The London School of Economics
and Political Science

Positive Incentives for Ecosystem Services

Matthew Cranford

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Declaration

I certify that the thesis I have presented for examination for the M.Phil/Ph.D. degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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Abstract

Use of payments for ecosystem services (PES) has grown around the world in recent years. Although there has been extensive discussion of how best to define PES and what is PES or 'PES-like', at the core of all definitions and all PES programmes is the delivery of a positive incentive to induce socially preferred environmental behaviour. Despite this, research on PES design has to date focused more on broader policy design than on incentive choice and design. In the developing world, PES are broadly perceived as a useful tool for environmental policy, but it is here that a continuing proliferation of programmes is occurring in many varied contexts. That has motivated a variety of approaches to be taken to PES, and prompted revisionists to call PES 'incentives', 'rewards', 'compensation', or something else besides 'payments'.

There are two primary academic objectives of this Ph.D. The first is to conceptualise PES as a broad category of positive incentives and explore the variation within that category. That is done through a) a conceptual review of PES; b) a review of empirical research on incentive design for PES; and c) an empirical study creating a typology of PES.

The literature review also highlights a few key considerations for incentive design relevant to developing country contexts that have not yet been adequately addressed. The second objective of the Ph.D. is to contribute, albeit in a small way, to addressing those key considerations through three empirical studies.

The contribution of this work to academic knowledge is twofold: 1) Through literature reviews and empirical methods, this paper offers an overarching synthesis of conceptualising and researching PES as incentives, and 2) it explores a few specific, novel ideas in incentive design to help adapt PES to the contexts in which it is applied.

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CHAPTER 1

Overview

1.1. Background

In 2002, Landell-Mills & Porras (2002) reviewed 287 market mechanisms for forest environmental services in developed and developing countries. It was the first attempt to catalogue such mechanisms on that scale, and remains one of the most cited documents on the topic.[1] As such, it provides a benchmark against which to identify how the discourse and experience with such mechanisms has evolved. In the past decade, three key aspects at the foundation of that study have changed.

First, there has been a move away from discussing market mechanisms as a broad category of environmental policy instruments and towards discussing payments for ecosystem/environmental services (PES). Programmes that use PES were originally defined as a market or market-based mechanism, but have more recently been defined as a broad category of policies that include markets for ecosystem services (MES) (e.g., Sommerville et al. 2009), or in other words, that PES programmes can be market-based or non-market-based (Farley & Costanza 2010).

The shift is evident in the fact that while market mechanisms are often conceptualised as important to internalise environmental externalities that arise from traditional market failures, Farley & Costanza (2010) call it paradoxical that market mechanisms based in more traditional economic thinking are proposed to fix market failures. They instead suggest that a PES programme can only address the key market failures that lead to an undersupply of ecosystem services (ES) "to the extent that it differs from conventional markets, not to the extent that it mimics them" (pg. 2064). That appears to manifest in implementation of PES. For example, prominent examples of PES originally intended to follow the idea of a market mechanism do not (at least yet) look much like a market mechanism (McAfee & Shapiro 2010; McElwee 2012; Fletcher & Breitling 2012).

[1] 842 citations in Google Scholar as of 29 December 2013, compared to a maximum of 939 for papers defining or conceptualising PES (Wunder 2005) and a second place of 758 (Engel et al. 2008).

That shift in perception of market mechanisms and PES has occurred as part of a broader evolving conceptualisation of what PES actually are. That is the second aspect that has changed. Still the most cited definition of PES, Wunder (2005) defines them as:

1. A ***voluntary*** transaction; where
2. A ***well-defined*** ES (or a land-use likely to secure that service); is being
3. 'Bought' by a (minimum one) ES ***buyer***; from
4. A (minimum one) ES ***provider***;
5. If and only if the ES provider secures ES provision (***conditionality***).

From about 2009, numerous studies have offered different definitions. Some claim to be refinements of Wunder's definition (e.g. Sommerville et al. 2009; Swallow et al. 2009), while others are more critical of that definition (e.g., Muradian et al. 2010; van Noordwijk & Leimona 2010), and some try to provide a synthesis of the different definitions and approaches (Tacconi 2012).

The evolving definition has itself also occurred within a larger change. The third aspect that has shifted is that experience with PES around the world has notably increased in the past decade, with an important increase in developing countries. For example, Landell-Mills & Porras (2002) identified 4 mechanisms that they classified as biodiversity credit/offset programmes, 75 as forest carbon offset programmes, and 41 as proposed and ongoing payments for watershed services (PWS). In 2010, Madsen et al. (2010) identified 39 active biodiversity credit/offset programmes and 25 in development. Similarly, Peters-Stanley et al. (2013) indentified 162 active forest carbon programmes in 2012.Finally, Bennett et al. (2013) identified 205 active incentive-based watershed programmes in 2011, and 76 in development. At least 120 of those active and 38 in development are PWS (see Chapter 4), and depending on one's definition of PES, it could be more.

The shift in thinking leads to questions of what PES actually are and based on that, how they should be designed if not as a 'market' mechanism. As elaborated further in Chapters 2 and 3, there is one important consistency across all definitions of PES and that has remained at the centre of PES discourse: incentives are at the core of all PES programmes. In fact, the discourse has evolved to not define PES as a mechanism, but as a class of incentives (Muradian et al. 2010; Tacconi 2012; Sommerville et al. 2009). They are a class of incentives that link conservation and land-use outcomes to market-

based mechanisms (Fisher et al. 2010) or to non-market-based programmes and policies.

As PES are defined as incentives, there should be a greater focus on incentive choice and design in relation to PES. As elaborated further in Chapter 4, previous characterisations of PES have often focused on institutional aspects and relation to markets (Swallow et al. 2009; Smith et al. 2006; Scherr et al. 2006), or the broader paradigm framing a PES transaction (Muradian et al. 2010; van Noordwijk & Leimona 2010). Although these are both helpful approaches to understanding policy design, much less attention has been paid to the incentives that are broadly agreed to be at the heart of such policies. A literature relevant for incentive design of PES exists, but there is only a small, emerging literature specifically focused on the topic.

In addition, the discourse on PES has always been largely defined by experience in developing countries. That includes the shift in this discourse. For example, many of the refinements and critiques of the original definition of PES have been motivated, at least in part, by the variety of PES programmes observed in developing countries, many of which do not fit the original definition (Muradian et al. 2010; van Noordwijk & Leimona 2010; Sommerville et al. 2009). That poses many areas of research that need to be addressed. In particular, with such a variety and prevalence of PES in developing countries, the question arises of how best to design such incentives in a developing country context. Some insight can come from more thorough analysis of what currently exists, which is becoming possible as PES become better researched and reported, and more information is available. Some insight might also come from other places. Lessons on incentive design, particularly in a developing country context, can be drawn from related areas of economics. As Fisher et al. (2010, pg. 1260) state, "care must be taken to make sure that the lessons we learn while heading down the PES path were not already learned in other contexts, with other literatures, and other buzzwords." As such, this Ph.D. draws from multiple economic sub-disciplines, particularly environmental/ ecological economics and development economics.

The research presented in the following chapters contributes to the small, emerging literature focussed specifically on incentive design for PES. The remainder of this introduction clarifies choices of terminology used throughout this Ph.D. and gives additional explanation for the focus on developing countries. Following the

introduction, the second section elaborates three key research questions. The third section then clearly outlines each chapter of this Ph.D., their specific aims, and which research questions they address.

1.1.1. Terminology

In relation to terminology, the PES literature is diverse in a number of ways, including working definitions of PES; context of specific case studies; and intellectual or ideological views of the researcher. As such, the terminology used in this Ph.D. tries to be broad and inclusive, but also as precise and easy to use as possible. The choice of terminology is not intended to support any particular viewpoint.

First, the focus of this Ph.D. is on the positive incentives (i.e. 'payments') provided to the ES provider, with an agnostic stance to the various mechanisms through which that incentive can be channelled. The definitions and conceptualisations of these programmes and policies continue to undergo dynamic debate. There are many similarities between them, however, and so they are addressed collectively here. The term PES is used to describe the general class of positive incentives used to induce a socially preferred behaviour, with the aim of increasing the supply of ES, irrespective of whether the programme through which that incentive is provided is called AES, PES, a market for ES, or something else.

Second, the recipients of the incentive are in many cases owners of farms of forests, but in some cases are also users of common pool resources. As such, they will at times be referred to as 'resource users', a term that encompasses all owners or users of land, water, timber, fish, etc. More often, and in the context of PES specifically, they are referred to as the 'providers' of ES. In terms of contract and incentive research, they would be considered the agent, while the ES buyers would be considered the principal.

Third, the term 'ecosystem services' is used because it indicates changes in land use and natural capital. All of the literature reviewed and analysis conducted is based on incentives that are intended to induce a greater provision of the benefits that people receive from nature, which is how ES are often defined (Millennium Ecosystem Assessment 2005). Swallow et al. (2009) describe the difference between environmental services and ecosystem services is that the former does not include provisioning services, such as water and food. The literature cited here and in the following chapters

does not focus on ecosystem goods that arise through provisioning services (e.g. timber), but some do focus on the provision of water.

Additionally, the use of the term 'ecosystem services' is not intended to imply that the studies focussed on programmes that provided incentives based on a strict measure of ecosystem service output. A few did, but the vast majority of studies look at incentives used to induce a change in actions by resource users, which in turn is believed to provide increased levels of ecosystem services.

Finally, in some parts of the world, 'environmental services' can refer to services provided using grey infrastructure. That is a particular risk for the water sector. The research presented here, however, is all focused on land- or ecosystem-based behaviours and so the term 'ecosystem services' helps to reinforce that.

1.1.2. Focus on developing countries

Payments for ecosystem services are used across the world, but this Ph.D. will focus on the design of PES in developing countries, specifically low- or middle-income countries as classified by the World Bank.[2] Although developed countries have a longer and deeper history with PES, the difference is slight. Further, evidence suggests that the majority of active programmes now occur in developing countries. Of the 205 incentive-based watershed programmes identified by Bennett et al. (2013), 113 (55%) of the active programmes and 53 (72%) of the programmes under development are located in low- and middle-income countries.[3] The data from Bennett et al. (2013) was filtered for relevance to this Ph.D., and 120 programmes[4] more strictly defined as those that use PES—payments for watershed services (PWS) programmes—were analysed in Chapter 3. The picture is similar for this reduced sample. An approximately equal

[2] See World Bank country classifications at http://data.worldbank.org/about/country-classifications/country-and-lending-groups.

[3] Based on GNI/capita in 2011. That is the latest year for which World Bank data is available for all countries represented in this database, and is the focus year of Bennett et al. (2013)

[4] The estimate is also very conservative in relation to China's Forest Ecological Compensation Funds (FECFs). One large national programme exists, complemented by multiple provincial efforts. Here they have conservatively been considered a single programme implemented in multiple provinces. They could arguably be considered all individual programmes. In that case 10s more programmes would be added to the developing country total and, due to China, they would noticeably outnumber those in developed countries.

number of PWS programmes were identified in developed and developing countries around 2012. Of the PWS programmes under development in that database, many more occur in developing countries, indicating that that the number of PES programmes for watershed services either currently, or will very soon, outnumber those in developed countries (*Figure 1*).

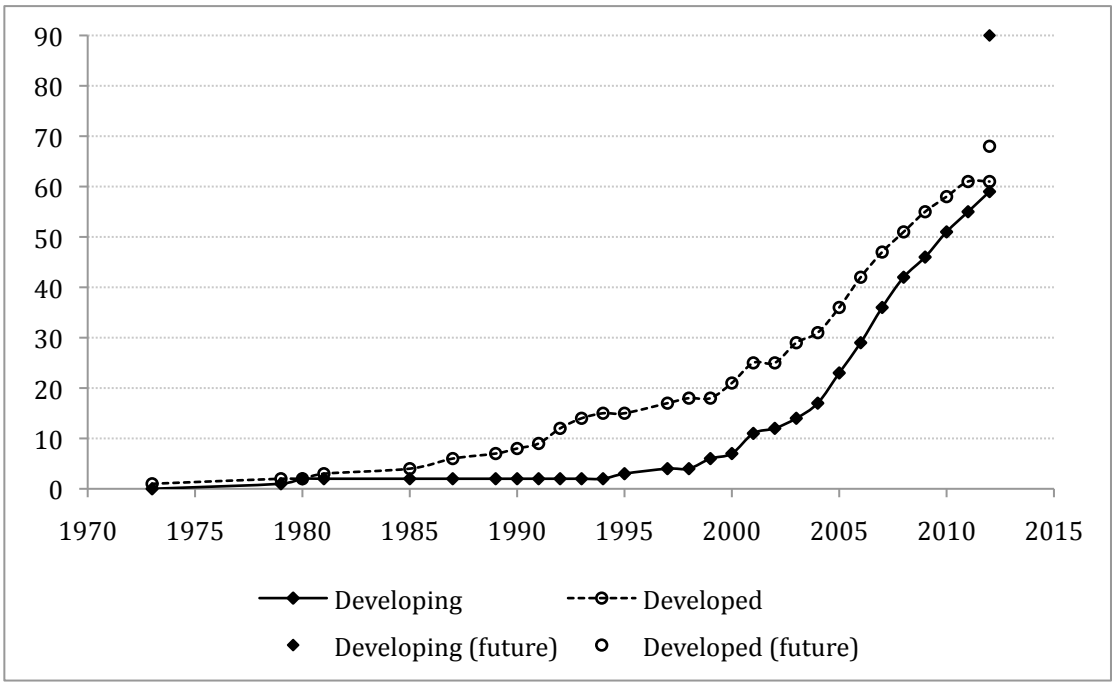

Figure 1. Cumulative number of programmes that use PES to protect watershed services, in developed and developing countries, based on year programme was established. The future estimate is based on the programmes identified as in development around 2012, and from that group only include the ones far enough developed to identify that they plan to use PES. Source: Bennett et al. 2013.

In addition to PWS programmes, many more programmes use PES to incentivise biodiversity conservation, environmentally friendly agricultural practices, and provision of land-based carbon services throughout the developing world. The use of PES in developing countries is likely to continue to increase, driven by various international agenda and dynamics related to environment and development. These include efforts by parties to the UN Convention on Biological Diversity, REDD+ under the UN Framework Convention on Climate Change, related concepts and initiatives such as green growth, and general increased demand from citizens for a healthy environment as countries become wealthier.

In addition to the prevalent use of PES in developing countries, the discourse on PES has been largely shaped by experience in developing countries. Arguably the most cited and researched PES programme is that of Costa Rica (Porras et al. 2013), originally developed through a World Bank project. The earliest conceptualisations and definitions

were based on experience from World Bank projects (Pagiola & Platais 2002) along with experience from the Center for International Forestry Research (Wunder 2005). Later re-definitions and re-conceptualisations of PES, critiquing the originally proposed defining characteristics of PES, were also based on experience in developing countries: what could be considered the basis of the ecological economics approach to PES was explicitly grounded in experience in developing countries (Muradian et al. 2010); experiences in Latin America have led to an approach framing the incentive exchange as a reciprocal exchange (Asquith 2011; Rare 2010); and experience in Asia inspired a paradigm-based categorisation of PES (van Noordwijk & Leimona 2010). Specific projects have even claimed their own unique approach to PES in developing countries, often with a focus on equity in the provision of PES, including WWF's Equitable Payments for Ecosystem Services (e.g. Kwayu et al. 2013) and the World Agroforestry Centre's Rewarding Upland Poor for Environmental Services (e.g. Leimona et al. 2009) projects.

In short, not only are PES more and increasingly numerous in developing countries, but it is also PES experience in developing countries that has inspired so many variations on how PES are defined. A focus on PES in developing countries is not only more relevant for these reasons, but the variety of PES makes for more interesting and fruitful research on the choice and design of incentives.

1.2. Research Questions and Novelty

In light of that background and focus, the overarching objective of the research presented here is to contribute to the growing body of knowledge on designing PES. Although many researchers and practitioners are interested in different facets of designing PES programmes, this Ph.D. is novel in its focus on PES as incentives. Significant research and literature is devoted to the design of policies and instruments, through which PES are provided, but that on incentive design for PES is much smaller.

After this overview, the following five chapters each make a contribution to this literature that, taken together, help to advance knowledge on the design of PES generally. Three broad research questions are elaborated below through an introduction to the chapters that address them. Although three questions are presented, the Ph.D. gives slightly more focus to the third. These questions are:

1. What is the state of knowledge on PES as incentives?
2. What types of incentives are used as PES?
3. How can PES be designed to overcome some of the issues related to incentives highlighted in the literature?

1.2.1. PES as incentives

What is the state of knowledge on PES as incentives?

Chapter 2 reviews the definitions and conceptualisations of PES. It finds that the definition of PES has evolved away from a focus on institutions and mechanism design. Instead, all definitions converge on PES as a class of incentives provided through different types of policies and mechanisms that align with varying types of framing and paradigms (e.g., Wunder 2005; Engel et al. 2008; Muradian et al. 2010; Tacconi 2012). Sommerville et al. (2009) aptly describe 'PES' as an umbrella term, recognising the variety of PES observed in implementation. The chapter goes on to describe a conceptualisation of PES as a class of incentives that can link to a variety of actors and policy instruments and institutions. The conceptualisation is closest to that presented by Sommerville et al. (2009).

Chapter 3 then illustrates that, although there is convergence on PES as incentives, researchers are only just beginning to specifically focus on understanding how best to design such incentives. There is a large body of literature on land-use technology adoption or participation in incentive-based programmes, but it generally treats any incentive for a change in behaviour as a generic, homogenous incentive. A smaller literature has emerged that analyses incentive choice and design in a PES context. The core of this literature is nearly 20 studies that use discrete choice analysis (DCA) to explore the preferences of potential ES provider for different incentive attributes. Additionally, across the PES literature some specific issues related to incentive design have emerged that are particularly relevant to PES in developing countries, but with limited empirical evidence of their effect on optimal choice and design of PES.

Both chapters are novel in their approach. Little conceptual or review research has taken the approach of focusing on PES as incentives, rather than as a policy instrument or other institutional arrangement for resource management. These two chapters establish

the concept and knowledge base of PES as a class of incentives linking land-use decisions with a broader institutional framework.

1.2.2. Types and attributes of PES

What types of incentives are used as PES?

Previous categorisations and typologies of PES programmes focussed on the institutional aspects of policies or their relation to markets (e.g. Scherr et al. 2006; Swallow et al. 2009; Smith et al. 2006), or on the framing or paradigm of the arrangement through which PES are provided (e.g. van Noordwijk & Leimona 2010). No effort has yet been made to characterise the types of incentives that comprise the class of incentives called PES.

Chapter 4 does this using data on PES in the context of watershed conservation. Using latent class analysis (LCA), a typology of payments for watershed services (PWS) is defined based on incentive attributes identified in Chapter 3 (literature review) as potentially affecting ES providers' willingness to accept PES.

The chapter is novel as no other study has yet characterized types of PES as incentives, and no study, irrespective of conceptual approach, has yet used a model-based method for developing a typology. All previous efforts have been qualitative and somewhat opaque in how defining variables where chosen and/or applied. Further, through this approach, observations can be made on the contexts in which different types of PES are used. In particular, the chapter explores how the prevalence of different types of PES changes with a country's development.

In addition to providing input to Chapter 4, Chapter 3 also helps answer this research question directly. Types of PES are defined by the attributes that comprise them. Understanding both the types of PES and all actual or potential incentive attributes, provides a common language, and more importantly, a critical knowledge base to inform PES design and research.

1.2.3. PES design elements

How can PES be designed to overcome some of the issues related to incentives highlighted in the literature?

As noted above, Chapter 3 includes two parts: a systematic review of studies that use DCA to assess ES providers' preferences for incentive attributes, and a review of three broad issues related to incentive design that have emerged from the PES literature. These three issues are the existence of market constraints, information asymmetries, and behavioural (i.e. 'non-rational') considerations. Chapters 5 and 6 are two case studies that follow the emerging practice in the literature of using DCA to study incentive attributes, but study specific incentive types and attributes in relation to overcoming the three identified issues.

Chapter 5 studies preferences for a novel incentive called credit-based PES. The study highlights interesting conclusions related to this form of PES. It also addresses the issue of indirect incentives, a possible solution to overcoming market constraints, and how such incentives are perceived, which relates to behavioural considerations.

Chapter 6 studies a long-standing question of whether to use cash or in-kind incentives and provides insight into specific reasons both ES provider and buyer may prefer in-kind incentives. These reasons relate to market constraints, information asymmetries and behavioural considerations. In addition, Chapter 6 also researches the novel PES attribute of group liability, an innovation borrowed from microfinance economics, to address the issue of information asymmetries.

Together, these two chapters draw not only from environmental/ecological economics, but also learn from development and behavioural economics to explore a number of novel or important attributes of PES. They also advance knowledge of PES design in respect to the three highlighted issues. Other studies on PES that use similar methods as in Chapters 5 and 6 tend to focus on preferences for the incentive attributes and do not go much further. The case studies here are designed to ensure that understanding of preferences in these cases will be helpful, albeit in a small way, to informing incentive design for PES more broadly.

1.3. Methodological Approach

1.3.1. Literature review

Two primary analytical methods are used for the research comprising the following chapters. The first is literature review, which is used as the primary method in Chapters

2 and 3, and as a component of Chapters 4-6. In Chapters 2 and 3, extensive review of many aspects of literature related to PES was carried out, with a portion of that review carried out systematically. The focus of Chapter 2 was to review papers that defined or conceptualised PES. Previous academic and grey literature papers that do so and are also prevalently cited were compared across various themes, with the most interesting and relevant highlighted in that chapter. In Chapter 3, two types of review are carried out. The first is a systematic review of papers that use similar methods to study potential ES providers' preferences for incentive attributes of PES. Following similar reviews of related topics, a vote-count methodology was carried out to compare across the studies (Delacote et al. 2012; Knowler & Bradshaw 2007; Prokopy et al. 2008). The second part of the chapter is less systematic and more discussion-based. Drawing from PES literature as well as other economic sub-disciplines, key issues related to incentive design for PES that are not yet resolved are discussed.

1.3.2. Discrete choices

The consumer choice can be divided into a discrete choice about what to consume and a continuous choice about how much to consume (Hanemann 1984). Discrete choice analysis (DCA) isolates the first part to determine what goods a consumer demands (Hoyos 2010). A fundamental component of DCA is to follow Lancastrian theory of consumer demand that the goods can be considered a bundle of attributes (Lancaster 1966).

The approach was originally developed to predict market demand by consumers, and early applications were made in the fields of transportation, energy, housing and marketing (Train 2009), but its use to assess design of environmental policies is increasing. It became popular among environmental economists as a tool for understanding individuals' preferences for environmental attributes through stated preference (SP) studies (Hoyos 2010), and has been used to evaluate preferences for forests (Brey et al. 2007), wetlands (Carlsson et al. 2003), beaches (Beharry-Borg & Scarpa 2010), landscape beauty (Dachary-Bernard & Rambonilaza 2012), fish (Agimass & Mekonnen 2011), and cultural heritage (Choi et al. 2010), amongst many other environs and ES.

Whatever the context, most applications of DCA are to understand preferences related to demand for ES, but DCA can also be used to understand preferences related to the

supply of ES. It has begun to be used to *ex-ante* assess land or resource users' preferences for the attributes of incentive and incentive-based policies, such as agri-environmental schemes in Europe (Christensen et al. 2011; Espinosa-Goded et al. 2010; Ruto & Garrod 2009), reforestation incentives in China (Grosjean & Kontoleon 2009; Qin et al. 2011), and marine PES in Tanzania (Barr & Mourato 2012). Studies that follow a discrete choice approach to studying PES are the ones systematically reviewed in Chapter 3, and these set a precedent for the methods used in the case studies in Chapters 5 and 6.

Both Chapters 5 and 6 study local ES providers' stated preferences for incentive choice and design using a discrete choice experiment (CE). The CEs are designed and implemented using good and common practice for environmental economics (Hoyos 2010) and analysed using advanced simulation-based methods (Train 2009). Detailed description of the experimental design and specification of econometric models for analysis are provided in each chapter.

Another method used for Chapter 4 is latent class analysis (LCA) combined with a multinomial logistic (MNL) regression model. Although the approach to Chapter 4 is founded more in cluster analysis, LCA and MNL both form an integral part of the DCA toolbox. Additionally, as with the CEs in Chapters 5 and 6, the approach taken in Chapter 4 views PES as a bundle of incentive attributes, and categorises types of PES based on different combinations of attributes. As such, although it is not specifically DCA that is used in Chapter 4, the methods can be considered an extension of the DCA approach. As with Chapters 5 and 6, a detailed description is provided in Chapter 4.

Finally, the data used is mostly primary, but some secondary data. Chapter 4 uses data obtained from a different study that used a combination of primary and secondary data. It was founded on a survey of PES programme managers, but additional coding was required, much of which is based on publicly available information. Chapters 5 and 6 use solely primary data collected specifically for those two case studies.

1.4. Outline of Ph.D.

To achieve the overarching objective of advancing knowledge on the design of PES, this Ph.D. works to address the research questions put forward above. It does so through

five analytical chapters, plus a final chapter that summarises and draws conclusions. To summarise this first overview chapter, an outline of all chapters is presented.

1.4.1. Overview (Chapter 1)

The aim of the current chapter is to provide an introduction and overview of the entire Ph.D. It does not include any true academic discussion or research, but explains the overarching objective of the Ph.D., broad research questions to be addressed, and clear outline and aims of each of the following chapters.

1.4.2. Conceptual basis (Chapter 2)

The primary aim of Chapter 2 is to present the definition and conceptualization of PES that is used throughout the Ph.D. It does this by reviewing the literature that defines and conceptualises PES, and finding what they all have in common and how, in other ways, the thinking on PES has evolved. It contributes most to Research Question 1.

1.4.3. Literature review (Chapter 3)

Chapter 3 presents a more traditional review of empirical literature. It does this in two parts. The first part focuses on specific attributes of PES incentives and is based around a systematic review of 19 identified studies that use DCA to analyse multiple attributes of PES in a single case study. The first half heavily informs Chapter 4, and both halves contribute to Research Questions 1 and 2. The second part of the literature review then identifies and discusses three key issues emerging in the PES literature for which little empirical research has been carried out. It informs the case studies in Chapters 5 and 6, and the most heavily weighted Research Question 3.

1.4.4. Categorising PES (Chapter 4)

The aim of Chapter 4 is to explore the types of incentives that could be considered PES, and increase the understanding of the contexts in which different types are used, particularly in relation to the level of development within a country. Payments for watershed services (PWS) are seemingly the most prevalent form of PES (Bennett et al. 2013; Madsen et al. 2011; Madsen et al. 2010; Peters-Stanley et al. 2013), and can most easily fit the original model of downstream ES beneficiaries paying upstream ES providers of ES. The typology is thus based on PWS specifically. Latent-class analysis is simultaneously estimated with a MNL model and both are interpreted in light of additional descriptive statistics. The results 1) define a typology of PWS based on

important attributes identified in the first part of the Literature Review (Chapter 3), and 2) illuminate the contexts in which different types of PWS are used currently around the world.

1.4.5. Case study (Chapter 5)

Chapter 5 presents a case study of a developing PES programme in Ecuador. The study had two aims: 1) to explore the dynamics of a novel type of PES, credit-based PES (CB-PES), and 2) to analyse how what many would consider an indirect incentive can help overcome market constraints and align with lessons from cognitive studies on improving incentive design. Both are issues highlighted in the second part of the Literature Review (Chapter 3). To achieve these aims, a CE was carried out with households in the Intag River Region of the Northern Ecuadorian highlands. It was analysed using a mixed logit (MXL) model, the new standard in DCA.

1.4.6. Case study (Chapter 6)

Chapter 6 presents a case study of a developing PES programme in Colombia. The study had two aims, both of which relate directly to issues highlighted in the second part of the Literature Review (Chapter 3). First, it aimed to better understand the reasons for preferring cash or non-cash incentives. Second, it aimed to understand potential ES providers' perceptions of group liability in PES contracts. To achieve these aims, a CE was carried out with households living around the Chingaza National Park near Bogota, Colombia. Again, a MXL model was used to analyse the results.

1.4.7. Conclusions (Chapter 7)

The final chapter aims to synthesise the most interesting results across the analytical chapters (2-6) and draw conclusions. It discusses those results and conclusions in relation to the three key research questions outlined in Chapter 1 (above), and briefly notes areas for future research.

CHAPTER 2

CONCEPTUAL BASIS

Payments for Ecosystem Services as Incentives

2.1. Introduction

As payments for ecosystem services (PES) have proliferated globally, in particular to induce the provision of regulating and cultural ecosystem services (ES), various definitions and conceptualisations of PES have emerged. The dominant earlier conceptualisation of PES programmes was that they are market-based mechanisms (Pagiola & Platais 2002) that could be conceptualised as a Coaseian transaction (Engel et al. 2008). PES programmes have most often been described as market-based or market-like mechanisms ever since (Farley & Costanza 2010; Fletcher & Breitling 2012).

Defining PES as a market-based mechanism, however, does not accurately reflect the various types of PES programmes that have been implemented (Muradian et al. 2010; Tacconi 2012). The definitions and conceptualisations of PES over the past decade have all presented slightly different ideas of how PES relate to markets. In particular, later conceptualisations clarify that not all PES are market-based, define market-based PES as a subset of all PES (Muradian et al. 2010), and posit that market-based PES are only appropriate in certain contexts to provide certain ES (Farley & Costanza 2010; Kemkes et al. 2010).

In addition to debate about whether or not being market-based is a defining characteristic of PES, the defining quality of other characteristics has been questioned due to variation observed across PES programmes. Those characteristics include, among others, how important economic incentives are to PES programmes (Muradian et al. 2010), how strict conditionality is (Farley & Costanza 2010; van Noordwijk & Leimona 2010), and the voluntary basis of PES (Vatn 2010). Different opinions on the connection of PES with markets and these other characteristics have led some to outline two broad approaches to PES: the environmental economics approach and the ecological economics approach (Farley & Costanza 2010; Tacconi 2012).

Yet, there are significant overlaps between these approaches (Tacconi 2012). The most basic and consistent overlap has so far failed to be widely acknowledged, or at least has been lost in a more ideological discourse. Fundamentally, all of the most prolific papers defining and conceptualizing PES agree that incentives are the core of all PES programmes (see Section 2.3). Losing this focus on incentives is detrimental to ensuring that PES are optimally designed and implemented, however and wherever in the world they are used.

Only a few papers have explicitly explored PES programmes as incentive-based mechanisms. Notably, Jack et al. (2008) were the first to describe PES programmes as 'incentive-based mechanisms' in the academic literature, but used the term 'incentive-based mechanism' synonymously with 'market-based instrument' (MBI). As implied above, the current PES discourse would argue that market-based instruments should be considered a different, but perhaps overlapping, concept to incentive-based mechanisms (Muradian et al. 2010; Farley & Costanza 2010).

This chapter attempts to define and conceptualise PES as incentives and PES programmes as incentive-based mechanisms, recognising the many varied contexts in which PES are used. That chapter provides the conceptual basis for the rest of this Ph.D. Following this introduction, Section 2.2. presents three key trends in PES conceptualisations. Aligning with those trends, Section 2.3. presents the definition and conceptualisation of PES as a broad class of positive incentives. Section 2.4. summarises.

2.2. Refocusing on PES as Incentives

From reviewing the literature that defines, conceptualises, and/or categorises PES, three key concepts emerge that support a conceptualisation of PES as incentives. The direction of discourse on PES has recognised that 1) PES programmes are a broad heterogeneous class of interventions, that 2) is only partly comprised of MBIs, but 3) there is little recognition that across all definitions, conceptualisations, and categorisations, there is agreement that incentives are the core of all PES programmes.

2.2.1. PES are heterogeneous

In a review of MBIs for biodiversity (BD) and ecosystem services (ES), Broughton & Pirard (2011, pg. 1) claim, "MBIs for [BD and ES] constitute an extremely heterogeneous group that makes little sense from an economic theory perspective as it mixes apples and oranges." They continue, emotively noting that, "MBIs as a category look more like an asylum country for all tools with a price component."

The situation is analogous for PES. Pirard (2012, pg. 61) describes that PES "may be understood as a principle—paying for the provision of a service—or as a specific type of instrument." It is in attempting to define PES as a particular type of instrument that the PES discourse has mixed apples and oranges. In their review of PES literature, (Schomers & Matzdorf *in press*, pg. e1) write, "PES remains a multi-facetted term with many diverse definitions coexisting". That is manifest, for example, in the persistent discussion of PES versus PES-like mechanisms (Wunder 2005; Muradian et al. 2010).

The cause of so many diverse definitions appears to be that many types of interventions follow PES in principle as described by Pirard (2012), but are heterogeneous in aspects of implementation. The discourse on PES has evolved to recognise that PES are a heterogeneous class of interventions. Wunder's (2005) original definition of PES is still the most cited, but as described by the author himself, it was narrow and intended to be a theoretical ideal used to help understand PES. Authors involved in the early conceptualisation of PES recognised that the theoretical ideal of PES was adjusted in practice to meet the "messiness of the real world" (Engel et al. 2008; pg. 672). Other academics, building in large part on experience in developing countries, went a step further and specifically sought to expand and revise the conceptualisation of PES to match theory with on-the-ground practice and the variety of programmes called PES (Muradian et al. 2010).

Evidence of the diversity of PES comes from the many different attempts to characterise or categorise PES. Wunder (2005) offers three binary characteristics by which to understand the variety of PES: area- or product-based, public or private, and use restricting or asset-building programmes. In their revised conceptualisation of PES, Muradian et al. (2010) offers a three-dimensional spectrum of PES based on directness of transfer, importance of the economic incentive, and level of commoditisation.

Other authors provide specific categories. Engel et al. (2008) adapts Wunder's (2005) characterisation of public and private programmes, to introduce a now prevalently cited divide of user-financed and government-financed PES. The former generally aligns with what Schomers & Matzdorf (*in press*) categorise as programmes that follow the Coaseian conceptualisation of PES and the latter with those that follow the Pigouvian conceptualisation. Other types of PES also exist, which Schomers & Matzdorf (*in press*) place in a third category of PES that align with conceptualisations beyond Coase and Pigou. Various other categorisations and characterisations of the heterogeneous universe of PES have also been offered as discussed more in Chapter 4 (e.g., Swallow et al. 2009; van Noordwijk & Leimona 2010; Lockie 2013).

2.2.2. Non-market PES are most prevalent

As noted above, PES have most often been described as market-based or market-like mechanisms (Farley & Costanza 2010; Fletcher & Breitling 2012), but it is unclear why this is the case. *Table 1* presents how different conceptualisations of PES have defined the relationship of PES to markets. Pagiola & Platais (2002) indirectly describe PES as markets in multiple ways (e.g., there is a need to establish market infrastructure, pg. 4), yet that concept quickly evolved. Wunder & Vargas (2006, pg. 29) state, "Instead of true markets, what we mostly find in the real world—both in developed but especially in developing countries—are bilateral, mutually-negotiated agreements between ecosystem service users and providers." Wunder (2005) describes that the term markets for ES (MES) implies the use of economic incentives, as well as "multiple actors, choices, and competition to some degree" (pg. 5), implying they are related to PES, but not equivalent to them.

One resulting interpretation is that MES are a subset or type of PES. Scherr et al. (2006, pg. 5) describe their use of 'PES':

> *"as an umbrella term to include both programmes that rely on one-off deals with rural landowners who agree to steward ecosystem services, as well as more complex 'markets' mechanisms involving offset credits traded among many buyers and sellers."*

Sommerville et al. (2009) agree with the dichotomy of market-based versus one-off/project-based, framing it in terms of negotiations, and broadly refer to MES as a subcategory of PES.

What has been described as the ecological economics approach to PES describes market and non-market PES (Muradian et al. 2010; Farley & Costanza 2010), and contests that market payment mechanisms are rarely appropriate based on the fundamental characteristics of ES and the contexts in which PES are implemented (Farley & Costanza 2010). Taking a slightly different approach, others simply state that market PES are rarely observed. Tacconi (2012) explains that PES usually rely on state, community and/or NGO engagement, and prices are negotiated, and do not represent the price that would be reached in a true market. A series of papers diving deeply into PES experiences in a few developing countries find that broadly, even when the original view or conceptualisation of PES in the policy design process was as a market mechanism, in implementation, the programmes do not have much resemblance to a market in Costa Rica (Fletcher & Breitling 2012), Mexico (Shapiro-Garza 2013) and Vietnam (McAfee & Shapiro 2010; Fletcher & Breitling 2012; McElwee 2012).

Table 1: Definitions and conceptualisations of payments for ecosystem services, with Google Scholar citation counts as of 29 December 2013.

Reference (*Citations*)	**Definition**	**Relation to Markets**	**Relation to Incentives**
Pagiola & Platais (2002) (*263*)	Does not define PES directly, but states, "The central principles of PES are that those who provide environmental services should be compensated for doing so and that those who receive the services should pay for their provision." (pg.2)	Implies that PES are a form of market for ES, describing that market infrastructure is necessary (pg.4) and that market participants need information about the ES being exchanged (pg.3).	States that the PES approach is an example of "systems in which land users are paid for the environmental services they generate, thus aligning their incentives with those of society as a whole." (pg.2)
Wunder (2005) (*939*)	"A PES is a voluntary transaction where a well-defined ES (or a land-use likely to secure that service) is being 'bought' by a (minimum one) ES buyer from a (minimum one) ES provider if and only if the ES provider secures ES provision (conditionality)." (pg.3)	States that the term 'markets for ES' implies economic incentives, as well as "multiple actors, choices, and competition to some degree" (pg. 5), implying they are related to PES, but not equivalent to them. Also notes that markets have some desirable and some undesirable qualities depending on the context.	States, "…incentives are at the very core of PES." (pg.7)
Engel et al. (2008) (*758*)	Follows Wunder, 2005	Describes PES as a market-based mechanism used to overcome a market failure, and notes that not all markets for ES are PES.	Explains that PES are mechanisms "to translate external, non-market values of the environment into real financial incentives for local actors to provide such environmental services." (pg.664)
Jack et al. (2008) (*240*)	Follows Wunder, 2005	Describes PES as "incentive-based mechanisms," which the authors say is synonymous with "market-based instruments."	Explains that "PES programmes rely on incentives to induce behavioral change…" (pg. 6465)
Swallow et al. (2009) (*90*)	Define 'Rewards for Environmental Services' (RES) as "inducements provided to ecosystem stewards to give them incentive to enhance or maintain environmental services." (pg.7)	Defines market-based instruments narrowly and akin to a tradable financial instrument: as a certificate or credit of ES provision (pg. 8). Implies that PES/RES are "market-oriented".	Describes that the type of "incentives" provided as rewards are a key variable of different RES (pg.7).

Table 1 (cont.): Definitions and conceptualisations of payments for ecosystem services, with Google Scholar citation counts as of 29 December 2013.

Reference (Citations)	Definition	Relation to Markets	Relation to Incentives
Sommerville et al. (2009) (*62*)	PES are "approaches that aim to transfer positive incentives to environmental service providers that are conditional on the provision of the service, where successful implementation is based on a consideration of additionality and varying institutional contexts" (pg.2)	Separates markets for environmental services and PES. States, "Many markets for environmental services… would not be classified as PES interventions" (pg.6).	Defines PES based on "positive incentives" (pg.2)
Muradian et al. (2010) (*271*)[a]	PES is "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources." (pg.1205)	Rejects PES as "only a market-driven tool", linking it to the literature on common-pool resource management and representing a broader range of situations and institutional arrangements in which PES can be implemented. (pg.1207)	States that "the main goal of PES ought to be the creation of incentives" for the provision of ecosystem services that are public goods (pg.1205).
Tacconi (2012) (*32*)	"A PES scheme is a transparent system for the additional provision of environmental services through conditional payments to voluntary providers." (pg.35)	Describes that PES are not market-based transactions and are minimally "market-like", because PES usually rely on state, community and/or NGO engagement (pg. 30); and prices are negotiated, and do not represent the price that would be reached in a true market (pg.31).	States that "PES programmes are essentially instruments to maintain or recreate the supply of ES through the provision of incentives." (pg.35)

[a] Farley & Costanza (2010) could arguably be included in this table, but in relation to defining or conceptualising PES, they effectively agree with and re-iterate Muradian et al. (2010)

2.2.3. PES are supply-side incentives

Although there are different conceptualisations of PES, there are many similarities among them. For example, Tacconi (2012) describes the environmental economics and ecological economics approaches as the two broadest and most directly competing approaches to PES, but also explains there is notable overlap between the two. The one crucial consistency across all points of view, including these two approaches, is that incentives are the core of all PES programmes (*Table 1*).

The environmental and ecological approaches have strong agreement on this point. From papers characterised as promoting the environmental economics approach, Wunder (2005, pg. 7) states, "incentives are at the very core of PES." Similarly, Engel et al. (2008, pg. 664) explain, PES are "a mechanism to translate external, non-market values of the environment into real financial incentives for local actors to provide such [environmental] services." The ecological economics approach agrees significantly. Muradian et al. (2010), who critiqued other aspects of the environmental economics approach, state, "the main goal of PES ought to be the creation of incentives" for the provision of ES that are public goods (pg. 1205). In an attempt to reconcile the two approaches, Tacconi (2012, pg. 35) states, "PES programmes are essentially instruments to maintain or recreate the supply of ES through the provision of incentives."

Through the evolving discourse and experience with PES, it has emerged that not only are PES incentives, but specifically they are most commonly viewed as supply-side incentives, and PES programmes are a supply-side innovation. Wunder (2008) explains two arguments for why PES are innovative. The first is that it is a supply-side innovation where conservation (or ES) is being directly 'bought'. The second is that PES programmes internalise environmental externalities: they link buyers and sellers, such that the user pays and the provider gets, leading to socially preferred resource allocation. These two arguments broadly equate with the Pigouvian and Coaseian categories of PES, respectively. In the Pigouvian category, the ES beneficiaries (i.e., users) can provide funding, but that is in no way assured. In line with a Pigouvian conceptualisation, Engel et al. (2008, pg. 665) note, "PES programs can also be seen as an environmental subsidy (to ES providers) combined, **in some cases**, with a user fee (on ES users)" (emphasis added). In fact, other payers also provide funding, such as government, civil society, or private sector for reasons other than the direct benefit of

receiving the ES being provided, such as offsetting their own negative influence on the level of ES. The key consistency on incentives across the Coaseian, Pigouvian, and all other approaches, is that positive incentives are given to the provider of ES. Simply, the heart of PES is not that the user pays; it is that the provider gets. That is borne out in practice, where the Pigouvian approach, which is focussed on the supply-side, is the most prevalent, followed by programmes that are neither Pigouvian nor Coaseian. Coaseian-type programmes, which have the largest correlation to the user pays concept, represent the smallest category of PES programmes (Schomers & Matzdorf, *in press*).

To clarify, users are still the most prevalent financiers of PES programmes, but they do not provide funding to all PES programmes, and so a definition of PES aiming to be inclusive of the majority of programmes in existence cannot be defined as user pays. Martin-Ortega et al. (2012) reviewed 40 payments for watershed services (PWS) programmes in Latin America and found that around 60% of them included financing from water users. Similarly, in the study of 120 PWS programmes presented in Chapter 4, 65% of programmes received funding from direct beneficiaries of the ES, but only 42% received user financing exclusively. At the same time, 56% received funds from a public entity's general budget.

Sommerville et al. (2009, pg. 3) recognise that the provider-gets aspect is the defining characteristic of PES and explain, "The use of positive incentives [to the ES provider], including (but not limited to) payments, is the core ideology of PES." Fisher et al. (2010, pg. 1253) also implicitly recognise this, stating, PES are "an important mechanism for **linking** conservation outcomes to market-based incentive approaches" (emphasis added). Further evidence is found in the fact that while the term 'payments' can indicate a link between a user and provider, suggested alternate terms for PES are rewards, compensation, benefits, or (positive) incentives, all terms that are more supply-side orientated.

2.3. Defining PES as Positive Incentives

2.3.1. Definition and conceptualisation

Building on the literature that has defined and conceptualised PES (e.g., Pagiola and Platais, 2002; Wunder, 2005; Swallow et al, 2007; Engel et al, 2008; Jack et al, 2008; Sommerville et al, 2009; Muradian et al, 2010; Farley and Costanza, 2010; Fisher et al, 2010; Tacconi, 2012; Fletcher and Breitling, 2012) a working definition and

conceptualisation of PES as positive incentives for ES is presented here that is used throughout the remainder of this Ph.D.. The definition put forward most closely resembles that from Sommerville et al. (2009), which has a strong focus on positive incentives, but here it is streamlined and followed by a slightly different conceptualisation.

For the purposes of this Ph.D., PES are defined as:

1. Positive, and
2. (at least somewhat) conditional,
3. incentives intended to motivate
4. socially preferred behaviour related to the environment.

The term 'incentive' in this case is used as a broad term that includes payments, subsidies, rewards, compensation, remuneration or any other transfer of resources that would induce a land user to provide ES (see Wunder 2005 and Swallow 2009 for descriptions of payments, rewards and compensation). The definition does not go so far as to rename PES as positive incentives for ecosystem services—PIES—although an argument could be made to do so. Although there are connotations associated with the term 'payment' that may make it more restrictive than the term 'incentive', it is also a fairly generic term for a positive and conditional incentive and is the most widely used in the literature. For these reasons, the term PES will continue to be used, but defined as a class of positive incentives broader than just financial incentives, and so the term 'incentivising' will be preferred over 'paying' ES providers. Further, PES are specifically positive incentives, which is in contrast to negative incentives such as fees or charges that may also be used to induce socially preferred behaviour related to the environment.

Muradian et al. (2010) and Tacconi (2012) explicitly reserve the term 'PES' for the incentive, using the term 'PES programme' to describe the broader policy and institutional structure through which that incentive is provided. The same will be done here, meaning a 'PES' is an incentive and a 'PES programme' could be referred to as an incentive-based mechanism.

Following the above definition, PES are a broad class of incentives, which fits with the ongoing discourse that continues to highlight the heterogeneity of PES programmes

around the world. Additionally, although beneficiaries of ES can provide funding, PES are not defined by the user paying. Incentives may be funded voluntary and transferred directly from an ES beneficiary to provider, they may be funded through taxation and be paid by the government to land-users, or they may be funded through a number of other mechanisms and transferred through a variety of institutional arrangements. The key is that PES are the incentives delivered to ES providers, which can occur through many different types of mechanism or institutional structure, and so PES are defined as provider gets (*Figure 2*).

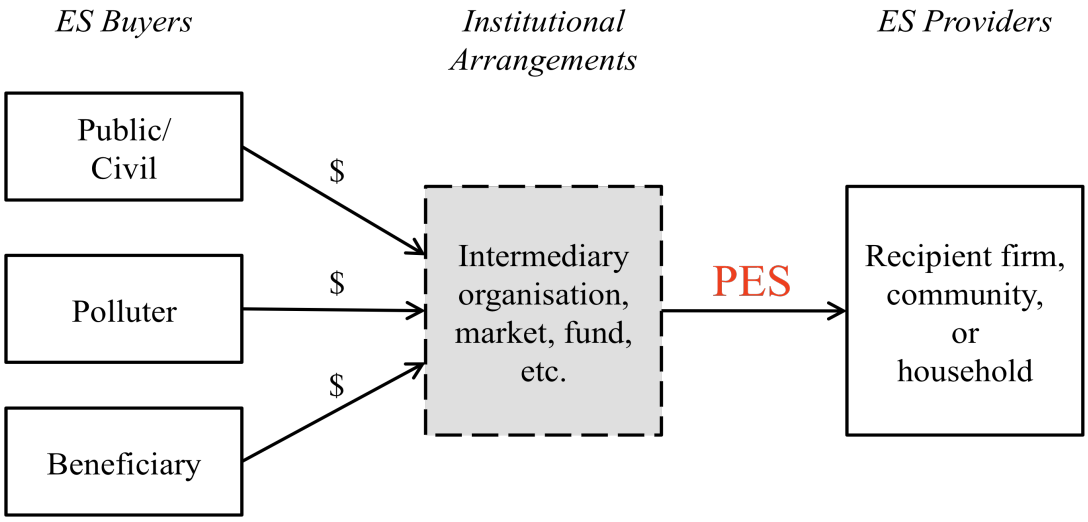

Figure 2: PES in the policy framework. Based on Parker et al. (2012). Public and civil organisations are grouped together as public-good providers.

The visual representation of this conceptualisation (*Figure 2*) has actors and institutions in boxes, and transfers of resources represented by arrows. The transfer from ES buyers to the central institutional arrangements can occur through a number of different fundraising mechanisms, such as voluntary payments, pollution charges, resources taxes, budget appropriations, and more. The figure then represents the observation that the majority of PES are provided through an intermediary institution, such as an organisation, trust, bank, or market. That creates a degree of separation between the payer and the ES provider. In some cases, although the minority of what is observed globally, the payer may bypass the intermediary institution and directly incentivise the provider (which is why the intermediary institution is represented with a dashed box). In other cases there may be multiple intermediaries, for example, a farmer receives incentives from a NGO that in turn sells environmental credits on to a market. Finally, the PES is specifically the incentive received by the ES providers.

That also clarifies the relationship of PES to markets. As described by Fisher et al. (2010), PES can link a MBI to an environmental outcome. For example, forest users may sell land-based carbon credits onto voluntary carbon markets (potentially via another intermediary aggregating farmers' carbon credits), or water quality trading between point-source polluters may permit those polluters to purchase credits generated by farmers reducing their own pollution. At present, however, very few true markets for ES exist.

The conceptualisation of PES as incentives is important because not recognising the agreement that PES are incentives permits the policy discourse to be driven by more ideological stances on the role of markets and inaccurate or inappropriate comparisons between different policy tools. Losing this focus on incentives is also detrimental to ensuring that PES are optimally designed and implemented, however and wherever in the world they are used. These two issues are now addressed in turn.

2.3.2. Considering PES in policy design

The shift from defining PES programmes as market-based mechanisms to incentive-based mechanisms may appear a semantic discussion on the surface, but that delineation is tangibly important for the policy discourse in two ways.

First, the delineation mitigates an ideological conflict. Based on the prolific early framing of PES as a market-based mechanism by practitioners and academics, policy makers also viewed PES programmes as market-based mechanisms. That placed PES distinctly in the realm of neoliberal policies and means that there is an ideological conflict about the use of PES, just as there is an ideological conflict about neoliberal policies generally, particularly in many developing countries.

A clear example of this phenomenon is in the text of the United Nations (UN) Convention on Biological Diversity (CBD). At the start of the 10th Conference of the Parties to the CBD in 2010, PES were included in the draft text related to resource mobilization as one of six innovative financial mechanisms (Cranford & Parker 2010). Reference of innovative financial mechanisms was drastically reduced in the final text,[5] and the list of specific mechanisms that included PES was dropped, in part due to a push

[5] CBD COP Decision X/3

back from developing countries about the use of market-based and so-called innovative mechanisms. At the following 11th COP in 2012 the term 'innovative' was reduced even further, and the only mention of 'markets' was in relation to the exploration and use of non-market-based mechanisms.[6]

Many references and significant language devoted to positive incentives were, however, retained in the text on incentive mechanisms.[7] That text is much less polarising as almost all parties agree that ES providers should be rewarded or compensated. The core difference between the two strands of negotiations were that in the former, on resource mobilisation, the concept of PES was conflated with concepts of market-based and innovative mechanisms, and that PES was presented as a policy mechanism cutting across fundraising, institutional arrangements, and delivery of finance. In the latter, on incentives, PES were clearly defined as positive incentives and recognised as a mode of delivering finance to reward or compensate ES providers.

That relates directly to the second point, that without recognizing PES as positive incentives, policy makers face a more opaque policy design process that conflates three key components of financing ecosystems and biodiversity (*Figure 2*; Parker et al. 2012): 1) raising funds, 2) transferring funds, and 3) delivering finance to achieve environmental outcomes.

The original conceptualisation of PES covered all three components, defining PES as paid directly from the ES beneficiary, via a private negotiation and transaction, to the ES provider (Pagiola & Platais 2002). Such a mechanism, however, is actually comprised of two major policy objectives: 1) motivating beneficiaries to pay for the ES they use, and 2) paying land users to provide ES. That is perhaps why Engel et al. (2008) stated that PES can be viewed as an environmental subsidy (i.e. delivering finance as PES) combined at times with a user fee (i.e. a fundraising mechanism). That is also why PES has sometimes been defined as both a beneficiary-pays and provider-gets mechanism. As already described, however, PES programmes are most accurately defined only as provider-gets mechanisms. As such, they relate directly to the third

[6] CBD COP Decision XI/4

[7] CBD COP Decisions X/44 and XI/30

component of the policy design process: delivery of an incentive to induce socially preferred environmental behaviour.

An opaque policy design process conflating the three key components of policy choice and design is not unique to PES. For example, the original conceptualisation of biodiversity offsetting covered all three components of the policy design process, but this conflated the different policies needed to raise, transfer/manage and deliver finance. Madsen et al. (2010, 2011) focused on the first component and used the term 'compensatory mitigation'. The key policy tool here is making polluters liable for their biodiversity impact, and they can offset that liability either by paying for a bespoke like-for-like offset, purchasing a more generic biodiversity credit through a market or clearing house, or paying into a conservation fund. In contrast, Bull et al. (2013) focus on the other end of the chain: delivery of finance. They claim that biodiversity offsets are not market-based instruments. That is because the authors define 'offset' as the act of receiving payment for habitat restoration or protection. Such a focus means that payment can be made from many sources and so could arise through a market-based or non-market-based mechanism. Following Bull et al. (2013) an offset could be viewed as a form of PES, and in this case the ES to be provided is biodiversity habitat restored to a very precise specification.

2.2.3. Incentive design for PES

As noted in Chapter 1, despite a sometimes-confused policy discourse, PES for regulating and cultural services have proliferated across the globe. In 2011, there were more than 200 active incentive-based programmes for securing watershed services in around 30 countries (Bennett et al. 2013), at least 120 of which can be considered PES (see Chapter 4). In 2012, over 162 forest carbon projects were active in over 50 countries (Peters-Stanley et al. 2013), and many of these programmes provide PES to households or communities living in and around forests. There are also agri-environmental schemes, and similar programmes called PES or eco-compensation programmes, through which national and sub-national governments offer USD billions to incentivise farmers to use their land in a way that provides ES valuable to those farmers and their fellow citizens. Examples are found in the US (Monke & Johnson 2010), Europe (Cooper et al. 2009), China (Bennett 2009), Mexico (Muñoz-Piña et al. 2008a), Ecuador (Fehse 2012), and more.

Yet with all of these programmes and the large amount of funds being spent, there is still a lack of well-formulated, empirical research on the environmental effectiveness of PES (Pattanayak et al. 2010). Some of the large national programmes have been analysed, in particular Costa Rica's PSA, one of the most prominent national programmes in developing countries (e.g., Robalino & Pfaff 2013; Arriagada et al. 2012; Arriagada et al. 2009). The vast majority of PES programmes, however, have never been evaluated, despite recurring calls for better programme evaluation in policies for BD and ES generally, and PES specifically (Ferraro et al. 2012; Ferraro & Pattanayak 2006a)

One major barrier is that such evaluation requires a lot of time and money, will often only come after a few years of programme implementation, and the best evaluations (i.e. experimental or quasi-experimental methods) must be built in to a programme during its design phase.[8] Yet, despite any lack of quantitative evidence, PES are popular, perhaps because of the intuitive logic of paying someone who provides public goods, the hope of coordinating environmental and development benefits, and prolific qualitative evidence of their success. Use of PES is likely to further increase in the coming years through, for example, REDD+, incentive-based mechanisms of the CBD, and programmes for green growth or sustainable development. With *ex-post* evaluation costing a lot of time and money, and providing results at earliest 2-3 years after programme implementation, yet PES continuing (and perhaps increasingly) being used, it is crucial to ensure that incentives are *ex-ante* designed as well as possible.

Additionally, well designed evaluation will not be able to assess all the possible different type of incentive arrangements implemented in all the varied contexts PES occur in. As described at various other points throughout this Ph.D., and as would be expected, local context appears to heavily influence incentive design. So, again, it is critical to design incentives as well as possible prior to implementing a PES programme.

[8] Notably, the Global Environment Facility (GEF) as a major financier of environmental projects (including implementation of incentive-based programmes) is beginning to incorporate experimental designs in project implementation following advice from its Scientific and Technical Advisory Panel (STAP) (Ferraro 2011)

2.4. Summary

Following a review of multiple papers that define, conceptualise, and/or categorise PES, this chapter presents a definition and conceptualisation that refocuses on PES as positive incentives, and as a supply-side innovation in the toolbox of environmental policies. Despite numerous attempts to define and conceptualise PES, the agreement that incentives are at the core of all PES programmes has received little attention. Refocusing on PES as incentives should have positive implications for both the policy decision process and, more specifically, incentive design.

In relation to the former, it realigns discussion away from the area of market-based instruments, which can be politically contentious particularly in developing countries, and towards the area of incentives for the provision of ES, which is more widely accepted. It also clarifies which policy objective is actually being addressed with PES. Previous conceptualisations have conflated objectives that raise funds, and potentially negatively incentivise over-use or degradation of resources, with those that positively incentivise improved environmental behaviour.

In relation to the latter, it can permit better incentive design in policies or programmes that use PES. In the first instance, this is taken up in Chapter 3, where a literature review of incentive design for PES presents relevant research to date. Additionally, previous work has tended to focus more on institutional aspects of PES programmes, or their relation to markets, by which to characterise and categorise PES programmes. The purpose of such work is primarily to develop groups within which experience and lessons can be shared. Chapter 4 develops a typology of PES based on incentive and contract attributes. It demonstrates that the conceptualisation of PES as incentives provides unique and useful insights for research and policy learning, both in isolation and when considered in conjunction with institutional aspects of the programmes using PES.

CHAPTER 3

LITERATURE REVIEW

Incentive Design for Payments for Ecosystem Services

3.1. Introduction

Agri-environmental schemes (AES), payments for ecosystem services (PES) programmes, water rights transfers (WRTs), and water quality trading (WQT) all use positive incentives to induce the provision of ecosystem services (ES); they all provide PES. Such policy instruments that provide PES are prevalent throughout the world. There are large AES programmes paying out USD billions in incentives each year in the EU (Cooper et al. 2009) and US (Monke & Johnson 2010), while in developing countries national PES programmes are paying out USD hundreds of millions if not billions annually in China (Bennett 2008), Costa Rica (Pagiola 2008; Porras et al. 2012), Mexico (Muñoz-Piña et al. 2008b), and Ecuador (Fehse 2012), among others. Bennett et al. (2013) researched incentive-based programmes for the provision of watershed services and identified 205 active programmes in 29 countries in 2011, with 76 more in development. The authors also found that the annual value of incentives transacted through these programmes was steadily increasing in 2008-2011.

The aim of these programmes is to incentivise resource users to change their behaviour in order to maintain, restore, or augment those resources. The majority of those resource users are farmers or forest users. In addition to AES, forest conservation programmes, and PES programmes, that holds true for WRTs, where rights are often sold or leased from large landowners, and WQT, where programme managers often find that emissions into waterways can be reduced more cost-effectively from non-point sources (e.g. farmers) than point sources (e.g. factories).

There has been ample research characterising which resource users are most likely to adopt environmentally-friendly practices (see Section 3.2.1), and a second related literature characterising which are most likely to join a programme that provides a positive incentive to induce such practices (e.g. enter into AES or forest conservation contracts; see Section 3.2.2).

Reviews find that some form of subsidy or payment has a mixed or insignificant influence on adoption of conservation agriculture (Knowler & Bradshaw 2007) or agricultural best management practices (BMPs) (Baumgart-Getz et al. 2012). It is difficult to conclude much from this result because such reviews treat PES as homogenous. Studies characterising programme participants also give little attention to programme or incentive attributes. They are often focused on participation in a particular programme, so do not observe variation of those attributes. As discussed in the body of this current review, however, there are many factors related to design of PES that might influence participation.

Similarly, there is little reliable evidence on the effectiveness of PES, because a lack of rigorous, statistical and unbiased analyses persists (Ferraro & Pattanayak 2006b; Miteva et al. 2012; Kleijn & Sutherland 2003). The evidence that does exist suggests heterogeneous effectiveness. For example, Costa Rica's national PES program is the longest standing and most researched PES programme in the tropics. Evaluations indicate it had little aggregate impact on increasing forest cover across the nation (Robalino & Pfaff 2013), but a moderate positive impact in well-targeted areas (Arriagada et al. 2012), implying a heterogeneous effect across the country. Heterogeneity in effectiveness can arise from differences in the quality of implementation across the country or differences in the responses by recipients of incentives (Arriagada et al. 2012). The latter suggests that applying a nationally homogenous incentive to heterogeneous households might, as would be expected, produce heterogeneous results.

Improving the design and implementation of the programmes that provide PES, through for example, spatial targeting (Wünscher et al. 2008), has been given significant attention. Improving the design of the incentive itself has received far less attention. That is a critical gap in thinking. No matter what conceptualization or definition of PES one follows, all agree that the incentive is the core of such an intervention (see Chapter 2). The aim of this review is to begin to fill that gap and draw attention to what has been researched related to designing PES, in a variety of economic disciplines and literatures.

Following this introduction, Section 2 describes the literature on adoption of environmentally friendly practices and briefly reviews the literature on participation in

programmes intended to incentivise such practices. Section 3 then begins to explore the design of PES by reviewing the available literature on ES providers' preferences for incentive attributes.[9] Understanding those preferences are a critical first step to inducing greater participation in PES programmes and consequent provision of ES. Following the discussion of ES supplier preferences, Section 4 then focuses on three key unresolved issues in PES design that are particularly relevant for developing countries. Finally, Section 5 concludes.

3.2. Adoption and Participation

3.2.1. Adopters of conservation practices

There is a large literature on the adoption of conservation practices, primarily on the adoption of environmentally friendly agricultural practice (see reviews such as (Baumgart-Getz et al. 2012; Knowler & Bradshaw 2007; Mercer 2004; Pattanayak et al. 2003; Prokopy et al. 2008). The adoption literature focuses primarily on endogenous characteristics of the resource user and the resource, with some consideration of exogenous factors. It has identified a large list of characteristics that might help predict adoption of environmentally friendly land use practices.

Knowler & Bradshaw (2007) reviewed 31 analyses of adoption of conservation agriculture practices. Those analyses included 167 distinct variables, which the authors reduced to 46 as most interesting and with more than a few uses among the analyses. The most prevalent variables included in empirical studies were education, age, farm size, land tenure, and off-farm activities/income. There are, however, mixed positive/negative and significant/insignificant results for all of these variables and most of the 46, leading the authors to conclude that the literature on adoption of conservation agriculture identifies "few if any universally significant independent variables" (pg. 42).

Knowler & Bradshaw (2007) also argue that once contextual factors are accounted for (e.g. region), the significance and direction of the effect of some of these variables is a little more consistent. Similarly, Prokopy et al. (2008) limited their review to studies of the adoption of agricultural BMPs in the USA, and claim that there are some variables that seem significant fairly consistently, although none are completely consistent.

[9] Although the three literatures addressed in Sections 2 and 3 overlap, they align fairly neatly into three separate groups based on the focus of the studies comprising each.

Baumgart-Getz et al. (2012) built on the same studies as Prokopy et al. (2008), but carried out a meta-analysis. Doing so highlighted the factors that help predict adoption with more confidence. In relation to the most prolifically studied variables, they found the following were significant (p-value ≤ 0.05):

- Education was insignificant overall, but this result was decomposed and specifically formal education had an insignificant effect, but agricultural extension training had a positive effect.
- Age had a negative effect
- Farm size had a positive effect
- Ownership of the farm (i.e. strong tenure) had a positive effect

They also find additional variables were significant (p-value ≤ 0.05), highlighting other important factors that can influence adoption, leading to an overarching conclusion on the three most important factors related to adoption:

- Access to and quality of information – Information on BMPs, agricultural extension training (which indicates access to extension services), and interactions with agricultural agencies all had a positive effect on adoption.
- Financial capacity – Total income, previous investment into farming, and the related variable of proportion of income from farming all had a positive relationship with adoption.
- Networks – In addition to extension training (which indicates connections to agricultural experts) and interactions with agricultural agencies, local organisations or neighbours and agribusiness all had a positive relationship with adoption.

These results were based on studies in one country (USA) and of one form of conservation-oriented activity (agricultural BMPs), so should not be considered conclusive across other countries or activities. They do, however, illuminate important nuances in understanding adoption, for example, the effect of formal compared to agricultural extension education, and highlight additional factors to consider outside of the most prolifically studied variables, such as access to information related to conservation activities and the financial capacity to implement them.

3.2.2. Participants in conservation programmes

Alongside the adoption literature is a large body of studies attempting to characterise participants of PES programmes. The participation literature analyses a similar set of variables as the adoption literature, but is more directly relevant for PES design. Most studies in this literature research agri-environmental or forest conservation contracts in the USA or Europe, and many state they are motivated by unexpectedly low participation in programmes in these regions. That said, there are a number of studies of programme participation in developing countries, which is anticipated to increase as the use of PES increases in developing regions, particularly with the introduction of large national programmes.

Studies in the participation literature can be grouped in two categories:

1. Revealed participation research comparing participants to a non-participant control group. This has the advantage of relying on actual participation data, but the sample selection and the econometric strategy rarely accounts for selection bias of participants; or
2. Contingent participation research, which has the advantage of no selection bias (and many also include a dummy variable to control for previous participation), but is based on hypothetical behaviour.

The discussion in this section follows the five most often studied variables in the adoption literature as identified by Knowler & Bradshaw (2007): age and habit, education and information, off-farm activity, size of land holding, and land tenure. It also includes consideration of the results of Baumgart-Getz et al. (2012), specifically considering the effects of information and income. The aim is, through a brief review of the participation literature, to clarify if there are any factors that could help determine optimal PES design or implementation. The discussion in this section focuses primarily on the participation literature, but does include reference to studies focussed on adoption or programme attributes where relevant.

3.2.2.1. Age and habit

A greater age of the decision maker is often cited as a negative influence on the probability that they will enter a conservation programme, and various empirical studies have demonstrated this relationship (Balana et al. 2011; Cook & Rabotyagov 2012; Langpap 2004; Lynch et al. 2002; Mullan & Kontoleon 2012; Vanslembrouck et al.

2002; Wynn et al. 2001). Some studies have shown the opposite effect (see Delacote et al. 2012) and many report an insignificant effect (Kwayu et al. 2013; Thacher et al. 1996; Yu & Belcher 2011; Zbinden & Lee 2005). There is some evidence that age might not always have a strong relationship with participation because there are other correlated land-user characteristics. Pattanayak et al. (2003) go so far as to categorise age, and a few other variables, as a 'preference proxy' for adoption.

One variable for which age might be a proxy is the strength of habit a resource user has with their current land use practices. Langpap (2004) find higher age to be negatively (and significantly) related to programme participation, but also found that years owning the land had a negative and significant effect, indicating that landowners who acquired their land more recently are more willing to participate. The author states, "One possible explanation is that landowners who have owned the property for a shorter time may be less likely to have developed a particular way of managing their forest, and thus could be more willing to accept alternate management plans" (pg. 383). Yu & Belcher (2011) support this reasoning as they find age to be insignificant, but that years of experience farming had a negative and significant relationship with programme participation. Mullan & Kontoleon (2012) also find age to be insignificant across the entire sample, but using a latent class model, find it to be insignificant for households with easy market access, but a negative predictor for households with constrained market access. This final example implies that even exogenous factors could relate to habit formation.

3.2.2.2. Education and information

Having had more education is often cited as making a land user more likely to participate, and various studies empirically demonstrate this positive effect (Balana et al. 2011; Cook & Rabotyagov 2012; Lambert et al. 2007; LeVert et al. 2009; Lynch et al. 2002; Mullan & Kontoleon 2012; Vanslembrouck et al. 2002; Zbinden & Lee 2005). As with age, many studies also report the opposite (see Delacote et al. 2012) or no significant effect (Kwayu et al. 2013; Langpap 2004; Mullan & Kontoleon 2012; Southgate et al. 2010; Vanslembrouck et al. 2002; Vanslembrouck et al. 2002; Yu & Belcher 2011). Education is another variable that (Pattanayak et al. 2003) categorise as a preference proxy.

In their review of BMP adoption in the US, (Baumgart-Getz et al. 2012) explicitly identify that general education is not the real effecter of programme adoption, but

instead that amount and quality of information on the BMP will lead to greater adoption. That is evident in the significant effect of both experience with agricultural extension services, connections to agricultural agencies or grassroots organisations, and exposure to information on the technology to be adopted (Baumgart-Getz et al. 2012). A similar effect may exist for programme participation. There appears to be a consistent positive effect of exposure to programme information—through access to extension services, attending meetings, or having programme proponents visit a household/farm—on participation (Kwayu et al. 2013; Lambert et al. 2007; Lynch et al. 2002; Thacher et al. 1996; Wynn et al. 2001; Zbinden & Lee 2005). Fortunately for programme managers, although they cannot provide general schooling, providing information about a practice or programme is within their control.

3.2.2.3. Off-farm activity

Various studies indicate that if a household receives a greater proportion of their total income from off-farm activities, they are more likely to participate (Loftus & Kraft 2003; Lynch et al. 2002; Southgate et al. 2010; Thacher et al. 1996; Zbinden & Lee 2005). It is logical that if a household is less reliant on farm-based income, it is more willing to set aside some of their farm area. A higher dependence on off-farm income also implies there is less labour available to work on the farm and generate profit from crops or livestock, so less chance for a competing land use opportunity to be fully realised. Indeed, studies of Costa Rica's PSA programme indicate that a greater availability of on-farm labour decreases the probability of programme enrolment (Thacher et al. 1996; Zbinden & Lee 2005). Households with labour available are more likely to prefer to work the land and extract profit from it, rather than set it aside for forestry.

3.2.2.4. Size of land holding

The evidence of the relationship between size of land holding and programme participation is mixed. A number of studies demonstrate the expected positive relationship, such that if a land user has a larger farm or forest, they are more willing to participate in a programme (Kwayu et al. 2013; Langpap 2004; Lynch et al. 2002; Southgate et al. 2010; Thacher et al. 1996; Vanslembrouck et al. 2002; Zbinden & Lee 2005). These results indicate that the marginal value of land is decreasing, such that land users with more land have a lower marginal opportunity cost of giving up production on that land. As they enrolled more land, however, presumably the marginal

opportunity cost of the remaining land would increase to a point when they were no longer willing to enrol additional land.

A number of studies find size of land holding was negatively associated with programme participation (Balana et al. 2011; Broch & Vedel 2012; Espinosa-Goded et al. 2010; Rabotyagov & Lin 2013; Vanslembrouck et al. 2002; Yu & Belcher 2011). These studies do not directly challenge the principle of decreasing marginal opportunity cost of land, but instead offer explanations of why contextual factors overrule that principle and lead to a different relationship between area and participation. For example, Yu & Belcher (2011) report farm size to be negatively related to participation in a programme requiring reduced usage of riparian areas around wetlands. In this case, based on other factors found statistically related to programme participation, the authors argue that smaller farms require smaller equipment, which is easier to manoeuvre around wetlands, making these farmers more willing to participate. In another example, Espinosa-Goded et al. (2010) report larger farms less willing to participate in a programme to introduce nitrogen fixing crops in dry land area, but also pointed out that larger farms in the study areas were specialised in different crops, so would have a greater foregone revenue from programme participation.

3.2.2.5. Land tenure

There appears to be less study of the effect of strong land tenure on programme participation compared to its effect on technology adoption. A few studies were identified that studied tenure and programme participation, two of which find no significant effect (Lambert et al. 2007; Kwayu et al. 2013). Others find a positive correlation between strong tenure and participation (Mullan & Kontoleon 2012; Thacher et al. 1996; Zbinden & Lee 2005). Mullan & Kontoleon (2012) demonstrate heterogeneity in this result, finding strong land tenure is only significant for the class of households that did not face significant market constraints. The authors explain this is unsurprising because it is households with stronger tenure and better market access that can reap the benefits of increased natural capital associated with participation in the programme studied.

3.2.2.6. Summary of participation literature

Overall, the participation literature leads to similar conclusions as the reviews of the adoption literature. At first glance, it appears that there are mixed results for the most

prolifically studied variables. A deeper look, however, indicates that these mixed results could be based on some variables acting as proxies for the true characteristics that have a relation to participation, or that contextual factors heavily influence results. That is perhaps the strongest conclusion to take from the literature: that more precise and context-specific factors must be considered to understand programme participation.

3.3. ES Provider Preferences for PES Attributes

In addition to needing to pay more attention to contextual factors, the participation literature identified that more attention to ES supplier preferences was required. Even though the paper was focused on characteristics, Wynn et al. (2001) was the earliest study identified that explicitly recognised that the " 'fit' between the farm and the scheme" (pg. 77) will affect farmer participation. Similarly, Vanslembrouck et al. (2002) claim to depart from previous research by assuming that participation is "not only influenced by farmer and farm characteristics, but also by the characteristics of the required practices" (pg. 490).

The literature quickly expanded its view to focus on the attributes of the programme more broadly: the attributes literature. Thomas, White, Kittredge, & Dennis (2002) provide the earliest paper identified that included multiple program attributes beyond required management practices. The authors conclude their literature review by stating (pg. 172),

> *"When taken together, the previous literature [characterising programme participants] provides valuable insight about landowner decision making, but it is not specific with respect to the types, and in particular the levels of management program attributes that would or would not attract greater participation by [resource] owners."*

Taking off from that departure, a number of studies have now explicitly researched the preferences of ES providers for programme attributes, demonstrating that different attributes and levels of attributes can affect programme participation.

Nineteen quantitative studies were identified for this review that all take a Lancastrian approach (Lancaster 1966), treating a programme as a bundle of attributes. Each study implements a survey and uses conjoint analysis (CA) or choice experiments (CEs) to

analyse the trade off between attributes (*Table 2*). Due to their similarity in approach, these studies can be systematically compared.

Table 3 summarises the results of those studies following the basic vote-counting method of meta-review as done for the adoption literature (Knowler & Bradshaw 2007; Pattanayak et al. 2003; Prokopy et al. 2008) and participation literature (Delacote et al. 2012). The studies analysed a large number of unique programme and incentive attributes, but many were specific to the type of management practice being researched. Similarity in the fundamental meaning of these tested attributes allows many of them to be grouped together, which produces a list of 14 attributes that were analysed in at least two studies.[10]

Two categories of incentive attributes clearly emerge. The first are contractual attributes: the attributes of the incentive related to the requirements to be met in order to receive the incentive. The second is the form of the incentive itself, such as the value and type of incentive. A few other variables were identified that can broadly be categorised as institutional attributes of a programme. On the surface, they do not specifically relate to the design of PES, but some evidence indicates that preferences for institutional attributes can interact with preferences for incentive attributes. As such, discussion of the institutional attributes is also included. The remainder of this section reviews these three categories of attributes—contract, form of incentive, and institutional—in order.

In addition to the quantitative studies, a collection of qualitative studies was also identified. These tend to be broader in scope, however, and with less focus on measuring the importance of different attributes. They are used to supplement the review of quantitative studies and are cited in the text when relevant. Similarly, some studies indentified from the adoption or participation literatures include consideration of one or two programme attributes, and are cited as appropriate.

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[10] Not many attributes were reported as insignificant. That is likely due to the nature of these studies. Pre-testing through, for example, focus groups or pilot studies would have been used to limit the number of attributes included in a survey to those believed most relevant or interesting. So there is an initial screening of attributes prior to survey implementation. Although some insignificant attributes may be screened out prior to survey implementation, general best practice is that once an attribute is included, the result should be reported irrespective of significance.

Researchers cannot simply revert, however, from studying supplier characteristics and ignoring programme attributes to studying programme attributes and ignoring supplier characteristics. As alluded to by Vanslembrouck et al. (2002) and Wynn et al. (2001), participation is ultimately dependent on the interaction of supplier characteristics and programme attributes. Most of the Lancastrian studies identified for this review were found to recognise this to a degree, and use analytical methods to account for heterogeneity in ES providers. Specifically, they do so by using split samples, including supplier characteristics in interaction terms in the right hand side of the model, and/or choosing an econometric model designed to account for heterogeneity.

In the remainder of this section, results about heterogeneity in the tastes of ES providers are discussed as appropriate. One overarching trend is that taste heterogeneity was generally manifest in a difference in the strength or consistency of preferences between groups of individuals present in the sample. Often, the sign of the coefficient of a program attribute was the same for each group, but the magnitude was different (e.g. Espinosa-Goded et al. 2010; Grosjean & Kontoleon 2009; Horne 2006; Ruto & Garrod 2009). In other cases, the coefficient was significant for one group but not the other (e.g. Kaczan et al. 2013). There are very few examples where the sign of a coefficient changed between groups. If that did occur, it was for unique and minority groups within the sample, that were either very likely to participate in the programme or very unlikely to participate (e.g. Beharry-Borg et al. 2013; Putten et al. 2011). That is, these groups with opposing preferences tended to represent the tails of the distribution of preferences within the population.

Table 2: Lancastrian studies focused on ES supplier preferences for the attributes of programmes that offer PES.

Study				Methods		
Reference	**Type**	**Country**	**Subject**	**Survey[a]**	**Econometrics[b]**	**Accounting for Heterogeneity**
Balana et al. (2011)	Journal Article	Kenya	Land management contracts with small landholders	CA	OLS, Logit, OL	No
Balderas Torres et al. (*in press*)	Journal Article	Mexico	Forest conservation or restoration on private or communal land	CE	MNL	Attribute choice influenced by heterogeneity of respondents
Barr & Mourato (2012)	Working Paper	Tanzania	Reducing fishing pressure on coral reef by artisanal fishermen	CE	CL, NLM, ASCL	Interaction terms
Beharry-Borg et al. (2013)	Journal Article	UK	Changing agricultural land management practices to protect water quality	CE	CL, LCL	Model choice
Broch & Vedel (2012)[c]	Journal Article	Denmark	Afforestation contracts with farmers	CE	RPL, LCL	Model choice
Christensen et al. (2011)	Journal Article	Denmark	Incentives for pesticide-free buffer zones on farms	CE	RPL	Model choice
Cook & Rabotyagov (2012)	Working Paper	USA	Purchasing water rights from agriculturalists	Dichotomous choice CV; CE	Interval model; MNL, RPL	Model choice, interaction terms
Espinosa-Goded et al. (2010)	Journal Article	Spain	Introduction of nitrogen fixing crops in dry land areas of farms	CE	RPL	Split sample, model choice, interaction terms
Greiner & Ballweg (2013)	Working Paper	Australia	Biodiversity incentives for land excluding cattle grazing	CE	RPL	Model choice
Grosjean & Kontoleon (2009)	Journal Article	China	Incentives for farmers to reforest sloped, previously cultivated land	Household data survey, CE	Simultaneous Probit, RPL	Model choice, interaction terms

Table 2 (cont.): Lancastrian studies focused on ES supplier preferences for the attributes of programmes that offer PES.

Study				Methods		
Reference	**Type**	**Country**	**Subject**	**Survey[a]**	**Econometrics[b]**	**Accounting for Heterogeneity**
Horne (2006)	Journal Article	Finland	Biodiversity conservation for NIPFs	CE	MNL	Split sample
IIED (2012)	Policy Brief	Brazil	Avoiding deforestation by rainforest communities	CE, CV	*Not stated*	*Not stated*
Kaczan et al. (2013)	Journal Article	Tanzania	Incentives for improved agroforestry by small landholders	CE	MNL, LCL	Model choice
Peterson (2011)	Conference Paper	USA	Water quality credits purchased by PS from NPS	CE	LCL	Model choice
Putten et al. (2011)	Journal Article	Australia	Generic conservation incentive for landowners	CE	LCL	Model choice
Rabotyagov & Lin (2013)	Journal Article	USA	Working forest conservation contract for small forest landowners	CE	RPL	Model choice, interaction terms
Rolfe et al. (2006)	Working Paper	Australia	Changing agricultural land management practices to protect water quality	CE	MNL	No
Ruto & Garrod (2009)	Journal Article	EU	Generic agri-environmental scheme for farmers	CE	MXL, LCL	Interaction terms, model choice
Stevens et al. (2002)	Journal Article	USA	Forest management for non-industrial private forests	CA	Logit	No

[a] CA = conjoint analysis; CE = choice experiment, CV = dichotomous choice contingent valuation

[b] OLS = ordinary least squares; CL = conditional logit; ASCL = alternative specific constant logit; MNL = multinomial logit; OL = ordered logit; RPL = random parameters logit; LCL = latent class logit

[c] Based on the same data as Vedel et al. (2010), but that is a conference paper. The included study is in a peer-reviewed publication, so preferred for inclusion here.

Table 3: Attributes analysed in 19 Lancastrian studies of potential ES providers' preferences for PES-programme attributes. Ranked by incidence of inclusion in studies. Effects are included if they are significant at 90% or greater. For studies that used a latent class model, the effect of an attribute is presented in this table based on the majority (>75%) of the population.

Category	**Attribute**	**Effect on programme acceptance**			**Total**
		Significant		**Not Significant**	
		+	—		
Incentive form	Value of incentive	16	0	0	16
Contract	Strength of restrictions	0	13	0	13
Contract	Contract length (e.g. years)	0	7	2	9
Institutional	Actors effect[a]	4		2	6
Contract	Amount of resource with restricted use	0	5	0	5
Contract	Contract flexibility (cancellation or suspension)	5	0	0	5
Incentive form	Non-financial incentives	3	0	1	4
Contract	Monitoring strength	2	1	1	4
Institutional	Administrative burden	0	3	1	4
Contract	Flexibility in defining restrictions (area or strength)	3	0	0	3
Incentive form	Up-front payments	2	0	0	2
Incentive form	Consistent payments	2	0	0	2
Incentive form	Group payments	1	1	0	2

[a] This attribute is not perfectly comparable to the others as it simply reflects whether or not different actors would affect participation rates. As such, there is no negative effect, only a positive (yes, different actors affect contingent participation) or insignificant (no such effect was observed) result.

3.3.1. Contractual attributes

3.3.1.1. Restrictions on resource use

In the design of environmental contracts, providers prefer to have less of their resources under restricted use agreements. Farmers prefer to commit less land area to management restrictions (Balana et al. 2011; Rolfe et al. 2006), forest owners prefer to enrol smaller patches to conservation programmes (Horne 2006; Rabotyagov & Lin 2013), fishers prefer smaller no-take zones (Barr & Mourato 2012), and farmers supplying water rights prefer split-season over full-season leases (Cook & Rabotyagov 2012). Similarly, on the area that is enrolled, resource users prefer to have less restrictions or requirement imposed on their activity within or around that area (Balana et al. 2011; Barr & Mourato 2012; Beharry-Borg et al. 2013; Christensen et al. 2011; Espinosa-Goded et al. 2010; Greiner & Ballweg 2013; Grosjean & Kontoleon 2009; Horne 2006; Rolfe et al. 2006).

3.3.1.2. Flexibility in restrictions

Providers also prefer to engage in contracts requiring a change in practice that they find easy to adopt (Kwayu et al. 2013; Wynn et al. 2001). That is why resource users tend to prefer contracts that are flexible, both in terms of the area enrolled (Espinosa-Goded et al. 2010; Ruto & Garrod 2009), and in the required restrictions or measures (Christensen et al. 2011; Ruto & Garrod 2009). Even when flexible or less restrictive land uses are permitted, there may be categories of potential participants whose willingness-to-accept is still prohibitively high to incentivise their participation (Peterson 2011). Additionally, the purpose of a resource user's tenure can influence their utility or disutility of particular practices. Small forestland owners in Washington State, USA, had a positive utility for contracts that required biodiversity management plans if their purpose for ownership was focused on conservation, but a disutility for such requirements if their ownership was focussed on timber production (Rabotyagov & Lin 2013).

3.3.1.3. Contract length

The studies that have included consideration of the length of the contract tend to find that shorter contracts are preferred (Balana et al. 2011; Balderas Torres et al. *in press*; Christensen et al. 2011; Greiner & Ballweg 2013; Horne 2006; Rabotyagov & Lin 2013; Ruto & Garrod 2009). That indicates that land users have a positive option value for using the land in other ways in the future. The magnitude of that value though,

depends on the context and the type of land-user. In some contexts the disutility of longer contract length is measurable for a five year contract (Christensen et al. 2011), while in others it only appears measurable for contracts of at least 30 or 40 years in length (Balana et al. 2011; Horne 2006).

Heterogeneity in the magnitude of the disutility of contract length appears to not only occur between study contexts, but within them too. Ruto & Garrod (2009) studied the interaction of farm and farmer characteristics with length of AES contract and find characteristics that are generally believed to predict programme participation also predict farmers that are willing to accept longer contracts. Specifically, they find evidence that age and weak land tenure are negatively associated with contract length, while level of education and farm size are positively associated with it. Rabotyagov & Lin (2013) find that all forest owners in their study prefer shorter (and non-perpetual) contracts, but those that agree that maintaining ecosystem health is a very important reason for owning forest had a lower disutility of contract length (and contracts in perpetuity).

3.3.1.4. Release clause

Also indicating the positive future option value, resource users prefer contracts that they can temporarily suspend or break (Christensen et al. 2011; Greiner & Ballweg 2013), or have the option to completely cancel even though they would be required repay the reward they have already received (Broch & Vedel 2012; Horne 2006). As with contract length, however, the disutility of strictly permanent contracts is lower for groups of land owners characterised as more willing to participate in the programme (Broch & Vedel 2012).

3.3.2. Incentive form

3.3.2.1. Incentive value

All studies focussed on programme attributes that included incentive value in their analysis, and even some of the studies from the participation literature, indicate that resource users prefer incentives of greater value (e.g. Beharry-Borg et al. 2013; Broch & Vedel 2012; Cook & Rabotyagov 2012; Espinosa-Goded et al. 2010; Greiner & Ballweg 2013; Grosjean & Kontoleon 2009; Horne 2006; Kwayu et al. 2013; LeVert et al. 2009; Lynch et al. 2002; Mettepenningen et al. 2013; Peterson 2011; Rabotyagov & Lin 2013; Rolfe et al. 2006; Southgate et al. 2010; Stevens et al. 2002; Wossink &

Wenum 2003; Yu & Belcher 2011). It is clear that a price effect exists, and a larger value of incentive makes any resource user more likely to participate.

3.3.2.2. Up-front payments

Including an up-front payment along with annual payments can help potential ES providers overcome the initial costs of changing practices. As expected, studies that have explored the utility of an up-front payment in addition to annual payments show that they are liked by farmers in Spain (Espinosa-Goded et al. 2010) or Tanzania (Kaczan et al. 2013). Explorations of heterogeneity in these results indicate farmers already participating in the studied programme still have a positive, but lower utility of an additional up-front payment (Espinosa-Goded et al. 2010). To some degree, however, these basic results simply highlight that potential ES providers have a positive utility of receiving larger incentives, whether up-front or annual. A deeper comparison is needed to understand which is more influential in participation.

Post-estimation analysis of those results reveals that the preference for an up-front payment is strong enough that providing one can lower the overall costs of the programme for the ES buyer. Espinosa-Goded et al. (2010) estimate that, based on the current average area enrolled by participants, and using a 4% discount rate, providing a fixed premium of EUR 1,000 would lower the overall willingness to accept (WTA) of the average farmer over the life of the contract by 23%. Similarly, Kaczan et al. (2013) find that providing a fixed premium equivalent to USD 140, intended to purchase inputs to agroforestry, would eliminate the need to provide annual payments. The authors explain that this could be due to high discount rates of the farmer and/or market constraints impeding the transition to agroforestry. A programme participation study of the US Conservation Reserve Enhancement Programme did not wait for post-estimation analysis, but directly compares an up-front payment to the present value of annual payments in the econometric model. The coefficients for both are positive and significant, but the former is larger, suggesting that increasing the up-front payment will have a greater effect on participation than increasing the present value of annual payments by the same amount (Suter et al. 2008).

3.3.2.3. Consistent payments

It has been suggested that variable annual payments indexed against the price of crops produced under alternative land uses could be an effective form of PES (Engel et al.

2012). That would make PES more attractive when the value of other land uses, and thus opportunity costs, are high, but cheaper when that value is low. Kaczan et al. (2013) explored preferences for incentives of constant value compared to varying value (indexed against the price of sugar cane, a dominant land use in the study area). They find that potential ES providers do not like the uncertainty associated with variable payments and have a higher WTA for the annual variable payment than a constant annual payment. Grosjean & Kontoleon (2009) tested a different cause of payment uncertainty: the ability of the programme to provide incentives in a timely and consistent manner. They too find a strong preference for consistency in payments, but also explored the difference in this effect between two study regions. Where less off-farm income sources were available and the average household had more land enrolled in the programme, the assurance of receiving full and on time payments is more important.

3.3.2.4. Group payments

Kaczan et al. (2013) also included an attribute in their choice experiment to explore if, on top of an annual individual payment, a community payment would be well received. Although the individual payment had a strong positive and significant effect on contingent participation, the effect of the group payment was also positive, but smaller and less significant. Further, the effect was non-existent for the quarter of the sample resistant to participation, although the individual payment still had a positive and significant effect within this group. Instead of considering them additive, IIED (2012) analysed the trade-off between individual and group payments. They found opposing results depending on the method used. Under open-ended questions, respondents stated they preferred an in increase in community benefits to individual payments. The authors suggest, however, that this may be influenced by social preference bias. Through a choice experiment, respondents clearly indicated a preference for increasing individual payments over community benefits.

Preferences for group- or individual-level incentives are likely influenced by pre-existing social norms. Narloch et al. (2012) used behavioural experiments with potential ES providers and compared household payments and community payments as separate options. They find that household-level payments will induce more pro-social behaviour in places where self-regarding behaviour is already the norm, while community-level incentives will do so where other-regarding behaviour is the norm.

3.3.2.5. Non-cash financial incentives

Aside from cash payments, financial incentives can be delivered through different modes. The evidence on how to deliver financial incentives does not indicate that one type of financial incentive is preferred over any other. It instead shows that there are a variety of different financial incentives, and which is preferred will differ by context and type of ES providers. Researching one-off conservation payments in Australia, Putten et al. (2011) found that land owners characterised as environmental preferred an up-front payment, while those focused on productive uses of land preferred a tax break. To engage in land management contracts in Kenya, Balana et al. (2011) find that resource users preferred direct cash payments over a reduction in fees for electricity or extension services, but saw no significant difference in preferences for cash or reduced water fees as the delivery mode.

In a qualitative study, Leimona et al. (2009) carried out focus groups in six communities participating in RUPES[11] in the Philippines, Indonesia and Nepal. Focus groups in only two of the communities mentioned cash incentives as desirable. All six, however, described non-cash financial incentives as desirable, with reductions in electricity bills and access to credit mentioned most. In another qualitative study of motivations for participating in payments for watershed services in the USA, Majanen et al. (2011) indicate that cash payments were the primary or a secondary reason for programme participation in 60% of programmes, but non-cash financial benefits were also a key motivation for participants in 38% of programmes. Although those non-financial benefits were not specific incentives by programmes, participation was motivated by these co-benefits, such as lower input costs or higher productivity, indicating that non-cash financial incentives with similar effects are worth considering.

3.3.2.6. Non-financial incentives

Provision of non-financial benefits can also increase the likelihood of programme participation. As such, although they are at times considered co-benefits of or other motivations for participation, they can equally be considered part of the incentive package. One key non-financial benefit that has received attention is technical

[11] Rewarding Upland Poor for Environmental Services (RUPES), a regional programme of multiple project sites coordinated by the World Agroforesty Center.

assistance, which should reduce the costs of entry into a programme. Espinosa-Goded et al. (2010) provide evidence that farmers in Spain prefer programmes that include free and compulsory technical assistance. Majanen et al. (2011) similarly find that access to technical assistance is a primary or secondary motivation for ES providers to participate in 37% of PWS programmes they identified in the USA.

A key issue in programme participation in developing countries is security in land tenure. A few studies indicate that farmers with strong land tenure are more likely to participate in PES programmes (Mullan & Kontoleon 2012; Thacher et al. 1996; Zbinden & Lee 2005). Rather than deter households with insecure tenure from participating, the programme could be designed to help strengthen tenure and thus improve participation and/or decrease the level of annual payment needed. Based on designing a PES programme in Bolivia, Asquith et al. (2008) outline various pros and cons of cash compared to in-kind incentives. Ultimately, the programme offered beehives as the incentive. One of the primary reasons those are preferred is that they clearly indicated that a household's land is in use, and so help secure tenure. In later rounds of the programme, some households have explicitly requested to receive barbed wire to demarcate their land. Grosjean & Kontoleon (2009) also find that programmes that strengthen a household's land tenure security are preferred.

A variety of other non-financial incentives have received attention, particularly for programmes implemented in developing countries. Grosjean & Kontoleon (2009) find that the quality of grain and seedlings provided as part of the incentive package is one of the greatest determinants of households maintaining reforested farm area. Balderas Torres et al. (*in press*) explored a hypothetical PES programme in Mexico and report that farmers were more willing to participate if social benefits were provided by the programme, such as health, education, employment and productive projects. The focus groups carried out by Leimona et al. (2009) identify multiple non-financial incentives as desirable, including road infrastructure, farm inputs, and various public services.

3.3.3. Institutional attributes

3.3.3.1. Actors

Two quantitative studies found that a difference in actors participating in the programme will not affect the level of participation of potential ES providers in PES programmes. It appears that more often, however, differences in actors and their roles

do matter. Cook & Rabotyagov (2012) find farmers that could potentially sell water rights in Washington State, USA, are indifferent to whether or not the intermediary is a public or non-profit entity. Farmers are, however, more willing to sell to irrigation districts and less willing to sell to developers, compared to a baseline category of selling to the State's Department of Ecology. Related to actors, Horne (2006) find that forest owners are more likely to participate if the initiate a forest conservation contract. They have a significantly lower utility for contracts initiated by a forest organisation, conservation trust, or environmental NGO.

Just as resource user characteristics and programme attributes can interact to determine participation, different programme attributes can also interact. For renewing enrolment in an established avoided deforestation programme in Brazil, IIED (2012) report that generally, most respondents prefer to increase individual cash incentives over community benefits. The strength of that preference is influenced by how respondents perceived the ES buyer. If the view the organisation as a government entity, they have a stronger preference for cash over community benefits, seemingly because they believe the government should provide social benefits regardless of environmental behaviour.

3.3.3.2. Monitoring and conditionality

Following a rational agent model, it would be expected that all resource users would prefer programmes that included less monitoring. Broch & Vedel (2012) provide an example of these results, with farmers in Denmark preferring programmes where a smaller fraction of enrolled landowners would be monitored. In contrast, Peterson (2011) finds that annual verification is preferred over a spot check system where only a fraction of enrolled landowners would be checked each year. The context of the study area was one where the probability of violation is small and intent to comply exists, so the results suggest, "that the perceived fairness and social benefits of stringent monitoring outweigh any expected costs" (pg. 13). Similarly, Kaczan et al. (2013) included three levels of conditionality and related monitoring for a hypothetical PES programme in Tanzania, and the moderate level is the most preferred. The lowest level does not include on-site visits, implying that some idea of fairness and avoiding free riding makes the moderate level preferable over the low level. For the two levels that include on-site visits, the moderate one is conditional on and monitored for reducing negative actions, while the high level is conditional on and monitors specific environmental outcomes that would require improved land management. That result fits

the trend of resource users disutility of increased contractual requirements (see Sections 3.1 and 3.2 above).

3.3.3.3. Additional institutional attributes

There are a few additional attributes of interest:

- Farmers prefer PES programmes that give them a lower level of administrative burden generally (Mettepenningen et al. 2013; Ruto & Garrod 2009), and specifically during the programme application (Christensen et al. 2011; Peterson 2011).
- Kwayu et al. (2013) provide evidence that farmers in Tanzania prefer programmes that were participatory in the design phases.
- Broch & Vedel (2012) find that participation by farmers in Denmark is influenced by the purpose of the programme, and farmers have a greater preference, in order, for programmes focused on biodiversity, groundwater protection and then recreation.

3.4. Unresolved Issues in PES Design

The relatively new, but expanding literature exploring ES supplier preferences for PES design is incredibly valuable. It highlights the importance of a number of key attributes related to contract and incentive design that should inform policy decisions. Concurrently, it highlights that the optimal design of PES is dependent on who is being incentivised and the context within which a change in practices is expected to occur. In relation to the former, the existence of heterogeneous preferences both between and within studies demonstrates this need for focus on the individual ES provider.

In relation to the latter, digging deeper into individual studies reveals specific factors related to market imperfections that are influencing preferences. For example, two studies indicate that ES providers do not like the lowest level of monitoring or conditionality (Kaczan et al. 2013; Peterson 2011). That implies some sense of fairness to avoid free riding under imperfect monitoring and/or enforcement is influencing preferences. Another example is that three studies find ES providers have a preference for up-front payments (Espinosa-Goded et al. 2010; Kaczan et al. 2013; Suter et al. 2008). That demonstrates that ES providers have difficulty overcoming initial barriers of meeting the programme requirements, indicating market constraints exist, which is

not surprising considering the rural and developing country contexts in which PES occur.

As PES have become increasingly popular, three particular issues related to imperfect markets have been identified that greatly influence optimal PES design. They are market constraints, information asymmetries, and behavioural considerations. All three are relevant to PES design generally, but are particularly important to consider in developing country contexts. The remainder of this section discusses each in turn.

3.4.1. Market constraints

Payments for ecosystem services were originally conceptualised as direct payments for the output of ES or a land use that would generate that output (Wunder 2005) and they were believed to be an improvement over previous indirect approaches used in community conservation (Cranford & Mourato 2011). These indirect approaches did not directly reward environmental outcomes, but attempted to either (McNeely et al. 2005) 1) redirect labour and capital away from activities that degrade ecosystems (e.g. agricultural intensification); 2) encourage commercial activities that supply ES as joint outputs (e.g. ecotourism); or 3) raise incomes to reduce dependence on resource extraction that degrades the ecosystem. In the context of PES, 'indirect payments' are often considered the second approach, specifically reducing the cost of inputs to activities that jointly produce private and public goods or increasing the price of the private good output (Ferraro & Simpson 2002; Groom & Palmer 2010). An example is providing the plants needed to establish a shade-grown coffee system, or ensuring there is a good price for the shade-grown coffee produced.

Ferraro & Kiss (2002) argue that using direct payments for the public good output is the first-best incentive-based policy primarily because it is the most cost-effective. Based on an economic model comparing direct payments and the indirect approach of reducing the cost of capital to a joint production activity, Ferraro & Simpson (2002) conclude the same, and also show that the ES buyer and provider have opposing preferences, with the former preferring direct PES and the latter preferring indirect PES. In the context of developing countries, that result can be interpreted as a tension between environment and development outcomes (Groom & Palmer 2010) because direct payments will be more cost-effective for achieving environmental objectives,

while indirect PES will be less cost-effective for environmental outcomes, but more profitable for the presumably less-well-off ES provider.

A key assumption of Ferraro & Simpson (2002) was unconstrained, and so perfectly elastic, markets for the inputs and outputs of the joint production activity. In a series of papers, Groom & Palmer (2009; 2010; 2012) remove that assumption and compare direct PES to the indirect approach of reducing markets constraints, specifically capital constraints, of a joint production activity. Where quantity constraints exist there are situations where relaxing them can be more cost-effective than direct PES and preferred by both the principal and the agent (Groom & Palmer 2010). The chance of these results increases as 1) the return to scale of the productive activity increases towards constant (assuming diminishing returns to scale), and 2) there is input complementarity between the conservation action and capital used in the production process (Groom & Palmer 2012). At intermediate levels of returns to scale and complementarity, use of an indirect intervention may not be strictly cost-effective for conservation outcomes, but can still lead to an overall increase in welfare and so can be overall more efficient (Groom & Palmer 2012). Thus, if the ES buyer (i.e. the principal) were concerned with improving welfare alongside environmental objectives, there is a greater chance he would prefer the indirect approach.

Market constraints can also influence the outcomes of specific policies related to resource use. For example, Mexico's PROCAMPO programme was not directly intended to support environmentally beneficial actions, but to support rural farmers. In this case, incentives were decoupled from production in order to incentivise intensification, with a co-benefit of not increasing pressure on surrounding forests. The opposite occurred, however, in areas where market constraints and lack of technical assistance existed, such that extensification occurred along with a decrease in forest area (Schmook & Vance 2009).

Regarding environmental policy specifically, directly paying for a public good output, such as carbon credits, is much less cost-effective when constraints to supply of that public good exists (Vivid Economics 2010). Unfortunately, constraints have not received much attention in relation to PES programmes. An exception is China's Sloping Lands Conversion Programme (SLCP), which requires households to reforest previously cultivated land and provides cash, grain and seedlings in return. A key piece

of the logic behind SLCP is that by reducing production constraints, households can shift their labour effort away from the farm, achieving the dual objectives of reducing environmental pressures and improving income through working off-farm. Reducing production constraints did have some success in achieving these goals (Uchida et al, 2009). That result is at risk, however, due to other constraints on the reallocation of labour away from farm activities (Groom et al. 2010). Constraints can not only affect outcomes for participating households, but can influence a household's decision to participate in the programme in the first place (Mullan & Kontoleon 2012). Moving away from SLCP, some research has also focused on liquidity constraints, indicating that poor access to credit can lead to reduced participation in PES (Jayachandran 2013).

The theory and available evidence clearly identify that market constraints must be considered in PES design. One way to do this is to couple incentives with reducing market constraints. For example, a direct cash payment could be coupled with improved credit access (Jayachandran 2013). Alternatively, the incentive itself could reduce market constraints. That is the argument put forward by Groom & Palmer (2009; 2010; 2012). In effect though, these two options are one and the same. As already described in this paper, the so-called co-benefits of programme participation, such as technical assistance or improved tenure security, have been cited as a key motivation for ES providers to engage with PES in various cases. A reduction in market constraints is a viable form of PES, either as a single incentive or part of an incentive package.

The case studies in Chapter 5 and 6 both provide evidence related to overcoming market constraints. The first was designed to research a policy that couples PES with overcoming credit constraints, while the second researches preferences for in-kind or cash incentives and a result that emerges is that market constraints can influence this preference.

3.4.2. Information asymmetries

In any transfer of incentive, the buyer (or principal) has less information about the supplier (or agent) then suppliers have of themselves. That can lead to strategic or lack of action by the suppliers, such that the buyer does not achieve the intended outcome of increasing supply of the demanded private or public good or service. There are two main consequences of information asymmetries. First, adverse selection arises when negotiating an agreement. The ES buyer does not know the true cost (including

opportunity cost) to the ES supplier of meeting the environmental requirement of a PES transfer, meaning that ES buyers could be overpaying and ES providers could be extracting informational rents (Ferraro 2008). Second, moral hazard occurs after the agreement has been negotiated and can be divided into ex-ante and ex-post moral hazard (Armendáriz & Morduch 2005). In the context of PES, the former relates to whether the potential ES supplier intends to comply with the agreement, the latter refers to once compliance does occur, whether it will be maintained for the length of the agreement.

3.4.2.1. Adverse selection and PES

Adverse selection has been predominantly researched in the context of agri-environmental schemes (AES) (Chambers 1992; Bourgeon, Jayet, and Picard 1995b; I. M. Fraser 1995; Wu and Babcock 1996; Latacz-Lohmann and Van der Hamsvoort 1997; Moxey, White, and Ozanne 1999; Peterson and Boisvert 2004; Canton, De Cara, and Jayet 2009). Ferraro (2008) draws on the AES literature and other research focussed on PES, and offers three categories of mechanisms for ES buyers to reduce informational rents: targeting, screening contracts, and procurement auctions. These mechanisms address adverse selection by either collecting information (in the case of targeting), or inducing ES providers (i.e. agents) to reveal information, about their true costs of ES provision. Although all three are useful and have been used to some extent in developing countries, there are also difficulties related to the use of each mechanism. First, targeting can increase transaction costs, and the level of improved efficiency gained for that extra cost depends largely on the strength of correlation between the known attributes of the agent and actual compliance costs the agent faces (Ferraro 2008), which can be difficult to determine. Second, screening contracts are technically complex (Ferraro 2008) and thus difficult to implement in developing countries where technical expertise may be limited. It does not mean that either targeting or screening contracts should not be used in developing countries, just that their use may be limited.

Third, for PES procurement auctions, standard auction theory does not wholly apply due to unusual attributes such as "multiple units, risk-averse bidders, budget-constrained buyers, and repeated auctions over time" (Ferraro 2008, pg. 814). Latacz-Lohmann & Van der Hamsvoort (1997) demonstrate that although a discriminative-price, multiple-unit auction does improve economic efficiency (compared to a posted-price AES) it is still an imperfect revelation mechanism. The bid not only increases with

the potential ES provider's opportunity costs, but also their expectation of the maximum acceptable price. In practice, conservation auctions exist in both developed and developing countries, although such auctions are "not necessarily functioning well or free from corruption" in developing countries and do require substantial human capital to design and implement (Ferraro 2008, pg. 818).

3.4.2.2. Moral hazard and PES

Lessons on dealing with moral hazard have been provided by theoretical research into AES (Choe and Fraser, 1998 and 1999; Ozanne et al., 2001; Fraser, 2004; Hart and Latacz-Lohman, 2005), but that body of research is small, it focuses on EU AES, and it primarily analyses optimising monitoring and increasing targeting, both costly and complex tasks. Further, although theoretical analyses of these mechanisms in the context of AES indicate that they could be useful, practical experience with them is minimal.

Moral hazard is not just a problem in developed countries, and monitoring compliance can constitute a significant portion of the total transaction costs of PES programmes, particularly in small-scale and/or user-financed programmes in developing countries and rural areas where access is more difficult (Wunder et al. 2008), as such, the monitoring is sometimes inadequate (Wunder & Albán 2008) (*Table 4*), leaving ES providers with "an incentive to avoid filling contractual responsibilities" (Ferraro 2008, pg. 811). In developing countries, monitoring may be insufficient not simply due to direct costs, but also weak governance institutions.

Table 4: The cost and adequacy of monitoring contract compliance in select PES case studies. In the cases with lower monitoring costs, the adequacy of monitoring is in question. Where the adequacy of monitoring in not in question, monitoring costs are a significant portion of total costs of the programme.

Programme	**Service Provided**	**Country**	**Monitoring**		**Years**	**Source**
			Costs (% of total)	*Adequacy*		
Pimampiro Municipality	Watershed protection	Ecuador	10%	In question due to budget and personnel constraints	2001-2005	Wunder & Albán (2008)
PROFAFOR	Forest carbon	Ecuador	10%	Undetermined	2000-2005	Wunder & Albán (2008)
Birdnest Protection Programme	BD habitat	Cambodia	26%	Seemingly adequate	2005-2008	Clements et al. (2010)

With a lack of monitoring, noncompliance could become a large problem. Looking to lessons from AES in developed countries, evidence is sparse, but it suggests that noncompliance is a problem. In Europe, noncompliance was estimated to be around 25% in the UK and 33% in Germany in the early 1990s (Land Use Consultants 1995 and Hanf 1993 respectively; both as cited by Hart & Latacz-Lohmann 2005). In the US, noncompliance appeared lower, at an estimated 5% in 1997 (Giannakas & Kaplan 2001) and closer to 2% in the following years (USDA 2009). These estimates, however, are based on the US Department of Agriculture's (USDA's) Compliance Status Review (CSR), which is not publicly available and has in the past been criticised for its poor methodology, including its sample selection. In a review of compliance monitoring on farms with impacts on highly-erodible land and wetlands, the CSR was criticised for disproportionately emphasising farm tracts "with little potential for noncompliance" leading to "inflated compliance rates" (GAO 2003).

Assuming monitoring is sufficient, reducing moral hazard can be achieved through providing incentives only after ES are supplied. In some cases, PES programmes provide signing bonuses, cost sharing, or other incentives that are difficult to return if the condition is not met. In this case, adverse selection can be mitigated with the threat of penalties. There is often, however, a practical or political limit to penalties for non-compliance with environmental regulation (Heyes 2000) and a similar concern for PES, where ES providers are often relatively poor and have limited liability (Jayachandran 2013).

3.4.2.3. Lessons from microcredit

Overcoming information asymmetries is a complex issues wherever an agreement is made. Typical approaches to dealing with adverse selection and moral hazard, however, appear to be costly, complex, and difficult to implement in a rural or developing country context. An alternative approach is needed for PES that are small-scale, with a lower budget, and/or in contexts where it is particularly difficult to gain information about the potential ES supplier.

Microcredit is a well-known case of economic innovation that can overcome information asymmetries in a context similar to PES: a financial or economic transaction where the beneficiaries are often poorer, rural populations. In better-developed credit markets, lenders have more information on the borrower, in addition to

collateral or other assurance they can use to recoup what is owed if the borrower does not repay. Microcredit focuses on lending when information about potential borrowers is minimal and borrowers cannot provide security in case of default. To lend in this context, three primary economic innovations have emerged (Armendáriz & Morduch 2005): creative collateral, dynamic incentives, and joint liability.

The first economic innovation is creative collateral. There are microfinance institutions (MFIs) that require collateral to secure loans, but they tend to take a non-traditional view of what collateral is. Rather than focus on the monetary resale value of collateral, the value of creative collateral is based on a judgement of how problematic it would be for households to give it up. Thus, the value of collateral is determined by the notional value of the asset to the borrower, not the expected market value. The recourse for the bank in the case of lending default is not to seize and sell the asset, but to deny access to it by the borrower (Armendáriz & Morduch 2005).

To date, there is no experience or theoretical analysis of the use of creative collateral in any PES programme. There is a normative argument, however, for its use. A PES agreement is designed to ensure that beneficiaries receive the ES they value, which have been degraded because society traditionally values that degradation over provision. If the ES provider fails to meet the contractual obligations, it is a like-for-like recourse that they are denied access to something with notional value; something they value but others do not.

The second mechanism, dynamic incentives, involves incorporating implications for future lending into current lending conditions (e.g., one can borrow more next time if they meet all obligations to pay back the first time). The general form is that dynamic incentives offer positive incentives for compliance as opposed to negative incentives against non-compliance. There has been some research into the use of a similar mechanism in PES programmes. Yano & Blandford (2009) made the first attempt to model compliance rewards rather than non-compliance penalties in AES. Where dynamic incentives in microcredit offer future lending in return for compliance (of the current lending contract), compliance rewards in AES would offer a bonus above the original contract payment once compliance with the current contract is established.

Yano & Blandford (2009, pg. 543) find that "under certain conditions the use of compliance rewards can mitigate the problem of moral hazard in incentive-based agri-environmental programmes." The conditions that favour compliance rewards are 1) constraints on the size of penalties that can be imposed for non-compliance, and/or 2) high per farm/household costs of monitoring and enforcement. Both of these conditions are highly relevant for PES programmes in developing country contexts. As noted above, imposing penalties may not be feasible or desirable (Jayachandran 2013). Additionally, many programmes occur in forests, highlands, fisheries, or other landscapes that are more costly to monitor than relatively homogenous and accessible industrial agricultural landscapes. As such, the evaluation and piloting use of compliance rewards and more advanced dynamic incentives could be considered for PES programmes.

The third mechanism, joint liability, involves a group (often of 3-5 people) being jointly liable for the repayment of the loan borrowed by a single member of that group. If one borrower defaults, the group defaults and no more lending is offered to any member of that group. Group liability leverages the fact that group members have better information about who would be a good borrower than the lender initially has, and relies on self-selected groups to form based on that information. It also leverages the social ties between group members because they will work together to ensure that no single member defaults, either through social pressure (when the borrower has the ability to repay) or developing a side arrangement to finance repayments (when the borrower does not have the ability to repay).

There are already examples related to group liability in PES when incentives are provided to communities (e.g. Sommerville et al. 2010) or groups of jointly liable households (Yang et al. 2013) rather than individual households or farms. The need for such group payments is sometimes related to equity concerns (i.e. it is not equitable to differentiate payments at the household level), but often makes economic sense due to the nature of the natural resources being protected: open-access or common-pool resources. As uptake of PES is rapidly increasing, and especially as it is being discussed for contractual arrangements to avoid degradation of ecosystems that directly face the problem of open-access (e.g. REDD), it is time to empirically analyse jointly liable PES (JL-PES). Chapter 6 takes up this challenge and collects both qualitative and quantitative evidence of potential ES providers' preferences related to JL-PES.

3.4.3. Behavioural considerations

3.4.3.1. Incentives and pro-social behaviour

There is a large literature on incentives and pro-social behaviour that PES research and practice can draw on. That literature arose from psychology (Frey & Jegen 2001), and since gaining the attention of economists has been the subject of many behavioural experiments (Bowles 2008) and has been analysed within extended models of rationality (Bénabou & Tirole 2003; Bénabou & Tirole 2006).

The classical approach to incentives assumes that behaviour motivated by explicit economic incentives and behaviour motivated by the non-fiscal motivations is separable, specifically that a change in the incentive should not alter behaviour originally motivated by personal or social preferences (Bowles & Hwang 2008). This assumption of separability led to a large body of economic thinking focused on designing mechanisms and contracts that would leverage the self-interest of the agent to achieve what the principal demanded.

More recently, a large body of research has demonstrated that the effects of incentives and pre-existing preferences are not separable, but in fact must be considered together to determine the true, total effect of incentives and thus optimal policy design (Ariely et al. 2009; Bénabou & Tirole 2002; Bénabou & Tirole 2003; Bénabou & Tirole 2006; Bowles & Hwang 2008; Bowles 2008; Brooks 2000; DeVoe & Iyengar 2010; Falk & Kosfeld 2006; Frey & Jegen 2001; Gneezy & Rustichini 2000a; Gneezy & Rustichini 2000b; Heyman & Ariely 2004). That is not to say incentives do not work, but that economists were previously too reliant on the relative price effect of incentives (Frey & Jegen 2001). As Bowles & Hwang (2008, pg. 1817) explain, "while explicit incentives do a tolerably good job in many situations, in others performance would be improved if mechanism design took account of the effects of incentives on preferences."

A major theme in the study of pro-social behaviour is that individuals may already have an intrinsic motivation to carry out pro-social behaviour, but that those motivations may be negatively affected by the introduction of extrinsic incentives. Multiple reviews have been carried out (Bowles & Hwang 2008; Bowles 2008; Frey & Jegen 2001) demonstrating there is significant evidence of the psychological mechanisms through

which separability fails and explicit incentives crowd-out intrinsic motivations to engage in pro-social behaviour. The mechanisms can be summarised as follows:

1. Self-regarding behaviour – The provision of extrinsic incentives indicates that self-regarding behaviour is more appropriate than pro-social behaviour. That framing can occur within a specific decision context, but incentives can also induce a long-term shift in social preferences.

2. Information – Incentives can indicate to the agent that the task to be carried out is undesirable to do, and/or that the principal thinks the agent is self-regarding in relation to this task so must be paid to do it. Additionally, if incentives are known to other individuals in society, the reputational benefit[12] of carrying out pro-social behaviour is reduced.

3. Over-justification – When provided incentives, the locus of control is external, giving the agent a lower sense of autonomy and self-determination, which can degrade intrinsic motivations to perform the task.

Incentives also have the ability to crowd-in intrinsic motivations. The mechanisms that crowd-out intrinsic motivations arise when the incentive is viewed as coercive: a 'pay-off'. If framed as supportive, however, incentives can crowd-in intrinsic motivation by reinforcing, rather than degrading, self-determination, and by conveying positive information that the agent's involvement and competence is appreciated (Frey & Jegen 2001).

Social mechanisms may also interact with incentives. For example, some tasks are carried out in order to improve other individuals' perceptions of the agent—known as image motivation. If the provision is publicly known, the image motivation is damaged by receiving an extrinsic incentive, making that incentive less effective (Ariely et al. 2009). If provision of the public good is not visible, then there is no image motivation to damage, and in the absence of any other intrinsic motivations, the extrinsic incentive is very likely to increase pro-social behaviour without any dampening of its effect.

[12] Ariely et al. (2009) call this 'image motivation' and describe it as the third type of motivation alongside intrinsic and extrinsic.

That example demonstrates that there are two categories of motivation crowding: intrinsic motivations arising from the agent and those arising from the agent's interaction with society. Extrinsic incentives can crowd-out or crowd-in motivations, whatever their ultimate source. *Figure 3* compares the two outcomes in basic economic terms. In both cases the price effect exists such that when an incentive is provided and raises the price from P^0 to P^1, the supply of pro-social behaviour increases from Q^0 to Q*. If the incentive has a net crowding-out effect, the supply curve will move left, such that P^1 induces the supply of Q^{OUT}. If crowding-in occurs, the supply curve will move right and P^1 will induce the supply of Q^{IN}.

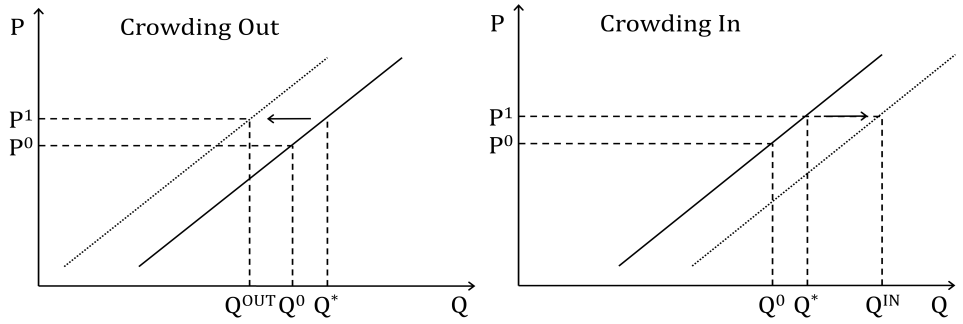

Figure 3: The supply of pro-social behaviour under motivation crowding. Adapted from Frey & Jegen (2001).

3.4.3.2. PES and pro-social behaviour

Researchers and practitioners, specifically those following an ecological or institutional economics approach and building on lessons from developing countries, have clearly highlighted the relevance of non-separability for PES design. They note the potential for crowding-out (Farley & Costanza 2010; Kosoy & Corbera 2010; Muradian et al. 2010; Sommerville et al. 2009; Vatn 2010), risk of entitlement as self-regarding behaviour becomes the norm (Farley & Costanza 2010; Sommerville et al. 2009), and potential cognitive costs of conditionality and monitoring (Farley & Costanza 2010; Jack 2009). These researchers have also noted the possibility of crowding-in intrinsic motivation through an arrangement framed as reciprocal (Farley & Costanza 2010; Vatn 2010) or a supportive co-investment (van Noordwijk & Leimona 2010). Despite this research, motivation crowding remains a largely unresolved issue in PES design (Ferraro et al. 2012; Pattanayak et al. 2010)

The evidence that is available suggests that crowding-in is most likely if PES are designed to support pre-existing preferences of the ES supplier. That is not to say that PES are best when they align with ES supplier preferences for programme attributes, but that the effect of that alignment is to increase enrolment. To reduce the risk of crowding-out, and thus increase the effectiveness of PES, they should align more broadly with supplier preferences and local norms.

In many cases, we see this phenomenon already occurring. Potential ES providers with a stronger pro-environment attitudes are more likely to adopt conservation-oriented practices (Baumgart-Getz et al. 2012) and to participate in PES programmes (Langpap 2004; Rabotyagov & Lin 2013). That does raise the question of selection bias: if those with a stronger environmental ethic are more likely to enter the programme, surely they are also more likely to carry out the activity in the absence of PES, reducing the efficiency of a PES programme. That is difficult to say, because actual participation will depend on a number of factors. For example, Ma et al. (2010) find that although the decision by Iowa soy farmers to consider enrolling in a PES programme is determined by pre-existing farmer characteristics (including environmental attitudes and previous experience with incentive programmes), the final decision to enrol is based on farm-level benefit-cost factors. Similarly, Pagiola et al. (2005) conceptualise the decision to participate in three parts: eligibility, desire and ability to participate.

While the effect on efficiency of PES potentially going to resource users that are more environmentally concerned remains an empirical question, there is one immediately apparent benefit. If a selection bias is occurring, the incentive is also more likely to be perceived as supportive rather than coercive, and crowd in rather than crowd out intrinsic motivation. Kosoy et al. (2007) report that programme participants in Central America were more likely than non-participants to carry out conservation in the absence of PES, but also that they viewed the incentive as support for their actions. These types of results, of a conservation norm being driven by other types of intervention, indicates that in some cases it may be better to consider direct cash payments as a reward for reinforcing good environment behaviour rather than as a driver of changing bad environmental behaviour (Cranford & Mourato 2011; Kosoy et al. 2007).

The idea of PES aligning with pre-existing preferences, however, goes beyond supporting resource users that already have positive environmental attitudes. A key

result from common pool resource management is that top-down, imposed—exogenous—governance structures are less effective than endogenously formed resource governance rules (Marshall 2005; Ostrom 2000). That does not mean PES must be endogenously generated, but suggests that they should at least align with pre-existing social norms to increase effectiveness. For example, as already noted above, Narloch et al. (2012) find that in a context where pro-social behaviour is more the norm, group-based incentives crowd-in motivation to carry out conservation. In contrast, where self-regarding behaviour is more the norm, household-based incentives are likely to work better.

Building on the principles that incentives can interact with motivations defined by personal preferences or social norms, there are some basic rules that can help guide PES design to make them less likely to crowd out and more likely to crowd in these motivations. Stern (2006) first reminds readers that there may be a subset of potential ES providers that do not maintain strong intrinsic motivations to provide ES. As such, an ES buyer will first want to determine which potential providers have intrinsic motivations. Stern (2006) then suggests two rules for PES design. The first is ensuring the size of the incentive is optimised to reduce the crowding-out effect. The second is framing the incentive and feedback in order to emphasise achievement and autonomy.

Regarding the first rule, Stern (2006) argues that disproportionately large incentives have a greater chance of crowding-out intrinsic motivation, in part because the salience of the incentive overrides that of non-financial motivations to act. There is conflicting evidence from psychological experiments, however, which suggest that low-level financial incentives are less effective than no incentive (Gneezy & Rustichini 2000b) or a non-cash reward of equal value (Heyman & Ariely 2004). Irrespective of these different results, both experiments highlight that the size of the incentive should be considered with respect to the pre-existing motivations of ES providers. These results, however, also point to the most prominent criterion of effective incentives: that they are supportive, rather than coercive. Field evidence from Mexico already cited indicates that low-level cash incentives were well-received because they were supportive (although the effect that had on effort was not measured; Kosoy et al. 2007). This tallies with Stern's (2006) second recommendation, which is synonymous with framing the incentive as supportive.

Evidence on motivation crowding can be reduced to three key dimensions, all of which can inform PES design (Vollan 2008):

1. Whether the external intervention is controlling or supporting
2. The degree of participants' self-determination
3. Pre-existing social norms of trust and reciprocity.

The research presented in Chapters 5 and 6 provides multiple results that are relevant for including behavioural considerations in PES design. The chapters do not carry out behavioural experiments, but instead maintain an environmental economics approach to complement the behavioural literature. They provide evidence that particular aspects of incentive design can help overcome the potential negative impacts of more traditional incentives (i.e. direct cash payments).

3.5. Summary

Despite the consensus that incentives are the core of all PES programmes (see Chapter 2), there has paradoxically been no coherent consideration of the optimal design of such incentives. The review presented here aims to provide a starting point for that discussion. It first briefly reviewed both the adoption and participation literatures as the historical and intellectual starting point for such a discussion. It then systematically reviewed the evidence that is available on potential ES supplier preferences for contract and incentive attributes. Understanding those preferences will allow ES buyers to balance supplier preferences with other considerations to design more effective, and cost-effective, PES. Finally, the review focuses on three more complex issues that have emerged as particularly important for PES in developing countries: market constraints, information asymmetries and behavioural considerations. Compiling lessons and information across the various strands of literature reviewed indicates that there is potential for strong synergies among multiple motivations for specific attributes when designing PES.

CHAPTER 4

TYPOLOGY

A Typology of Payments for Ecosystem Services: The case of payments for watershed services

4.1. Introduction

Along with various definitions and conceptualisations of PES, there has been a recurring discussion of what is PES or PES-like (Wunder 2005; Muradian et al. 2010). Many PES researchers and practitioners, particularly in developing countries, perceived a greater prevalence of PES-like programmes than true PES. That was a key motivation for multiple re-definitions and re-conceptualisations of PES driven by experience in developing countries (Muradian et al. 2010; Sommerville et al. 2009; Swallow et al. 2009; van Noordwijk & Leimona 2010). So, as PES has been re-defined and re-conceptualised it is worth now considering what is meant by the term 'PES', what comprises this broad category of positive incentives, and what types of PES are most prevalent in developing countries.

Typologies in the social sciences tend to be derived based on conceptual or theoretical validity and are used to label particular observations into different categories (Ahlquist & Breunig 2012). The same is true in relation to analysis of economic instruments for biodiversity (BD) and ecosystem services (ES), and PES specifically. Two basic approaches are observed.

The first aims to understand economic instruments by focussing on a small number of key characteristics and visually representing the universe of possible instruments. For example, Lockie (2013) described market-based instruments (MBIs) based on a two-by-two matrix of 1) whether the benefits accrue privately or publicly, and 2) whether the desired action was within the ES provider's normal duty of care. Muradian et al. (2010) focussed on PES and conceptualised them based on a three-dimensional spectrum that included the importance of the economic incentive, the directness of the transfer of the incentive between ES buyer and seller, and the degree of commodification of nature implied in the transaction.

In another approach, what can more rightly be called a typology is defined based on a complex, but opaque, set of characteristics evaluated by expert judgement. Pirard (2012) classified MBIs for BD and ES based on "…their intrinsic economic characteristics and…relations to markets" (pg. 64). He created a typology that included direct markets, tradable permits, reverse auctions, Coaseian-type agreements, regulatory price signals, and voluntary price signals.

Specifically regarding PES, Scherr et al. (2006) and Smith et al. (2006) both described the same four types of programmes: private payment, public payment, cap-and-trade, and certification schemes. There is little clarity on how this typology is defined, with the authors respectively stating it is based on "basic institutional structure" (pg. 5) or "degree of government intervention in administration" and "characteristics of the buyers and sellers" (pg. 42). Swallow et al. (2009) depart from the terminology of PES and present a typology of what they call compensation and rewards for environmental services (CRES). Compensation comprises 1) restitution for damages to the environment (a negative incentive) and 2) a tradable permit system (negative for some, positive for some), while rewards comprise 3) reward for threat reduction and 4) reward for conservation of or investment in an ecosystem.

Following a similar approach, some authors have moved away from describing a typology of policy instruments, but instead describe a typology of approaches or paradigms for PES. Building on the now-classic binary characterisation of PES as user-financed or government-financed (Engel et al. 2008), Schomers & Matzdorf (*in press*) described three approaches to PES as the Coaseian approach (akin to user-finance), the Pigouvian (or standards and fees; akin to government-finance) approach, and a catchall category for all other approaches. Van Noordwijk & Leimona (2010) built on their own experience and, with a focus on conditionality, defined three paradigms of PES: commoditised environmental services, compensating for opportunities skipped, and co-investment in stewardship. These authors used more than conditionality in defining their typology, but did at least provide a clear discussion of types of conditionality, which is the key defining characteristic of their different paradigms.

The conceptualisations and typologies have been highly informative and helpful in understanding economic instruments for BD and ES, and specifically, PES programmes.

Yet despite agreement that incentives are at the core of all PES programmes, little effort has been made to define the different types of incentives used. That is important, particularly as the conversation defining and conceptualising PES has questioned the relevance of economic incentives. Muradian et al. (2010) introduce the degree of importance of the economic incentive as a defining characteristic of PES programmes, and various other authors have now accepted their definition and conceptualisation (e.g. Farley & Costanza 2010). At the same time, the list of possible motivations for potential ES providers to participate in such programmes has expanded. For example, authors are suggesting that even if a price effect (i.e. a cash incentive) motivates participation, other incentives are also important such as receiving technical assistance or non-cash economic benefits (Majanen et al. 2011).

As demonstrated in Chapter 3, there is increasing discussion in the PES literature that multiple incentives or benefits are inducing ES providers to participate in PES programmes. The aim of this chapter is to better understand those types of incentives by developing a typology, and to the degree possible identifying which types are used in developing countries. The approach is novel in two ways. First, where other typologies of PES categorised them based on institutional or market characteristics, the approach here is to define a typology based on incentive attributes. Programmes often offer more than one clear incentive, for example, cash incentives plus technical assistance. As such, the typology will more precisely define incentives as incentive packages. Second, other typologies have been qualitatively developed. Here, a model-based method is used, although it is still exploratory in nature so open to some interpretation.

Developing a typology that is transparent regarding variable selection and approach, and most importantly, takes an incentive-focused approach, is highly relevant for the PES literature. It provides an objective view on defining what PES actually are, helping to overcome the PES and PES-like debate. More directly relevant to policy design, it provides objectively defined categories that permit programmes that are similar to learn from each other. As discussed more in later sections of this chapter, the typology highlights that sometimes-similar incentives are at times implemented through very different institutional settings, while other times very different incentives are provided through programmes that have similar institutional settings.

Following this introduction, the second section describes the model-based approach to classification implemented here, while the third section presents the raw model results. The fourth section discusses those results and presents the typology, followed by the fifth section that discusses the typology more broadly. The sixth section concludes.

4.2. Methods

4.2.1. Data collection

Bennett et al. (2013) is the second in a series of reports on the state of incentive-based programmes for watershed services around the world. The data collected for that report is the basis for the data used to develop the typology here. A full description of data collection is presented in that report, but the process is briefly described here.

The known set of incentive-based programmes for watershed services were identified by 1) gathering the list of programmes previously surveyed in the first report (Stanton et al. 2010), 2) carrying out desk-based research, and 3) consulting experts with experience and knowledge of such programmes globally or in particular regions.

Managers of the identified programmes were contacted and asked to complete a survey that was primarily administered through an online platform. In some cases, the online format was not possible for programme managers to complete due to a lack of computer or Internet access, or it was culturally deemed not optimal. In these cases, the survey was administered over the phone and with the support of regional experts in Latin America, China, and the Western United States. Where information on a particular programme was still lacking, it was collected through one of two modes. A significant amount of the information was reported in publicly available documents, or where it was not publicly available, follow-up contact was made with the programme managers.

The variables of data collected for Bennett et al. (2013) focused more on institutional characteristics of a programme, so did not fully align with the variables of interest for a typology of incentives. As such, significant additional coding was carried out specifically for this chapter by reviewing the open-ended survey responses by programme managers and publicly available literature.

A number of observed programmes in the initial database were based on negative incentives so did not fit the conceptualisation of PES as positive incentives, or were

sub-national replications of the same programme.[13] These programmes were removed from the database, leaving 138 programmes that could potentially be defined as PES. Seven were programmes where user fees or other levies (e.g. earmarked sales tax) were paid to a public or civil sector organisation dedicated to environmental protection that directly carried out this conservation. These programmes were fundamentally economic instruments to raise funds, not a supply-side innovation as PES is defined in Chapter 2. Additionally, 11 programmes could easily be categorised as programmes that only used cash incentives to pay for partial or full property rights. It is unclear if transfers of property rights should be considered PES. Some researchers have discussed conservation easements as a form of PES (Wunder 2005; Kemkes et al. 2010), but if foregoing partial property rights is PES, should outright land purchase for the purpose of conservation also be considered PES? The transfer of property rights does not quite fit the essence of PES. Additionally, that transfer is only feasible in certain parts of the world with strong legal systems, and could receive significant normative resistance in developing countries. Due to this ambiguity, but also because property rights transactions for cash payments are easily categorised as a separate type of incentive, programmes based on property rights were removed from the dataset. They could easily be reintroduced as a separate type of incentive if later desired. The final dataset comprised 120 payments for watershed services (PWS) programmes.

4.2.2. Latent class analysis

Cluster analysis is famously defined as the art of finding groups in data (Kaufman & Rousseeuw 2005) and is a common approach to classification or typology development. The aim of cluster analysis is to take sets of data and identify groups of individuals that are similar in many characteristics, but dissimilar from individuals that are in other groups. There are three methods: hierarchical, partitioning, and model-based clustering (MBC).

When data availability permits it, MBC is the preferred method because it (Ahlquist & Breunig 2012) meets three characteristics:

1) It easily enables understanding of uncertainty of the clustering results (e.g. observation x is placed in cluster 1 with 90% certainty);

[13] This is most relevant for China, where the national forest ecosystem protection fund (FECP) provides incentives alongside provincial FECPs.

2) It uses statistical tools to aid in model selection, which also helps identify the number of clusters in the data; and
3) It can accommodate a large range of cluster shapes.

Beyond methodological preferences, there is also evidence that MBC performs better than other methods (Magidson & Vermunt 2002).

Latent class analysis (LCA) is a special case of MBC used for categorical data. It models a population as a finite mixture of probability distributions of the number of clusters specified at the start of analysis.

Equation 1: Latent class model

$$x \sim \sum_{g=1}^{G} (\pi_g \prod_{i=1}^{k} \prod_{j=1}^{d_i} p_{ijg}^{1\{x_i = j\}})$$

Equation 1 presents the model used in LCA, where:

- g is a group of observations (i.e. cluster/class), $g = 1,\ldots,G$ and G is the total number of groups;
- i is a variable included as a manifest variable in the analysis, and $i = 1,\ldots,k$; and
- j is a categorical value of variable i, and $j = 1,\ldots,d_i$ based on the number of possible discrete outcomes variable i can take.

The estimated parameters are p_{ijg} and π_g, such that:

- p_{ijg} is the probability of the ith variable taking value j in group g, where $1\{x_j=j\}$ is the indicator function that takes value 1 if the variable does take the value j and 0 if not; and
- π_g is the proportion of group g in the population, where $0>\pi_g>1$ and $\sum_{g=1}^{G} \pi_g = 1$

The analysis uses an expectation-maximisation (EM) algorithm to predict the parameters of the mixture model. The distribution of each cluster will be defined by the combination of estimated values of p_{ij} within each group g, with the overall population characterised by the mixture of these distributions.

The analysis presented here was carried out using the poLCA software package in the R statistical computing environment (Linzer & Lewis 2011a; Linzer & Lewis 2011b). poLCA was chosen because it is specifically designed to deal with observed data that is categorical in nature, it easily extends to include simultaneous estimation of a multinomial (MNL) regression of covariates that predict cluster membership, and it easily provides visual results for the predicted probabilities derived from that MNL regression.

4.2.3. Model specification

There are two key aspects to model specification in LCA: selecting the number of classes and the manifest variables to include as defining the classes.

Determining the number of classes can be based on some theoretical expectation, but one reason to choose MBC over other types of clustering analysis is that model selection decisions can also be based on statistical measures of model fit. In this case, the Bayesian Information Criterion (BIC) (Schwarz 1978) was the measure of model fit used (*Equation 2*). The BIC relies on the maximum log-likelihood (Λ) but penalises an increase in the total number of estimated parameters (Φ) in relation to the number of observations (n). Comparing models, those with a lower BIC are considered a better fit for the data, so the aim in model specification is to minimise the BIC.

Equation 2: Bayesian Information Criterion

$$BIC = -2\Lambda + \Phi \ln(n)$$

The BIC was chosen for three reasons. First, it is one of the most, if not the most, commonly used measure of model fit in LCA. Second, it has a relatively strong penalty for additional parameters, meaning it will penalise additional classes. The data set here is small, and so it is prudent to not include additional classes unless there is reasonable evidence they provide additional information. Using the BIC pushes the analysis to be conservative in this regard.

Third, our data set was too small to use any of the also popular chi-square goodness of fit tests.[14] That does not mean the LCA is invalidated in any way: the data is simply a

[14] When data sets are larger, a chi-squared goodness of fit measure is often used that compares observed to predicted cell counts. Cells in this case are a category of one particular sequence of categorical

small, but highly variable set. It does, however, invalidate the use of any chi-square goodness of fit to guide the model choice related to the latent classes.

The second aspect of model specification is selection of the manifest variables. As with linear and non-linear regression models, variable selection is ultimately at the discretion of the researcher who may base it on theoretical or statistical evidence. Here, selection of manifest variables was fundamentally founded in theory. As presented in Chapter 3, a number of variables have been indicated as possibly significant factors in determining an ES provider's willingness to participate in a PES programme. That provides an empirical basis for the assumption that these attributes are an important characteristic of the incentive package a potential ES provider faces. As such, the approach to variable selection here was to include as many of those previously identified attributes as data availability would allow. Where the exact same variables were not available, a conceptually similar one was included. For example, the strength of restriction identified in Chapter 3 is approximated in this chapter as the type of action that is required: restrictive or building. The incentive variables that were included are presented in *Table 5*, along with a description of each possible categorical outcome.

Although the variables were included based on theory, a statistical validity check was carried out. Following the initial steps proposed by Dean & Raftery (2010) the full LCA model was defined based on the number of classes with the lowest BIC (4 classes in this case). The variance of each variable was then calculated, and the variables were ranked by variance. Two variables—restrictive and technical assistance—had a variance less than 0.25. From previous research on the same data set (background research to Bennett et al. 2013)[15], a rule of thumb for this dataset is that variables with variance greater than approximately 0.25 tend to substantively affect the classification estimation. As such, these variables with a variance lower than 0.25 were tested through an exclusion step (see Dean & Raftery 2010), but found worth including in the model.

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outcomes of the variables: a particular sequence of *j*. The distributional assumptions of using chi-squared goodness of fit criteria are not met, however, if too many cells contain too few observations. One rule of thumb is that no more than 10-20% of the cells should contain fewer than five observations for the a chi-square test to be used (Linzer & Lewis 2011b). In our data, nearly all of the cells had an observed count lower than 5, the average was 1.56.

[15] Also carried out by the Ph.D. candidate, Matthew Cranford, but focussed on institutional attributes of PES programmes that were of interest to the authors of the parent report (Bennett et al. 2013).

Table 5: Variables included in LCA of PWS incentive packages.

Variable (i)	Variable Description	Categorical Value (j)	Category Description
Categorical variables – each programme can only have one categorical outcome			
Upfront payment	Whether all or a portion of the incentive is provided at the beginning of the agreement period.	None	No portion of the incentive package is provided upfront
		Cost	All or a portion of the incentive package is provided upfront, but for the specific purpose of covering the direct costs of ES provision faced by the provider
		Signing Bonus	A portion of the incentive package is provided upfront without an explicit purpose (e.g. it could based on area enrolled in the programme)
		All	All of the payment is provided upfront, but not related to costs
Tim-ing	The singular or recurring nature of the incentive	One-off	The incentive package is received once
		Intermittent	All or some of the incentive package is received multiple times, with no clear schedule
		Interval	The primary incentive is received on a regular basis, typically annually
Defined Length	Whether or not the agreement of ES provision has a defined duration.	Open-ended	The agreement has no defined period
		Defined	The agreement to provide ES has a specific length (usually expressed in years) defined in the contract or other signed agreement document
Basis	The measure of success by which the incentive is provided	Practice	Incentive is provided based on ES provider carrying out agreed practices or actions
		Level of ES	The incentive is provided based on a specific measure of ES provided

Table 5 (cont.): Variables included in LCA of PWS incentive packages.

Variable (i)	Variable Description	Categorical Value (j)	Category Description
Binary variables – programmes can have more than one categorical outcome, so each categorical value is coded as binary			
Actions	The type of actions the agreement requires the provider to undertake	Restrictive	Agreement requires provider to reduce or stop their use of a natural resource
		Improving	Agreement requires provider to improve or augment a natural resource
Incentives	The types of final benefits received by the ES provider	Cash	Provider receives cash that is intended to be an incentive and has no specific purpose
		Technical Assistance	Provider receives technical assistance or other training that directly or indirectly facilitates their ability to provide ES
		Non-cash	Provider receives direct in-kind support to their household and/or is the beneficiary of community benefits provided as part of the PES programme
		Inputs	Provider directly or via a cash transfer (e.g. cost-share) receives inputs required to provide ES

In addition to the incentive attributes, the database included two further categories of information. The first category is basic PWS programme information (*Table 6*). Variables from this category were each separately tested as covariates in the LCA regression model. Due to the small sample size, there was a risk of over-fitting the model. As such, variables were only retained in the model if their coefficient had a p-value < 0.05 for at least two of the alternatives in the MNL, but the BIC score for the model including them was lower than that without them. Additionally, only this category of variables was tested because a clear causal theory can be developed for each variable.

Table 6: PWS programme information tested as covariates to the LCA through a simultaneous MNL

Variable	**Data Type**	**Possible Values**
Year Established	Continuous	1973-2012
Regional Location	Categorical	Africa Asia Europe US/Canada Latin America and the Caribbean Oceania
Country Wealth	Continuous	Ln(GNI/Capita) in 2011, current USD [6.15-11.24]
Additional Objectives	Binary for each option	Biodiversity benefits Carbon sequestration and/or storage Landscape beauty Welfare improvements

Year established is included because the experience and discourse on PES has changed drastically during the past couple decades. It is reasonable to hypothesise that such change in experience and thinking could affect the types of incentive packages that are used. Similarly, experience and discourse on PES are often perceived as different between geographic regions, and 'regional location' is included to account for regional and cultural factors that affect incentive use that are not accounted for in other variables. Using country for this purpose was considered, but only a single programme, or a small group of highly similar programmes, represents some countries. As such, using country could lead to spurious results, so region is preferred. Additionally, PES and other sustainable development policies are typically discussed by region, so this level is most broadly useful.

That also relates to the measure of wealth, which is the gross national income (GNI) per capita of the country in which an observed PES programme is located. There would have been perfect correlation between country and level of wealth. In contrast, although

there is some correlation between region and wealth, there is also diversity that can permit interesting results to emerge. Specifically, there is noticeable diversity in wealth for countries in Africa, Latin America and particularly in Asia, where the largest range of wealth is observed in the data set. This research has a focus on developing countries, so it is helpful to include the wealth effect because it is a proxy for level of development. As described in Chapters 2 and 3, various factors related to developing country contexts could affect the use of incentive type.

It is also worth noting that Ln(GNI/capita[16]) was chosen as the measure of wealth to align with the World Bank country categories defined by GNI/capita: low income, lower middle, upper middle, and high income countries. Other measures, including a linear approximation based on the country categories (i.e. 0-3) and the absolute value (GNI/capita) were considered, but the natural logarithm transformation was chosen because it allows a continuous variable to be used, but one that aligns with the reality that there are few countries at the top end of the absolute scale of GNI/capita. The results are visually represented below, so this characteristic is useful for interpretation. The results were also tested with those other measures and found to be effectively the same.

Whether or not a programme had environmental objectives in addition to watershed improvements was also considered. Data was collected for three secondary environmental objectives (biodiversity, carbon services, landscape beauty) and one social objective (welfare improvement/poverty reduction). A possible causal link is that programmes with specific secondary objectives would prefer different types of incentives. For example, those with a biodiversity objective might more often provide inputs to ES provision, while one with a welfare objective might more often provide non-cash incentives.

In addition to basic information about the programme, the other additional category of information is the institutional context through which the incentive is transferred. It includes the types of actors paying for or providing ES, the motivation for paying or providing, and the exchange arrangement through which the incentive is transferred

[16] Gross National Income (GNI) per capita was retrieved from http://data.worldbank.org/. Data from 2011 is used because it is the latest year with an estimate for all countries represented in the PWS data.

(*Table 7*). These variables are not *a priori* hypothesised to be significant covariates because they are highly context dependent, meaning there is little basis on which to expect there is a consistent causal link to incentives used, and they are hard to measure. The example previously described of Brazil in Chapter 3, where the perception of the payer changed the preference of incentive type is a good example here too (IIED 2012). From the data available it is impossible to say how ES providers would perceive the ES payer being a civil society organisation compared to a public sector agency, and how that would change the type of incentives provided. That would require surveying the ES providers in each programme. As such, these variables are not included in the model, but are instead used to present descriptive statistics of the classes, which are defined by incentive attributes.

4.3. Results

As described in the previous section, an LCA was estimated where classes were defined based on the incentive attributes in *Table 5*. The LCA was simultaneously estimated with an MNL where the programme variables described in *Table 6* are used to predict the probability of observing each class of incentive in a given context (i.e. with a specific combination of programme variables). Additional institutional variables described in *Table 7* are outside the model, and are the basis of descriptive statistics developed to understand the institutional context in which different classes of PES are used. Each set of results—LCA; MNL and post-estimation analysis; and descriptive statistics of institutional context—are presented in turn.

4.3.1. LCA results

Models with 1-8 clusters were estimated including all variables over one hundred iterations with random starting values for the parameters. The iteration with the maximum log-likelihood was the final model taken to represent the population when modelled with that number of classes.[17] Based on the BIC, the optimal model contained four classes (*Figure 4*).

[17] To ensure validity of these results, estimation for the model with the optimal number of clusters and models with one more or less cluster were all re-run with 500 iterations. They all indicated a best-fitting model with the same BIC and log likelihood as those run with only 100 iterations.

Table 7: Institutional variables used to develop descriptive statistics

Variable (i)	Variable Description	Categorical Value (j)	Category Description
Payer	Type of actor that is ultimately funding the provision of ES	Polluter	An entity that directly adversely impacts provision of watershed services
		Beneficiary	An entity that has use value of the watershed services provided
		Public sector	A government entity that supports the provision of public goods, but does not directly impact or use the watershed services being provided
		Civil sector	A civil-sector entity that supports the provision of public goods, but does not directly impact or use the watershed services being provided
Payer Motive	Type of motivation the payer has to participate	Mandatory	Regulation requires specific actors to pay for ES provision
		Levy	An specific tax or charge requires beneficiaries to pay for ES provision
		Compliance	The payer has chosen to meet regulatory requirements through an incentive-based intervention
		Voluntary	The payer funds the incentive on a wholly voluntary basis
Provider	Type of actor that is receiving the incentive package	Individual	An individual
		Family unit	A household or farm
		Community/ Group	A group of households or farms tied by social bonds, e.g. a village or farmer cooperative
		Business	A private sector business
		Civil sector	A civil society organisation
		Public	A government agency, including municipal and city governments
Provider Motive	Type of motivation the provider has to participate	Mandatory	Regulation requires specific actors to provide ES, but compensates or supports them in doing so
		Compliance Support	Providers have obligations that they have chosen to meet through ES provision
		Regulatory carrot	Providers have a regulated baseline, but are rewarded for achieving more
		Voluntary	Providers participate on a wholly voluntary basis
		Mission	Provider has an organisational mission to provide ES (typically civil or public sector)
Ex-change	Arrangement through which incentive is transferred	Bilateral	Direct transfer of resources between payer and provider (possibly with a facilitating intermediary)
		Trust	Payer gives funds for provision of ES to a third party that decides how and whom to pay to provide ES
		Bank	Actions to provide ES are taken prior to payment to generate a pool or bank of ES benefits or credits
		Market	An arrangement in which the transaction between payers and providers occurs in a common forum

Table 7 (cont.): Institutional variables used to develop descriptive statistics

Variable (i)	Variable Description	Categorical Value (j)	Category Description
Other Actions	Other interventions included to provide ES	Water rights	The payer acquires water rights through purchase, donation, or both
		Easement	The payer purchases conservation easements on private land
		Land purchase	The payer purchase land, and all bundled rights, for the purposes of watershed conservation
		Direct invest	The payer also directly carries out activities to provide ES
		PS-PS	Point source (PS) to PS water quality trading occurs alongside the PS to non-PS trading coded as PWS

Although models with more than four clusters were not statistically optimal, the BICs of the 4- and 5-cluster model are 1597.92 and 1606.85, respectively, a difference of 8.93. A proposed rule for differences in BIC is that a difference of two is not worth mentioning and a difference of >10 is strong evidence for one model being preferred over another (Dean & Raftery 2010). As such, the 5-cluster model is not likely to be statistically optimal, but cannot be completely rejected. It may contain information useful to the exploratory research here, and so both the 4- and 5-class models were carried forward.

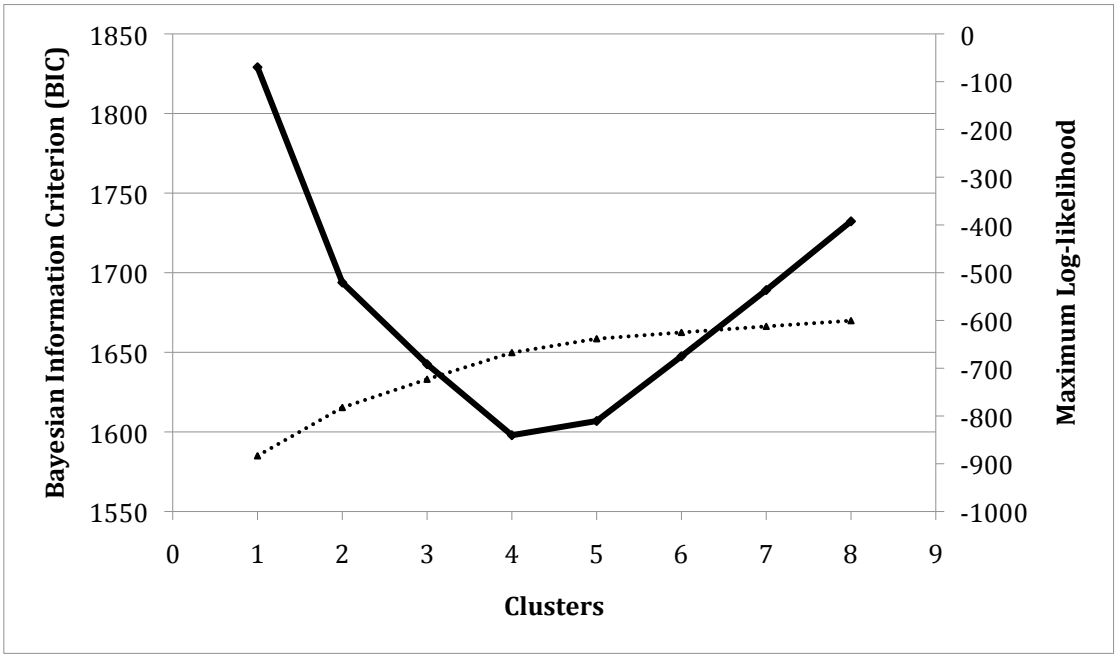


Figure 4: Bayesian Information Criterion (BIC; solid line) and maximum log-likelihood for basic LCA models (i.e. without covariates; dashed line) with 1-8 clusters.

Table 8: Estimated parameters of the four types of incentive packages as determined by LCA, N=120. Values in parenthesis are based on the alternative 5-class model and presented for comparison.

		Class➔	**1**	**1a**	**1b**	**2**	**3**	**4**
Variable ⬇		*% of population in class (π_g) ➔*	*0.36*	*(0.09)*	*(0.27)*	*0.26* *(0.27)*	*0.24* *(0.23)*	*0.14*
Upfront	None		0.41	(1.00)	(0.16)	0.84	0.89 (0.93)	0.00
	Cost		0.55	(0.00)	(0.75)	0.00	0.04 (0.03)	0.00
	Signing Bonus		0.02	(0.00)	(0.03)	0.16	0.03 (0.04)	0.00
	All		0.02	(0.00)	(0.06)	0.00	0.03 (0.00)	1.00
Timing	One-off		0.73	(1.00)	(0.68)	0.00	0.07 (0.04)	0.88
	Intermittent		0.09	(0.00)	(0.12)	0.00	0.55 (0.57)	0.00
	Interval		0.18	(0.00)	(0.19)	1.00	0.38 (0.39)	0.12
Length	Open-ended		0.53	(0.64)	(0.47)	0.65 (0.66)	0.83 (0.85)	0.00
	Defined		0.47	(0.36)	(0.53)	0.35 (0.34)	0.17 (0.15)	1.00
Basis	Practice		0.58	(0.00)	(0.78)	0.87	1.00	0.06
	Level of ES		0.42	(1.00)	(0.22)	0.13	0.00	0.94
Actions*	Restrictive		0.12	(0.00)	(0.19)	0.63 (0.60)	0.58 (0.57)	1.00
	Improving		0.95	(1.00)	(0.94)	0.64 (0.66)	0.79 (0.78)	0.00
Incentives*	Cash		0.50	(1.00)	(0.28)	1.00	0.24 (0.25)	1.00
	Technical Assistance		0.50	(0.27)	(0.56)	0.27 (0.28)	0.72 (0.75)	0.24
	Non-cash		0.05	(0.00)	(0.10)	0.19	1.00	0.00
	Inputs		0.66	(0.00)	(0.90)	0.00	0.49 (0.50)	0.00

* For each observation, multiple categorical outcomes were possible for these variables and each category was coded as a binary variable. As such, the sum of the probability parameters can be >1.00.

With the number of classes of interest defined, all programme information identified as a possible significant covariate was tested in a LCA regression model[18] after 500 iterations.[19] In this model, both the LCA defining the classes and a MNL regression of covariates predicting class membership are simultaneously estimated. Nearly all of the covariates were included in the final model. The binary dummy for landscape beauty was excluded because it was not significant for any of the MNL alternatives. Additionally, the binary dummy for carbon benefits was also excluded. Although it was found to be significant for two of the alternatives in a 4-class model, it was highly insignificant for the third. A 4-class model excluding it was tested and found to have a BIC decreased by seven, so the variable was not reintroduced.

Throughout the model specification process, the LCA parameters remained close to stable with, for example, π_g never fluctuating more than 0.02 away from the values in the final model. All LCA parameters are presented in *Table 8* for both a 4-class model (not in parenthesis) and a 5-class model (in parenthesis). The first row gives each class a number, simply for identification purposes in the remainder of this chapter. The second row presents π_g, the estimated proportion of the population in each class. The columns under each class present p_{ijg}, estimates of the proportion of individual cases in a class that have the given attribute (rows 3 to bottom) as described in *Table 5*.

As indicated by comparing the 4-class and 5-class LCA parameter values, the 5-class model identifies three of the same classes as the 4-class model. The largest class in the 4-class model, however, is not well defined by the LCA parameters. Specifically, there are very few p_{ijg} over 0.75, and many pairs of p_{ijg} around 0.50. That indicates that there are no strong defining characteristics of this class; it is still highly heterogeneous. In place of that poorly defined class, the 5-class model identifies two well-defined classes without substantively affecting the parameters of the other three classes. Further, post-estimation analysis indicates that the same observations predicted to be in class 1 under the 4-class model are predicted to be in class 1 or 2 in the 5-class model. One of the

[18] Also known as a "latent class model with covariates" or "concomitant-variable latent class analysis" (Linzer & Lewis 2011b, pg. 4)

[19] Linzer & Lewis (2011b) state that a model should be repeated a handful of times to ensure that a global maximum is found instead of a local maximum and demonstrate that 500 iterations is more than sufficient to find the global maximum (note: the authors describe this process of iterations as 'repetitions' of model estimation, reserving 'iterations' for the EM algorithm).

additional classes in the 5-class model is the smallest of all classes estimated. The reduced statistical power of the 5-class model is likely due to having a small amount of data on that particular class. That also explains why it is difficult to identify which covariates are significant for this class in the MNL model, which would further reduce the BIC measure of fit.

It is believed that if more observations were included, the 5-class model would at least not be rejected in favour of the 4-class model and may even be preferred over it. Further, the exploratory nature of this work means any additional, well-defined class is of interest. As such, the 5-class model will be used to describe the typology of PES incentive packages. For post-estimation analysis, however, the 4-class model will be used. That is because the predicted probabilities in post-estimation are predictive in nature, not exploratory. They are derived from the MNL coefficients, so it is prudent to use those from the 4-class model that has a better statistical measure of model fit for the observed data.

4.3.2. MNL results and post-estimation analysis

The MNL coefficients are presented in *Table 9*. The raw results are mostly informative in identifying the programme variables that are significant for predicting different classes. The results, however, are all relative. They indicate the significance of any given variable on the probability of the base class, in this case class 1, being observed compared to any other class. From the MNL coefficients, predicted probabilities of class membership can be estimated, which are more informative than relative MNL coefficients. This was implemented with the aim of understanding which types of incentives are preferred in which regions, specifically with regard to a change in wealth within that region. The results for the 4-class model are presented graphically for Asia, Latin America and Africa in *Figure 5*, *Figure 6* and *Figure 7* respectively.

Across all predicted probabilities, the year is input as 2011, to align with the available data for wealth from the same year. Additionally, for each region a separate decision was made about whether or not to assume the typical PWS programme in that region had a biodiversity or welfare objective. If the majority of observed programmes from that region did have an additional objective, the predicted probabilities are estimated with that objective included. The situation for each region is indicated in the caption for the respective figure below.

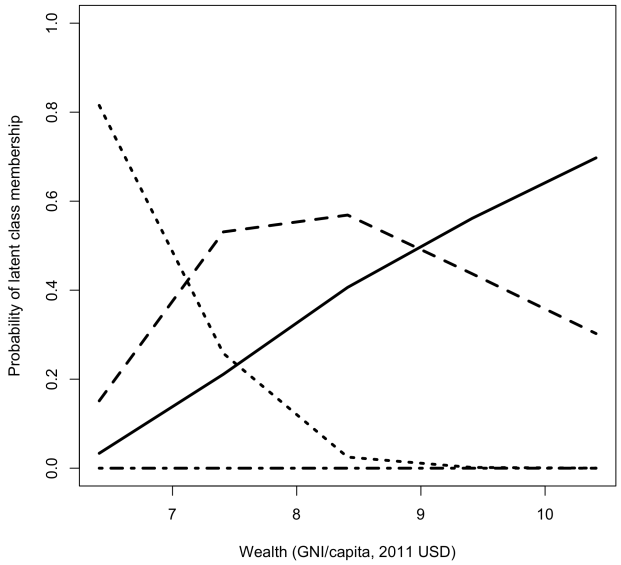
Finally, for each region, the x-axis for wealth, measured as Ln(GNI/capita) in 2011 (current USD), is constrained to the region-specific range of values observed in the data set. That means that Asia provides the most useful overall picture of how predicted probabilities for different incentives change as wealth increases. It is helpful to view the predicted probabilities of the other two regions, but any discussion of these should be more cautious. Although there are a reasonable number of observations in Latin America, the range of wealth is narrower than in either other region, and although the range of wealth observed in Africa is greater than Latin America, only four African PWS programmes were observed in this data set.

As a robustness check, the same post-estimation analysis was done for the 5-class model, and although the values were different (as would be expected with different MNL coefficients) the figures took the same shape and demonstrated the same relative dynamics between the different classes. The small additional class introduced in the 5-class model is only observed in developed countries (primarily the US) and that line of the graph overlapped with the line of Class 4 in all figures of predicted probabilities for that model. Additionally, class 1b of the 5-class model mimicked the dynamics of class 1 in the 4-class model. That is expected since class 1b is not only larger than class 1a, but is the largest of all classes.

Table 9: Estimated coefficients for MNL of class membership, 4-class (left) and 5-class (right) models

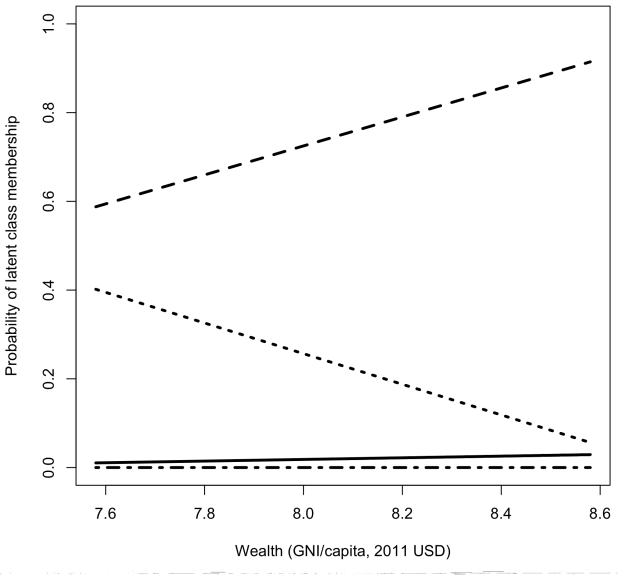
Variable	**Coefficient**	**SE**	**P**	**Coefficient**	**SE**	**p**
Class 2 compared to 1				*Class 2 compared to 1a*		
(Intercept)	-0.006	0.004		-0.003	0.002	
Asia	0.566	0.364		0.313	0.297	
Europe	1.372	0.636	*	1.204	0.271	***
Latin America	1.718	0.349	***	0.031	0.310	
North America	-2.580	0.526	***	-2.033	0.272	***
Oceania	0.003	0.019		0.030	0.090	
Ln(GNI/capita)	-0.586	0.296	(*)	-1.251	0.250	***
Year	0.003	0.002	(*)	0.008	0.001	***
Poverty	-1.401	0.492	**	0.189	0.312	
Biodiversity	0.653	0.431		-0.575	0.314	(*)
Class 3 compared to 1				*Class 3 compared to 1a*		
(Intercept)	0.005	0.005		0.005	0.002	*
Asia	-2.734	0.224	***	-1.045	0.190	***
Europe	-0.316	0.002	***	0.105	0.002	***
Latin America	1.673	0.223	***	0.821	0.174	***
North America	0.052	0.002	***	-0.242	0.001	***
Oceania	-0.010	0.000	***	-0.010	0.001	***
Ln(GNI/capita)	-2.992	0.564	***	-3.183	0.392	***
Year	0.012	0.002	***	0.014	0.001	***
Poverty	1.227	0.304	***	2.127	0.252	***
Biodiversity	0.776	0.344	**	0.218	0.304	
Class 4 compared to 1				*Class 4 compared to 1a*		
(Intercept)	0.002	0.001		0.008	0.002	***
Asia	0.083	0.005	***	0.871	0.003	***
Europe	-2.270	0.002	***	-2.227	0.002	***
Latin America	-0.615	0.001	***	0.177	0.004	***
North America	3.260	0.005	***	2.010	0.005	***
Oceania	-0.142	0.000	***	-0.085	0.000	***
Ln(GNI/capita)	0.869	0.019	***	0.814	0.019	***
Year	-0.011	0.000	***	-0.006	0.000	***
Poverty	0.869	0.005	***	-2.005	0.002	***
Biodiversity	4.206	0.033	***	2.278	0.051	***
				Class 1b compared to 1a		
(Intercept)				-0.004	0.003	
Asia				0.370	0.253	
Europe				0.697	0.268	*
Latin America				-1.218	0.277	**
North America				-0.244	0.294	
Oceania				0.104	0.087	
Ln(GNI/capita)				-0.830	0.255	**
Year				0.005	0.001	**
Poverty				1.500	0.351	**
Biodiversity				-1.234	0.387	**
BIC			1590.77			1618.849
LL			-599.10	LL		-558.0811

(*) p<0.10, * p<0.05, ** p<0.01, *** p<0.001



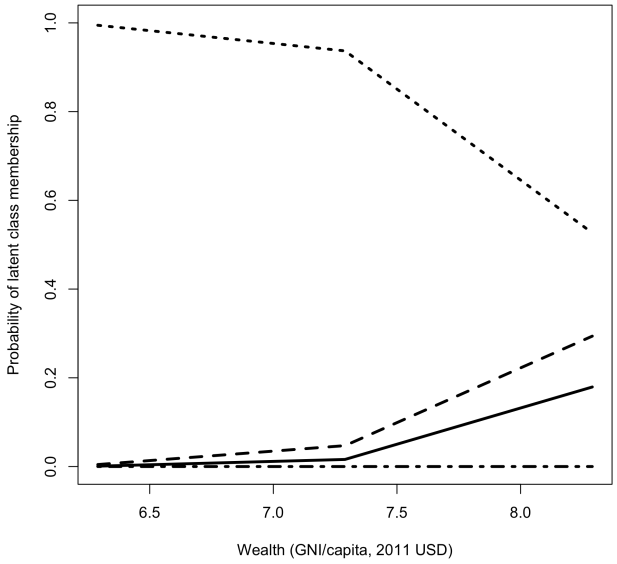
▬▬▬	Class 1	— — —	Class 2
--------	Class 3	— - — -	Class 4

Figure 5: Predicted probability of latent class membership (y-axis) in **Asia** relative to country wealth (x-axis). The biodiversity and welfare dummy variables were input as 0 and 1 respectively, because approximately 33% of PWS programmes observed in Asia have a biodiversity objective and 72% have a welfare objective.



▬▬▬	Class 1	— — —	Class 2
--------	Class 3	— - — -	Class 4

Figure 6: Predicted probability of latent class membership (y-axis) in **Latin America** relative to country wealth (x-axis). The biodiversity and welfare dummy variables were input as 1 and 0 respectively, because approximately 91% of PWS programmes observed in Latin America have a biodiversity objective and 45% have a welfare objective.



▬▬▬	Class 1	— — —	Class 2
--------	Class 3	— - — -	Class 4

Figure 7: Predicted probability of latent class membership (y-axis) in **Africa** relative to country wealth (x-axis). The biodiversity and welfare dummy variables were input as 1 and 1 respectively, because approximately 75% of PWS programmes observed in Latin America have a biodiversity objective and 75% have a welfare objective.

4.3.3. Additional characteristics

To better describe the classes defined via LCA, the prevalence of institutional characteristics among the programmes included in each class were observed. As described above, these attributes are not included as manifest variables in LCA, but instead are used to provide descriptive statistics of the institutional contexts through which different types of incentive package are transferred (

Table 10).

4.4. A Typology of Payments for Watershed Services

Each class of incentive package is described below, in order of prevalence in the database. The description of each class includes:

1. A characteristation of the class, based on the LCA parameters in *Table 8*;
2. A discussion of the institutional context in which that incentive package is transferred, based on the descriptive statistics in *Table 10*; and
3. A noting of the prevalence of that incentive by region and country wealth, based on the predicted probabilities visually presented *Figure 5*, *Figure 6*, and *Figure 7*.

Reference to additional qualitative information is included where relevant, with particular reference to how the programmes describe the incentive they provide.

Table 10: Proportion of observed programmes predicted to be members of each class that have the stated characteristics. Descriptive statistics of the 4-class model presented in columns 3-6, and of the 5-class model in columns 7-11. Categories of each institutional variable do not add to 1 because each programme can include multiple categories (e.g. multiples types of payer).

		1	2	3	4
Payer	*Polluter*	0.35	0.06	0.00	0.06
	Beneficiary	0.42	0.58	0.83	0.29
	Public sector	0.28	0.39	0.66	0.76
	Civil sector	0.09	0.03	0.41	0.41
Payer Motive	*Mandatory*	0.12	0.13	0.07	0.29
	Levy	0.09	0.23	0.45	0.00
	Compliance	0.37	0.10	0.00	0.12
	Voluntary	0.51	0.61	0.83	0.65
Provider	*Individual*	0.00	0.06	0.03	0.00
	Family unit	0.74	0.68	0.62	0.94
	Community/ Group	0.19	0.23	0.41	0.18
	Business	0.09	0.06	0.00	0.12
	Civil Sector	0.07	0.00	0.00	0.18
	Public	0.19	0.03	0.00	0.53
Provider Motive	*Mandatory*	0.00	0.29	0.14	0.00
	Compliance Support	0.02	0.06	0.00	0.00
	Regulatory Carrot	0.12	0.03	0.00	0.00
	Voluntary	0.77	0.65	0.86	1.00
	Mission	0.19	0.00	0.00	0.12
Ex-change	*Direct*	0.53	0.61	0.24	0.59
	Trustee	0.33	0.39	0.76	0.24
	Bank	0.07	0.00	0.00	0.12
	Market	0.07	0.00	0.00	0.06
Other Actions	*Water rights*	0.00	0.00	0.00	0.82
	Easement	0.16	0.03	0.00	0.06
	Land Purchase	0.12	0.19	0.10	0.00
	Direct Invest	0.16	0.10	0.45	0.29
	PS-PS	0.16	0.00	0.00	0.00

1a	1b	2	3	4
1.00	0.13	0.06	0.00	0.06
0.00	0.56	0.56	0.86	0.29
0.00	0.38	0.41	0.64	0.76
0.09	0.09	0.03	0.43	0.41
0.00	0.16	0.13	0.07	0.29
0.00	0.13	0.22	0.46	0.00
1.00	0.16	0.09	0.00	0.12
0.09	0.66	0.63	0.82	0.65
0.00	0.00	0.06	0.04	0.00
0.91	0.66	0.69	0.64	0.94
0.09	0.25	0.22	0.39	0.18
0.36	0.00	0.06	0.00	0.12
0.00	0.09	0.00	0.00	0.18
0.09	0.22	0.03	0.00	0.53
0.00	0.00	0.28	0.14	0.00
0.00	0.03	0.06	0.00	0.00
0.36	0.03	0.03	0.00	0.00
0.73	0.78	0.66	0.86	1.00
0.09	0.22	0.00	0.00	0.12
0.36	0.63	0.59	0.21	0.59
0.18	0.34	0.41	0.79	0.24
0.18	0.03	0.00	0.00	0.12
0.27	0.00	0.00	0.00	0.06
0.00	0.00	0.82	0.00	0.00
0.09	0.00	0.06	0.03	0.19
0.00	0.11	0.00	0.19	0.16
0.09	0.46	0.29	0.09	0.19
0.55	0.00	0.00	0.00	0.03

4.4.1. Cost-share

The majority of observations predicted to be in the first class of the 4-class model are also predicted to be in class 1b of the 5-class model. In class 1b, ES providers directly or indirectly (via an earmarked cash transfer) receive the **inputs** ($p_{ijg} = 0.90$) they need to carry out **improving actions** ($p_{ijg} = 0.94$). The class is seemingly the least well defined, but still has some dominant characteristics. Most programmes: provide payment upfront, to cover **costs** ($p_{ijg} = 0.75$); pay based on **practice** ($p_{ijg} = 0.78$); and make **one-off** payments ($p_{ijg} = 0.68$).

The slightly increased heterogeneity is also demonstrated in the descriptive statistics, where not many clear characteristics emerge to describe the context in which these types of incentives are used. Yet despite this slightly increased heterogeneity indicated by the LCA parameters and descriptive statistics, the programmes predicted to be in this class are all clearly similar in that they are focused on providing the inputs to or

offsetting the costs of ES provision. Most call the incentives they provide grants or cost-share. Some call the incentive 'rewards', but that reward is competitively allocated to a proposed conservation or sustainable development project. One notable descriptive characteristic is that although most providers provide ES voluntarily, this class has the highest percentage of programmes with providers doing so because it is their mission to improve natural resources. That is a further indication of the grant or cost-share nature of this type of incentive package.

Cost-share incentives are primarily observed in use in developed countries. Some have been observed in developing countries in Latin America, Africa, and particularly Asia, but not in low-income countries. The predicted probabilities for Asia illustrate how the expected prevalence of cost-share incentives increases with a country's wealth.

4.4.2. Regular payments

Class 2 is best defined by the fact that all members of this class include **cash incentives** ($p_{ijg} = 1.00$) received on an **interval basis** ($p_{ijg} = 1.00$). Most incentive packages in this class do **not include an upfront payment** ($p_{ijg} = 0.84$), but if they do, it is as a **standardised signing bonus** ($p_{ijg} = 0.16$), for example, a small upfront payment based on the area the ES provider enrols in the PWS programme. Additionally, the majority of payments are made for a change in **practice** ($p_{ijg} = 0.87$) believed to provide ES, only a few are based on a **specific measure of ES** ($p_{ijg} = 0.13$). Notably, those programmes predicted to be in this class that do pay based on a specific measure, do not do so to purchase an offset, credit, or tradable permit (as in class 1a, see 'Offsets' below).

Exploring the data further, the programmes in this group tend to call the incentive they provide a payment, compensation for opportunity costs, or subsidy. The descriptive statistics also indicate that this class fits well with the most broadly cited concept of PES programmes (following Engel et al. 2008; Wunder 2005): it is primarily user-financed or government-financed; paying households and farmers, or community groups that will funnel incentives to their members; via a direct bilateral arrangement or trustee (typically a trust fund).

Based on the MNL results and predicted probabilities, it is clear that this class of incentives is relatively prevalent (compared to the other classes) in Asia (specifically China), Latin America, and to some degree in Europe too. Based on the predicted

probabilities in Asia, Latin America, and Africa, its use appears to increase with wealth. Experience in Asia, however, indicates that its use might peak at a wealth corresponding to middle-income countries.

4.4.3. Reciprocity

Class 3 is defined by all incentive packages including one or more **non-cash benefits** (p_{ijg} = 1.00) and being provided based on a change in **practice** (p_{ijg} = 1.00). To reiterate, a transfer of cash might occur between the payer (or intermediary) and provider, but the ultimate intent of it is to fund other in-kind or community benefits. This is also the class with the highest rate of **technical assistance** (p_{ijg} = 0.72) and lowest rate of **cash incentives** (p_{ijg} = 0.24). The majority of incentives are based on agreements of **undefined length** (p_{ijg} = 0.83) and have **no specific upfront payments** (p_{ijg} = 0.89). That said, timing is unclear for these incentives. The highest rate of **intermittent incentives** (p_{ijg} = 0.55) occurs in this class. Qualitatively, based on experience coding the data, it can be said that even for the programmes with interval timing, it is unclear when receipt of the incentive occurs in relation to meeting the environmental condition (i.e. carrying out a specific practice).

The programmes in this group tend to call the incentive they provide compensation, benefits sharing, rewards, or benefits. Some in Latin America even refer to their programme as a reciprocal arrangement. Yet they are delivered through a seemingly similar institutional context to the regular payments in class 2 and incentives in class 3: funded primarily by users and government; to households and farmers, or community groups that will funnel incentives to their members; via a direct bilateral arrangement or trustee (typically a trust fund).

The MNL results highlight that this class has the strongest positive association with an additional poverty objective, and strongest negative association with country wealth levels. The predicted probability results clearly illustrate the latter, indicating that even within Asia, Latin America and Africa, the prevalence of class 3 incentives drops drastically as wealth increases.

4.4.4. Leases

Class 4 incentives are a strictly United States (US) phenomenon to date. They are defined by **upfront** incentives (p_{ijg} = 1.00), paid for **restricted resource use** (p_{ijg} =

1.00), based on a **measure of ES** (p_{ijg} = 0.94). Most incentives are **one-off** (p_{ijg} = 0.88) and all are provided through an agreement of **defined length** (p_{ijg} = 1.00). All incentives are **cash** (p_{ijg} = 1.00) with some additional **technical assistance** (p_{ijg} = 0.24).

It is clear from the programmes predicted to comprise this class, that these incentives are all water leases. The majority of leases are implemented for the purposes of restoring in-stream flows, often with the concurrent aim of improving conditions for biodiversity. These incentives are typically offered alongside offers from the ES buyers to purchase water rights. While the acquisition of water rights is also used in Australia, no examples of leasing were identified outside the US. Although property rights are not transferred from the ES provider to ES buyer in leases, the arrangement means the ES provider's rights are contractually restricted during the agreement period, which could potentially be enforced through legal recourse. Indeed, a strong legal system may be necessary for this type of incentive to be implemented successfully.

The MNL and predicted probability results reflect the fact that leases are often used for the benefit of biodiversity and primarily occur in the US. No examples of leases in developing regions were identified.

4.4.5. Offsets

The smallest class of incentives is Class 1a. Incentives in this class are defined clearly as **one-off** (p_{ijg} = 1.00) **cash incentives** (p_{ijg} = 1.00) paid based on the **level of ES** (p_{ijg} = 1.00) provided by **improving actions** (p_{ijg} = 1.00). Notably, these payments appear strongly conditional, and are **not paid before** (p_{ijg} = 1.00) actions are implemented.

The programmes predicted to be in this class call their PES arrangement a credit or offset. Polluters paying as a compliance option, with some room for NGOs to also contribute, fund all the programmes. The vast majority pay a family unit, or specifically farmers, and this is the class where the programme is most likely to include point source (PS) to PS pollution trading. Generally, this class includes programmes where non-point sources (NPS) of pollution (e.g. farms) implement good resource management practices (e.g. agricultural best management practices), thereby reducing their pollutant loads. The PS (e.g. wastewater treatment plants) pay for that reduction to be credited to them, thereby offsetting their own emissions into waterways. Paying for offsets are only observed in the United States and New Zealand in this data set.

4.5. Discussion

In this chapter, a typology of PES for the provision of watershed services was developed. The 4-class model is a better fit as measured statistically by the BIC, and so is used to more accurately estimate predicted probabilities based on the data used here. For describing the typology, however, the 5-class model is more informative. *Table 11* provides a summary of the types of incentive package identified by the 5-class model, from most to least prevalent in the dataset used to develop this typology.

The primary caveat to this study is that it is very difficult to understand what proportion of PWS programmes are captured and how representative the dataset is of the all programmes globally. Despite this difficulty, the study is based on the largest inventory of PWS programmes yet assembled and is believed to include most of the PWS programmes globally. Only a few programmes are known but excluded: less than 1% of programmes included in the database were excluded based on a lack of data. The main concern is which programmes were not known when the dataset was compiled. Since the data was collected, only a few programmes, representing less than 10% of the sample, have been identified.

Table 11: Summarising the general characteristics of PES used for watershed services

Type	Primary benefit	Required Action	Agreement Attributes
Cost-share	Inputs and often technical assistance	Practice-based, improving resource base	Not well defined, but tends to be upfront payment (to cover cost of inputs) and one-off
Regular Payments	Cash incentive	Practice-based, for either restricting resource use or improving resource base	Payments at regular intervals, rarely including a signing bonus
Reciprocity	Non-cash benefits and technical assistance	Practice-based, for either restricting resource use or improving resource base	Often unclear timing of incentive, through an agreement of undefined length, rarely including a clear upfront incentive
Leases	Cash incentive	ES-based, for restricting resource use	All payments upfront and for a defined period of time, usually one-off, but agreement can re-start once completed
Offsets	Cash incentive	ES-based, for improving resource base	All payments one-off, with no upfront payment.

A key area of difficulty in terms of identifying programmes is ensuring that a programme where PES is one of multiple components is included. Specifically, this would relate to water leases, which are often within larger programs of water acquisition, and offsets, which are often part of a PS-PS credit trading programme. These two types of PWS, however, have been identified, so if there is a lack of representation, it has not hindered typology development. If more water acquisitions and water quality trading programmes were included, they would likely reinforce the types already identified.

Broadly, if more programmes of any kind were included, they may potentially introduce additional incentive types, but would also reinforce the types identified. It is highly unlikely that the types defined here would be lost in a larger dataset. Throughout the analysis, the classes identified through the LCA were highly robust, with approximately the same parameters always identified.

Based on that analysis, two types of incentive were identified that are predominantly used in the United States. The first, leases, has arisen due to the historical influence of westward expansion, where water rights in the Western US are based on the prior appropriation doctrine, colloquially known as "first in time, first in right" (Hansen 2010). A similar basis of water rights exists in Australia, but programmes identified in Australia prefer to outright acquire water rights, rather than lease them (and so are not included in analysis). The second type of incentive, offsets, is also nearly exclusive to the US where PS to NPS water quality trading is accepted. Relevant programmes identified in Australia generally only permit PS to PS trading, while Europe has not yet embraced water quality trading (Greenhalgh & Selman 2012). Although offsets comprise the smallest class of incentives in relation to water, the class would likely be much larger if the research were broadened to include PES programmes with primary objectives of providing carbon services or improving biodiversity status. Both carbon and biodiversity offsets are a common type of PES.

Beyond these incentive types that are US-centric (at least when used to incentivise the provision of watershed services), three others incentive types were identified as the most prevalent and are widely-occurring across the world: cost-share, regular payments, and reciprocity. The second, regular payments, is in many ways the archetypal incentive described in original conceptualisations of PES (i.e. annual, conditional, cash

payments), but also reflects the reality of implementing PES, since payments in this class are made mainly based on resource users implementing practices believed to provide ES. There are also some unique elements. Specifically, although the majority of cases in this class are voluntary from the perspective of the provider, some are mandatory. These are cases in China where areas have been zoned for public benefit provision, and although they receive compensation, previous users of the resource face required restrictions on future use of the resource. Although the incentive looks like a typical PES, and it is compensating for opportunity costs, the context in which it is provided is not voluntary and so the programmes provide a different institutional context.

In contrast, reciprocal incentives broadly fit the dominant institutional conceptualisation of PES in terms of payer (user- or government-financed), provider (mainly land users), voluntary nature of the programme, and exchange mechanism (direct or via government/civil intermediary). The incentive itself, however, in many ways incorporates the critiques of earlier conceptualisations of PES with which class 2 aligns. Researchers and PES practitioners with experience in developing countries questioned strict conditionality (Farley & Costanza 2010; van Noordwijk & Leimona 2010), highlighted the demand for non-cash benefits (Asquith et al. 2008; Leimona et al. 2009), and even called specifically for a concept of PES that is reciprocal or otherwise supportive in nature (Asquith 2011; Farley & Costanza 2010; Kosoy et al. 2008; van Noordwijk & Leimona 2010; Vatn 2010): all characteristics of this incentive type.

Regarding cost-share incentives, their prevalence and global dispersal is striking. Compared to the other types of incentive, this type is relatively heterogeneous, but clearly still has a common primary purpose of supporting ES providers in their own endeavours to provide ES. It is notable that this is the class with the highest proportion of providers that are mission driven, and also the class with the highest proportion of programmes that also directly invest in the provision of ES. It appears to be the incentive type that most aligns with the proposed PES paradigm of co-investment in stewardship (CIS) (van Noordwijk & Leimona 2010). Additional support for this comes from the fact that Van Noordwijk & Leimona (2010) derived their paradigms of PES from experience in Asia, and as indicated by the predicted probabilities, cost-share incentives are not at all uncommon in the region.

With a focus on developing countries, it is natural to ask if any statements can be made about the use of different incentives as countries develop. The evidence from Asia is most reliable in this regard and clearly indicates a transition through the three incentive types observed in developing regions as a country's wealth increases. The predicted most-prevalent type of incentive transitions from reciprocity, through regular payments, to cost-share as country wealth increases. Evidence from Africa and Latin America is not as clear in this regard, but is in general alignment. The regions, respectively, provide a snapshot of the first stage where relatively lower income countries prefer reciprocity and the second stage where middle-income countries have transitioned to a greater use of regular payments.

4.6. Summary

This chapter is a novel contribution to the PES literature. It is the only attempt to date to define a typology of PES based on statistical methods. Following the transition to define PES as incentives (as recognised in Chapter 2) it is also the first typology, based on any method, to define types of PES as types of incentives, rather than institutional arrangements. That is highly valuable to inform future research on and design of PES, as well as the other studies presented in Chapters 5 and 6.

At a theoretical level, the study has highlighted that discussion of incentives and institutional arrangements for PES programmes should be better defined. That is not to say they should ever be completely decoupled, as institutional arrangements could influence the use of incentives. It is to conclude, however, that the research and practice of PES must not overly conflate the two considerations in policy design. The study has highlighted both how the same type of incentive can be transferred through highly contrasting institutional arrangements (i.e. regular payments for ES providers' mandatory actions in China) and how very different types of incentive can be transferred through very similar institutional arrangements (i.e. comparing regular payments and reciprocal incentives).

Not recognising these results related to incentives and institutions risks trying to compare apples and oranges, a concern highlighted by Pirard (2012) in his typology of MBIs for BD and ES. More worryingly, it risks not learning lessons from programmes that might seem dissimilar, but actually have a strong commonality in the incentives they provide. For example, cost-share programmes are observed in lower-middle

income countries in Asia, as well as the US and Europe, and beyond. Highlighting these similarities and differences is highly policy relevant. It permits a clearer comparison and learning between programmes that are similar, or that use similar incentives. It also helps highlight how PES programmes are different, and these differences should be clearly understood, particularly when most research on PES is based on case studies, many of which are qualitative and descriptive. Understanding similarities and differences in incentive type and institutional context are critical to appropriately taking lessons from one case and applying them to another.

Finally, the transition of incentive prevalence as country wealth increases cannot be ignored. It is difficult from this data to identify specific mechanisms through which wealth might change incentive use. Yet, evidence from the literature, particularly related to market constraints and behavioural considerations as described in Chapter 3, aligns closely with this result. For example, the lowest income countries likely have the highest market constraints, in addition to related barriers such as low technical capacity of ES providers and low legal/enforcement capacity, which would predispose them to prefer the use of non-cash and technical assistance benefits in reciprocal arrangements.

Future analysis should include additional PWS programmes. Ideally, the data would strive to include programmes representing a larger number of countries, particularly in Africa, and a broader range of wealth in Africa and Latin America. What may be more interesting, and inherently provide such variation, would be to include PES programmes focussed on different ES, such as carbon services or biodiversity conservation. This expanded data could provide more clarity on any link between wealth and incentive choice, and develop more evidence on different programme objectives and incentive choice.

Yet even with the current dataset, significant and interesting results emerge that are novel and useful to PES research and practice. The remaining analytical chapters will note the incentive type being explored, with further discussion left for the final chapter.

CHAPTER 5

CASE STUDY

Credit-based Payments for Ecosystem Services: Evidence from a choice experiment in Ecuador

5.1. Introduction

As described in Chapter 3, it was initially argued that direct performance-based payments were the most cost-effective form of incentive to induce the provision of ES and conservation of biodiversity (Ferraro & Kiss 2002; Ferraro & Simpson 2002). Where market constraints exist, however, indirect interventions that reduce them may be preferred by both the agent and the principal (Groom & Palmer 2010). In addition to economic constraints, current PES discourse continues to reference research from psychology and behavioural economics that explores the efficacy of direct incentives, with particular concern for the potential crowding-out of intrinsic motivation to provide ES (Farley & Costanza 2010; Muradian et al. 2010; Sommerville et al. 2009; Vatn 2010). The key issue with alternative interventions, such as those that relieve market constraints, is that historically most have not been conditional and so do not ensure that conservation will occur (Wunder 2005). Thus the key innovation that is required is to incorporate ES conditionality into the reduction of market constraints.

The research presented here uses discrete choice analysis (DCA, described in Chapter 1) to explore incorporating an environmental conditionality into what would previously be considered an indirect intervention for conservation that reduces market constraints. A choice experiment (CE) was carried out in Ecuador to explore local farmers' preferences for a novel incentive: credit-based PES (CB-PES). The research adds to the literature in two ways. First, it is one of the few studies that empirically explores interventions to induce land use change through reducing market constraints in a PES context, and provides the first empirical research of incorporating strong conditionality into the provision of credit. Second, it also adds to the small literature that has used DCA to explore policy design from the perspective of the agent supplying the desired policy outcome.

Following this introduction, section 5.2. reviews the relevant literature on PES on credit and environmental outcomes. Section 5.3. describes the case study and analysis carried out, section 5.4. explains the results of that study, and section 5.5. discusses the broader implications of those results. Section 5.6. concludes.

5.2. Toward Credit-based Payments for Ecosystem Services

The proposal of CB-PES is motivated by two key considerations. The first is that market constraints can influence land-use decisions. Where conventional land-use is environmentally degrading, a transition to less damaging practices usually requires capital inputs. If capital constraints exist, it is arguably harder for a transition to the less degrading practices to occur, even in the presence of direct, demand-side incentives. The second consideration is motivation crowding. There is broad concern that direct payments can crowd out intrinsic motivations of the agent to provide positive environmental externalities, and thus reduce the effectiveness of those incentives. A credit-based intervention may be easier to align with the intrinsic motivations of the agent, reducing the risk of crowding-out or other negative consequences of non-separability. Both of these issues are described in detail in the literature review in Chapter 3. As such, the remaining literature review specific to this chapter is focused on mechanisms linking credit and environmental outcomes.

There is a small, but growing, literature on the interactions of credit and natural resource management (NRM) that is rooted in microfinance literature and relevant here. It is understood that microfinance institutions (MFIs) can impact NRM by effecting changes in physical, human, and social capital that interact with natural resources (Anderson et al. 2002). More recently, there is increasing attention paid to strengthening the link between credit provision and specific environmental outcomes. Allet (2011) identified five strategies that MFIs employ to manage their environmental impact. These strategies are not specific to MFIs and have been developed and used by financial institutions of varying size. They are adopting environmental policies, reducing the institution's internal ecological footprint, managing portfolio environmental risks, providing green microcredit, and providing environmental non-financial services. Across the latter three strategies we observe different approaches to linking the provision of credit to environmental outcomes. Environmental organisations are also starting to implement these strategies, as well as introducing some of their own

innovations to link credit provision with environmental outcomes. The resulting five approaches are summarized in *Table 12*.

The approaches established by financial institutions make credit provision weakly conditional on environmental outcomes. The first is selective lending, either through negative screening to exclude certain activities or borrowers with high environmental risk (Allet 2011), or by positive selection of inherently environmentally friendly enterprises, such as ecotourism projects (e.g. Conservation International 2013; EcoEnterprises Fund 2012; Proyecto CAMBio 2013). The second approach is concessional lending, which expands on selective lending, such that financed activities receive favourable lending terms (e.g. Annex 2 in Greiber 2009). Selective lending and concessional lending are the two types of lending typically considered green credit (or green microcredit) (Allet 2011) and would be considered an indirect intervention to improve conservation via the mechanism of reducing market constraints (Ferraro & Kiss 2002; Groom & Palmer 2009). The third approach is where access to credit is not coupled to the inherent environmental friendliness of the activity to be financed, but conditional on meeting environmental covenants, which may or may not be directly related to the financed activity, in order to access credit (Anderson et al. 2002; Assunção et al. 2013; Senaratna Sellamuttu et al. 2008; Yuhe & Yi 2000).

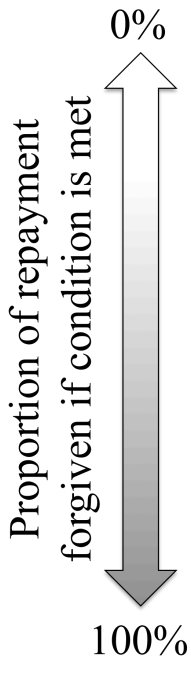
Table 12: Approaches for incorporating an environmental condition into lending, with examples of micro- and meso-scale lending connected to biodiversity and ES.

Approach	**Description**	**Example**	**Environmental Conditionality**		
			Strength	*Coupled to activity*	*Reward*
Selective Lending	Credit is only provided to inherently environmentally friendly activities	There are a number of funds that selectively lend to biodiversity-friendly SMEs, with a particular focus on Latin America (Conservation International 2013; EcoEnterprises Fund 2012; Proyecto CAMBio 2013).	Weak	Yes	Access to credit
Concessional Lending	Selected activities receive credit with reduced interest rates	In 2000-2006, the former German Technical Cooperation Agency (GTZ) funded a short-term project in Colombia where farmers were given low-rate loans to finance the uptake of sustainable agricultural practices, with the ultimate aim of reducing eutrophication of the Fúquene Lagoon (Annex 2 in Greiber 2009).	Weak	Yes	Favourable terms
Covenants	Meeting environmental conditions are either a requirement to become a member of a lending institution or are included as covenants in the loan contract	Resolutions 3545 and 3583 published in 2008 by the Brazilian National Monetary Council made access to rural credit in the Amazon Biome conditional on borrowers adhering to environmental (and legal) regulations (Assunção et al. 2013).	Weak	No	Access to credit
Environmental Mortgage	The total capital available for lending is correlated to and changes depending on the condition of the natural capital to be conserved	Originally suggested by Mandel et al. (2009). Potential pilot projects are being scoped and assessed in Peru, Ecuador and Madagascar (Josh Donlan, *personal communication*).	Strong	No	Access to credit
Credit-based PES	The repayment on credit is reduced only after confirmation that an environmental condition is met	Wetlands International's Bio-rights programmes provide credit that converts to PES (i.e. -100% interest rate) once conditions for mangrove or wetland restoration are met. They have implemented projects in Asia and Africa (van Eijk & Kumar 2009; Wetlands International 2009).	Strong	No	Favourable terms

There are two approaches developed by conservation organizations that attempt to create a stronger conditional link between credit provision and an ecological objective. The first is to link access to credit to conservation outcomes. Mandel et al. (2009) proposed an environmental mortgage, where a community development fund would be capitalized to an amount that is correlated to the value of natural capital that the community is charged to protect. The natural capital acts as collateral against the value of the fund, and if it degrades, the size of the community fund would be decreased. Activities financed by the fund would not specifically face an environmental conditionality, but would need to be environmentally neutral or positive to ensure that they do not degrade the natural capital collateral.

Credit can also be conditionally linked to environmental outcomes by making the cost of credit dependent on good environmental behaviour. An environmental condition can be included in the loan contract, such that the interest rate is lowered if the condition is met but is not lowered if the condition is not met. In other words, if the condition is met, a portion of the annual repayment is forgiven, either directly by the credit provider or by a third party paying a portion of the repayment. We call this a credit-based payment for ecosystem services (CB-PES) (*Figure 8*). Concessional lending *ex-ante* subsidizes credit and only lends to activities that are inherently environmentally friendly. In contrast, CB-PES is rewarded *ex-post*, if, and only if, the environmental condition is met. Additionally, the activity to be financed can be decoupled from the environmental objective, although as with environmental mortgages, it should at minimum be environmentally neutral.

An intervention like CB-PES could be useful for both market and behavioural reasons. Where other interventions either aim to reduce market constraints or directly reward provision of ES, CB-PES links these two objectives. It is the only known intervention to include a clear conditional link between ES provision and the reduction of market constraints where success of meeting the condition is determined *ex-post*. Additionally, by reducing market constraints and being voluntary in nature such that the potential ES provider must choose to take out a loan, CB-PES intuitively fits the framing of a supportive incentive.



Credit vs. PES	Budget Constraint	Example
Credit, with covenants	No constraint	International Crane Foundation
Blend of credit and PES	Proportion of credit that is conditional is constrained by budget of ES buyer	No known examples
Convertible: credit or PES	Total loan size is constrained by budget of ES buyer	Wetlands International "Bio-rights"

Figure 8: Conceptualising credit-based payments for ecosystem services (CB-PES).

The examples that can inform CB-PES fall on either end of a spectrum of conditionality (*Figure 8*). At zero conditionality, some lenders include requirements for environmental actions in their contract (e.g. plant a tree) (Allet 2011; Anderson et al. 2002) or require that borrowers adhere to environmental regulation (Assunção et al. 2013) in order to access credit, but if the condition is not met, there is no change in the required repayment, and no other immediate reward or punishment. That is the covenants approach to linking credit and environment described above and in *Table 12*.

At 100% conditionality, if the environmental condition is met, the loan is converted to PES and does not have to be repaid, which has been carried out in Asia and Africa (van Eijk & Kumar 2009). If the condition is not met, however, the loan must be repaid as normal.

Between these two ends of the spectrum lay possible mechanisms where credit is borrowed and if an environmental condition is met, the interest rate and thus the amount that must be repaid is lowered. To the best of our knowledge, only convertible (i.e. 100% conditional) loans have been implemented, and these projects have reported success (van Eijk & Kumar 2009; Wetlands International 2009).

5.3. Methods

As discussed so far, for both economic and behavioural reasons, CB-PES could be a desirable incentive in various contexts, particularly in developing countries. To further explore this proposition, we carried out a CE to *ex-ante* assess the preferences for loan terms by small-scale agriculturalists living in an area where market constraints exist. Through implementing a CE among local households, we aimed to 1) understand farmers' preferences for loan attributes, including an environmental conditionality, 2) comment on CB-PES as an incentive, and 3) understand the broader dynamics of providing CB-PES.

5.3.1. Case study of the Intag Zone of Ecuador

The Intag Zone of Northern Ecuador (Figure 9) ranges over approximately 1500-4000 meters above sea level and includes the range of ecosystems seen across the Andes, from sub-tropical forest to páramo, including 44,000 hectares (Ha) of cloud forest (HidroIntag 2009). The loss of cloud forests is detrimental to society as they are a source of many ES, and are particularly valuable for their high level of biodiversity and regulation of water quality and supply (Bubb et al. 2004). Agricultural expansion is the greatest threat to cloud forests across Latin America (Bubb et al. 2004) and in the Ecuadorian Andes (Wunder 1996). Along with timber collection, agricultural expansion has led to large-scale deforestation in Intag. With much of the forest already removed, the average annual deforestation rate from 2001 to 2006 was 1.92% in Cotacachi Canton (Intag covers 75% of this canton) and 2.47% across the entire Imbabura Province in which Intag sits (Peck 2009). Both rates are greater than the average across Ecuador during the same time period (FAO 2010).

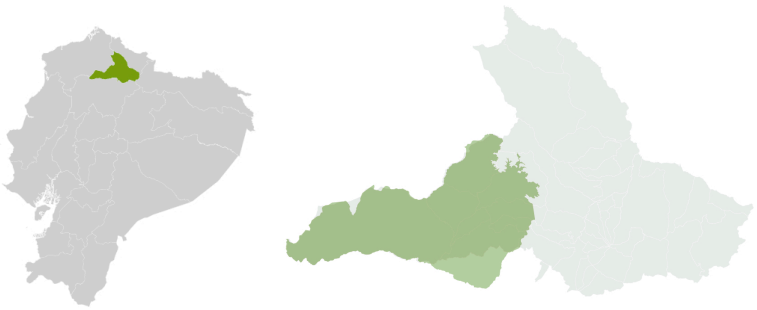


Figure 9: Map of Ecuador (left) indicating the location of Imbabura Province, and map of Imbabura Province (right) with the ecological boundary of Intag-Manduriacos ecological zone overlaid. Light green on the map of Imbabura (right) indicates the areas where the ecological zone reaches outside of the political boundary. The zone is often referred to simply as Intag, because the vast majority of the population in this area lives in the Intag River Watershed, which approximately comprises the Eastern half of the ecological zone. Following that convention, we refer to the entire ecological zone as Intag. Maps reproduced with permission from Kocian et al. (2011).

The vast deforestation in Intag has led to a lower level of biodiversity habitat and multiple ES, which are valuable on local to global scales. Efforts to better conserve biodiversity and provide higher levels of ES in Intag have led to a recent focus on increasing agroforestry practices on private land. In Intag an uptake of such practices helps to decrease pressures on forests, in part through broader acceptance of protected areas (Mecham 2009). Additionally, ecologists and agricultural specialists working in Intag believe that agroforestry in the region directly provides key ES, in particular increased biodiversity habitat, increased carbon sequestration and storage, reduced soil erosion and consequent siltation of waterways, and increased water regulation. Not only are those services immediately valuable, but they also support climate change adaptation in the region. Climate change is predicted to increase annual rainfall in the zone,[20] and practices of forest conversion and monocropping have left a highland landscape with much less tree cover than is natural. Without improved land-use practices, increases in rainfall will increase runoff, reducing the productivity of farmland and increasing siltation in waterways, with potentially severe implications for food security.

In addition to these environmental benefits, over the long run, properly designed agroforestry systems are more profitable than most conventional agricultural systems in the region. *Table 13* presents the net present value (NPV) of three production systems that are not conventional in Intag, but produce greater levels of the environmental

[20] As indicated by the climate scenarios in 'Proyecto de Adaptación al Cambio Climático a través de una Efectiva Gobernabilidad del Agua en el Ecuador (PACC),' http://www.pacc-ecuador.org/.

benefits noted above. They are shade-grown coffee, mixed agroforestry, and sustainable forestry patches included in the farm mosaic.[21] The NPV calculation includes all costs associated with establishing these new systems. For comparison, the NPV of ongoing cash flows associated with two conventional systems are also presented. The most prevalent conventional system is rotating maize and bean production, which provides two crops that can be consumed or sold by households. Sugar cane production is the only conventional system in the area that can compete in terms of income with the agroforestry systems. It is less prevalent throughout the region though, due to its high costs and the fact that it produces a cash crop and is not as useful for subsistence production. Two notable features of the comparison are that the agroforestry systems are more profitable than the most prevalent conventional systems, but will not be profitable for a few years after implementation. Even though shade-grown coffee and mixed agroforestry break even in year 2 and 3 respectively, neither reaches full productive capacity until year 4. Financing is needed to help bridge this temporal gap in profitability.

Table 13: Summary of cash flow models of shade-grown coffee, mixed agroforestry, and sustainable forestry systems in the Intag River Region of Ecuador, compared to two conventional agricultural systems. Net present values (NPV) are per hectare, and assume that introduced production systems are implemented to a high quality.

Production System	NPV 15 years[c]	NPV 25 years[c]	Break Even Year
Shade-grown coffee[a]	$ 15,571	$ 33,205	2
Mixed agroforestry[a]	$ 25,909	n/a	3
Sustainable forestry[a]	$ 22,571	$ 25,071	12
Mixed beans and corn (low)[b]	$ 3,815	$ 5,180	n/a
Mixed beans and corn (high)[b]	$ 10,604	$ 14,399	n/a
Sugar cane[b]	$ 20,925	$ 28,413	n/a

[a] Data provided by local agricultural expert (Jose Cueva, *personal communication*)

[b] Annual cash flow estimates from (Martinet 2006) as cited in (Kocian et al. 2011)

[c] Discount rate of 5%

[21] Nair (1993) explains that for many years, the working definition of agroforestry at the International Centre for Research in Agroforestry (ICRAF) was "land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence." (pg. 14). ICRAF is now also known as the World Agroforestry Centre, and on its website presents a broad definition of agroforestry as simply "integrating trees into agriculturally productive landscapes".

Households in Intag have increasingly practiced agroforestry since 1998 with the establishment of the Asociación Agroartesanal de Caficultores Rio Intag (AACRI), a local coffee cooperative. A UK-based NGO, Rainforest Concern, is also carrying out a conservation project in the region to create the Chocó-Andean (ecological) Corridor including a 5,000-hectare area known as Paso Alto. A management plan for Paso Alto was developed by Rainforest Concern, AACRI, and ALLPA (a partner organisation to AACRI), and agreed with the Ecuadorian Ministry of the Environment. Promoting sustainable agricultural practices is a significant part of that plan. Under the project, over 40 farms were provided finance to convert a one-hectare parcel of their land to agroforestry (mainly shade-grown coffee), with the aim that they would see the benefits and independently convert further land to agroforestry (Mecham 2009).

To date, however, the support for agroforestry practices has been primarily grant-based. Further, agroforestry is still only practiced by a minority of households, and only on a small fraction of the land of those households. A major reason is that broad market constraints are present in the zone: Intag is remote and the terrain is tough, making it difficult to get supplies in and goods out. Post-production constraints are being reduced through cooperatives in the region that either purchase crops directly (as with AACRI and coffee) or are developing projects to support getting crops to market, such as an Intag store in the nearest major market town. Pre-production constraints, however, remain more difficult to remove. Specifically, although households in the region are familiar with credit, it is not readily available in the region, and local agricultural specialists believe that to be constraining the uptake of agroforestry systems (Arisman 2012; Cranford et al. 2010; Jose Cueva, *personal communication*). As predicted by Groom and Palmer (2010), with these market constraints in place, donors (the ES buyers) are interested in the potential for linking credit provision and conservation activities.

5.3.2. Survey and choice experiment

A survey of households in Intag was carried out from August to mid-October, 2010. The sample was collected by local extension workers, which due to very difficult terrain could only be done through opportunistic sampling, but with some guidance. Extension workers focused on communities situated on the south-eastern side of the Intag River, lying between the river and the Chocó-Andean corridor project noted above. Since some

of the communities in this part of Intag have been engaged in shade-grown coffee or the specific pilot programme to promote agroforestry as part of the Paso Alto management plan, the extension workers' aim was to collect a sample of households with a range of agroforestry experience. The extension workers also strived to collect surveys across a range of altitudes to ensure the sample included a diversity of ecosystem contexts and farm compositions that represented the zone and the Andes more broadly.

The main body of the survey collected information about each household's social characteristics, land ownership and use, crop production, livestock rearing, forest-related activities, and non-farm income. The latter portion of the survey collected information on their experience with and views towards agroforestry, which was followed by a CE. The CE was designed to determine a household's preference for the attributes of a loan, with particular focus on an environmental condition. The hypothetical situation presented was as realistic as possible and involved a conversation between the survey implementer and respondent that covered these key points:

1) An organization could provide credit to some families in your community
2) Credit could be borrowed for any purpose
3) The organization would like to see an increase in agroforestry
4) Some of the loans may have a lower interest rate and a condition that you must convert one hectare of your land to agroforestry
5) That lower interest rate, however, is only available if you are able to meet the condition
6) If you do not meet the condition, you will have to pay back the loan at normal interest rates (which are 12-18% in surrounding areas).

The attributes of the alternatives were basic loan characteristics, and the attributes and levels were determined through meetings with extension workers and local agricultural experts. The four attributes presented in the choice experiment (*Table 14*) were loan size (in US $), maturity (years), conditionality (a binary dummy variable), and annual interest rate (%). To reduce cognitive burden, the average annual payment associated with the loan was listed as a value in US $ alongside the interest rate as a percentage.[22]

[22] The annual repayment amount shown on the choice card and throughout this paper always assumes a normal amortizing loan.

Table 14: Attributes and levels for choice experiment in Intag agroforestry survey.

Attribute	**Levels**
Loan size	$1000, $2500, $5000
Maturity	Short (1-2 years), Medium (3-5 years), Long (6-10 years)
Conditionality	1 if conditional loan, 0 if unconditional loan
Interest rate	0%, 5%, 12%, 18%

The levels of the loan size and maturity were determined by ensuring that the middle level of each matched the amount of investment needed to meet the environmental condition and the timeframe over which a positive return on shade-grown coffee (the most prevalent and popular form of agroforestry) would be realized. That information was based on the business models of agroforestry developed by local agricultural experts (*Table 13*). One level lower and higher than these middle levels were also included to ensure that the hypothetical loans could be decoupled from the environmental condition and used for other activities. The lower loans were too small and too short to provide the total support for conversion to any form of agroforestry, while the larger levels were too large and too long to be appropriate for the single, specific use of converting one hectare to agroforestry.[23]

A full factorial design of the attributes produced 72 possible loans, which were reduced to 16 using an orthogonal design. From this fractional factorial design, a shifting procedure[24] was used to create 16 pairs of 32 alternatives. Although this CE design approach is sometimes not viewed as the most efficient, it was deemed appropriate here due to the relatively small sample size and lack of *a-priori* information about the parameter values of the econometric model (Ferrini & Scarpa 2007).

Due to the condition attribute being binary, the shifting technique naturally produced 16 choice sets where there was always one conditional and one unconditional loan. The

[23] The extension workers implementing the survey were permitted to discuss the costs of agroforestry with any respondent that required it. It is assumed that respondents that had previous experience with agroforestry or knowledge of it (63% said they understood what agroforestry was) would have reasonable knowledge of the costs associated with conversion to agroforestry practices.

[24] The levels of a given attribute are qualitatively coded in rank order (e.g. 1, 2, 3 for an attribute with three levels). Each attribute is shifted one level up, where if the top level is reached, on the next shift the level returns to 1.

order of the two loan alternatives on each card was randomized (i.e., A, B vs. B, A), meaning that the CE was unlabeled. In addition to the conditional and unconditional loan options, each choice set included an option to not take any loan (an opt out/status quo option). An example of a choice card used during the survey is presented in *Figure 10*.

The sample included 345 households in 50 of the approximately 76 rural communities in Intag[25] (Kocian et al., 2011). Due to the nature of the non-linear models used to analyze choice experiments, precisely determining the optimal sample size depends on having *a-priori* information about the values of the model parameters (Hoyos 2010), which did not exist in this case. Nonetheless, rules of thumb are available to provide some confidence that a sample is large enough to produce stable estimates of the parameters. (Orme 1998) as cited in (Rose & Bliemer 2008) reports the rule of thumb presented in *Equation 3*.

Would you prefer: OPTION A OPTION B NEITHER ?

	A	B
Amount	$5000	$2500
Payback Time	Long (6-10 years)	Medium (3-5 years)
Condition	You have to convert one hectare of your land to agroforestry	None
Interest	0% (pay between $833 and $500 during each year of the payback time)	5% (pay between $918 and $577 during each year of the payback time)

Figure 10: Example of choice card in choice experiment for CB-PES.

[25] The idea of a "community" in this case refers to any named collection of households. Some are large villages, others are a small collection of houses.

Equation 3: Estimating the minimum sample size for choice experiments.

$$N = 500 * (\frac{L}{J * T})$$

where L is the largest number of levels for any attribute, J is the number of alternatives per choice set, and T is the number of choice sets for each respondent. In this study, for the initial 30% of respondents, only one randomly assigned choice set was answered in order to ensure the choice experiment was functioning properly, which it was. For the remaining 70% of the respondents, four choice sets were randomly assigned without replacement, and no other changes to experimental design were made. In relation to minimum sample size, the average number of choice sets per respondent was used for T (i.e., 2.95), and the rule of thumb indicates a minimum sample size of 226, which is 66% of the sample collected. Additionally, there is no standardized information available on the number of households in Intag, however it is broadly cited that there were approximately 17,000 inhabitants in the region around the time of this study (HidroIntag 2009; Kocian et al. 2011). Based on the number of people reported dwelling in each household surveyed here, approximately 7.6% of the population of Intag was accounted for in this survey.

5.3.3. Econometric framework and model specification

A mixed logit (MXL) model, also known as a mixed multinomial logit or random parameters logit, was used to analyze the CE. The MXL was introduced by (Boyd & Mellman 1980; Cardell & Dunbar 1980), developed through a sizeable literature, and demonstrated as able to approximate any logit model for discrete choices under utility maximizing behaviour by (McFadden & Train 2000). We implemented a CE where each respondent was presented with multiple choices sets. Under this condition, the random utility function with random parameters takes the form in *Equation 4* (following Train 1998).

Equation 4: Random utility function with random parameters.

$$U_{jnt} = \beta_n' x_{jnt} + \varepsilon_{jnt} = b' x_{jnt} + \eta_n' x_{jnt} + \varepsilon_{jnt}$$

where U is the utility of alternative j (j = A, B, C) in choice set t (t = 1, …, 4) to household n (n = 1, …, N). x_{jtn} is a vector of explanatory variables that are observed and include attributes of the alternatives, socio-economic characteristics, and potentially descriptors of the decision context. β_n and ε_{jtn} are stochastic influences not observed by

the analyst and ε_{jtn} is assumed to be independent and identically distributed (IID) extreme value type 1. Under a multinomial logit (MNL) model, β is fixed across the population, but in a random parameters specification, the vector β_n is expressed as the population means b and individual deviations η_n from those means to account for unobserved heterogeneity. The vector η_n is correlated over alternatives and choices situations and can take various distributional forms across the population. The form can be different for each x leading to a mixed distribution when estimating the econometric model.

The model is operationalised using a logit formula, the outcome of which is integrated over the mixture distribution of η to determine the probability of the respondent n choosing alternative j. The integral does not take a closed form and is estimated using simulation techniques. Estimation was carried out in Stata 11 using the mixlogit command (Hole 2007). The final results from MXL are the estimation for each parameter of 1) the population mean, and 2) the standard deviation of the population around that mean, dependent on the distributional form the analyst applies to that parameter.

The MXL model was chosen here in order to remove the three restrictive assumptions of the more prevalent MNL models.[26] Specifically the MXL 1) does not assume independence from irrelevant alternatives (IIA) and so permits unrestricted substitution patterns, 2) can easily be adjusted to account for correlation in unobserved factors over choice situations, and 3) incorporates random parameter estimates to account for preference heterogeneity among respondents (Train 2009).

The first point is important because early exploration of the data for this paper compared a nested logit to a MNL. It was found that there are unobserved factors that are constant over the unconditional and conditional loan alternatives that need to be accounted for. The MXL relaxes the IIA assumption and an analogue to a nesting structure can be incorporated into MXL by addition of a dummy variable for the hypothesized nest (Train 2009), in this case a dummy variable for loan was included.

[26] A MNL was also estimated for this data and the results agree with those of the MXL: the sign of the MNL parameters are all the same as the sign of the mean of the parameter in the MXL. Additionally, all interactions included in the MXL were significant to at least 90% in the MNL.

Related to the second point, to account for repeated choices by each respondent, 1) the mixed logit model is specified so that the random parameters vary over individuals, but held constant over the choice sets each individual was presented with, and 2) the unconditional probability used for maximum simulated likelihood estimation is based on the probability of the sequence of choices made by an individual, not the probability of each choice treated separately (Train 2009).

Finally, the third point is testable using a MXL. In our case we found that the standard deviation of two attributes and the loan dummy variable entered the model with statistical significance, indicating they could be modelled as random to account for unobservable preference heterogeneity among households. Some preference heterogeneity is observable and introduced in the model through interactions between household characteristics and loan attributes.

Table 15: Variables included in the models of loan choice. Attribute averages are calculated over all chosen alternatives and over chosen alternatives that were loans, household characteristic averages are calculated across all 345 households in the sample.

Variable Type	**Variable**	**Description**	**Mean [Min, Max]** (All Chosen Alts.)	**Mean [Min, Max]** (Only if Loan Chosen)
Choice Attributes	Loan	=1 if choice alternative is a loan	0.87 [0, 1]	1 [1, 1]
	Size of loan	In US$, scaled by 1/1000	2387.30 [0, 5000]	2785.19 [1000, 5000]
	Payback period	Maturity of loan, in years	3.66 [0, 8]	4.27 [1.5, 8]
	Condition	=1 if agroforestry condition applied	0.41 [0, 1]	0.48 [0, 1]
	Interest rate	Annual rate as a %, i.e. 5% = 5	3.49 [0, 18]	4.07 [0, 18]
Respondent Characteristics	Afford loan	=1 if household's annual gross cash income is greater than size of chosen loan	0.75 [0, 1]	0.71 [0, 1]
	Titled land	=1 if a household claims title to some land	0.63 [0, 1]	
	Crop value	US$ value of all crops produced in 2010	3912.56 [0, 132650]	
	Children	Number of children in household	1.37 [0, 7]	

The final variables used in the regression are presented in *Table 15*. In order, they include a dummy variable for the hypothesized nest of loan discussed above, the four loan attributes, and four respondent characteristics included as interactions with

different loan attributes. The loan dummy variable was included to account for latent demand for credit, irrespective of whether or not it was conditional credit. The loan attributes are all included, to model respondent preferences for different credit terms. Finally, respondent characteristics were only introduced into the model specification process if there was a possible economic reason for them to interact with specific loan attributes. These interaction terms were introduced using a blocking approach in a nested logit specification, and those found to be statistically significant were maintained in the MXL models only if they passed a log-likelihood test compared to a model excluding them in the nested logit specification. Further detail of the estimated parameters associated with these interaction terms and economic reasoning for their inclusion is provided in Section 5.4.2.

One characteristic that was included through an interaction term, crop value, is a constructed variable, calculated using *Equation 5*.

Equation 5: Constructed variable of crop value.

$$V_n = \sum_{c=1}^{C} (P_{n'c} * Q_{nc})$$

where V is the total value of all crop production by a household n, P is the farm-gate sale price of crop c that household n reported, and Q is the quantity of c that household n produced. Where a household did not report selling any portion of Q_c, and so did not report a farm-gate sale price, P is the average of the prices reported by all other households that did report selling a portion of Q_c.

The aim of this constructed variable is to provide a proxy to account for the loss or gain a household would receive from carrying out the environmental condition, and in the final model it is interacted with the condition attribute. Crop value is a complex variable that includes information about factors such as amount of land, productivity of land, availability of inputs to production, a household's knowledge of and ability to farm, and the market price that a household could receive for crops. Where crop value is low, these underlying variables are likely to be smaller, indicating a greater opportunity cost and a lower chance of profiting from the agroforestry condition. Where crop value is high, however, it indicates that one or more of these underlying variables are higher and the household's opportunity cost of the condition is lower, and in many cases even

negative (i.e. a gain from the condition). It is expected that households will have a negative preference for the condition overall, but that households with high crop value will have a less negative preference.

5.4. Results and Post-estimation Analysis

5.4.1. Descriptive statistics

The survey implementers were instructed to try and speak with male heads of households, who have the most say over household and land-use decisions. The average respondent was male, 50 years old, and with 5.7 years of education, corresponding to primary school in Ecuador. Their household included 2.4 adults and 1.3 children (<18 years of age). Regarding land, 63.8% of households claimed legal title to a portion of their land. On average, households claimed some form of tenure over 15.4 hectares of land, 3.6 of which was set aside for cultivation and 6.1 of which was actively used for pastureland. A summary of these descriptive statistics and comparison to data from censuses or other studies is provided in *Table 16*. The median (mean) annual gross cash income for 2010 was $4,014 ($6,736) and the median (mean) portion of that income from crops was 63% (55.5%).[27] No data was identified with which to compare household income.

In relation to agroforestry, 63% of respondents stated they understood what agroforestry was before an explanation was given. After that explanation, 90% of respondents reported preferring agroforestry to traditional agriculture and 57% stated an economic reason why they believed agroforestry was better. The primary reason given was that agroforestry incorporates a diversity of crops that helps smooth production and income over the year. All households believed agroforestry to be more environmentally friendly. On average, each household currently has 1.4 Ha of land under a use that could be considered agroforestry, but if lending was available and affordable, they would on average like to convert an additional 2.9 Ha, with the greatest demand for silvopasture at 1.7 Ha.

[27] The most prevalent source of non-farm income was still related to agricultural practices in the region: 57% of households reported that one or more household members earned income by providing manual labor on other households' farming land.

Table 16: Select descriptive statistics of the sample compared with information from censuses and other studies. INEC (2010) is the population census in the same year as this study, carried out by Instituto Nacional de Estadística y Censos (INEC). INEC (2000) is the most recent agricultural census, carried out by INEC and Ministerio de Agricultura, Ganadería, Acuacultura y Pesca (MAG). Arisman (2012) is a study focused on agroforestry in Intag that also used an opportunistic sample of 41 households and tried to survey the head of each household.

Description (units)	**Sample Value**	**Comparison**		
		Value	*Scale*	*Source*
Respondent				
Average Age (years)	50	51	Intag	Arisman (2012)
Household				
Average household size (people)	3.7	4	Intag	Arisman (2012)
Titled land (% of HH)	64	70	Imbabura[a]	INEC (2000)
Average farm size (Ha)	15.4	14.7	Cotacachi[b]	INEC (2000)
		17	Intag	Arisman (2012)
Population/Sample				
Achieved 1^{o} education (%)	77	67	Intag (men)[c]	INEC (2010)
Achieved >1^{o} education (%)	8	20	Intag (men)[c]	INEC (2010)
Under 18 years of age (%)	38	42	Intag	INEC (2010)

[a] Intag is located in, but comprises a small area of, Imbabura province.

[b] Intag includes seven parishes, six of which are located in and comprise ~75% (by area) of Cotacachi county.

[c] 93% of survey respondents were male, making the comparison to men only more meaningful than a comparison to the entire mixed population.

5.4.2. Model results

Results from three mixed logit models are presented in *Table 17*. The first model includes only the attributes of the CE and estimates their coefficients as random parameters, the second is the same as the first, but also includes interaction terms. The third model includes the interaction terms, but only models the alternative attributes as random parameters if their standard distribution entered significantly into model 2.

Table 17: Mixed logit model of loan choice, estimated via simulation with 1000 Halton draws.

Parameter		**Model 1**			**Model 2**			**Model 3**		
Attribute	**Element**	**Coeff.**	**S.E.**	**p**	**Coeff.**	**S.E.**	**p**	**Coeff.**	**S.E.**	**p**
Loan (dummy variable)	Mean	2.653	(0.340)	***	1.871	(0. 335)	***	1.867	(0.327)	***
	St. Dev.[a]	1.309	(0.282)	***	1.249	(0. 302)	***	1.250	(0.280)	***
	* # Children in HH				0.427	(0. 126)	***	0.423	(0.124)	***
Size of loan ($) (scaled by 1/1000)	Mean	0.207	(0.042)	***	0.145	(0. 043)	***	0.146	(0.042)	***
	St. Dev.[a]	0.149	(0.095)		0.103	(0. 142)				
	* HH can afford loan				0.293	(0.059)	***	0.291	(0.057)	***
Payback period (years) (transformed by Ln)	Mean	0.355	(0.092)	***	0.673	(0. 138)	***	0.672	(0.137)	***
	St. Dev[a]	0.063	(0.352)		0.007	(0. 213)				
	* Titled land				-0.512	(0. 162)	**	-0.509	(0.161)	***
Condition	Mean	-0.150	(0.117)		-0.800	(0. 308)	**	-0.808	(0.306)	**
	St. Dev.[a]	0.654	(0.250)	**	0.721	(0. 246)	**	0.737	(0.241)	**
	*Ln (Crop value)				0.107	(0. 044)	*	0.107	(0.043)	*
Interest rate (%) (multiplied by -1)	Mean	-1.416	(0.080)	***	-1.382	(0. 079)	**	-1.387	(0.076)	***
	St. Dev.[b]	0.555	(0.079)	***	0.517	(0. 077)	***	0.523	(0.074)	***
Simulated LL		-706.57159			-678.14348			-677.99478		
LR X^2		53.21			49.79			50.08		
Total Choice Sets		1017			1017			1017		
Respondents (N)		345			345			345		

* p<0.05, ** p<0.01, ***p<0.001

[a] Normal distribution

[b] Lognormal distribution

The results confirm that there is demand for credit as indicated by the positive and significant coefficient for the loan dummy variable. Importantly, the parameter for loan is modelled as random to account for unobserved characteristics of respondents that would influence their preferences related to borrowing. Some of that heterogeneity is observed in the interaction of loan and the number of children in a household. The more children, the greater the probability a household will demand a loan. That is likely because these households have a future to invest in and include more individuals able to work to help ensure the loan is repaid.

In contrast, the environmental condition has a negative association with choice of an alternative. Without considering interactions (Model 1), there appears to be preference heterogeneity for the condition because although the population mean is not statistically different from zero, the standard deviation is. In Models 2 and 3, an interaction of the condition and the natural logarithm of the value of a household's crop production was introduced, to account for the potential opportunity cost or gain associated with meeting the condition. It reveals that the mean main effect of the condition on choice of alternative is negative, and that households with higher crop value demonstrated a less negative, and possibly positive preference for the condition. The result it predicts is intuitive, but important to have empirically shown: that the uptake of CB-PES will depend on a household's predicted cost or gain associated with the environmental condition proposed.

Finally, interest rate has a negative association with the respondents' choice of alternative. As is expected and common in CEs, respondents demonstrate a negative utility for the attribute associated with them making a payment. It is highly unlikely that any respondent would demonstrate a positive utility for interest rate, so the random parameter for this attribute is specified in the model to integrate that assumption. Following common practice, this was done by multiplying the variable by negative one and then modelling it using a lognormal distribution (Hensher et al. 2005). That negative transformation is reversed for all post-estimation analysis.

5.4.3. Welfare change associated with environmental conditionality

The choice experiment method is consistent with utility maximization and demand theory, so when the parameter estimates of the model are obtained, welfare measures

can be obtained (Bateman et al. 2002). The marginal change in welfare of an attribute is usually expressed as a monetary value and found by taking the ratio of the coefficient of that attribute over the coefficient of a price attribute (Hoyos 2010). Here, the same basic approach is applied to measure the welfare change associated with the attribute of the environmental condition, but uniquely and appropriately to the context, the valuation attribute used is annual interest rate of a loan. The resulting marginal willingness-to-pay (MWTP) can be interpreted as the increase or decrease in interest rate that a household would require in order to accept a change in the relevant loan terms.

There are a number of specific approaches used to estimate the MWTP in an MXL model when one or more of the parameters is random (Sillano & Ortúzar 2005). The simplest and most common method is to use only the mean of the random parameters in any associated MWTP calculation. It is preferable to use all of the information associated with the random parameter and simulate the MWTP (Hensher et al. 2005), but that leads to estimates further from zero and with larger confidence intervals. Both methods were carried out and the results are presented in *Table 18*.

The most relevant portion of these results is the MWTP for the agroforestry condition ($MWTP_{AFC}$). Prior to further discussion of that result it should be noted that although agroforestry may be more profitable in the sense that it increases cash flow per hectare, a household's decision to transition to agroforestry would depend on a number of other considerations and potential opportunity costs. For example, to convert one hectare of land to agroforestry, a household with only a small area of land under tenure would forgo a larger proportion of their land available for subsistence food production compared to a household with more land. So although agroforestry may have a higher NPV based on cash flow analysis, the transition to agroforestry will be more or less desirable based on household characteristics. That broader idea is what is being considered when we discuss change in welfare associated with the condition, which is estimated as the MWTP for the condition. When that MWTP is negative, it implies that a household perceives its total costs of conversion to agroforestry as relatively high, so would require a relatively lower rate of repayment in credit in order to compensate for that.

The results indicate that, holding all else equal, the main effect of including the environmental condition is to lower the WTP for a loan by approximately 3% of the

annual interest. That effect is reduced and potentially reversed by a positive MWTP associated with the interaction of condition and Ln(Crop value), such that for every unit increase on this scale, a household's WTP for a conditional loan increases by approximately 0.4% annual interest rate.

Table 18: Mean marginal willingness to pay (MWTP) for a loan where annual interest rate (%) is the price parameter. Simulations carried out with 1000 Halton draws.

Attribute	Parameter	MWTP [95% C.I.][c]	Simulated MWTP [95% C.I.][d]
Loan (dummy variable)	(main effect)[a]	6.516 [4.484, 8.549]	7.773 [-2.011, 20.824]
	* # Children in HH[b]	1.478 [0.643, 2.313]	1.761 [0.977, 2.940]
Size of loan ($) (scaled by 1/1000)	(main effect)[b]	0.511 [0.226, 0.796]	0.609 [0.338, 1.016]
	* HH can afford loan[b]	1.015 [0.632, 1.398]	1.209 [0.671, 2.018]
Payback period (years) (transformed by Ln)	(main effect)[b]	2.347 [1.391, 3.303]	2.796 [1.551, 4.667]
	* Titled land[b]	-1.777 [-2.866, -0.688]	-2.117 [-3.533, -1.174]
Condition	(main effect)[a]	-2.822 [-4.908, -0.736]	-3.347 [-10.826, 2.392]
	* Ln(Crop Value)[b]	0.375 [0.081, 0.670]	0.447 [0.248, 0.746]

[a] Simulated MWTP has a random parameter in numerator and denominator

[b] Simulated MWTP has a random parameter in denominator only because the numerator is either an attribute modelled with a fixed parameter or an interaction term (which were all modelled as fixed parameters).

[c] Estimated via delta method

[d] Estimated via Krinsky-Robb method

Understanding these population moments is very useful, but can disguise underlying complexity in the MWTP distribution. To fully explore the $MWTP_{AFC}$, another simulation was carried out that 1) jointly considered the main and interaction effects for the condition, and 2) used the sample population data for crop value to relate it to the case study. The results presented in Figure 4 show a more complex picture of $MWTP_{AFC}$ in this case study. It indicates the existence of three groups with varying levels of crop income and resulting $MWTP_{AFC}$. One group has high crop income and a positive $MWTP_{AFC}$ for the condition, one has lower crop income and a negative $MWTP_{AFC}$, and the final group has very little or no crop income and a large negative $MWTP_{AFC}$. The characterization of these groups is presented in *Figure 11* and *Table 19*. The overarching result, however, is that the majority of the population has a small

positive or small negative $MWTP_{AFC}$, with an estimated small negative mean $MWTP_{AFC}$ across the entire population.

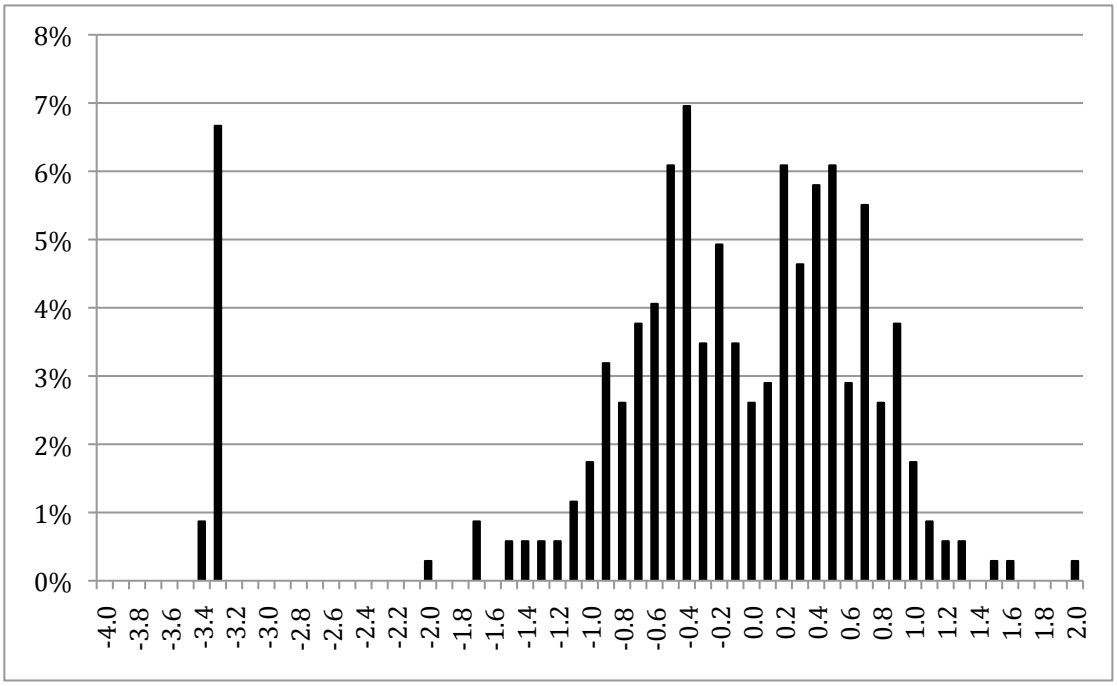


Figure 11: Histogram of the proportion of the sampled population with a given marginal willingness-to-pay for the agroforestry condition ($MWTP_{AFC}$), measured as a change in annual interest rate of a loan (%). Categories on the x-axis are .1% ± 0.05% change in annual interest rate. The results presented are from a simulated MWTP incorporating the attributes: condition, condition*Ln(Crop value), and interest rate of the loan. It was simulated using 1000 Halton draws and the crop value data of the 345 households sampled.

Table 19: Three subgroups with differing MWTP for the agroforestry condition ($MWTP_{AFC}$), measured as a change in annual interest rate (%).

Group	**(+)$MWTP_{AFC}$**	**(-)$MWTP_{AFC}$**	**(- -)$MWTP_{AFC}$**	**Whole Sample**
Mean $MWTP_{AFC}$	0.53%	-0.58%	-3.31%	-0.27%
Max. $MWTP_{AFC}$	1.99%	-0.01%	-3.26%	1.99%
Min. $MWTP_{AFC}$	0.02%	-1.98%	-3.39%	-3.39%
Portion of Population	*46.38%*	*46.09%*	*7.54%*	*100.00%*

5.4.4. Simulating demand

The predicted utility to each respondent of alternatives with specified attribute levels can be simulated based on the MXL coefficients, from which the rate of demand for conditional and unconditional loans can be estimated. The actual uptake of such loans will depend on a number of other factors, but simulating demand helps to understand households' preferences for and perceptions of these loans. *Table 20* presents the estimated demand for a conditional, $2,500, four-year loan where the reference market interest rate for unconditional loans is 12%. That reference rate is the low-end of market rates in areas surrounding the case study area, but is presented here for illustrative

purposes and deemed reasonable since it is assumed that measures to ensure credit repayment, such as joint liability or collateral requirements, would be put in place and permit this more reasonable rate.

Table 20: Simulating demand for loans with an agroforesty condition, based on a $2500, 4-year loan in a choice set with 1) the same unconditional loan at 12% interest, or 2) no-loan status quo. The second to last column indicates the portion of the CB-PES that corresponds to compensation for the marginal change in welfare associated with the PES condition, averaged based on expected participation in CB-PES at a given interest rate. The last column is the same statistic, but averaged over the entire sample.

Interest Rate (%)	Predicted Demand (%)	CB-PES ($/year)	CB-PES as % of annual loan repayment	Mean % of CB-PES that compensates self-selecting participators	Mean % of CB-PES that compensates across whole sample
12	34.89	-	-	-	-
10	45.50	34.41	4.18	3.51	13.28
8	56.15	68.28	8.30	2.43	6.59
6	66.31	101.61	12.34	2.11	4.35
4	75.15	134.36	16.32	1.94	3.23
2	82.26	166.53	20.23	1.79	2.56
0	87.61	198.09	24.07	1.65	2.11

Following the third row of *Table 20* where the interest rate for a conditional loan is 8%, we find that given this scenario, it is predicted that 56% of respondents would like to receive a conditional loan. Compared to a 12% market rate, the conditional 8% interest rate corresponds to a CB-PES payment of $68.28 per year, which would be awarded as a decrease in the amount that the borrower had to repay each year of the loan as long as the environmental condition was being met.

During the simulations for predicted demand, each household's MWTP for the condition was also simulated (following the same approach as in *Figure 11* and *Table 19*) as an estimate of that household's welfare change associated with accepting the agroforestry condition. Multiplying the probability of household *n* accepting a conditional loan by their MWTP for the condition gives an expected change in welfare associated with the condition for each household, under the given loan conditions. The mean expected MWTP is presented in column five as a percentage of the CB-PES.

There are two key results revealed by *Table 20*. First, when the interest rate offered if the condition is met is 8%, the CB-PES represents only 8.3% of the total annual loan repayment. Even at lower rates (thus larger CB-PES), the ES payment always represents a small portion of total loan repayment, meaning that under this scenario, households are willing to take on the majority of the financial burden of borrowing a conditional

loan. That indicates that households do demand credit and providing it, even with an environmental condition, would be relieving a market constraint. The result aligns with the fact that the coefficient for a loan, irrespective of whether or not it is conditional, in the econometric model is positive and significant, indicating latent demand for credit.

Second, based on the expected household demand for conditional loans (i.e. assuming self-selecting participation in a CB-PES program) at an 8% interest rate, only 2.4% of the CB-PES represents compensation for the on-average negative marginal change in welfare a household anticipated to experience due to the agroforestry condition. That is, on average across the 56% of households demanding loans with these terms, only $1.66 of the entire $68.28 CB-PES is compensation for an anticipated decrease in welfare associated with carrying out the environmental condition. For comparison, assuming non-self-selecting participation was feasible and implemented, the mean (negative) $MWTP_{AFC}$ across the entire population could be covered by only 6.6% of the CB-PES under this scenario. That is 3-fold higher than a self-selecting scenario, but still only a small portion of the CB-PES. The general result is the same for all scenarios simulated: only a small portion of the CB-PES would be compensation for the opportunity costs of meeting the agroforestry condition.

Table 21: Comparing the annual loan repayment if the condition is met to the repayment required if the condition is not met, expressed in both $/year and as a % of reported 12-month gross cash income. Both are estimated as a mean expected value of the portion of the population that it is predicted would accept CB-PES at the interest rate given. Based on a $2500, 4-year loan.

Condition is Met			**Condition is Not Met (12% Interest Rate)**	
Interest Rate	**Repayment ($/year)**	**Repayment as % of Gross Cash Income**	**Repayment ($/year)**	**Repayment as % of Gross Cash Income**
12%	$823	12.65%	$823	12.65%
10%	$787	15.67%	$823	16.32%
8%	$755	18.64%	$823	20.28%
6%	$721	21.25%	$823	24.16%
4%	$689	23.22%	$823	27.64%
2%	$657	24.45%	$823	30.51%
0%	$625	24.98%	$823	32.72%

A final key consideration is to look further at the debt burden that households are hypothetically being asked to accept if they participate. *Table 21* compares the annual repayment that a household would be liable for with conditional loan interest rates ranging from 12% to 0%. The liability is expressed in both $/year and as a percentage of gross cash income reported for the 12-month period prior to the survey being

implemented. The percentage does not account for the entire population, but is a mean expected value representing only the portion of the population that it is predicted would demand conditional loans with the given loan terms.

It is difficult from this data to say what an acceptable level of liability is, but an annual repayment of 20-30% of annual income is reasonable compared to microcredit examples in other countries where smaller loans (on the scale of $100's, rather than $1,000s) are taken out and repaid multiple times a year in communities with lower average annual income than this case study (Collins et al. 2009). More importantly, the increase in liability if the CB-PES condition is not met, is not very large for all reasonable scenarios. If a household were deemed able to handle the liability in the first place, then the change associated with the undesirable outcome of not meeting the conditionality generally represents only a few percent of gross annual income. As such, the surprise liability if the condition were not met does not appear overly burdensome relative to the total liability a household would be accepting.

5.5. Discussion

5.5.1. Summary of case study

The Intag Zone represents a credit-constrained context where it is believed that increasing the use of agroforestry helps save the forested area that remains, provides increasing levels of biodiversity and ES on agricultural land, and supports adaptation to climate change. Our choice model and simulation results indicate that if CB-PES were implemented, where the magnitude of payment is approximately $70 per hectare per year with a condition of converting one hectare of land to agroforestry, more than half of households would be interested in accepting conditional loans of $2,500 paid back over four years. A payment of that size is in line with other case studies in Latin America.[28] For example, a case study of implementing the World Bank's RISEMP in Nicaragua, reported a maximum PES of $75/ha/yr over 4 years (Pagiola et al. 2007). In

[28] No comparable case studies were identified of PES for agroforestry actions in Ecuador. For reference, however, one case of PES for reforestation in Ecuador paid approximately $40-$60 per hectare annualized over 3 years (Wunder & Albán 2008) and the country's national program for forest conservation, Socio Bosque, pays $30/ha/yr for the first 50 hectares of forest cover under contract (Fehse 2012).

Costa Rica, the national PES program paid $1.30/tree in an agroforestry system, spread over three years (FONAFIFO 2009); when the same terms are applied to the cash flow models of a mixed agroforestry system in Intag (*Table 13*) it equates to an average $100/ha/yr over the first five years. Most interestingly, under these CB-PES conditions, the participating households are willing to accept over 90% of the loan repayment burden and only 2.4% of the CB-PES compensates for the negative average welfare change associated with meeting the agroforestry condition.

5.5.2. CB-PES as incentive

The case of Intag does not allow a direct comparison between CB-PES and more conventional cash PES, but it does illustrate some key points about CB-PES as an incentive. By incorporating strong conditionality into credit provision, CB-PES explicitly links the dual objectives of overcoming market constraints and providing a relatively direct reward for the provision of ES. It is inherently designed to support both environment and development objectives, rather than create trade-offs, which is something that all stakeholders should prefer.

The key empirical result is that CB-PES fits key criteria of a good incentive as proposed from behavioural studies. The results indicate that under any reasonable scenario, potential ES providers are willing to take on the majority of the burden of a conditional loan repayment and only a small proportion of the CB-PES reward is considered compensation for meeting the environmental condition. CB-PES is thus an incentive that potential ES providers would perceive as supportive, rather than controlling (Frey & Jegen 2001). Related to that, CB-PES fits the paradigms of PES as co-investment (van Noordwijk & Leimona 2010) or a more reciprocal arrangement (Farley & Costanza 2010) that many PES academics and practitioners consider the best ways to frame PES, particularly in a developing country context, and especially in Latin America.

It is recognised that the case study presented here was where the condition aligned with a broad agenda in the area, the increase of agroforestry. Nonetheless, even for households that are expected to have a negative welfare change associated with agroforestry, the results hold. When the interest rates of conditional loans are so low that it is estimated that nearly 90% of the households would demand them, those households would have to accept 75% of the loan repayment and the compensatory

portion of CB-PES would continue to only represent a small portion of the reward. In effect, the CB-PES would be primarily working to make borrowing more affordable instead of compensating for opportunity costs of the environmental condition.

Further, because the reward is time constrained and is really a reward that lowers a burden, rather than increases a payment, it is less likely to induce long term shifts in endogenous preferences. In practice, this would reduce the risk of entitlement among ES providers, which is a concern of direct cash PES highlighted by ecological and institutional economists (Farley & Costanza 2010; Vatn 2010).

5.5.3. Implementing CB-PES

In analyzing the dynamics of CB-PES the empirical results highlight considerations for its implementation.[29] Both the cost to the ES buyer and demand for conditional loans of the ES provider are sensitive to the reference market interest rate. A higher market interest rate would imply a greater demand for the conditional loan at any given interest rate. That is, if the reference rate were 18%, the demand for conditional loans would be greater than the 56% illustrated in this study when the reference rate was 12%. That dynamic is intuitive: if the unconditional reference rate is higher, households will have a greater willingness to accept the environmental condition in order to receive a lower interest rate. Any organization wanting to implement CB-PES would need to determine what the appropriate and/or feasible reference interest rate for loans is before being able to understand the cost of such a program and willingness of households to accept conditional loans.

Our case study and model also illustrate that the demand of an individual household for a conditional loan is dependent on their expected loss or gain associated with carrying out the environmental condition. As is the case with any voluntary incentive policy there is a self-selection bias, where households that anticipate a low cost or even a gain associated with the condition are more likely to participate. Targeting may be required to improve the environmental performance of CB-PES, as is true with PES broadly (Wünscher et al. 2008). That would change the cost of the program and require

[29] In addition to the considerations for implementation that arise from the analysis here, various other implementation issues would need to be considered. For example, monitoring and enforcement would need to be addressed.

heterogeneous contracts to achieve optimal cost-effectiveness, but the results related to acceptance of repayment burden and only a small portion of CB-PES being compensatory would hold. That is demonstrated in , where the compensatory portion of CB-PES is assessed over the entire sample and not just the households that would self-select to participate under specific conditions. Further, the variation in the anticipated cost or gain of meeting the condition provides a second reason specific to CB-PES for preferring heterogeneous contracts. With variation in the MWTP for an environmental condition, heterogeneous contracts would permit cross-subsidization between borrowers, reducing the total current cost to the ES buyer. Doing so would help maintain the level of capital available for lending, bringing the mechanism closer to being self-financing once capitalised.

Additionally, access to affordable credit is considered a development issue and CB-PES is an incentive mechanism with dual environment and development objectives. If the proposed reward is large, more households will be interested in accepting conditional loans with the reported intent of meeting the condition, but there is concern over whether they would be able to pay back the loan at the higher reference rate if the condition is not met. In the case study here, the level of payback appears reasonable, but safeguards would nonetheless need to be in place to ensure no household is taking on an unacceptable level of debt. Further, to be supportive of lower-income households participating in CB-PES, the reward may be better constructed as a partially conditional reward. For example, if the reward were a reduction in annual repayments of $100, perhaps $50 would be unconditional and reward the attempt to meet the condition, while $50 would be conditional. Or put another way, $50 could be considered paying for the development benefit of access to affordable credit, while $50 could be considered paying for the delivery of ES. If multiple donors with these different objectives could work together, that approach could both 1) reduce the interest rate lower than the budget constraint of the ES buyer, and 2) reduce the surprise burden if the environment condition is not met.

Finally, only one institutional factor entered the model, and it is one worth noting: land title. Respondents with legal title to at least some portion of their land had a lower utility for longer-term loans than those without any legal title. That implies titled households are more willing to accept shorter loan periods. A shorter period would require higher annual repayments, but leads to an overall lower cost of financing. That

would in turn lead to a lower CB-PES. Land titling could also make CB-PES more feasible, particularly if a normal lender was providing the loan, and the CB-PES was paid by a third party interested in environment (and/or development) outcomes. An evaluation of a pilot project by the Inter-American Development Bank (IDB) to improve land titling in Ecuador found that, amongst other benefits, improved land titling permitted agriculturalists greater access to credit, and a larger-scale project is now underway (IDB 2013). Overall, it appears that improved land tenure could make CB-PES more feasible and cheaper to implement.

5.6. Summary

In this study we propose and *ex-ante* assess CB-PES, a novel incentive for the provision of ES alongside the reduction of a key market constraint. It is found to be a promising form of PES that combines a performance reward with a reduction in the credit constraint, and in doing so fits key criteria that are believed to make for good incentives and are increasingly discussed in the PES literature.

Through this study, the broader dynamics and key implementation considerations are also identified. In terms of design, the uptake of conditional loans and cost of CB-PES will depend greatly on the reference market interest rate and the expected loss or gain associated with the environmental conditionality. In terms of implementation, particular attention should be paid to the debt burden a potential ES provider may be attempting to take on; heterogeneous contracts could be highly beneficial; there is a case for both environmental and development benefits to be jointly financed through a credit-based reward; and improved land tenure could make CB-PES more feasible and cheaper to implement.

The case study was chosen as one where negative environmental trends need to be reversed and market constraints relieved to ensure sustainable development of the area. It is a context that is prevalent throughout developing countries and so our results are widely relevant. Based on those results, it is wholly recommended that the CB-PES be explored further and piloted beyond the few examples of convertible lending that, notably, have reported success.

CHAPTER 6

CASE STUDY

Incentive Choice and Joint Liability in Payments for Ecosystem Services: Evidence from a choice experiment in Colombia

6.1. Introduction

Despite such wide proliferation of PES, there remains a lack of well-designed studies evaluating their effectiveness (Miteva et al. 2012; Pattanayak et al. 2010). Costa Rica's national PES program is the longest standing and most researched PES programme in the tropics. Evaluations indicate the introduction of incentives had little aggregate impact across the nation on improving forest cover (Robalino & Pfaff 2013), but a moderate positive impact in well-targeted areas (Arriagada et al. 2012) implying a heterogeneous effect across the country. Heterogeneity in the effect of PES can arise from difference in the quality of implementation across the country or differences in the responses to the incentive by PES-recipient subgroups (Arriagada et al. 2012).

The case study here focuses on the latter, because despite PES programmes being incentive-based mechanisms (Jack et al. 2008), efforts to apply economic knowledge of incentives to PES design is still limited and primarily focuses on contract theory (e.g. Zabel & Roe, 2009). There is evidence that in non-industrialised nations various factors can affect the optimal choice and design of conservation incentives. For example, different market contexts can affect the outcomes of direct compared to indirect incentives (Muller & Albers 2004); different social preferences can affect whether household- or community-based incentives are preferred (Narloch et al. 2012); and perceptions of the ES buyer can affect the type of incentive an ES provider would accept from the buyer (IIED 2012).

This chapter explores two key aspects of incentive design for PES. First, the research directly compares cash and in-kind incentives, an issue that has received significant attention among PES researchers and practitioners, but without much empirical

research. Second, it analyses the possibility of joint liability PES (JL-PES), where a group of households will all receive a reduction in their payment if one household within that group fails to meet the environmental condition of the PES. A choice experiment (CE) is used to *ex-ante* assess incentive design in a developing PES programme in Colombia to explore both aspects of PES design. The CE was implemented with respondent households living in communities that are already targeted as conservation priorities, so would be the pool of potential recipients of a PES programme under development. The key question is how best to design incentives to ensure that these households work to provide the desired public goods.

Following this introduction, the next section provides a focussed literature review on these two key aspects of incentive design for PES. Section 6.3 describes the methods used for this case study and Section 6.4 presents the results. Section 6.5 discusses those results in more depth, followed by a summary in Section 6.6.

6.2. Two Aspects of Incentive Design

6.2.1. Cash or in-kind incentives

To date, the primary argument for cash over in-kind PES is their economic flexibility (Wunder 2005), permitting recipients to spend the money as they want. Arguments against cash payments in the PES literature are primarily based on psychological evidence of the negative cognitive effects of extrinsic incentives on pro-social behaviour (Farley & Costanza 2010; Sommerville et al. 2009; Vatn 2010). The cognitive literature cited usually states or implies that the extrinsic incentive provided is cash. Specific studies on the introduction of cash corroborate the cognitive effects. Reviewing a series of experiments, (Vohs et al. 2006) conclude that the introduction of cash, or even just the idea of cash, can induce a reduction in pro-social behaviour. In contrast, through laboratory experiments, (Heyman & Ariely 2004) find that subjects exert more effort for low-level in-kind than low-level cash rewards.

There is another literature relevant here, on cash compared to in-kind transfers in redistributive policies. As in the PES literature, the primary argument for cash over in-kind transfers is that they are flexible and can be used for whatever the recipient wants to purchase: “in-kind incentives constrain the behaviour of the recipients, while cash transfers do not” (Currie & Gahvari, 2008, pg. 333). There is an additional overlap between the two literatures as PES can be part of a redistributive policy. Some policy

programmes that use positive incentives have an element of or are wholly viewed as revenue recycling or benefit-sharing mechanisms, as is true with national REDD+ programmes (Peskett 2011).

In the literature on redistributive policies, the theoretical arguments for in-kind transfers are usually based on paternalism, self-selection, or political economy (Currie & Gahvari 2008; Hessami & Uebelmesser 2013). The arguments for in-kind transfers based on the Samaritan's Dilemma and pecuniary benefits are also relevant to PES. All five are briefly presented in turn (drawing on Currie & Gahvari, 2008):

> 1) When there is some social or government preference for what transfer recipients should consume, this paternalism can be implemented through providing in-kind transfers. There is a related consideration in the PES literature, that if given cash, PES recipients may indulge in myopic spending (Wunder 2005); spending on short-term indulgences, rather than spending on needed goods and services, such as health and education. In which case, less flexible in-kind incentives may be preferred in order to guide recipients' consumption.
>
> 2) Under information asymmetries, providing in-kind transfers may induce self-selection of recipients. If cash is provided, there is inevitably a set of individuals that are not the main target of the policy, but would be incentivized to try to claim eligibility. There is a range of transfer-design strategies to help ensure self-selection by making an in-kind transfer only valuable to the targeted population. As in any incentive-based policy, PES must also overcome issues of information asymmetries and targeting.
>
> 3) The political feasibility of cash or in-kind transfers may determine which is used. One study of PES found that in-kind incentives were preferred by recipients if the ES buyer was a non-governmental organization (NGO), but cash was preferred if the buyer was the government (IIED 2012). Recipients of PES deemed it unacceptable that the government might provide social benefits conditional on good environmental behaviour, when the government was always responsible for providing those benefits. Additionally, in-kind incentives may be more politically palatable for community-based incentives because an

egalitarian allocation is considered fairer when it is an allocation of goods rather than cash (DeVoe & Iyengar 2010).

4) The Samaritan's Dilemma (Buchanan 1975) argues that when receiving financial support, the recipient may come to rely on it and not invest in their own human capital improvement to move out of poverty. In-kind transfers may be preferred to directly provide the human capital development. This is a similar mechanism to entitlement cited in PES literature, where because recipients receive cash incentives, the intrinsic motivation to provide public goods is reduced, leaving everyone worse off if cash payments cease (Farley & Costanza 2010).

5) There may be pecuniary benefits to providing in-kind transfers. One argument is that by providing goods or services directly as in-kind incentives, the public sector will increase their supply and lower the price in the local market into which they are introduced. Such a mechanism may be beneficial for PES, particularly in developing countries. There is concern that PES can have livelihood impacts on those not participating in the programme, through, e.g., changing labour markets or local commodity prices (Grieg-Gran et al. 2005). Well-chosen in-kind incentives may make these impacts more positive. Similarly, providing in-kind benefits could insulate recipients from inflation, which has at times been a motivation for their use in OECD countries (Hessami & Uebelmesser 2013).

Table 22: Perceptions of cash and non-cash payments for ecosystem services in a Bolivian case study. Adapted from Asquith et al., 2008; Robertson & Wunder, 2005.

Category	**Perceptions of cash vs. beehives as incentives**
Economic character of incentive	- Beehives are inflexible assets to sell - Beehives are inflexible assets to subdivide - Cash would be spent rapidly and leave no long term benefits - Honey is a useful subsistence or sellable product
Cognitive perception of incentive	- Some recipients reject money - Receiving cash 'smells' more like giving up future property rights - Demonstration effect (to neighbours) of bees and the sweet taste of honey gives PES implementers more goodwill than a corresponding cash transfer
Effects on cost/benefit of program	- Some recipients little skilled and little interested in beekeeping, thus losing benefits - Extra training costs for implementing NGO - Extra costs for recipients to benefit because beekeeping demands labour inputs - Beekeeping includes an incentive to protect forest as bee habitat

Despite a well-developed theoretical literature, there is limited empirical evidence of why cash or in-kind transfers are ultimately used, or the factors that may shift that preference (Hessami & Uebelmesser 2013). The empirical literature "seems to largely accept the paternalism theory and move on to other questions" (Currie & Gahvari 2008; pg. 334). There is equally limited empirical evidence comparing cash or in-kind PES. One problem is that much PES literature presents in-kind incentives as synonymous with community-level social benefits (Goldman-Benner et al. 2012; IIED 2012; Sommerville et al. 2010), conflating the discussion of type of incentive with the pros and cons of community-level incentives and interventions.

Only one case study of a PES programme was identified that directly compared household-level cash and household-level in-kind incentives (Asquith et al. 2008; Robertson & Wunder 2005). When establishing a programme of payments for watershed services in Los Negros, Bolivia, the programme proponents discussed the benefits of cash or a particular in-kind incentive that would provide an alternative livelihood: beehives. The ES providers' perceived advantages and disadvantages of cash and in-kind incentives were reported, and they fall into three categories (*Table 22*). The first is the economic character of the incentive, which broadly aligns with the arguments of flexibility of the incentive, for good or bad. The second are the cognitive perceptions, all favouring in-kind PES. The third is the effect of the incentive on the costs or benefits of the PES program. The direct effects noted are that in that particularly case study, there would be some additional costs associated with the in-kind incentive (e.g. training). There is also an indirect effect that the in-kind incentive is related to a joint production activity, which aligns with a paternalistic argument: the in-kind incentive provides not only a direct motivation to not fell trees, but also a secondary benefit of moving recipients towards livelihoods that are socially preferred.

6.2.2. Joint liability

As described in Chapter 3, joint liability is a key economic innovation for lending to overcome the effects of information asymmetries—both adverse selection and moral hazard—in a context similar to that in which many PES programs, particularly in developing countries, are implemented. It involves a group of borrowers all being liable for the repayment of the loan borrowed by a single member of that group. If one borrower defaults, the group defaults and no more lending is offered to any member. Group liability leverages the fact that group members have better information about

who would be a good borrower than the lender initially has, and relies on self-selected groups to form based on that information. It also leverages the social ties between group members because they will work together to ensure that no single member defaults, either through social pressure (when the borrower has the ability to repay) or developing a side arrangement to finance repayments (when the borrower does not have the ability to repay) (for deeper reviews of the economics of joint liability see Armendáriz & Morduch, 2005 or Ghatak & Guinnane, 1999). Joint liability could help overcome information asymmetries in PES through 1) using self-selected groups as a strategy to identify households that are *ex-ante* more likely to meet their contractual obligations (i.e. overcome *ex-ante* moral hazard), and 2) leveraging social ties to ensure that households do in fact meet them (i.e. overcoming *ex-post* moral hazard or unintended failure). There are two relevant literatures that indicate the potential dynamics of JL-PES.

The first and most immediately relevant is on collective action to conserve common-pool resources. Evidence of the effect of group size is mixed and hampered by lack of consideration for relevant contextual factors (Poteete & Ostrom 2004; Yang et al. 2013). Broadly, however, there appears to be evidence of both positive and negative effects of group size on collective action outcomes. Yang et al. (2013) reviewed this literature and evaluate the effect of group size on a PES program in Wolong Nature Reserve, China. In this program, groups of one to 16 households were responsible for monitoring parcels of land, in order to deter illegal logging, but over which no household had tenure. If the reserve administration found evidence of illegal logging on that parcel, all responsible households would receive a reduced PES. The authors found that, *ceteris paribus*, the most monitoring effort per household and the greatest environmental success occurred at an intermediate group size, nine on average. Based on their case study and the literature they argue that increasing group size supports better within-group enforcement, but that at some point the incentives to free ride begin to overwhelm those benefits, leading to an overall parabolic dynamic of group size on level of monitoring and ultimately, environmental outcomes.

The second literature is joint liability in lending. There is some evidence that the same two opposing effects occur, leading to a quadratic dynamic. In their review and analysis of the economics of joint liability, Ghatak & Guinnane (1999, pg. 217) suggest that as group size increases the benefits also increase, but at some point "coordination

difficulties and free-rider problems in organizational matters overwhelm the informational and enforcement benefits of a group". They note that through trial and error Grameen Bank in Bangladesh settled on five as the preferred group size, and cite qualitative reports that a group of 20 lenders is too large in Nepal (Mosley & Dahal 1985) and the Dominican Republic (Devereux & Fishe 1993). Moving beyond qualitative case studies, modelling efforts also provide evidence that the intermediate group sizes are optimal (Armendáriz de Aghion 1999; Kaminski 2009) and its specific size will depend on the ability for within-group enforcement (Kaminski 2009).

There are already examples of PES for communities rather than households, and at least one clear example of group-based PES that could be considered JL-PES (Yang et al. 2013). Those examples, however, are where PES are used to incentivise collective action for directly conserving a common-pool resource (CPR). There are also many PES used to incentivise provision of ecosystem services from private land. Joint liability could improve PES in these cases by overcoming information asymmetries, but empirical research is needed to understand how potential PES recipients would perceive it.

6.3. Methods

To test potential PES recipients' preferences related to incentive choice and joint liability, we use a CE of a developing PES programme in Colombia. As part of the CE, potential recipients chose between receiving cash and in-kind incentives (or receiving no incentive and not participating in the program). The aim was to provide some empirical evidence of why cash or in-kind incentives may be preferred by ES providers, and see how that relates to policy design arguments for use of one or the other (borrowing from the literature on redistributive policies). We do not attempt to demonstrate any cognitive effects, but to complement the psychological evidence already broadly cited in the PES literature. We focus on the more traditional economic effects, asking if there is any evidence that PES design could be informed by the arguments for in-kind transfers, or other additional arguments for cash or in-kind PES that may emerge. Additionally, within the CE, potential recipients were also presented with different group sizes under JL-PES. The aim was to assess the overall effect of group size on the acceptable value of the incentive, and identify any characteristics of households that would affect this dynamic.

6.3.1. Case study

The emerging model for watershed conservation in Latin America is a water fund (Goldman-Benner et al., 2012). Bennett et al. (2013) tracked 23 active funds in 2012, with more in development, and in 2011 the Latin America Water Funds Partnership pledged USD 27 million to support and capitalize such funds.[30] In a water fund, various ES buyers will raise finance for watershed conservation from special water use fees, through normal household and business water utility bills, international donor financing, and/or contributions from private companies. These funds will be held by a joint committee of the buyers and other relevant programmes stakeholders (e.g. representatives of affected communities) and is usually managed as a trust fund. The committee will then decide how best to invest finance for watershed conservation. That investment can be in land purchase, land restoration, community conservation projects, PES, and more.

In 2011, the capital of Colombia, Bogotá produced 24.4% of Colombia's GDP (DANE 2013) and it currently has an estimated population of nearly 8 million people. Bogotá receives all of its water from national parks comprised of páramo and cloud forest, and investing in reducing sedimentation through land use change could reduce water treatment costs by millions of dollars (Calvache et al. 2012). These national parks also provide habitat to a range of threatened and endemic species. That scenario is common throughout Latin America, and water funds are proliferating.

To help maintain the vital ecosystems around Bogotá a water fund called Agua Somos was formally launched in 2010.[31] The fund stakeholders include Empresa de Acueducto y Alcantarillado de Bogotá (EAAB; Bogotá's water utility), Bavaria (a beer maker), Parques Nacionales Naturales de Colombia, Patrimonio Natural (national conservation trust fund), The Nature Conservancy, and the Inter-American Development Bank. As part of its suite of efforts to protect the ecosystems that provide water to Bogotá, Agua Somos is considering providing positive incentives (i.e. PES) to households living around the protected areas that provide water to Bogotá.

[30] The partnership is a joint effort of The Nature Conservancy, FEMSA Foundation, Inter-American Development Bank, and Global Environment Facility. More at http://www.nature.org/ourinitiatives/regions/latinamerica/latin-american-water-funds-partnership.xml

[31] For more on Agua Somos, see http://www.aguasomos.org/.

To inform the use of PES by Agua Somos and other water funds in Latin America, a case study was developed for Chingaza National Park. More than 80% of the water used for human consumption in Bogotá comes from Chingaza (Calvache et al. 2012). Additionally, as with many water funds and PES programs across the region, the main threat to the provision of water services and biodiversity habitat in Chingaza continues to be livestock production.

6.3.2. Survey and choice experiment

A local extension worker and the primary researcher carried out a survey of 152 households from 17 communities in August through October 2011. EAAB has carried out community conservation with a small, but increasing number of households around Chingaza since 2007. These activities have been implemented in the communities with which it is most important to work to protect the watershed as initially determined by EAAB[32]. As such, these are the most likely to receive PES and sampling was carried out to focus on them. In the highest priority communities nearly 100% of households were surveyed, and sampling was opportunistically carried out within communities that a potential PES program may expand into in the future. Overall, 45% of households surveyed had previously been directly engaged with EAAB-funded activities. As such, the sample covers all of the households that would be primary targets for PES, and many target households of secondary importance.[33]

The main body of the survey collected information about each household's social characteristics, economic activities, and views related to the key ecosystem services provided by Chingaza. That was followed by a CE designed to understand households' preferences for cash compared to in-kind incentives and their willingness to participate in JL-PES.

The hypothetical situation presented was as realistic as possible and due to the complexity of the attributes, was presented in two parts. The first part focused on incentive types. It described that a conservation NGO would like to improve the

[32] Now the stakeholders of Agua Somos are working together to determine the areas that are conservation priorities.

[33] It is also worth noting that the sample size was sufficient for analysis based on the rule of thumb for minimal CE presented in *Equation 3*. In this case study, the minimum would be 111, which is 73% of the actual sample.

sustainability of production systems around Chingaza to help protect local water resources and biodiversity. It then stated that under a potential PES program:

- Households would include approximately 160 additional trees on their land, across slightly more than 1 Ha
- Trees would be for living fences or riparian reforestation as agreed between household and NGO
- The NGO would cover up-front costs, but the household has to manage and protect the new trees.

Four types of possible incentives in the PES program were then discussed and examples given for each (*Table 23*). The incentive options were cash or three types of in-kind incentive: livestock support, crop support, and alternatives to tree use. Within the three types of in-kind incentive it was clear that they were all household-level incentives, and did not include social benefits (e.g. schools) or physical capital (e.g. irrigation). While discussing the four different types of incentive, respondents were asked to rank them in order of most preferred to least preferred for their household. The examples given for the in-kind incentives were either support that EAAB had already given or EAAB or Agua Somos had discussed, so they were generally familiar to respondents and all possible to implement.

Table 23: Types of incentives described in the CE scenario.

Incentive Type	**Example**
Cash	To use however your family wants
Support for crop production	Good seeds, subsidies for manual labour, organic fertilizers
Support for livestock production	Good feed, subsidies for more productive cattle, support for better pasture production (e.g. organic fertilizers)
Alternatives to tree use	Subsidies for natural gas, fuelwood from elsewhere, treated wood for posts that last longer

The second part of the scenario introduced the concept of joint liability. It was explained to respondents that to reduce monitoring costs, the NGO might randomly assign participating households to groups of up to seven families (i.e. the responding household plus six more). The NGO would only monitor one randomly selected household per group per year, if that household had protected its trees, all families would receive their PES, if not, then no family would. The basic costs and benefits were also outlined: that each family would have to expend some effort to ensure that other

families in their group were managing their trees, but also families could support each other in their efforts.

Following the scenario, a CE was carried out where the attributes of the alternatives were value of the incentive (in Colombian Pesos; COP), group size (number of households), and whether or not the incentive was cash or in-kind (binary) (*Table 24*). The levels of the value and group size were determined based on a small pilot survey, with input from the local research assistant and EAAB. It was estimated that the average main effect would be positive for higher incentive values, and the effect would be quadratic for group size.

Prior to the survey and CE it was unclear whether respondents would prefer cash or in-kind incentives. Respondents were permitted to assume that the in-kind incentive was whatever type of incentive they preferred, and that was directly recorded on the choice card (on the line underneath "Materials", *Figure 12*). The choice of in-kind incentives was permitted in order to neutralize the flexibility benefit of cash. That benefit is well established, and so here the aim was to observe what other dynamics were at work.

Table 24: Incentive attributes and levels for choice experiment in Chingaza PES survey.

Attribute	**Levels**
Value (COP)	150000, 235000, 260000, 350000
Group size (Number of jointly liable households)	1 (i.e. solo, no group), 3, 4, 7
Type	Cash or In-kind

A full factorial design of the attributes produced 32 unique alternatives, which were reduced to 16 using an orthogonal design. From this fractional factorial design, a shifting procedure[34] was used to create 16 pairs of 32 alternatives. Although this CE design approach is sometimes not viewed as the optimal method, it was deemed appropriate here due to the relatively small sample size and lack of a-priori information on parameter values of the econometric model (Ferrini & Scarpa 2007).

Due to the in-kind attribute being binary, the shifting technique naturally produced 16 choice sets where there was always one cash incentive and one in-kind incentive. The order of alternatives in each choice set was randomized (i.e. A, B vs. B, A), meaning

[34] The levels of a given attribute are qualitatively coded in rank order (e.g. 1, 2, 3 for an attribute with three levels). Each attribute is shifted one level up, where if the top level is reached, the level returns to 1.

that the CE was unlabeled. Each choice set also included an option to not receive any PES and so not participate in the program (a status quo option), so each choice set included three alternatives. An example of a choice card used during the survey is presented in *Figure 12*. For each respondent, six choice sets were randomly assigned without replacement.

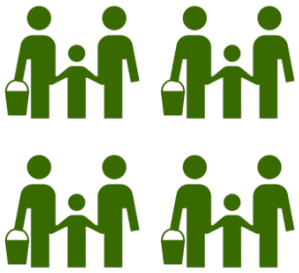
	A	B
Value of incentive	COP 350,000 per family per year	COP 150,000 per family per year
Type of incentive	Cash	Materials… _____
Family group	4 families 	Only your family 
To protect approximately 160 native trees in living fences in two fanegadas of your productive land, which incentive would you prefer? A B Neither		

Figure 12: Example of a choice card from the Chingaza PES survey, translated from Spanish. 1 fanegada = 0.64 hectares.

6.3.3. Econometric framework and model specification

The econometric approach for this case study is the same as that in Chapter 5 and is fully described there. As noted in Section 5.3.3, one of the benefits of the mixed logit (MXL) model of the multinomial logit (MNL) model is that incorporates random parameter estimates to account for preference heterogeneity among respondents (Train 2009). That should be tested to ensure that the MXL is a valid model for any given data set. When analysing the data from Chingaza, the standard deviation of all three CE

attributes entered the model with statistical significance, indicating they could be modelled as random to account for preference heterogeneity among households.

It was important to account for this preference heterogeneity in this case because the in-kind attribute was a broadly defined one, which different respondents could interpret differently. That interpretation could lead to preference heterogeneity of the attribute itself, and also manifest in the trade off between attributes. Some of the heterogeneity is observable and accounted in the model through interactions between respondent characteristics and incentive attributes. The remaining heterogeneity is unobserved and accounted for by using the MXL specification.

6.4. Results

6.4.1. Descriptive results

The average respondent was 51 years old with 5.4 years of education, corresponding to only completing primary education, and 54% were male. Households comprised on average 2.9 adults and 1.2 children (under 18 years old). They reported a median gross annual income of USD 4,392. The average household received 33% of its income from off-farm activities, including 32% of the sample that did not have any off-farm income.

On average, households claimed some form of tenure to 17.2 hectares (Ha) of land each, which included 6.6 Ha for grazing livestock, 5.2 Ha of wooded area, and only 0.6 Ha for crop cultivation. Regarding the type of tenure, 59% claimed they had title to some of their land, while 48% claimed traditional rights to some land. Typically, titled land was used for pasture and was closer to the household, while traditional rights were claimed for páramo in the national park. Households claiming tenure of páramo area generally stated they no longer use it for grazing, but that they still hold familial rights to the land.

Descriptive statistics of the ranking of incentive type are presented in *Table 25*, which indicates the percentage of the sample that gave each type of incentive (columns) a given ranking (rows). The two most popular incentives are livestock support and cash. Livestock, however, is preferred with a steadily declining proportion of sample ranking it 2, 3 and 4 respectively. Cash, however appears to most often be the preferred incentive (ranked 1), or notably not preferred (ranked 3 or 4). Crop support is the least popular incentive type.

Table 25: Ranking of incentive types by respondents to Chingaza PES survey.

	Livestock	Cash	Trees	Crops
1	38%	36%	22%	5%
2	31%	14%	39%	16%
3	24%	29%	24%	23%
4	7%	21%	16%	57%

In addition to the ranking exercise, descriptive information was collected on each respondent's choice heuristics during the choice experiment. After each choice set was presented and an alternative chosen, the respondent was asked which attribute most influenced their choice, which was crosschecked with observations by the researchers to determine the attribute that was most important on the majority of choice sets for a given respondent, as well as the attribute that was most important on the second most number of choice sets. Choosing a choice set based largely on these attributes was considered the primary and secondary choice heuristic, respectively, of the respondent. *Table 26* indicates that 56% of the sample initially stated a negative preference for group liability, while only 14% have a distinct positive preference for group liability. Additionally, 40% of the sample has an observable negative preference for cash incentives, while only 21% have a clear positive preference for cash.

Table 26: Observed heuristics by CE respondents. Percentages represent the proportion of respondents that stated a positive opinion (+) or negative opinion (-) of the attributes that were their primary and secondary choice heuristics.

Incentive Attribute	Respondent Opinion	Primary	Secondary	Primary or Secondary
Group	–	35.53%	20.39%	55.92%
Cash	–	25.00%	15.13%	40.13%
Value	+	19.74%	17.76%	37.50%
Cash	+	11.84%	9.21%	21.05%
Group	+	6.58%	7.24%	13.82%
Unclear		1.32%	30.26%	31.58%

Respondent statements regarding cash or in-kind incentives, and joint liability were also recorded (*Table 27*). Those statements did not relay any information on cognitive effects of different types of incentives, but they do align with typical economic arguments. Cash incentives were considered beneficial because they are flexible, but respondents also raised the risk of myopic spending. No negative statements of in-kind incentives were given, and all of the positive statements referred to materials being what was truly needed, at least in part because they were difficult or costly to obtain out in the communities. Regarding joint liability, respondents identified the key benefits of such arrangements, with some respondents clearly stating the logic for joint liability that

academics cite. Similarly, respondents also identified that joint liability would require more effort and risk on their part and would be difficult due to individualistic attitudes.

Table 27: Respondent opinions on the pros and cons of incentive attributes.

Cash Pros - Manage how I want - I manage cash well - Buy what I want - Flexible - I need cash, more useful - It is easier	**Cash Cons** - Difficult to manage cash - Gets spent on other things - I would buy beer, meat - Cash "goes" - Useful in short term only
In-kind pros - Manage materials better - Materials are expensive to transport - I need materials - It is easier - Materials are useful - With cash I would buy materials	**In-kind cons** (None stated)
Joint Liability Pros - In few families is best - Increase the "conscience of conservation" - Families help each other when one is sick or has problems - Reciprocal and benefits all - Social pressure is motivation	**Joint Liability Cons** - Bad experiences with cooperatives - We do not have union here - Here it is "me, me, me" - We are individualists here - We have different ideas - I prefer to work alone - In a group is more complicated and difficult - Too much distance between families - Without group is safer

6.4.2. Model results

The variables used in the MXL models are presented in *Table 28* and *Table 29* presents two MXL models. Model 1 is the basic model and includes only the attributes tested in the choice experiment, all modelled as random parameters. Model 2 is where some preference heterogeneity is observable through interaction terms between attributes and respondent characteristics. Overall, the models confirm that there is a positive and statistically significant association with the value of the incentive offered. The higher the value, the more likely any respondent is to accept it.

In relation to the effect of joint liability on the utility of the PES to respondent households, some explanation of the final model selection is useful. The attributes-only model (Model 1) indicates that the mean effect of increased group size is negative and significant, but the significant standard deviation of this parameter shows that there is heterogeneity in preferences of households for larger group sizes that should be accounted for. A number of household and respondent characteristics that could potentially interact with group size were tested. The only interaction found to be

significant was the number of adults in a household. The interesting result is that this interaction reduced the mean effect to not be statistically different from zero, but the standard deviation and the interaction are both significant. As such the interaction was maintained in the final model with interactions (*Table 29*), and following appropriate practice in modelling, the main effect is also maintained.

A similar result occurred for the squared transformation of group size. The variable for (group size)^2 had a p-value of 0.108 in a model without interactions or any other transformations. It continued to be tested because it was very nearly significant at 90% and there was a theoretical basis for observing it. Throughout the model specification process, the transformation continued to be on the edge of significance, with a p-value around 0.1 in all models tested. The introduction of the interaction with number of adults in the household had a similar result as for the interaction with the mean effect for the group size (i.e. not squared): although the mean effect of (group size)^2 is not highly significant, the interaction is worth retaining in the model. To ensure this was the case, a likelihood ratio test was carried out comparing models with and without (group size)^2 plus the interaction with number of adults in the household. The model including both coefficients was found to be a better fitting model with a 95% confidence threshold.

Table 28: Variables included in the models of incentive preference. Attribute averages are calculated over all chosen alternatives and household characteristic averages are calculated across all 152 households in the sample.

Variable Type	**Variable**	**Description (Unit)**	**Mean [Min; Max]**
Choice Attributes	Value	In Colombian Pesos (COP) scaled by 1/100000	268431 [150000, 350000]
	Group size	Number of households, in addition to respondent, in joint liability scenario	1.81 [0, 6]
	In-kind	=1 if incentive is in-kind	0.33 [0, 1]
Respondent Characteristics	Adults	Number of adults in household	2.93 [1, 8]
	Work income	Value of annual cash income from off-farm activities (COP/year)	$3.0x10^6$ [0, $30x10^6$]
	Age	Age of respondent (years)	51.3 [19, 87]
	Drive time	Time to drive from respondent's community to market town (minutes)	178.80 [108, 340]
	Cows	=1 if respondent states livestock support is their preferred in-kind incentive	0.51 [0, 1]
	Trees	=1 if respondent states alternatives to trees is their preferred in-kind incentive	0.39 [0, 1]

Table 29: Mixed logit model of incentive choice, based on whole sample and including interactions with attributes. Estimated via simulation with mixlogit in Stata using 1000 with normal distributions for group size and in-kind attributes, and a lognormal distribution for the value attribute.

		Model 1			Model 2		
Parameter		**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**p**	**p**
Value[a]	Mean	0.504	0.139	0.000	0.502	0.143	0.000
	St. Dev.	-0.625	0.195	0.001	-0.641	0.193	0.001
Group Size	Mean	-0.602	0.112	0.000	0.644	0.518	0.214
	St. Dev.	0.813	0.144	0.000	0.788	0.139	0.000
	* Adults	.	.	.	-0.556	0.187	0.003
(Group Size)^2	Mean	.	.	.	-0.117	0.077	0.129
	St. Dev.	.	.	.	.	.	.
	* Adults	.	.	.	0.061	0.027	0.022
In-kind	Mean	0.649	0.207	0.002	-3.254	1.277	0.011
	St. Dev.	1.877	0.291	0.000	1.768	0.284	0.000
	* Work Income[b]	.	.	.	0.010	0.005	0.051
	* Age	.	.	.	0.033	0.015	0.030
	* Cows	.	.	.	1.467	0.697	0.035
	* Trees	.	.	.	0.715	0.712	0.316
	* Drive Time[c]	.	.	.	0.517	0.260	0.047
LR X^2		117.600		0.000	105.550		0.000
Simulated LL		-448.797			-431.988		
Total Choice Sets		1804			1804		
Respondents (N)		152			152		

[a] Value scaled to 1/100,000 of actual value

[b] Work Income scaled to 1/100,000 of actual value

[c] Drive Time scaled to 1/100 of actual value

As such, the models indicate two significant results related to joint liability. First, there is reasonable evidence for the hypothesized parabolic dynamic of joint liability. The second, and highly related, result is that the number of adults in a household interacts with the number of households in a group such that the mean effect of group size is not statistically different from zero. That indicates a stark and important trade-off in the cost of intra- and inter-household coordination that mediates the utility of JL-PES.

The most extensive results relate to the whether the incentive was in-kind or cash. The basic model without interactions indicates there is a positive utility associated with in-kind incentives, but based on observations and preliminary analysis, there was suspicion that this is in large part due to the collection of respondents that would prefer livestock support as their in-kind incentive. Model 2 demonstrates that there is a set of observable characteristics that influence respondents' utility for in-kind incentives relative to cash incentives. The main effect in the full model is negative for in-kind incentives, but there are two respondent-specific interactions that must be accounted for: age and off-farm

income. The interactions indicate that both older respondents and respondents from households with a greater income from off-farm activities have a higher utility for in-kind incentives. The interaction with off-farm income has a p-value slightly greater than 0.05, but is retained in the model as it was significant at the 90% or 95% level throughout all iterations and tested models.

As noted above, the attribute of in-kind incentive is very broadly defined. Interpretation of the attribute by respondents would naturally lead to heterogeneity of the model parameters. That is one reason a MXL model was used, and this attribute was modelled as a random parameter. To account for some observable heterogeneity, the respondent household's preferred form of the three types of in-kind incentive identified earlier in the survey entered the model as categorical dummy variables interacted with the in-kind attribute, with preference for crop support as the baseline. That means that the probabilities estimated by the MXL model were conditional on the respondent being able to receive their preferred in-kind incentive; mimicking a generic and flexible in-kind incentive. Under these conditions, the model indicates that respondents preferring livestock support had a significantly higher preference for in-kind incentives than those that demanded crop support. Respondents that demanded alternatives to tree usage did not have a significantly different preference from those preferring crop support.

There is also evidence of an increasing preference for in-kind incentives the farther the respondents' community is from a large market town. Under logistic constraints, the only feasible measure of distance to market was a simple measure of driving time from the social centre of a respondent's community to La Calera, which was the nearest common town with a market and en route to Bogotá. A measure of distance specific to the respondent's household would likely have reduced measurement error, but even with a simple community-level measure, there is evidence that the farther from market a respondent lives the greater their preference for in-kind incentives. It should also be noted that although this measure of distance was the same for all households within a community, community-specific dummy variables were tested in the model and found to be statistically insignificant. It is only this ratio-scaled measure that is significant in the MXL model.

6.4.3. Estimated welfare change

The choice experiment method is consistent with utility maximization and demand theory, so when the parameter estimates of the model are obtained, welfare measures can be obtained (Bateman et al. 2002). The marginal change in welfare of an attribute is usually expressed as a monetary value and found by taking the ratio of the coefficient of that attribute over the coefficient of a price attribute (Hoyos 2010). Here, the same basic approach is applied to measure the welfare change associated with the attributes of the hypothetical incentives offered in the CE. The resulting marginal willingness-to-accept (MWTA) can be interpreted as the increase or decrease in the value of incentive that a household would require in order to accept a change in the relevant attribute of the incentive. Where there was a positive coefficient in the MXL model that will correspond to a negative MWTA.

There are a number of specific approaches used to estimate marginal value in an MXL model when one or more of the parameters is random (Sillano & Ortúzar 2005). The simplest and most common is to use only the mean of the random parameters in any associated calculation, but it is preferable to use all of the information associated with the random parameters and simulate the MWTA (Hensher et al. 2005). Both of these methods were carried out and results presented in *Table 30*.

Table 30: Mean marginal willingness-to-accept (MWTA) to participate in a PES program estimated by either by a) using the population mean of the random parameters, or b) simulating the distribution of the random parameters (1000 Halton draws). A positive MWTA indicates respondents have a negative utility for the relevant attribute, so need an incentive of higher value to accept an increase in that attribute; a negative MWTA indicates the opposite.

	Population Mean		**Simulated**	
	COPx10^5 [95% CI[a]]	**USD**	**COPx10^5 [95% CI[b]]**	**USD**
Group * Adults	0.274 [0.096, 0.451]	14.88	0.366 [0.172, 658]	19.88
Group^2 * Adults	-0.030 [-0.055, -0.005]	-1.63	-0.040 [-0.072, -0.019]	-2.18
In-kind	1.603 [0.358, 2.848]	87.11	2.294 [-5.664, -0.140]	124.70
In-kind * Off-farm Income (/100000)	-0.005 [-0.010, 0.000]	-0.26	-0.006 [-0.011, -0.003]	-0.34
In-kind * Age	-0.016 [-0.031, -0.001]	-0.89	-0.022 [-0.040, -0.010]	-1.19
In-kind * Cow	-0.723 [-1.394, -0.051]	-39.28	-0.966 [-1.736, -0.453]	-52.48
In-kind * Drive (/100)	-0.255 [-0.507, -0.002]	-13.83	-0.340 [-0.612, -0.160]	-18.48

[a] Estimated via delta method

[b] Estimated via Krinsky-Robb method

The MWTA estimates must be interpreted relative to an individual household. For example, although the main effect of the incentive being in-kind has an estimated MWTA of USD 87.11-124.70, the interactions will mediate this, such that without considering their preference for type of in-kind incentive, a respondent with the mean values of off-farm income, age and drive time have an approximate MWTA for in-kind incentives of USD 8.92-20.41.

6.4.3.1. Welfare change associated with joint liability

We can gain a better understanding of the welfare change associated with joint liability by aggregating the mean MWTA for the interaction of adults in a household with group size. *Figure 13* illustrates the change in mean MWTA joint liability considering the size of the group and the size of the responding household, holding all else equal. It demonstrates the trade-off between intra- and inter-household coordination indicated in the MXL results. Additionally, it illustrates the parabolic dynamic: there is a point at which respondents perceive the marginal benefits of working in a group of households to be greater in magnitude than the marginal costs. As such, the most costly incentives are predicted to be those that require joint liability between the respondent household and four or five neighbours. As the group increases to the respondent household and six neighbours, the MWTA is approximately equal to that of a group of four households.

6.4.3.2. Welfare change associated with incentive type

We can also gain a better understanding of the welfare change associated with in-kind incentives by aggregating the mean MWTA for the main effect and all interactions with the in-kind attribute. *Figure 14* illustrates the change in mean MWTA relative to cash incentives as a household's drive time to market increases, for a respondent of mean age and with a mean off-farm income. It indicates that for this average respondent, if they prefer livestock support they always have a negative MWTA associated with in-kind incentives, meaning they would perceive a lower value in-kind incentive as equivalent in utility to a higher value cash incentive. Conversely, if they preferred other in-kind support to livestock support, they would have a positive MWTA for in-kind, meaning they would prefer to receive cash incentives, unless they lived very far from market.

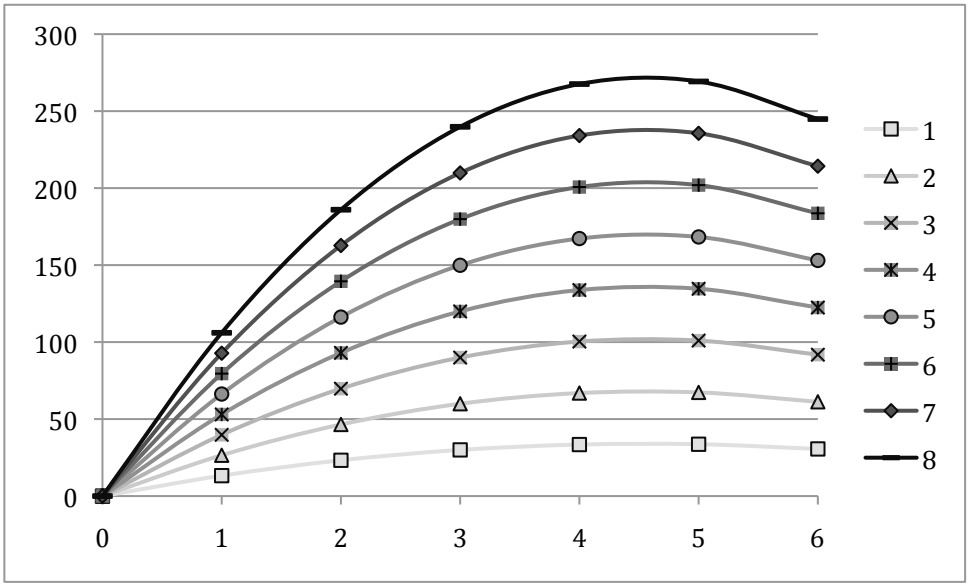


Figure 13: Change in mean MWTA (y-axis) as the number of partner households (i.e. additional to the respondent household) within a jointly liable group increases (1-6, x-axis). Each curve represents the estimated mean MWTA for households with a different number of adults (1-8).

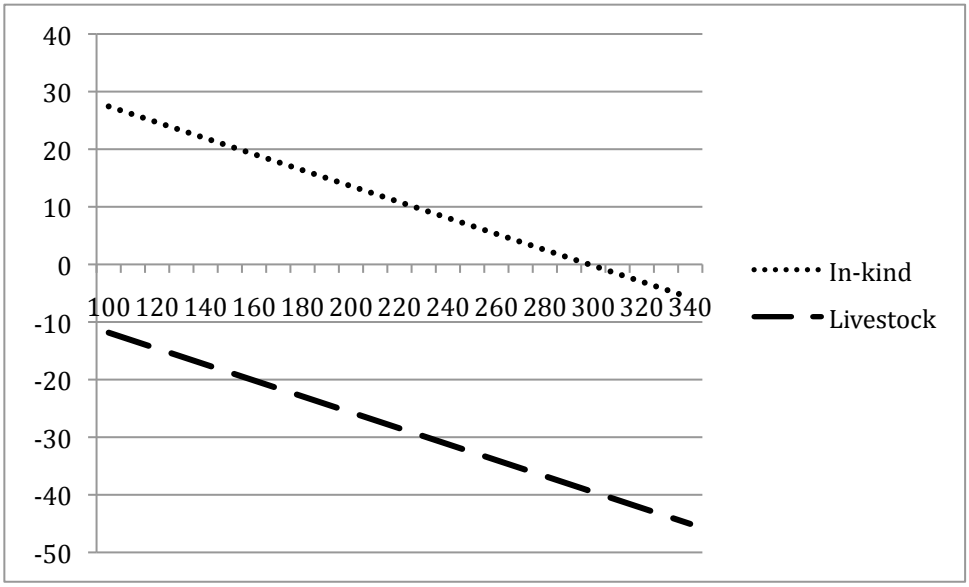


Figure 14: Change in mean MWTA for in-kind incentives (y-axis) as drive time to a household's community increases (x-axis). Results are for an average respondent that is 51.3 years old with an off-farm income of COP 3 million. Bottom curve represents households that prefer and expect to receive livestock support; top curve represents households that prefer and expect to receive other in-kind support.

Understanding population moments of welfare changes via mean MWTA is very useful, but can disguise underlying complexity in the MWTA distribution within a population. With so many interactions with the in-kind attribute it was essential to further explore estimates of MWTA. To do so, a MWTA in-kind incentives was simulated that uses the information on the mean and distribution of the coefficients for incentive value and the in-kind attribute, and all of the interactions with the latter, to estimate each household's MWTA in-kind incentives. A positive MWTA indicates the model predicts they will

prefer cash incentives, and a negative WTA means it predicts they will prefer in-kind incentives, assuming they have a flexible choice over which type of in-kind incentive they receive.

The results reveal notable detail of the MWTA in-kind incentives in this case study (*Table 31*). Approximately 70% of the sample has a preference for in-kind incentives over cash incentives. Notably, all respondents that indicated livestock support as their preferred type of in-kind incentive fall within this group. Considering that subsample has such a strong preference for in-kind incentives, we can segregate it out and in doing so identify and characterise three distinct groups within the sample with differing preferences for in-kind compared to cash incentives. The group that prefers livestock support as their in-kind incentive has a large negative MWTA in-kind incentives and comprises 41% of the sample, while the group that prefers other in-kind incentives has a smaller MWTA for in-kind incentives and comprises 29% of the sample. The third group comprises 30% of the sample and prefers cash incentives.

Table 31: Three groups of potential PES recipients based on simulated MWTA in-kind incentives (1000 Halton draws). The top half of the table reports the mean value within each group (columns) of a given respondent characteristics (rows). The bottom half of the table reports the p-value of student's t-tests comparing those means between groups. N = 150, two of original sample were excluded from these simulations because they were not heads of household, who it is assumed would make the final decision related to acceptance of PES.

Incentive Preference è		**Livestock Support (1)**	**Other In-Kind (2)**	**Cash (3)**
Mean Statistic	**Unit**			
MWTA In-Kind	(USD/year)	-58.84	-18.29	17.18
Age	(years)	51.64	58.40	46.00
Adults	(people)	2.75	3.16	2.84
Off-farm Income	(COP/year)	$2.94x10^6$	$4.41x10^6$	$1.86 x10^6$
Cows	(binary)	1.00	0.00	0.00
Drive	(minutes)	205.39	193.23	131.09
Proportion of Sample		41%	29%	30%

T-tests	**1 vs. 2**	**1 vs. 3**	**2 vs. 3**
MWTA In-Kind	0.000	0.000	0.000
Age	0.017	0.009	0.000
Adults	0.109	0.738	0.278
Off-farm Income	0.152	0.057	0.013
Cows	0.000	0.000	0.000
Drive	0.433	0.000	0.000

6.4.4. Predicting participation

The predicted utility of alternatives with specified attribute levels to each respondent can be simulated based on the MXL coefficients, from which the rate of willingness to

participate in a hypothetical PES program can be predicted. Doing so permits evaluation of the overall effect of introducing joint liability and incentive options into a PES program. *Figure 15* illustrates the same effect of group liability as *Figure 13*, where for a given incentive value, as the group size in JL-PES increases to a household plus four or five neighbours, predicted participation continually decreases, but then it begins to increase again as group size continues to increase. Additionally, *Figure 16* illustrates the expected effect that for a given group size, as the value of the incentive increases, predicted participation increases.

An interesting result arises when comparing three different types of PES programs, offering either: cash incentives only, the household's choice of in-kind incentives only, or the full choice of cash or in-kind incentives. In both *Figure 15* and *Figure 16*, the predicted participation for the first two types of program is roughly equal. A program offering a full selection of cash and in-kind incentives, however, has a predicted participation in the range of 4-17% greater than either of the other two programs. Under incentive structures that are relatively less attractive to households, specifically where the price is low relative to the group size, this difference is at the high end of the range: for a group of three households and incentives of USD100 down to USD50, the difference increases for 8% to 17.5% respectively (*Figure 16*).

6.5. Discussion

6.5.1. PES and Chingaza National Park

Across Colombia, over 55% of forest cover lost in 2005-2010 was due to transition to pasture, 30% of which occurred in the Andes region (Cabrera et al. 2011). It may have been higher, but livestock rearing has already overstretched the land area that is suited for it in Colombia. Colombia's livestock strategy to 2019 (FEDEGAN, 2006) cites data indicating that 19.3 mHa of land in Colombia is suitable for livestock, but livestock was using 38.3 mHa of land. Further, the majority of livestock rearing is extensive. The strategy included a proposal to return 10mHa of pasture to a more natural state (which could include, e.g., reforestation or silvopasture), and intensify production on the remaining livestock land.

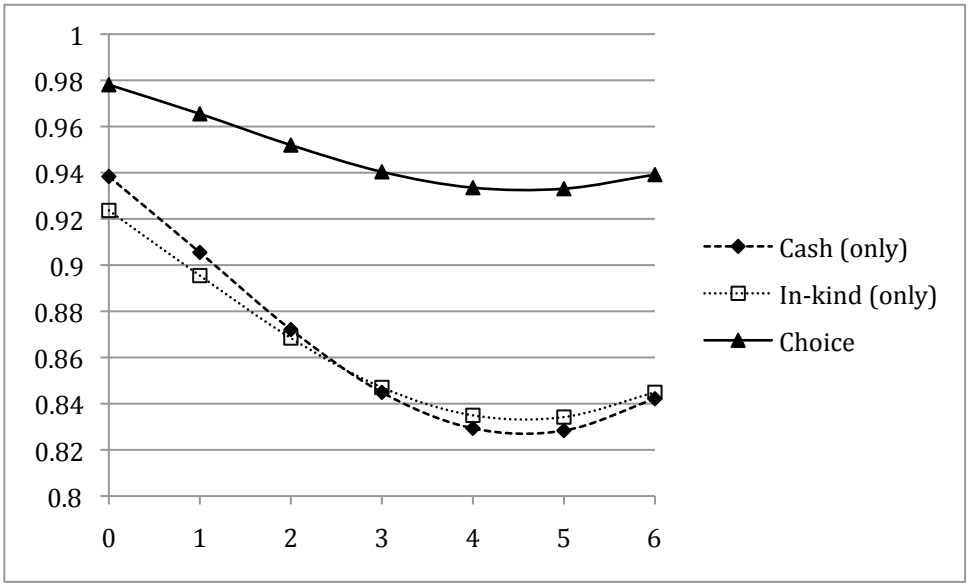


Figure 15: Predicted participation (y-axis) in the PES program offering USD 100 (COP 184,000) per family per year, as group size for joint liability increases (x-axis). Three potential programs offer only cash incentives, only (flexible) in-kind incentives, or a choice of the two. N = 150, two of original sample were excluded from these simulations because they were not heads of household, who it is assumed would make the final decision related to acceptance of PES.

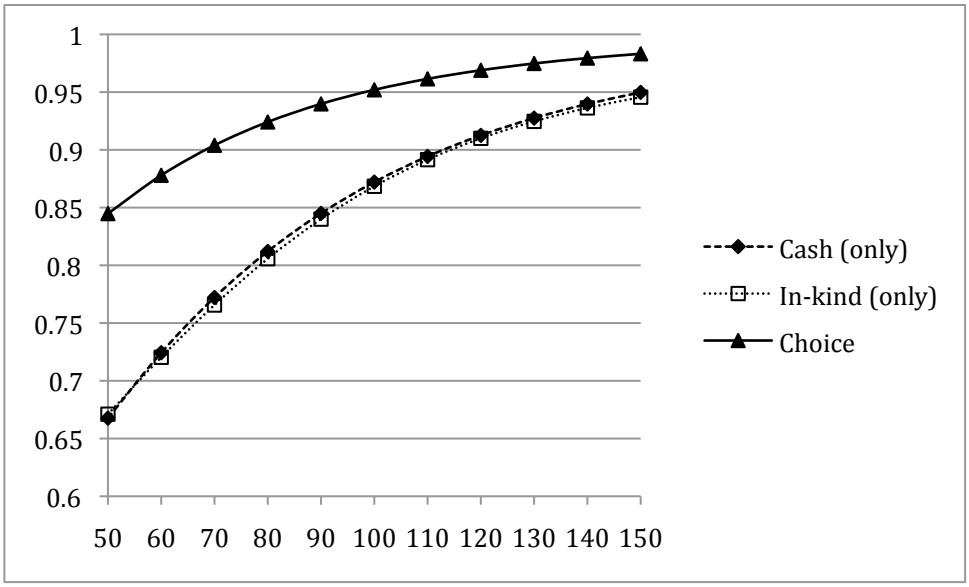


Figure 16: Predicted participation (y-axis) in PES program with joint liability across groups of three households (respondent plus two others), offering USD 50-150 (COP 92,000-276,000) per family per year. Three potential programs offer only cash incentives, only (flexible) in-kind incentives, or a choice of the two. N = 150, two of original sample were excluded from these simulations because they were not heads of household, who it is assumed would make the final decision related to acceptance of PES.

The case of Chingaza National Park and the surrounding area is a case study relevant throughout Colombia, as well as in other nearby countries. Dairy production is both the dominant economic activity of the area and the most prevalent local anthropogenic threat to the valuable páramo and cloud forest ecosystems there. One major aim of Agua Somos and conservation efforts for Chingaza is to reduce the environmental impact of livestock by switching to intensive rearing practices and re/afforesting critical areas,

potentially introducing more silvopasture. All of which aligns with the stated national aims.

It is therefore understandable and fortunate that the most popular type of incentive for a potential PES program in this area is livestock support. Providing only livestock support as the in-kind incentive in a PES program would target the 41% of the sample that prefer this type of in-kind incentive. For that group, the cost of the program would be reduced significantly as indicated by the relatively large and negative MWTA in-kind incentives for this group. It would also inherently target households that carry out livestock rearing and are the conservation priority. Further evidence of innately targeting the conservation priority is in the fact that the communities of the households in this group are on average 205 minutes drive from market, meaning they are close to the park and buffer zone.

As such, the self-selection argument for in-kind over cash transfers would be a key motivator in this case. The recommendation for a PES program in this area would be to initially only offer livestock support as the incentive. Over time as the program developed, it could increase the types of incentive it provides and expand to other households that are of lower conservation priority. Even then, in-kind incentives may be preferred to induce self-selection, since households that prefer in-kind incentives are also on average farther from market so closer to Chingaza, and lower costs, since they still have a negative MWTA in-kind incentives.

Regarding joint liability, there may be a case for including it in a PES program in this area, but that will depend largely on monitoring costs. If the average monitoring cost across a group of households is higher than the average MWTA group size increase across this group, then joint liability may be beneficial. Since households with fewer adults have a lower MWTA associated with joint liability, it may be worth exploring the cost effectiveness of creating groups among small households. Indeed, this is the scenario in which the benefits of group support, such as support and reciprocity, may be best realized. There are additional considerations related to joint liability as discussed in Section 6.5.3.

6.5.2. Designing PES: Incentive choice

The discourse on PES has typically asked the dichotomous question of whether cash or in-kind incentives are preferred. A better question would be an open one asking what type of incentive is best from a broad menu, considering the local context and the incentive characteristics preferred in that context. Here the best incentive is support for livestock rearing. There are three interrelated reasons for this that all align with the theory of in-kind incentives in redistributive policies, and which can inform incentive design in other PES programs, particularly in developing countries.

First, in-kind incentives that overcome market constraints are valuable to PES recipients. In this case a household's distance to market increases the transportation costs for the inputs to their production practices. That is why the in-kind attribute interacts with drive time to markets in the MXL model. If the PES provider can leverage economies of scale and provide materials in the community cheaper than each household can obtain them, there would be an overall social benefit: the household would receive the incentive they value, and so have a lower WTA, making the PES cheaper. It is reasonable to think project proponents could lower transportation costs as they are likely visiting the area regularly anyway for monitoring or planning PES, or other conservation-related activities. Additionally, they may be able to buy materials in bulk to get a cheaper price and/or receive concessional prices if they are an NGO or public entity eligible for donor financing.

Second, supporting the primary local economic activity is a popular incentive. The interaction of the in-kind attribute and preference for livestock support indicates that for PES recipients involved in the primary industry in the area, providing incentives to bolster their production is a very attractive incentive. It will lower their WTA, so lower the costs of the programme. It does mean the recipient receives a smaller value incentive in the short term, but it should have the longer-term benefit of supporting their production. From the perspective of the PES payer, it could also be attractive. If this is an industry the government, for example, is focused on improving as in this case study, their may be a paternalistic or political motivation for providing incentives related to it.

Third, the right incentive can induce self-selection. In many contexts that PES is introduced, there is a local anthropogenic threat to ecosystems. This is the basis of REDD+, AES, and many other conservation or environmental incentives. In the case

study, the greatest threat is livestock rearing, as it is in much of the Andes and Latin America broadly. Providing incentives related to livestock support leads to self-selection through two complementary mechanisms. It ensures that only those participating in this activity are interested in the incentive. Additionally, providing a preferred incentives type lowers WTA, meaning there is price point that can reinforce self-selection. Both are strategies noted in the literature on transfers.

Beyond reasons for choosing a specific incentive over others, the results also indicate there may be value to providing a menu of incentives, depending on the goals of the program. The primary advantage of cash incentives is their flexibility, but the CE presented here mimicked flexibility for in-kind incentives by accounting for respondents' observed preferred type of in-kind incentives in the predicted probabilities. The predicted probability results indicate that with this difference in flexibility neutralized, a cash or generic in-kind incentive would induce approximately equal participation. Therefore it is reasonable to extrapolate that a program offering a single type of in-kind incentive, thus not offering flexibility, would likely have a lower participation rate than one offering cash incentives. Conversely, if PES are implemented in a rural context where transportation costs are high and financial services non-existent, the flexibility benefit of cash is lower, and that program may have higher participation by offering in-kind incentives.

More strikingly, the results indicate that a program offering a full selection of cash or in-kind incentives with a reasonably high payment relative to group size, would have at least a 4-5% higher participation rate than a program offering only cash incentives or only a selection of in-kind incentives. The ability of the recipient to choose their preferred incentive is so valuable that under less desirable scenarios for the PES recipient, of low payments relative to group size, the predicted participation for a PES program that offers a menu of incentive types may be up to 17% higher than one only offering cash or (flexible) in-kind incentives. It is intuitive that such selection would induce higher participation, but the potential scale of increase is notable. Almost all proponents of PES programs are under tight budget constraints. If the proponent offered joint liability incentives to reduce their monitoring costs (while hopefully increasing success rates, see below), but could only offer a limited value of incentive, they could still increase participation significantly by offering the PES recipients their choice of incentive type. That would be of interest if either 1) the goal of the program was to be as

broad reaching as possible, or 2) there was a good targeting mechanism with the program so that the priority households could be identified, then there might be situations where a menu of incentives could be used to maximize participation within that group.

6.5.3. Designing PES: Joint liability

The results demonstrate the quadratic dynamic of group size in joint liability, where the lowest utility and highest MWTA occurs at an intermediate group size of 5-6 households. The existence of two opposing effects, leading to this non-linear dynamic is corroborated by literature from collective action on common-pool resources and joint liability lending as discussed in Section 6.2.2. Evidence from those other literatures is from the perspective of the principal attempting to incentivize an agent to monitor and enforce conservation or loan repayment. Here we are assessing the agents' preferences directly and find results that align with the principal's perspective. As group size increases initially, potential PES recipients anticipate having to exert more effort to monitor and support/enforce contract compliance with other households, so through the CE state a higher MWTA for joint liability. In order to induce households to accept JL-PES, the principal would have to provide a higher value of incentive to each household, just as in the Wolong PES program where intermediate group sizes exert more effort, are more successful, and ultimately receive higher valued incentives.

As group size continues to increase, it reaches a threshold size at which the MTWA for joint liability begins to reduce again. The other literatures interpret this as the point at which free riding begins to overwhelm the ability of the group to monitor and support/enforce compliance. An analogous interpretation can be applied here. As group size continues to increase, the probability that any particular household is monitored decreases and any given household may rely on others to do the monitoring and necessary support/enforcement. As such, there is concurrently a rise in potential for moral hazard and in free riding related to organizational matters.

There is a second, more positive interpretation that may also apply. There were no comments from respondents indicating they would succumb to moral hazard or free ride in larger groups. The positive comments for joint liability all relate to the group being 'reciprocal', increasing the 'conscience of conservation', or generally creating support among households. Rather than assuming there is a tipping point at which moral hazard

and free riding begin to overwhelm the benefits of cooperation, it may be that households see a decreasing marginal cost of coordination, which at some point becomes overwhelmed by the marginally increasing social capital or network benefits. Due to the nature of this study being stated preference, the evidence identifies this alternative, positive hypothesis in the context of PES on *de facto* private land. It must also be recognized, however, it is unlikely likely that respondents would state their expectation to succumb to moral hazard or free ride. In the end, the two interpretations are not mutually exclusive, and the reality may be a combination of both.

Either way, we have established that the intermediate group size is the least desirable for a household, and so would cost the ES buyer the most per household. The decision to use joint liability will be dependent on two factors. The first is a basic cost-benefit assessment, where assuming joint liability is of equal environmental effectiveness, if the costs of joint liability is lower than the cost of monitoring an additional household, it would be worth implementing. The second factor is a question of environmental effectiveness. In the Wolong PES program, researchers found a measurable increase in the effort expended by each household as group size increased from one to the optimal of nine. In Chingaza, the evidence indicates a similar dynamic would occur; that households are anticipating exerting more effort as group size increases to five or six. Although that will cost more for the ES buyer, both the Wolong PES case study and the available evidence from joint liability lending give reason to expect that this intermediate group size will not only exert more effort per household, but will also as a result perform better. If they do not, they should receive a reduced value incentive.

A second result that is unique to this study is that the number of adults within a household mediates the effects of group size. That indicates that there is a trade-off between intra- and inter-household coordination. The result is intuitive in retrospect: joint liability already *de facto* occurs within a household, meaning larger households incur some degree of coordination costs before considering coordination with other households. As such, joint liability will be cheapest for and most beneficial to households with few adults.

Moving beyond the direct results of this study, a final consideration in implementing joint liability PES is the role of social capital. Joint liability generally relies on social ties and sanctions, but the full role of social capital has been debated in relation to

lending (Armendáriz & Morduch 2005). Recent case study evidence suggests that with strong social capital between members of a group there may be implied joint liability, where individual lending can benefit from the same social insurance that explicit joint liability is intended to induce (de Quidt et al. 2012; Giné & Karlan 2011). Those examples are where there is strong leadership within the community and crucially, group meetings are maintained to build the needed social capital for implied joint liability to work. Most PES programs have such meetings, and where there is also strong leadership, these programs have the basic initial conditions to leverage implied joint liability.

6.6. Summary

There is a range of possible reasons why one type of incentive may be preferred over another. The PES literature has focused on preferring cash for its flexibility or in-kind incentives for cognitive reasons. Here we draw from the literatures on PES and redistributive transfers to outline a number of other theoretical reasons that could motivate choosing a particular type of incentive. The empirical results from this case first and foremost indicate that the majority of potential PES recipients have a negative MWTA in-kind incentives, and so prefer them to cash incentives. Complementing the cognitive reasons for preferring in-kind incentives, the results highlight three overlapping motivations for using in-kind incentives in this case, that they can: overcome market constraints, directly support the primary local economic sector, and induce self-selection of participants. Cash incentives would still garner a high degree of participation, but would be more costly and not support self-selection of participants. These motivations for providing in-kind incentives are relevant for PES throughout Latin America, and developing countries broadly, and can be used to guide incentive choice in other PES programs. Additionally, a menu of cash and multiple types of in-kind incentives could be offered to maximize participation from the target population in a PES program.

We also add evidence to previous findings of two opposing effects of group liability in PES: a negative cost of coordination and a positive benefit of support between group members. The magnitude of the cost of inter-household coordination, however, is mediated by a household's initial fixed cost of coordination within itself (i.e. intra-household coordination). Aggregating these two effects indicates that intermediate group sizes would be the most costly because households anticipate expending the most

effort in these groups. That aligns with evidence from elsewhere, which in turn gives some indication that although more costly, intermediate group sizes may also be most effective. In that case the ES buyer should prefer joint liability. The ES buyer should also consider how joint liability could lower their monitoring needs when deciding whether to use it in PES.

Overall, the broadest conclusion that this study leads to is that optimal PES design is heavily context dependent. The thorough evaluations of PES to date have been for national-level programmes, and provided some initial evidence of heterogeneity in the environmental impact of PES. One likely reason is that these programs inherently take a one-size-fits-all-households strategy to incentive design. They do offer different incentives for different types of land use, but do not consider how best to incentivize the different types of households and communities—the actual agents—that will affect the desired provision of positive environmental externalities. In contrast, for example, here we have shown that if ES buyers consider local economic conditions, they could choose and design incentives that promote self-selection of the target households into their PES program. With the continued proliferation of PES in a diversity of contexts around the world, programme proponents and policy-makers should give more proactive consideration to optimal incentive design based on the local context.

CHAPTER 7

Conclusions

7.1. Introduction

Significant discussion has been provided within each analytical chapter of this Ph.D. Therefore, this chapter focuses on providing a synthesis of key results across chapters and in relation to the three research questions listed in Chapter 1:

1. What is the state of knowledge on PES as incentives?
2. What types of incentives are used as PES?
3. How can PES be designed to overcome some of the issues related to incentives highlighted in the literature?

Each research question will be addressed, but in reverse order. As noted in Chapter 1, this PhD gives slightly more weight to Research Question 3, discussion of which comprises the largest portion of this chapter in the following Section 7.2. Following that discussion, Section 7.3. highlights interesting results related to Research Question 2, Section 7.4. then discusses Research Question 1 and the overarching fundamental conclusion for this Ph.D. Finally, Section 7.5. briefly suggests useful future research.

7.2. PES Design Elements

The three unresolved issues in PES design that have been highlighted are the existence of market constraints, information asymmetries, and behavioural considerations. An analysis of the current stance in the relevant literature on these issues was completed in Chapter 3, while the case studies in Chapters 5 and 6 undertook a more in-depth view of the same issues in specific locations. The main conclusion from the research presented in those chapters is that there are a number of ways incentives can be designed to overcome these issues. Multiple examples are discussed in the following three sub-sections.

7.2.1. Market constraints

In the case study in Chapter 6, the choice of incentive is related to market constraints. The econometric results demonstrate that in-kind incentives have higher utility for

households living in communities located farther away from a central market town. Qualitative results support this. For example, some households stated that materials were expensive in the community because of travel costs, which was corroborated by local extension workers' and the researcher's observations. Households also made related statements, such as materials were more desirable than cash. If the ES buyer or PES intermediary can provide in-kind incentives, that helps mitigate the negative effects of markets constraints faced by the households. Households living farther away from markets indicate their preference for this type of incentive through a lower WTA. A classical interpretation is that the lower WTA accounts for the increased cost of transport. If the ES buyer or intermediary can use economies of scale or receive concessional prices for those materials, however, they could not only overcome market constraints from the households' perspective, but also reduce the total costs of the PES programme.

That result aligns neatly with Chapter 4. The typology of payments for watershed services identifies reciprocity as the type of incentive most prevalent in low-income countries. The name 'reciprocity' is derived from the fact that this class of incentives appears to be only loosely conditional, defined in part by an ongoing agreement of undefined length, and the observed cases predicted to be in this class used reciprocity or related terms to describe the incentive and/or arrangement. What is notable in relation to market constraints, and also defines this class of incentives, is that this class always includes in-kind incentives. It is reasonable to extrapolate, particularly in light of evidence from the case studies in Chapters 5 and 6, that the link between the use of in-kind incentives and low-income countries is at least in part due to market constraints in those countries. Further evidence is found in the literature review in Chapter 3. Other studies identified that explicitly explore the use of in-kind incentives are all based on experiences in developing countries and generally promote the use of in-kind incentives over direct cash payments.

More evidence of the value of incentives that overcome market constraints is found in Chapter 5. The case study explores the novel incentive of credit-based PES (CB-PES). Multiple strands of evidence demonstrate the value of overcoming credit constraints to households in the case study area. First, there is latent demand for credit. Second, households state they are willing to accept the large majority of debt burden, even for loans with an environmental conditionality attached to them. Third, and most important,

the portion of the CB-PES that represents compensation for an on average negative change in welfare associated with that condition, represents a small fraction of the value of CB-PES. As such, from the perspective of the household that would be participating in the programme, the buy-down of loan repayments that is a CB-PES, is primarily a reward that helps overcome market constraints. The case study goes on to estimate that for a payment approximately equal in value to PES in other well-known programmes in Latin America, over 50% of the sample would demand conditional loans.

Overall, Chapters 4-6 present a number of specific results that are useful for actors developing PES programmes and deciding what types of incentive to provide as PES. Collectively though, all three chapters provide their own evidence that, in general, ES providers living with incomplete markets are likely to have a high utility for incentives that help reduce market constraints.

Additionally, previous PES discourse has often presented a dichotomy of direct and indirect incentives, the latter aligning with in-kind incentives or incentives that overcome market constraints. Research presented here, particularly the case studies, were designed to demonstrate that this dichotomy can be overcome. Specifically, that reducing market constraints, which would previously have been considered an indirect incentive, can be incorporated as a relatively direct incentive. In the case of in-kind incentives in Chapter 6, the choice experiment made clear that the incentive would be provided on a household basis only if the households were adhering to the condition of maintaining increased tree cover on their productive area. The condition ensured that their productive activity was more sustainable, while the incentive provided the inputs to continue supporting that activity. In that way, the incentive reduced market constraints, but was provided as a direct incentive. The case of CB-PES in Chapter 5 is similar. The provision of credit is in itself reducing market constraints. The incentive of reducing repayment is a direct incentive, but also helps reduce market constraints because once credit is available it still needs to be affordable.

Integrating PES and overcoming market constraints permits ES providers to carry out desired or needed productive activities to support their households. So, where ES providers face market constraints and the PES is designed to help reduce such constraints, the incentive inherently fits the model of a supportive incentive. That is the

key criterion for a good incentive provided by the behavioural economic literature, and the topic discussed in Section 7.2.3.

7.2.2. Information asymmetries

Of the three unresolved issues of incentive design for PES identified in the literature review, overcoming information asymmetries received relatively less attention in this Ph.D. Nonetheless, it is present throughout the two case studies, with some important results.

First, the most direct result is the testing of jointly liable PES (JL-PES) in Chapter 6. The literature review (Chapter 3) highlights that minimal research on group size in PES has occurred, and aside from the case study in Wolong, China (Yang et al. 2013), no other research on joint liability in PES was identified. These are separate, but related concepts that should receive more attention. The results in Chapter 6 indicate that it is a topic worth researching more, and specifically highlights three useful results for joint liability.

The maximum WTA of potential ES providers in the case study occurred at an intermediate group size of 5 or 6 households (i.e. the respondent household plus 4 or 5 more). That indicates that respondents expect to expend more effort at such group sizes, and is in line with other research from microfinance (Ghatak & Guinnane 1999) and PES for common-pool resources (Yang et al. 2013). The general conclusion is that the benefits of group size increase until some optimum intermediate group size, the specific size of which is dependent on the context. After that optimum, other free riding within the group lowers the level of effectiveness, and that group will in turn receive lower benefits from the programme, which means lower payments in the case of PES.

Chapter 6 provides evidence to support that dynamic, but the second result is that the qualitative evidence also indicates that a more positive dynamic could be occurring that has not yet been identified in the literature. That second dynamic may be that there is a decreasing marginal cost of coordination between households that at some point becomes overruled by an increasing marginal benefit of cooperation. That interpretation would show the same dynamic in relation to the parabolic utility function indentified here, and in other related literature, but would align with the qualitative statements made by respondents to the survey in Chapter 6. The positive and negative

interpretations of the dynamics driving the parabolic function may not be mutually exclusive. Further research could be helpful to tease these out, but it is likely that these will be highly context-dependent and that some mix of them is occurring in reality.

The third result is also unique and critical to the dynamics of JL-PES in this case study. There is evidence of a trade-off between inter- and intra-household coordination that largely mediates a household's preference for joint liability. That result is intuitive in retrospect. It is highly relevant for PES design, and if practitioners are interested in applying joint liability, they should be aware of it during the design phase. The result, however, is also interesting beyond PES and for the economic concept of joint liability broadly. In any context where meeting the conditions of a joint liability contract depends on a household to be successful, there is potential for a trade-off between inter- and intra-household coordination. The result also lends additional support to the positive interpretation of the existence of the parabolic dynamic witnessed in JL-PES. Smaller households experience the benefits of joint liability more acutely, and as such, they have a lower disutility/WTA for higher group sizes. Additional research would be useful to clarify this further.

In addition to testing JL-PES, another key result emerged related to information asymmetries that builds on a concept learned in development economics and relates to reducing adverse selection. One of the reasons to provide in-kind incentives instead of cash under redistributive policies is to support self-selection of participants. Many PES programmes occur in contexts where there is a local, dominant anthropogenic threat to ecosystems and the provision of ES. For example, in Chapter 6, the threat is livestock rearing, which needs to become less extensive, incorporate best-management practices, and transition to silvopasture to support the provision of ES. The results indicate that although the mean main effect of in-kind incentives was to increase the WTA of potential ES providers, if able to choose from a menu of incentives, those that chose livestock support would actually have a lower WTA compared to cash incentives.

Two reinforcing mechanisms are occurring: the choice of incentives and the value of the incentive would both mean that the PES of livestock support would only be attractive to households with significant livestock activities, which are in fact the initial target population. Although spatial targeting would refine the targeting to specific livestock rearing households with the most potential to provide ES, the choice of incentive could

already do a lot of the work, and with less effort. In a voluntary programme where households choose to opt-in, the choice and price point of the incentive offered can make opting-in only attractive to households that implement the key ES-degrading activity(ies). That provides a first-level of targeting that is blunt, but has the potential to be cheaper and more feasible, particularly in a developing country context. In doing so, it helps reduce the problem of adverse selection in PES programmes.

These results are not intended to necessarily promote a particular method of overcoming information asymmetries, although the two presented above are worth exploring further. The overarching conclusion is that there are innovative ways of overcoming information asymmetries that are relevant to developing country contexts and have the potential to improve PES implementation. Actors designing PES could incorporate these results, as well as explore more innovations for overcoming information asymmetries.

7.2.3. Behavioural considerations

The final issue addressed by research in this Ph.D., particularly in the case studies, is concern over how incentives may be perceived and so how ES providers may react to them. As noted throughout the preceding chapters, an extrinsic incentive is more likely to induce an increase in the provision of ES if it is supportive, rather than coercive. Results from both case studies demonstrate how an incentive can be designed to be supportive and still relatively direct, particularly if the incentive is linked to overcoming market constraints.

Chapter 5 has the strongest focus in this regard. The key result is that on average only a small fraction of CB-PES would be compensation for a negative welfare change associated with meeting the environmental condition. That indicates that the incentive would be a supportive, rather than coercive incentive. This results intuitively makes sense: a household will only borrow if it wants to carry out an activity or project for which it needs more capital, so lowering their repayment as CB-PES does, supports them in carrying out that activity or project. On another level, simply the introduction of credit into the case study region, which is initially credit constrained, could be viewed as supportive. That is upheld by further analysis related to the welfare change associated with the environmental condition, indicating that the incentive is in effect mainly acting to reduce market constraints. A similar result is found in Chapter 6, where households engaged in agricultural activities and living farther away from market preferred support

for those activities to other types of incentives. The qualitative evidence highlights a primary reasons these households preferred in-kind incentives: materials are what they need most, but materials are expensive to transport.

Both chapters also provide other interesting results in relation to behavioural considerations in PES design. Chapter 5 presents a time constrained incentive, that because it is supportive in nature, is less likely to lead to an endogenous shift in preferences, and so less likely to lead to entitlement. Chapter 6 illustrates that the respondents themselves identified one of the key risks of cash incentives noted in PES literature: that it is spent on short-term indulgences rather than goods with longer-term welfare benefits. Additionally, respondents identified the key benefit of cash is its flexibility. Providing flexibility in incentives inherently fits the idea of a supportive incentive. Another key attribute tested in that study is providing a menu of incentives, which is analogous to providing flexible incentives. The predicted participation results indicate that a menu of in-kind incentives (i.e. a 'flexible' in-kind incentive) would induce a level of participation equal to a cash incentive. Strikingly, a full menu of in-kind and cash incentives, which was the most flexible option, was the scenario predicted to induce the highest level of participation, particularly under PES scenarios that are less desirable for the ES providers. It indicates that ES providers perceive value in the ability to choose the incentive they want to receive.

Some less direct, but nonetheless interesting results arise from the typology presented in Chapter 4. Although that chapter did not discuss the effectiveness of different types of incentives, it does indicate which types are most prevalent and where. The most prevalent type of incentive overall is a cost-share incentive. That type naturally fits the framing of a supportive incentive, or a PES programme as reciprocal or co-investment. Cost-share incentives are much more prevalent in high-income countries than low-income countries. The most prevalent incentive in low-income countries, reciprocity, has a similar dynamic in that it is supportive, but fits the context of low-income countries where ES providers are better supported by a) receiving in-kind incentives, and b) receiving incentives related to improving welfare.

7.3. Types and Attributes of PES

The typology (Chapter 4) and literature review (Chapter 3) advance knowledge on the types of PES in use or being considered by research and practitioners. The knowledge

developed in these chapters is useful on its own, but can also help interpret more direct research on PES design as presented in the case studies. A strong understanding of the types and attributes of PES that are in use, or that could be used, illuminates design elements to make PES more effective.

For example, by understanding the types and attributes of incentives, credit-based PES (CB-PES) were identified as a type of incentive that fits multiple criteria of a goods incentive, so was worthwhile to research. The results of the Chapter 5 confirm this, and make clear it would also be worthwhile to implement. CB-PES best fit the class of regular payments: financial incentives (possibly cash, depending on how the CB-PES is delivered) are provided on an interval basis, for a change in practice, and do not include an upfront payment. Regular payments appear to be the class of PES that fits the most efficient form of incentive as defined by environmental economists: a relatively direct, cash incentive, with fairly strong conditionality. It also appears to be the class most likely to be viewed as a coercive rather than supportive incentive, at least compared to cost-share incentives and reciprocity. That is not the case with CB-PES though. It aligns with the criteria related to economic efficiency, particularly it is direct and with strong conditionality, but it is also a supportive incentive. Additionally, although no CB-PES is provided upfront, the provision of a loan is similar in nature to an upfront incentive. The review in Chapter 3 discusses that upfront payments are desirable to ES providers. Receipt of a loan that is only feasible because of CB-PES is effectively a key component of the incentive structure, which is similar in nature to receiving an upfront incentive.

Similarly, understanding the types and possible attributes of PES informed the design of the case study in Chapter 6. That case study explores a reciprocal incentive. Based on the typology and prevalence of this class of incentives in low-income countries, it is suspected that their value is to overcome market constraints and support sustainable development. The case study provides quantitative evidence of this. Additionally, the greatest concern with reciprocity is that this type of PES may not be strongly conditional. The CE presented in the case study clarifies that incentives are strongly conditional on maintenance of replanted areas. It demonstrates that strong conditionality can be incorporated into this class of incentives, while still maintaining the key benefits.

Those examples focus more on understanding the types of incentives broadly. Understanding the attributes that characterise them is also helpful for PES design. A couple examples within this Ph.D. illustrate that point.

First, the review in Chapter 3 indicated that ES providers generally prefer agreements of shorter length, so have a higher willingness-to-accept for longer agreements. That is problematic, since ES buyers generally prefer provision of ES to occur over the long term. Results testing preferences for CB-PES, however, indicate that ES providers prefer longer agreements in that case. That illustrates that it is possible to design an incentive structure where both ES providers and buyers prefer longer incentives.

Second, the review also identified that in-kind incentives are desirable to ES providers, but the reviewed studies mostly researched in-kind incentives transferred alongside cash incentives. Chapter 6 is one of the few, if not only, case studies to quantitatively compare cash and in-kind incentives as different options, rather than part of the same incentive package. It demonstrates that within a case study area there are households that will prefer in-kind incentives and others that will prefer cash. Rather than provide a combination to all households, which will likely increase transaction costs, an option of one or the other can be offered. In fact, providing choice in incentive type, even if just a single type is provided to each household, has the potential to significantly increase programme participation.

7.4. PES as Incentives

The above discussion is not aimed at touting the benefits of any particular type of incentive or incentive attribute. Its primary aim is to demonstrate:

1. That understanding the types and attributes of PES (Research Question 2) is useful to inform PES research and design; and that
2. Research informed by this knowledge base (e.g. Chapters 5 and 6) can identify design elements to help PES overcome the three key issues for PES in developing countries (Research Question 3).

All of the above results, however, arise from the fact that this Ph.D. takes what might be called the incentives approach to PES. That is the most general contribution of this Ph.D. to academic knowledge: to demonstrate the value of this approach.

In exploring the knowledge base of PES as incentives (Research Question 1), it was found that 1) the discourse on PES has evolved to view PES as a class of positives incentives, and 2) consumer theory, particularly work by the likes of Hanemann (1984) and Lancaster (1966), is emerging as an important intellectual basis for viewing and researching this class of incentives. Those are the two key elements of this 'incentives approach' to PES.

Following this approach leads to many interesting results related to specific incentive attributes or types of incentive (packages)—i.e. different bundles of incentive attributes—throughout this Ph.D. All of them are relevant to researchers and practitioners involved in the detail of designing and implementing PES.

At a more fundamental level, the results demonstrate that treating PES as a bundle of incentive attributes is a successful approach to creating incentive designs that can meet 1) the demands for effective and efficient incentives from buyers, and 2) the preferences of ES providers. Further, it demonstrates that ingenuity can be employed to incorporate incentive attributes in previously unexpected ways. For example, as found in the case study on CB-PES, a cash or other financial incentive can be valuable not for compensating for opportunity costs, but for its support in overcoming market constraints. Or, as found in the case study comparing cash and in-kind incentives, the attribute of flexibility can be obtained by providing a menu of incentives.

As this Ph.D. has been extensively informed from other sub-disciplines of economics, perhaps its contribution to the study of environmental policy can be shared back and applied more widely for policies with an incentive element. Focusing squarely on the incentive structure within a policy mechanism, and viewing that structure as a bundle of attributes, could provide unique insights that improve policy design in a number of areas.

7.5. Future Research

A broad range of future research can build off of this Ph.D. Focussing on PES, the incentives tested in the case studies could be implemented and tested for effectiveness. More generally, choice or field experiments explicitly comparing different, unique combinations of incentive attributes would also be valuable. That could include

comparing incentives across different classes of PES and different contexts to better understand the motivation for their use and their comparable effectiveness.

More broadly, it would be worthwhile to follow the incentive approach for research in other topic areas. Within environmental policy, for example, the design of environmental levies could be researched by focusing squarely on the negative incentive structure and treating it as a bundle of attributes. Moving outside of environmental policy, the review of literature on redistributive policies in Chapter 6 highlights that there is a need for more research on how to design such policies, which could be carried out through the approach demonstrated in this Ph.D. Related to that, some research has begun to compare conditional cash transfers and PES, but still focuses on institutional attributes more than incentive attributes (Persson & Alpízar 2013). Following the incentives approach could provide a more accurate and realistic view of ES providers' preferences and the relevant incentives. Essentially, this approach is an effective and useful way to examine all types of policy in which incentives are used.

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