (Engel *et al.*, 2008). This can be appropriate when ES providers have relatively low income as compared to ES beneficiaries. In general, the choice of principle is a decision about the distribution of property rights (entitlements to pollute).

Finally, some basic preconditions should be satisfied (Wunder, 2015). First, property rights should be clearly defined and well enforced. Otherwise PES design is highly complex and often ineffective (Engel and

[2] Note that the term "social (or societal) benefits" in economics does not necessarily mean that benefits are incurred by all of society. Rather it refers to the sum of benefits of all others in society. In the case of water-related PES, the main beneficiary can sometimes be a private company (e.g., a hydroelectric company or a brewery).

[3] In these cases, environmentally friendly behavior is privately profitable, but market imperfections, lack of awareness, etc. lead to a distorted calculation of private profits.

Palmer, 2008; Engel *et al.*, 2013). Introducing PES in a context of weak property rights can increase conflict over such rights and strengthen the position of those receiving PES in such a conflict (Engel *et al.*, 2013; Engel and Wunder, 2008). Second, like most other policy instruments, effective implementation of PES requires sufficient administrative, monitoring, and enforcement capacity. When these preconditions are not satisfied, PES design — like the design of any other policy — becomes highly complex and often ineffective (Wunder, 2013). In these cases, it would be preferable to focus on creating the preconditions first, before implementing PES.

Wunder (2013) also lists low intrinsic motivations for environmental conservation as a further precondition for PES. Several authors have pointed out that in situations where intrinsic motivations are important, there is a possibility that PES may "crowd-out" such motivations (Kosoy and Corbera, 2010; Vatn, 2010). For example, if landholders are providing ES based on pro-environmental or pro-social motivations, they may be less willing to do so once PES are introduced. Results from behavioral economics and psychology suggest that such 'crowding effects' of economic incentives can be important in many settings (Bowles and Polonía-Reyes, 2012). There is a rise in studies on the behavioral economics of environmental policy in general (Gsottbauer and Bergh, 2011; Noussair and van Soest, 2014; Shogren and Taylor, 2008), and PES in particular (included in the review by Rode *et al.* 2015). While I agree with Wunder (2013) that PES design is best understood, and also most relevant, for situations where intrinsic motivations are less important, I incorporate emerging insights on behavioral economics lessons on PES design in this review wherever possible.

Figure 2 summarizes the main considerations in deciding whether PES is an appropriate approach.

2.3 Types of PES and Funding Sources

Two basic types of PES can be distinguished (Engel *et al.*, 2008; Schomers and Matzdorf, 2013; Tacconi, 2012). *Coasean* PES result from a direct negotiation between ES beneficiaries and ES providers. An example is that of the water bottling company Vittel ('the beneficiary') paying nearby farmers ('the providers') for adopting agricultural

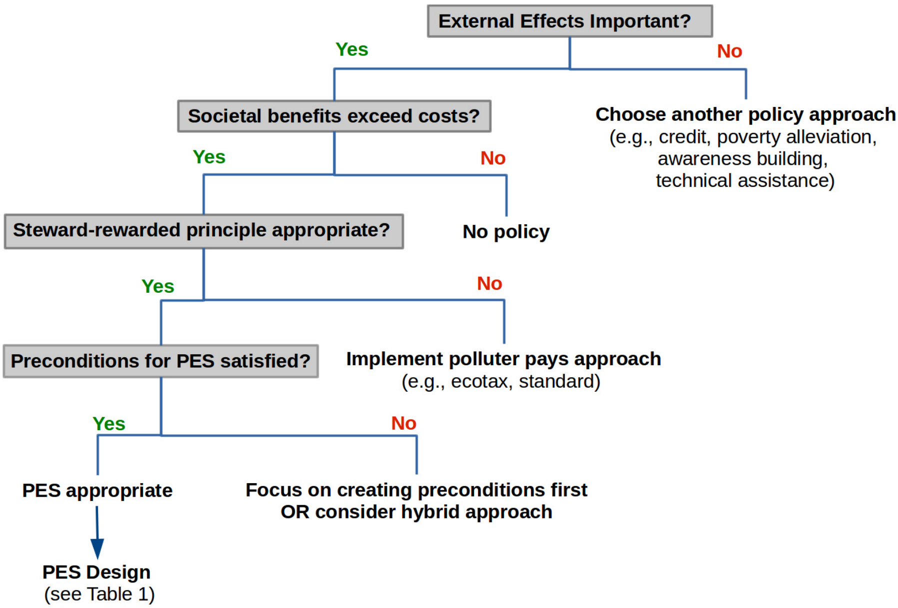

Figure 2: Decision guide for determining if PES is the appropriate policy approach.

practices that reduce nitrate pollution.[4] *Pigouvian* PES resemble an environmental subsidy, where payments are made by a government agency out of earmarked user fees (e.g., a water charge) or general tax funds. Agri-environmental payments in Europe are among the many examples. Many existing PES schemes represent *hybrids* of the two types. For example, the Costa Rican PES program bundles funds from public and private sources as well as international organizations. The conditions for a Coasean negotiation between ES providers and beneficiaries are frequently violated in practice because ES are often public goods and transaction costs of negotiation can be high (Tacconi, 2012). Consequently, the majority of PES programs involve third party actors (e.g., governments, international organizations, NGOs, or carbon project developers).

The chances for private sector involvement in funding PES are often overestimated (Tacconi, 2012; Vatn, 2010). Private sector funding is

[4]Though the Vittel example comes closest to the concept of a Coasean PES it still involved an intermediary organization facilitating the negotiations (Perrot-Maître, 2006).

promising only if there are few beneficiaries with a large proportion of relatively high total benefits (as in the Vittel example), beneficiaries are well organized (e.g., water user associations), or when complementary policies create a demand for service provision (e.g., through caps on carbon emissions or biodiversity offsetting requirements) (Matzdorf *et al.*, 2013).

2.4 Objectives of PES

Many PES programs bundle different ES objectives (e.g., water and biodiversity services) into one scheme. Bundling can help to achieve a payment level high enough to cover ES provision costs. It can also help reduce transaction costs. Disadvantages of bundling lie in the potential for free riding among the beneficiaries of different ES[5] and the fact that aiming to achieve several ES with one policy instrument may induce tradeoffs (Tinbergen, 1956). Effective bundling requires understanding such tradeoffs (Naeem *et al.*, 2015).

As explained above, PES is primarily an instrument aimed at addressing environmental degradation. In practice, however, distributional considerations are often implicit or explicit side objectives of PES (Adhikari and Agrawal, 2013; Wunder *et al.*, 2008). The idea that PES can kill two birds with one stone, i.e., address environmental degradation and poverty at the same time, has been important in promoting PES and obtaining donor funding (Landell-Mills and Porras, 2002). Moreover, it is possible that negative distributional outcomes or procedural unfairness in the implementation of PES could undermine environmental effectiveness because perceived unfairness can cause resistance against the program (Corbera and Pascual, 2012; Pascual *et al.*, 2010, 2014). Pagiola *et al.* (2005) thoroughly explain how the impact of PES on the poor depends on the poors‘ eligibility, willingness, and ability to participate in PES, and that also other poor groups such as landless workers and customary users may be affected. In practice, there are often tradeoffs in PES design between the two objectives of environmental effectiveness and poverty alleviation (Alix-Garcia *et al.*, 2015; Bulte *et al.*, 2008; Pagiola *et al.*, 2005). In what follows I will focus

[5] For example, Asquith *et al.* (2008) describe how the fact that a PES program in Bolivia was co-financed by an international NGO interested in biodiversity conservation led to a low willingness of a downstream irrigators association to contribute funds.

primarily on PES design for environmental effectiveness. In Section 3.6, I summarize some key insights into avoiding negative impacts on the poor. In Section 4, I also highlight the need for more research on the potentially important link between social equity and environmental effectiveness.

3 PES Design

Sattler and Matzdorf (2013) distinguish four phases of PES design: exploration, development, pilot testing, and program operation. While the previous section touched upon issues in the exploration phase, the remainder of this paper focuses on the program development phase, where the 'nitty-gritty' of a PES scheme is decided on. Pilot testing can imply reconsideration of design elements, while program operation may lead to later adaptations to new information or changing conditions (Sattler and Matzdorf, 2013).[6] In this section, I review the main issues in and lessons on PES scheme design (program development). Sections 3.1 to 3.5 focus on PES design for environmental effectiveness. Because, as explained earlier, poverty alleviation is often a side objective of PES and negative equity impacts could in principle reduce effectiveness, Section 3.6 also summarizes some key insights into avoiding negative impacts on the poor. The review focuses on payment design and does not go into procedural aspects of program development, such as issues of participation and legitimacy. This is purely due to a need to limit the scope of this paper. The potentially large importance of procedural aspects is briefly pointed to in Section 4.

The review below is based largely on studies applying conceptual modeling, simulation models, meta analyses, comparative case studies, incentivized economic experiments testbedding PES policy instruments, and a few ex-post impact analyses on the performance of actual PES schemes. The lack of rigorous ex-post impact evaluation studies on conservation policies is even more prevalent when it comes to comparing different design features (Baylis *et al.*, 2016). Yet, their potential is

[6] Asquith *et al.* (2008) describe a successful experience with the adaptive development of a PES scheme in Bolivia. Sims *et al.* (2014) describe how the Mexican national PSAH scheme was adapted over time to incorporate lessons into improved design.

also limited because — as shown below — which design feature works best is likely to depend on the socio-economic and ecological contexts. Studying this context dependence with ex-post impact analyses would require implementing identical randomized control trials in different contexts, a very difficult and costly endeavor.

There is an additional large body of literature analyzing ES providers‘ preferences for alternative contract attributes (see Cranford, 2014 for a review). While these studies can provide interesting insights for understanding participation in PES, it is important to note that maximizing ES providers‘ willingness to participate in a PES scheme is not equivalent to PES effectiveness. For example, landholders might prefer a scheme with high flexibility, little restrictions on resource use, and low conditionality, but such a scheme may well end up paying for activities that would have been implemented also in the absence of PES, implying low effectiveness. Maximizing landholder participation in PES is thus neither a necessary nor a sufficient condition for environmental effectiveness. Below, I therefore draw on participation studies only to a limited extent.

The insights into PES design presented in this paper are summarized in Table 1 in the form of a decision guide. For each design issue, columns 2 and 3 list a design default option and an alternative design feature.[7] Column 4 states conditions which make the alternative feature more favorable over the default option.

3.1 Payment Details

3.1.1 Payment Amount

The *minimum PES* would just cover the ES provider's provision costs. Provision costs include the loss in profits from switching activities (‘opportunity costs') as well as transaction costs involved in switching activities and enrolling in PES (Engel *et al.*, 2008). By contrast, the *maximum PES* would encompass the full value to the ES beneficiaries of the increase in ES arising from the switch to the environmentally friendly activity (see Figure 1). It is thus misleading to interpret the payment amount as ‘the value' of ES. Rather the payment level determines the distribution of net gains between ES providers and ES beneficiaries.

[7] Which option is referred to as the default here is somewhat arbitrary, but broadly reflects the currently more prevalent option.

Table 1: Decision guide on selecting among alternative design features

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Payment amount (Section 3.1.1)	Close to ES provision costs (opportunity cost + transaction cost)	Close to social value of ES	• Social value of ES can be estimated at low cost or proxy available • No free riding on part of ES beneficiaries (→ no budget scarcity) • ES providers have lower incomes than ES beneficiaries
Payment mode (Section 3.1.2)	Cash	In-kind	• Providers prefer in-kind payment, • In-kind option can be identified that is sufficiently divisible, needed repeatedly, and cost of delivery is low
Payment differentiation (Section 3.1.3)	Fixed payment	Differentiated payment — by provision cost — by ES provision	• Opportunity costs or potential for ES benefits per ha/activity varies significantly across sites • Estimates on differentiating criterion available
Contract length (Section 3.1.4)	Short (e.g., <5 years)	Long (e.g., ≥ 5 years)	• Low uncertainty about future opportunity costs and/or social values of ES • Strong contract enforcement capacity

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Payment duration (Section 3.1.5)	Permanent	Temporary	• Desired activity becomes profitable for provider after some time
Degree of conditionality (Section 3.2.1.)	Partly ex-ante	Fully conditional	• Desired activity requires no significant ex ante investment by providers • Providers have access to credit
Type of conditionality (Section 3.2.2)	Activity-based	Results-based — Absolute performance-based — Relative performance-based	• Monitoring results is less costly than monitoring activities; AND — Results do NOT depend to strong degree on external factors — Providers risk aversion is relatively low — External factors affecting results strongly correlate locally

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Unit of control (Section 3.2.3)	Individual provider	Group of providers	• Group has good collective action potential, AND • Group of providers has joint property rights; OR • Performance can only be observed at group level; OR • Spatial coordination of activities desired; OR • Effective internal monitoring and sanctioning mechanisms exist; OR • Relocation of harmful activities to nearby sites likely
Additionality (Section 3.3.1)	Strict focus on additionality	Provisions for initial high ES providers	• Significant share of initial high ES providers • High ES providers are intrinsically motivated

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Leakage (Section 3.3.2)	No consideration	Discount for leakage, increase unit of control, OR promote activity delivering equivalent output	• PES restricts production of products with high returns and inelastic demand (e.g., cash crops for the world market); OR • PES leads to reduced demand for capital and labor, and these are mobile; OR • PES reduces production of a resource vital to local livelihoods and nearby land is available as alternative production site
Permanence (Section 3.3.3)	Fixed payment	Index payment to price index correlated with opportunity costs	• Opportunity costs expected to increase over time, but remain lower than social benefits • Index available that correlates strongly with opportunity costs

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Benefit targeting (Section 3.4.1)	No targeting	Targeting according to expected ES benefits	• Budget is insufficient to include all applicant sites • Sites differ significantly in environmental benefits and/or threat • Data on environmental benefits and/or threat available
Cost targeting (Section 3.4.2)	No targeting	Targeting low cost sites	• Budget is insufficient to include all applicant sites • Sites differ significantly in provision costs • Approximate provision costs of different provider types known OR an auction can be implemented (large number of providers)

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Group vs. individual payment (Section 3.5.1)	Payment to individuals	Payment to group	• Transaction costs of individual payments are high • Group has better information on benefits and costs within the group • Group members trust in internal distribution mechanisms/Elite capture not a problem • Group is averse to external control over payment distribution
Spatial coordination (Section 3.5.2)	None	Incentivize spatial coordination — Agglomeration bonus — Consider spatial patterns in targeting (e.g., combinatorial auction)	• Spatial patterns important for effective ES provision, AND — Number of potential ES providers is small or organized in small groups — Number of potential ES providers is large

(*Continued*)

Table 1: (*Continued*)

Design feature (Section covering details)	Default design feature	Alternative design feature	Alternative feature favorable if...
Facilitating conditions for poor ES providers (Section 3.6.1)	None	Reduce participation hurdles (e.g., administrative & technical support, allow group applications & informal title)	• Poor providers are eligible, but face hurdles through high transaction costs or other factors
Reducing negative impacts on landless workers and customary users (Section 3.6.2)	None	Support alternative income opportunities (e.g., employment of landless workers in monitoring, complementary programs)	• Activities supported by PES reduce labor demand relative to conventional activities, affecting poor landless laborers; OR • Activities supported by PES reduce availability of or access to resources for poor customary users

Note: Which feature is labeled the default is somewhat arbitrary, but broadly reflects the currently more prevalent option. If all or most conditions in the right column are satisfied, the alternative option is likely to be preferable. If conditions are separated by 'OR', the alternative option is preferable already if only one condition is satisfied.

Making payments close to the social value requires that the full societal value of the increase in ES can be estimated and translated into actual funding. In practice this is only rarely the case due to the methodological difficulties related to non-market valuation techniques, the cost of valuation studies, and the fact that free riding among ES beneficiaries tends to imply scarce budgets for PES (Engel and Schäfer, 2013). In some cases, such as for carbon sequestration, the carbon market price can be used as an — yet rather imperfect — approximation.

In practice, payments are often set close to an estimate of opportunity costs (Wunder *et al.*, 2008). This has the advantage that it does not require or involve an economic valuation of ES benefits and that payments are kept low to achieve more with given budgets. There is evidence in behavioral economics that setting payments too low (below the minimum) can be counterproductive (Gneezy and Rustichini, 2000; Kerr *et al.*, 2012).[8] It appears thus important to estimate provision costs to include not only opportunity costs, but also transaction costs (Wünscher and Engel, 2012; Wünscher *et al.*, 2008). Moreover, current opportunity costs can be misleading when capital constraints keep landholders from conducting more profitable activities. When PES are made, the capital constraint of landholders may be relaxed and the more profitable activity can become the relevant alternative, thus raising opportunity costs (Kaimowitz and Angelsen, 2008; Reutemann and Engel, 2016).

3.1.2 Payment Mode and Timing

Most PES are made in *cash*, but some studies have demonstrated cases where ES providers stated a preference for *in-kind* payments (Kaczan *et al.*, 2013; Zabel and Engel, 2010) or have described PES programs implementing in-kind payments (Asquith *et al.*, 2008; Wunder and Albán, 2008). In-kind payments can be a suitable approach if there are local constraints to absorb cash in a manner that enhances welfare over

[8]This is not to say that low payments necessarily do not work. For example, Kosoy *et al.* (2007) found payments below opportunity costs to be effective, which is likely due to intrinsic motivations. What the findings in behavioral economics suggest is that low payments carry a higher risk of crowding out intrinsic motivations over time, thus reducing environmental performance when payments stop (as compared to the performance before payments started).

the long term (Asquith *et al.*, 2008) or if payments are made to groups and there is concern about elite capture. For example, in Bolivia PES recipients opted for beehives as in-kind payment because these were perceived as creating a lasting benefit, while cash would more likely have been spent right away (Asquith *et al.*, 2008). A challenge with in-kind payments is that they may not be sufficiently divisible and suited to be continuously repeated, requiring a switch to different in-kind payments over time, and transaction costs for ES buyers and intermediaries may be high (Asquith *et al.*, 2008). If imposed externally, in-kind payments can also be perceived as paternalistic, while cash payments can be used flexibly by the recipients (Wunder, 2005). On the other hand, some authors have pointed to a risk that the introduction of cash payments reduces ('crowd out') pro-social behavior (Farley and Costanza, 2010; Vatn, 2010). Research in social psychology suggests that this risk might be smaller for in-kind payments (Heyman and Ariely, 2004; as cited in Cranford, 2014).

In poor areas with market imperfections timing of payments can also be an issue. Specifically, it can be useful to disburse payments at times of the year that tend to be economically tight, e.g., prior to the main crop harvest (Zabel and Engel, 2010).

3.1.3 Payment Differentiation

A common practice in PES is to make *fixed payments*, e.g., per hectare of land on which a pre-specified activity is conducted. However, fixed payments imply high rents for ES providers with low participation costs while those with high participation costs are unlikely to participate (Wünscher *et al.*, 2008). Alternatively, payments can be *differentiated* either on the basis of provision costs (paying higher amounts to high-cost providers) or on the basis of environmental benefits (paying higher amounts where sites provide higher services) (Hanley and White, 2013). A recent meta-analysis found that payment differentiation increases the probability of the PES scheme being environmentally effective (Ezzine-de-Blas *et al.*, 2015). Payment differentiation is important only if there is considerable variation in provision costs or in environmental benefits. It requires data on the variable by which payments are to be differentiated. Particularly participation costs can be difficult to estimate due to asymmetric information. This issue is further discussed in Section 3.4.2 on cost targeting.

3.1.4 Contract Length

PES involves a contract between ES buyers and ES providers. In practice, the length of the contracts varies considerably. The PES literature is lacking a systematic analysis on optimal contract length (Hanley and White, 2013). Participation studies (reviewed in Cranford, 2014) have shown that ES providers tend to prefer *shorter contracts* as they leave more flexibility to change land use once contracts end. From a landholder's perspective this makes sense due to uncertainty about future market conditions, which may affect their opportunity costs. Also, when first enrolling in a new activity, ES providers may wish to try out the new practice for a short time before committing to pursue it for a longer term. *Longer contracts* — assuming they are enforceable — would then require a risk premium to assure participation (Hanley and White, 2013).

Implementing agencies also face uncertainty about the future values of the ES. If it is unclear whether the societal value will exceed provision costs in the longer run or future funding is insecure, the agency may prefer shorter contracts to maintain flexibility to cease payments eventually (Hanley and White, 2013). Moreover, when there are initially high uncertainties regarding optimal scheme design, shorter contracts support an approach of adaptive management and learning-by-doing. On the other hand, from the perspective of the implementing agency, longer contracts could help assure conditionality and permanence (see Sections 3.2.1 and 3.3.3). The longer the period contracted for, the larger the potential sanction on ES providers in case of non-compliance because more payments can be withheld in the future. Also, if contracts can be enforced, a longer contract can assure a longer-term provision of the service for the ES beneficiary.

3.1.5 Payment Duration

A PES program may intend to make payments *indefinitely* or only *temporarily.* Some activities promoted under PES, for example switching to agroforestry or silvopastoral practices, imply high short-run costs, but start to become profitable for the landholder after some years of implementation. In this case, temporary payments can be sufficient to induce the landholder to adopt the environmentally friendly practice (Pagiola *et al.*, 2004, 2014). Yet, many activities or land use changes promoted under PES, for example avoided deforestation or land retirement, imply opportunity costs for the ES providers indefinitely. In this case, payments have to be secured for the long run to avoid the reversal of gains in ES provision (Wunder *et al.*, 2008) or that intrinsic motivations are crowded out once payments stop (Gneezy *et al.*, 2011).

Securing long-term funding can be challenging. Three approaches have been discussed in the literature. A first approach is to directly involve private sector actors that benefit from the ES. For example, a hydropower company paying for water services is likely to keep offering payments as long as its benefits exceed the costs. Yet, as discussed earlier, the potential for private sector funding in PES is limited by the public goods nature of many ES. A second approach is to link payments to earmarked revenues from user fees or taxes. For example, Costa Rica uses a water charge and a fuel tax to provide the bulk of funding for its national PES program (Pagiola, 2008). A third approach is to invest the available funding in a trust fund and make payments only from the interest earned.[9] Though this implies lower annual funding availability, and interest rates and thereby available funds may somewhat vary over time, the approach secures long-term availability of funds.

Note that payment duration is different from contract length. Payments can be made indefinitely, but still be offered in the form of subsequent shorter-run contracts.

3.2 Conditionality

3.2.1 Degree of Conditionality

Conditionality refers to the idea that payments are made if and only if the ES are provided or an activity is implemented that is clearly linked to provision of ES. Conditionality is widely seen as a key feature of PES, distinguishing it from more conventional integrated conservation and development programs (Ferraro and Simpson, 2002; Kinzig *et al.*, 2011). Implementing conditionality requires *monitoring compliance* and *sanctioning non-compliance* (Engel *et al.*, 2008). Sanctions in PES commonly take the form of withholding future payments and sometimes also withdrawing current payments (Wunder *et al.*, 2008). In principle,

[9] An example is FONAG in Quito, Ecuador (http://www.un.org/waterforlifedecade/green_economy_2011/pdf/session_4_biodiversity_protection_cases_fonag.pdf).

sanctioning could also take the form of forcing PES recipients to pay back past benefits. This seems to be rarely done due to limited political feasibility. In the Ecuadorian PROFAFOR scheme private landowners had to provide upfront guarantees for contract compliance (Wunder and Albán, 2008).

In general, there are then two main ways to ensure compliance in PES: a higher monitoring intensity and a higher payment (Hart and Latacz-Lohmann, 2005). Theoretically, a third way is additional fines for non-compliance, but these seem to be rarely used in PES (Wunder *et al.*, 2008). The choice of monitoring intensity also depends on the expected propensity of ES providers to cheat (Hart and Latacz-Lohmann, 2005). Moreover, results from behavioral economics and social psychology suggest that, if ES providers are control averse, a medium monitoring intensity may be preferable to a high one (Lindenberg and Foss, 2011). There is some evidence that a medium level of conditionality is also preferred by ES providers (Kaczan *et al.*, 2013), which could be due to fairness preferences. In practice, many PES programs lack effective monitoring and sanctioning (Hart and Latacz-Lohmann, 2005), and this was found to negatively affect environmental effectiveness (Ezzine-de-Blas *et al.*, 2015).

PES programs may also involve an *unconditional ex-ante payment* (Pagiola *et al.*, 2004; Wunder *et al.*, 2008). Ex-ante payments can be in-kind (for example, technical assistance, seedlings) or cash. They can be appropriate if the desired activity requires significant ex-ante investments on part of the ES providers and providers lack access to credit to pre-finance such investments, or when fairness considerations ask for the rewarding of past conservation efforts (Pagiola *et al.*, 2004, see also Section 3.3.1). However, the larger the share of ex-ante payment in overall payments, the lower the conditionality of the program.[10,11]

[10]"In principle, upfront payment could still be conditional in the sense that contracts could stipulate that the payment has to be repaid in case of non-compliance. In practice, however, such provisions are often unenforceable due to weak legal systems, high transaction costs of enforcement, and poverty considerations." (Wunder *et al.*, 2008, p. 843).

[11]Another dimension of monitoring that is often confused with conditionality is the need to *monitor progress in reaching program objectives*, i.e., the level of ES targeted (Naeem *et al.*, 2015). Regardless of whether payments are made for activities or results (see Section 3.2.2), it is important to monitor whether the PES scheme's objectives are being achieved. This is equally true for any other policy intervention.

3.2.2 Activity-based PES vs. Results-based PES

Payments can be made *conditional on activities* (e.g., land use or an agri-environmental practice) *or on results* (e.g., carbon sequestration, soil nitrate content).[12] Results-based PES are appealing because they imply that payments are made directly for the desired outcome. Moreover, results-based PES can be advantageous when it is less costly to monitor outcomes than activities (Hanley and White, 2013). Recent development in the availability of remote sensing data is likely to reduce the cost of monitoring ES outcomes over time (Hanley and White, 2013). Another advantage of results-based PES is that they can induce farmer innovation by specifying desired outcomes without prescribing specific measures to achieve such outcomes (Hanley and White, 2013). In practice, ES results often depend not only on landholders' activities, but also on external factors (e.g., weather, natural forest fires) (Friess *et al.*, 2015; Naeem *et al.*, 2015). A major disadvantage of results-based PES then is that they push the risk of non-delivery onto service providers who are often risk averse. This implies that a risk premium needs to be paid in results-based PES to assure providers' participation (Hanley and White, 2013). When the external risk is strongly correlated locally, an interesting option can be to make payments conditional on *relative performance* (Zabel and Roe, 2009). For example, agri-environmental payments can be made on the basis of a farmer's nitrate content in the soil relative to average values of nitrate content in the soil of all farmers in the area (Zabel and Roe, 2009). Some authors have proposed mixed schemes where part of the payment is based on activities and the other based on results (Derissen and Quaas, 2013; White and Sattler, 2012). While this is theoretically plausible, a mixed scheme could involve high monitoring and transaction costs. To date, the majority of PES schemes are activity-based (Wunder, 2008).

Some PES programs translate data on activities into an ES score, using predefined conversion rates. Examples include the U.S. Conservation Reserve Program (Claassen *et al.*, 2008) and a PES program promoting silvopastoral practices in Colombia, Costa Rica, and Nicaragua (Pagiola *et al.*, 2004). Such schemes are activity-based, but make the link to ES more explicit than broad brush per hectare payments.

[12] Activity-based PES are also sometimes called input-based, while results-based PES are also referred to as performance-, outcome- or output-based.

3.2.3 Unit of Control

Most PES are made conditional upon the activities or ES results of *individual ES providers*. Yet, there are at least three situations where it is appropriate to use the aggregate performance of *groups of ES providers* as the unit of control. First, land may be under the joint property of local communities, as is common for many developing country forests or grazing lands (Vatn, 2010). Second, environmental quality may be observable only on an aggregate level. For example, in Sweden payments for wildlife conservation are based on numbers of wildlife offspring in the area surrounding a village (Zabel *et al.*, 2014). Third, when spatial patterns of activities matter for effective ES provision basing at least part of the payment on group activity patterns can be an option (see also Section 3.5.1). Furthermore, making payments conditional upon group performance could activate peer monitoring and enforcement within the group (Cranford, 2014; Hanley and White, 2013) and reduce the potential for relocation of harmful activities to nearby sites (see Section 3.3.2). In a meta-analysis of payments for water services, Brouwer *et al.* (2011) found that schemes were more effective if the contract was made with the entire community rather than individual ES providers. They hypothesize that a possible explanation may be that the community plays an important role in compliance and enforcement.

When payment is based on group performance, the group faces a *commons dilemma*: every group member benefits from the payment, but incurs a private cost in contributing to performance, implying incentives to free ride (Vatn, 2010; Zabel *et al.*, 2014). This implies that the successful implementation of payments conditional upon group performance likely depends on the group's ability for collective action (Zabel *et al.*, 2014), which in turn depends on a range of factors such as group size, heterogeneity, exit options, etc. (Agrawal, 2001; Ostrom, 1990). Moreover, payment distribution among group members matters, particularly when group members differ in their provision costs (Zabel *et al.*, 2014). Note that making payments conditional upon group performance does not necessarily imply that the payment is also paid out to the group as a whole (see Section 3.5.2).

Whether payments are based on individual or group performance also has behavioral implications. Narloch *et al.* (2012) found that where self-regarding behavior is the norm, payments based on group performance are more likely to crowd out intrinsic motivations for environmentally friendly behavior while payments based on individual performance appear to crowd in intrinsic motivations. Midler *et al.* (2015) found that ES providers perceived the payment based on group performance as less fair, although this may be different in other contexts (Narloch *et al.*, 2013).

3.3 Additionality, Leakage, and Permanence

Additionality, leakage, and permanence are major issues prominently discussed in the context of REDD+ (Angelsen and Wertz-Kanounnikoff, 2008), but equally relevant to other ES contexts.

3.3.1 Additionality

Additionality refers to the difference between the environmental outcome with PES and a hypothetical baseline of what would have been the outcome in the absence of PES (Wunder, 2005). Many authors argue that payments should be made only for activities that would not have been implemented in the absence of PES (Wunder, 2005). Lack of additionality (‘Paying for nothing’, ‘Paying for hot air’) may well be the most serious design problem of current PES (Naeem *et al.*, 2015; Pattanayak *et al.*, 2010). Assuring additionality requires estimating realistic *baselines* on what would have happened in the absence of PES. The baseline should consider not only the level of ES when payments start, but also expected changes in external factors during the period when PES are being made and which may affect ES providers‘ activities (Naeem *et al.*, 2015). Many current PES schemes do not compute baselines, but rather just pay on the basis of an activity being implemented (Wunder *et al.*, 2008).

The additionality issue is given most attention in carbon sequestration projects, but the approaches used there are also far from perfect (Angelsen and Wertz-Kanounnikoff, 2008).[13] Crediting baselines used can essentially be seen as rough proxies for analytical baselines. A commonly used approach is historic baselines (Angelsen and Wertz-Kanounnikoff, 2008). Yet, these fail to consider socio-economic dynamics

[13] Baseline methodologies for the CDM are presented in UNEP (2005).

in resource use.[14] Moreover, baselines need to provide incentives for action for ES providers with low levels of ES provision without undermining action by those with an effective track record of high ES provision (Angelsen and Wertz-Kanounnikoff, 2008). Historic baselines may reduce intrinsic motivation for pro-environmental action by those who were acting pro-environmentally before the introduction of PES (Alpizar *et al.*, 2013). This is because basing payments purely on additionality may be perceived as "rewarding the bad guys" (Dobbs and Pretty, 2004, as cited in FAO, 2007). In the context of the debate on REDD+, where ES providers are countries, most proposals use historical baselines, but incorporate 'national circumstances' and 'rewarding early action'.[15] Pagiola *et al.* (2004) describe a similar approach at the level of individual farmers: In a PES program promoting silvopastoral practices continuous payments were made conditional upon activities that were not previously applied by the farmer, but an ex-ante payment was made to reward early action.

More sophisticated approaches for estimating analytical baselines to assess additionality use socio-economic models, e.g., deforestation (Kaimowitz and Angelsen, 1998), to predict the probability that ES would be lost or not provided in the absence of PES (Alix-Garcia *et al.*, 2008; Wünscher *et al.*, 2008). Proxies can also be used to roughly estimate analytical baselines; for example, Sanderson *et al.* (2002, as cited in Wünscher and Engel 2012) use population density, land transformation, accessibility, and electrical power as proxies for the probability of habitat destruction.

3.3.2 Leakage

Leakage refers to the risk that PES causes a displacement of the environmentally harmful activity elsewhere. In the case of avoided deforestation, leakage is more likely under the following conditions (Angelsen and

[14]For example, historical rates of deforestation underestimate actual deforestation for countries at early stages in forest transition and overestimate actual deforestation for countries at later stages (Angelsen and Wertz-Kanounnikoff, 2008).

[15]The dilemma is that if baselines are too generous and take national circumstances into account there is a risk of undermining overall emissions reductions and credibility. On the other hand, if baselines are set too tightly, there is a risk of low participation and rejection by developing countries (Angelsen and Wertz-Kanounnikoff, 2008).

Wertz-Kanounnikoff, 2008): cultivation of cash crops for the world market; capital and labor mobility; easily accessible, unprotected, cheap neighboring forest lands of similar quality; high returns and inelastic demand for forest products; provision of only a small share of the world market by the country at stake; and fixed input coefficients in the production technology. More generally, one could say that PES is more likely to exhibit leakage if (i) PES restricts production of products with high returns and inelastic demand (e.g., cash crops for the world market); (ii) PES leads to reduced demand for capital and labor, and these are mobile; and/or (iii) PES reduces production of a resource vital to local livelihoods and nearby land is available as alternative production site. Leakage tends to be less of an issue when payments are made for activity creation (e.g., agroforestry, alternative agricultural practices) than when they are made for activity reduction (e.g., avoided deforestation, land retirement) (Wunder, 2008).

Three main approaches for addressing leakage have been proposed. First, payments made for ES provision can be *discounted* based on the estimated extent of leakage (Murray, 2009). For example, a project creating 100 ES score units but estimated to create 20% leakage would receive a payment for only 80 units.[16] A second approach commonly discussed in the REDD+ debate is to reduce leakage by increasing the *scale* of accounting and crediting emission reductions (e.g., to the national rather than project scale) (Wunder, 2008). In a national or subnational PES context, and if leakage is likely to occur on nearby sites, this could be an argument for making PES conditional upon the aggregate performance of a group or community of ES providers (see Section 3.2.3). A third approach is to implement *projects producing equivalent output* while reducing environmental damage. For example, in Kenya, payments to reduce charcoaling were complemented by the promotion of ecocharcoaling, relying on scrapwood (Veronesi *et al.*, 2015).[17]

[16] Leakage in this case is defined as emissions moved to a new location divided by emissions avoided at project site (Murray, 2009).

[17] Reutemann *et al.* (In press) describe a case where the combination of payments for avoided deforestation with rotational grazing in Brazil is intended to increase cattle production per hectare while reducing deforestation.

3.3.3 Permanence

Permanence refers to the issue of how to assure that environmental service provision paid for is not reversed later. Non-permanence can be seen as leakage in time. Permanence is linked to the issue of payment duration (Section 3.1.5). If the activity promoted by PES implies opportunity costs indefinitely, payments will have to be continued indefinitely, and continuous funding has to be secured to assure permanence. Permanence is also linked to contract length (Section 3.1.4). If contracts could be made for very long time periods and perfectly enforced, permanence could be assured. Yet, this is often not possible in practice. ES providers are likely to resist long-term contracts in light of uncertainty about market prices, and contract monitoring and enforcement become difficult if the incentives to breach a contract strengthen.

Even if payments are maintained at constant rates indefinitely, permanence in ES provision can be at risk due to (i) increasing opportunity costs (e.g., due to growing world demand for food and biofuels), or (ii) natural factors (e.g., natural forest fires). Though increasing opportunity costs would not be problematic if contracts were perfectly enforceable, in practice the temptation for ES providers to breach a PES contract becomes high when opportunity costs rise significantly.

Several approaches to address the risk of non-permanence have been discussed in the literature (Dutschke and Angelsen, 2008) and only the most relevant for broader PES design are summarized here. First, a common practice in forest carbon projects is to assign *liability* to carbon buyers and require that reversed emission reductions need to be compensated for elsewhere. This is often combined with a second approach of project credit buffers: a portion of total carbon credits earned are not issued but temporarily banked as a *buffer* in the event that some of the original emission reductions are reversed (Dutschke and Angelsen, 2008). While this approach may be suited to dealing with external stressors, it seems unlikely to effectively address increasing opportunity costs over time. As opportunity costs increase, the risk of non-compliance increases, which would require a larger buffer. However, a larger buffer implies lower payments, which in turn increases the probability of non-compliance.

An approach to address the issue of increasing opportunity costs has been proposed by Benítez *et al.* (2006) and Dutschke and Angelsen (2008). The idea is to link the payment level to an agricultural price index which is thought to covary with the opportunity costs of landowners. Three recent studies have tested the performance of such *indexed payments* (Engel *et al.*, 2015; Veronesi *et al.*, 2015; Reutemann *et al.*, in press), with mixed results on their cost-effectiveness relative to other approaches (fixed payments or payments based on carbon market prices). Theoretical considerations in Engel *et al.* (2015) and the empirical evidence suggest that the results depend crucially on the quality of the index available. Because agricultural price indices are imperfect measures of opportunity costs, indexing payments introduces an additional source of uncertainty for the ES provider (Kaczan *et al.*, 2013). Only if the index is strongly correlated to opportunity costs is indexing likely to be more cost-effective than other approaches. Another caveat is that if opportunity costs increase beyond the value of the ES to society or beyond the cost of alternative activities for providing the services, paying for the activity is no longer socially optimal. For example, if increasing food and bioenergy prices increase the opportunity costs of avoided deforestation strongly in some areas, avoided deforestation in these areas may no longer be a cost-effective approach for carbon emission reductions (Karsenty *et al.*, 2014).

3.4 Site Selection (Targeting)

Frequently the number of applications of ES providers for receiving PES exceeds the available budget. The question then arises how to select among applicant sites. A number of studies have demonstrated that selecting (targeting) sites on the basis of benefit and cost considerations can significantly increase the amount of ES obtained with a given budget (Babcock *et al.*, 1997; Ando *et al.*, 1998; Polasky *et al.*, 2001; Barton *et al.*, 2003; Ferraro and Simpson, 2002; Johst *et al.*, 2002, all as cited in Alix-Garcia *et al.*, 2008; Armsworth *et al.*, 2012; Drechsler, 2011; Ezzine-de-Blas *et al.*, 2015; Wunder, 2008; Wünscher and Engel, 2012). Many of these studies demonstrate that large gains in cost effectiveness can be obtained through a combined *cost–benefit targeting* approach, often also combined with payment differentiation. Some also show that the gain in cost-effectiveness from cost–benefit targeting outweigh the implementation costs (Armsworth *et al.*, 2012; Wünscher *et al.*, 2008). For example, Armsworth *et al.* (2012) demonstrate that for UK agri-environmental payments targeting combined with payment differentiation can yield a 49–100% increase in biodiversity benefits, the value of which would outweigh an increase in implementation costs of up to 70% of the budget. Yet, these studies focus on countries with relatively high administrative capacity and good data availability. Data and institutional requirements for targeting can be high. Decision support tools are a promising way to facilitate the implementation of cost–benefit targeting (Johst *et al.*, 2015).

In general, targeting can be implemented at different levels. Area-based targeting criteria, for example identifying ecologically important regions, are relatively inexpensive (FAO, 2007). Targeting becomes more data-intensive and expensive when conducted at the individual landholder level. Targeting thus involves a trade-off between the complexity of the targeting strategy and its cost (FAO, 2007).

In the remainder of this section I briefly review the ideas behind considering expected benefits and costs in site selection, respectively. A more detailed review is provided in Wünscher and Engel (2012). Integrated cost–benefit targeting involves the consideration of both costs and benefits in site selection. This can be done, for example, by ranking sites by their benefit–cost ratio and including those with the highest ratio until the budget is depleted Wünscher and Engel (2012).[18] In addition, timing of conservation activities may also be considered in a spatio-temporal targeting approach where the benefits and costs of conservation measures are sensitive to timing (e.g., agri-environmental measures for biodiversity protection, such as mowing times) (Johst *et al.*, 2002; Wätzold *et al.*, 2015).

3.4.1 Targeting Expected ES Benefits

When sites differ in their potential for ES provision, it can be useful to select sites on the basis of *expected ES benefits*. A common practice is to focus PES on ecological priority areas. But ES benefits can also vary significantly within such an area. In this case, it can be worthwhile to

[18] In theory, a further approach to targeting is to offer menus of screening contracts specifying combinations of payment amounts with quantity of land enrolled or ES provided (Arguedas and van Soest, 2011; Ferraro, 2008). However, this idea has not been picked up in practice so far; it requires prior information on the cost functions of different landholder types and may be difficult to implement (Ferraro, 2008; Hanley and White, 2013).

compute a site-specific ES score, which may be based on the activities to be implemented at the site in combination with site characteristics such as steepness of slope or proximity to a water source (Wünscher and Engel, 2012). Because ES supply is inherently linked to location, the use of geographical criteria (for example, slope) can represent a low cost approach to benefit targeting (FAO, 2007).

Sites can also differ significantly in the degree to which ES benefits are threatened or not provided in the absence of payments (Alix-Garcia *et al.*, 2008). Thus, it can be useful to base site selection on expected ES benefits, based on both ecology and *threat* (which is closely linked to additionality). For example, Wünscher *et al.* (2008) compute expected ES benefits from forest conservation as the product of a site's ES score with the expected probability of deforestation. The latter are computed on the basis of deforestation models, but may also be based on more rough estimations of areas under threat. Alix-Garcia *et al.* (2008) also found that using predicted deforestation as a targeting criterion enhanced cost-effectiveness of PES significantly. Targeting benefits in site selection is only relevant if there is considerable variation in ES benefits and/or threat. For example, Wünscher *et al.* (2008) found for Costa Rica that considering the threat did not increase cost-effectiveness significantly because deforestation rates were generally very low.

If multiple ES are targeted or multiple indicators are chosen to describe ES or the threat, there is a need to combine these to consider tradeoffs (Drechsler, 2011). Approaches proposed in the literature include (Wünscher and Engel, 2012): a weighted sum of standardized indices (Claassen *et al.*, 2008; Pagiola *et al.*, 2004), normalizing indicators to make indicators directly comparable (Wünscher *et al.*, 2008), a simpler stepwise approach ranking attributes and objectives according to importance (Myers *et al.*, 2000), or a more complex non-parametric distance function approach (Ferraro, 2004).

3.4.2 Targeting ES Provision Costs

When landholders differ in their opportunity costs, and thus in their provision costs, it can be useful to select sites on the basis of such costs. Cost targeting implies favoring low cost sites over high cost sites in order to obtain ES at a lower cost to society, or in order to achieve more ES provision with given budgets. Cost targeting is often combined with payment differentiation, setting payments equal to or just above provision costs (see Section 3.1.3), but this need not be the case. For example, auctions can be used to elicit information on provision costs, but still pay a uniform price to selected landholders (Ferraro, 2008). In the study by Wünscher *et al.* (2008) on a region in Costa Rica, the largest part of the increase in cost-effectiveness from improved targeting came from payment differentiation and cost targeting. In general, gains in cost-effectiveness are larger the greater the heterogeneity in ES provision costs of landholders.

A difficulty in cost targeting (and also in payment differentiation) lies in the fact that information on ES provision costs tends to be asymmetric. Landholders generally have better knowledge about these costs than implementing agencies. Moreover, landholders have an incentive to overstate their costs. The main approaches for estimating micro-level opportunity costs in practice include (Wünscher and Engel, 2012): computing farm budgets (Wünscher *et al.*, 2008), inference from land values (Chomitz *et al.*, 2005), estimating values on the basis of economic and environmental data (Wilson *et al.*, 2006), and applying auctions to identify the minimum willingness to accept by landowners (WTA) for the inclusion of a site in a PES program (Ferraro, 2008). In addition to opportunity costs the WTA includes transaction costs and accounts for landowners‘ preferences (such as risk, time, and social and environmental preferences), and is therefore a more relevant measure. In Australia, landholders hand in sealed bids on their WTA for changes in land use management (Wunder *et al.*, 2008). Funding is provided in the order in which the bidders provide the greatest service at the lowest cost until the funds are used up (FAO, 2007). A similar approach is applied by the U.S. Conservation Reserve Program (Claassen *et al.*, 2008). For an auction to be effective, competition between ES providers is required, implying the need for a sufficiently large number of potential ES providers (Ferraro, 2008; Schilizzi and Latacz-Lohmann, 2013). Auctions can be expensive and difficult to implement, especially when countries have limited institutional capacity and landholders have low levels of information and formal education (FAO, 2007). Yet, some evidence exists of the effective implementation of auctions in a developing country context (Leimona 2007 as cited in FAO, 2007; Jack, 2013; Khalumba *et al.*, 2014). Also, since auctions in the context of PES tend to be repeated over time, learning effects reduce the incentives for ES providers to reveal their true willingness to accept over time (Latacz-Lohmann and Van der Hamsvoort, 1997).

3.5 Advanced Issues in PES Design

3.5.1 Spatial Coordination

Environmental benefits sometimes depend on the pattern of sites where a specific land use or agri-environmental measure is implemented. This is particularly the case for biodiversity-related ES (Hanley and White, 2013). Two main approaches have been proposed in the literature to deal with this issue. First, targeting can include spatial patterns as an additional site selection criterion. A rudimentary way to do so is to include a variable like proximity to protected areas or other sites in targeting (Barton *et al.*, 2003; Wünscher *et al.*, 2008). A more sophisticated way to include spatial interactions in targeting is *combinatorial auctions* (Reeson *et al.*, 2011). These are multiple round auctions where information is spread on the location of other bids, and preference in site selection is given to spatially connected bids. The other main approach to spatial coordination is the *agglomeration bonus* (Parkhurst and Shogren, 2007; Parkhurst *et al.*, 2002). Under this approach, landholders receive a bonus for spatially coordinated activities. While the agglomeration bonus may be easier to implement than a combinatorial auction, the former implies a coordination game for ES providers. Some experimental evidence suggests that coordination can be achieved, but success depends on transaction costs (Banerjee *et al.*, 2015). Game theory suggests that coordination and thus the agglomeration bonus is likely to work better where the number of potential ES providers is small or they are organized in well-functioning smaller groups. By contrast, a combinatorial auction — like any auction — is likely to work better for larger numbers of potential ES providers.

3.5.2 Paying Individuals or Groups

When payment is based on group performance (see Section 3.2.3), the question arises whether to make *individual payments* (for example, linking individual payment level to group performance, or equivalently, distributing a total payment on a per-person basis to all group members) or hand over a *collective payment to the group*. An advantage of group payments is that they may involve lower transaction costs for the implementing agency than individual payments (Corbera *et al.*, 2007).

It has been shown that groups vary in how they distribute a group payment internally. Some communities receiving group payments under the Mexican PSAH program invest all payments in public goods, while others divide the payment equally among members, and the remainder have a mixed strategy (Braña *et al.*, 2005, as cited in Munoz-Pina *et al.*, 2008). For village-level payments for wildlife conservation in Sweden, Zabel *et al.* (2013) found that some villages invested the payment in village commons, while others distributed them on the basis of herd size, and the remainder used a mixed distribution rule. In this case, communities distributing payments based on herd size were found to perform best in terms of wildlife conservation (Zabel *et al.*, 2013). This is in line with the general finding by Ostrom (1990) who identifies a proportional distribution of benefits and costs as a design principle of successful commons management institutions (Zabel *et al.*, 2013). This raises the question whether it would be preferable for the agency implementing PES to distribute payments to individuals based on expected differences in provision costs. Yet, doing so may have two disadvantages. First, individual-level differences in costs can be difficult to observe for the implementing agency. Second, experiments on endogenous vs. exogenous rule making suggest that communities may dislike external imposition of an internal distribution rule (Ostrom, 2006; Walker *et al.*, 2000). Systematic research on this issue is lacking. Yet, it appears likely that group payments are preferable if transaction costs are significantly lower for group payments than for individual payments, the group has better information on benefits and costs within the group, group members trust internal distribution mechanisms (i.e., elite capture is not a problem), and the group is averse to external control over payment distribution.

3.6 Avoiding Negative Impacts on the Poor

3.6.1 Facilitating Participation of Poor ES Providers

Several studies have shown that *transaction costs* are the main barriers to participation of poor landholders in PES (Adhikari and Agrawal, 2013;

Pagiola *et al.*, 2005, 2010). Further hurdles may include lack of access to information and credit and lack of trust in government programs. When these issues are relevant, PES design can be adapted to reduce barriers to participation for poor ES providers, for example by keeping transaction costs low (e.g., allowing group applications, lowering requirements on proof of formal title), supporting poor landholders through capacity building, technical assistance, access to inputs and credit, and building trust through transparency and credible intermediary organizations (Adhikari and Agrawal, 2013; Pagiola *et al.*, 2005, 2010).

3.6.2 Reducing Negative Impacts on Other Poor

PES may also impact landless workers and customary resource users (Pagiola *et al.*, 2005). *Employment impacts* depend on the difference in labor demand between current land use practices and those promoted under PES. Such impacts can be problematic when payments are made for activity reduction; for example, maintaining forest cover may require less labor than conversion to agriculture (Pagiola *et al.*, 2005). Employment effects are likely to be less problematic when payments are made for activity creation; for example, silvopastoral practices may increase farm labor use (Pagiola *et al.*, 2004). PES can also impact the *access to and availability of forest products* for poor customary users. Again, negative impacts can be a major issue when payments are made for forest conservation (Phelps *et al.*, 2010). By contrast, agroforestry practices can result in increased availability of fuelwood, fodder and fruits (Pagiola *et al.*, 2004). PES design can sometimes counteract negative effects through work programs for conservation on public lands, employing landless workers as guards, and by complementary programs providing alternative income opportunities for customary users (Pagiola *et al.*, 2005). For example, Asquith *et al.* (2008) describe a case where in-kind PES in the form of beehives also created alternative work and income opportunities for landless households.[19]

[19]Veronesi *et al.* (2015) describe the case of a policy mix in Kenya, where negative impacts of REDD+ on customary charcoalers were addressed by setting up eco-charcoal factories purchasing scrapwood collected on roadsides.

4 Open Questions in PES Design

While many lessons for PES design are emerging from studies conducted over the past decade, some important aspects are still underresearched.

First, the majority of the studies on the behavioral economics of PES focus very broadly on the comparison of no payment to payment (Sommerville *et al.*, 2009; Travers *et al.*, 2011; Reichhuber *et al.*, 2009; Van Hecken and Bastiaensen, 2010; Garcia Amado *et al.*, 2011, 2013; Greiner and Gregg, 2011; Fisher, 2012, all as cited in Rode *et al.*, 2015). The resulting evidence is mixed: some found crowding out and others found crowding in (enhancement) of intrinsic motivations when payments are made. A more detailed analysis of specific PES design features is needed to understand which features can avoid crowding out effects or even promote crowding in. The answer is likely to be dependent on initial prevalence of social or environmental preferences. The literature in behavioral economics and social psychology points to many different mechanisms through which economic incentives can affect intrinsic motivations (Bowles and Polonía-Reyes, 2012). As Rode *et al.* (2015, p. 279) put it: "Understanding the psychological mechanisms that can be expected in a particular context and for a specific population may make it easier to design incentives in a way that prevents crowding out and fosters crowding in." For example, Stern (2006) suggests that it is important to frame PES programs as emphasizing achievement and autonomy rather than control. Such considerations could be highly important for how PES is perceived and how it will impact behavior. Rigorous experimental studies are needed to test such hypotheses.

The behavioral economics considerations in PES design will be particularly important when payments are made to groups or are conditional upon group performance, because social preferences are important determinants of cooperation in groups (Fehr and Falk, 2002; Rustagi *et al.*, 2010). We know now that many people behave as conditional cooperators (Fischbacher *et al.*, 2001), implying that their behavior depends on what they believe others in the group will do. PES design aspects, such as how PES is framed and monitored and how participatory its development is, may affect such beliefs as well as intrinsic motivations (Narloch *et al.*, 2012). Again, there is a need for well-designed experimental studies to test these hypotheses.

Another important behavioral economic issue in PES design is the potential link between social equity and environmental effectiveness. As Pascual *et al.* (2014) point out, it is possible that social equity impacts are not only important *per se* as side objectives of PES, but that they also affect environmental effectiveness. For example, perceptions regarding legitimacy or fairness of a PES scheme could affect compliance (Pascual *et al.*, 2014). This would have important implications not only for payment design, but also for procedural aspects in PES design, such as the role of participation, accountability and legitimacy, issues that were beyond the scope of this paper. Here again, further research is needed to provide rigorous evidence on what appear to be potentially important issues.

A second issue for further research is the estimation of transaction costs of more complex PES design in different contexts (Muradian *et al.*, 2010). Ultimately, transaction costs (both on the side of the implementing agency and on the side of ES providers) need to be weighed against cost savings from more sophisticated designs.

Third, practitioners are often confronted with complex starting conditions where the preconditions of PES are not fully satisfied. For example, property rights over land may be well-defined so that payments can be made to landowners, but customary use by non-owners may be the main source of environmental degradation. In such settings, hybrid approaches combining PES with more conventional integrated conservation and development program approaches could be suitable for addressing the problem. For example, Veronesi *et al.* (2015) propose to combine REDD+ payments to landowners with conditional payments for ecocharcoaling material as an alternative income and fuel source for customary users. Cranford (2014) proposes conditional microcredit as a hybrid and cost-effective approach to promote the adoption of agroforestry. More research is needed to understand the potential and performance of such approaches.

5 Concluding Remarks

PES is not a panacea or a magic bullet. Its appropriateness in a given context needs to be carefully evaluated. Yet, there are many cases where PES appears to be a promising approach. Recent evidence on the lack of environmental effectiveness of PES schemes is starting to cause some disillusionment with the instrument (Ferraro, 2011). This paper argues that we should not throw the baby out with the bathwater yet. Rather, it is time to incorporate lessons into PES design that have emerged over the past decade. PES design is a complex task. The objective of this paper was to provide some guidance in dealing with this complexity. Clearly, PES design has to start from a careful understanding of the specific ecological and socio-economic contexts. We already understand a lot about which design features are likely to be best suited to which context. It is time to put these insights into practice. Ideally, this would be accompanied by rigorous impact evaluation studies to demonstrate that well-designed PES can indeed deliver on environmental effectiveness.

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