University of Alberta

Designing an incentive program to reduce on-farm deforestation in the East Usambara Mountains, Tanzania

by

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Abstract

This thesis is a set of two papers on the design of a 'payment for ecosystem services' (PES) program for the reduction of on-farm deforestation in the East Usambara Mountains, Tanzania. The forests of this area are internationally recognized as one of the world's most biodiverse ecosystems; however they face an ongoing threat from clearing for agriculture. I firstly assessed what design of PES program would be most likely to encourage forest conservation by farmers, using a choice experiment approach. Notable results are that payment for manure fertilizer, representing an investment in farm productivity, was highly effective at motivating farmer support, and that minimal program conditionality was not always preferred. I secondly assessed the risk of motivational crowding out – the detrimental interaction of intrinsic and extrinsic sources of motivation - under different types of hypothetical conservation policy. My experimental economics approach found no evidence of persistent motivational crowding out.

Acknowledgements

This research was only possible due to the generosity, openness and support of the farmers of the East Usambara Mountains, Tanzania. Their willingness to participate in questionnaires, experiments and interviews, answer my questions and provide cups of tea was invaluable for completing field work. I hope this research will contribute to the success of their farming in the future and to the protection of their forests. It was a privilege to stay briefly in their villages.

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Introduction

Agricultural and environmental policies increasingly feature market incentives to promote environmentally beneficial land management actions. One such incentive based policy instrument is 'payment for ecosystem services' (PES), where landholders are given incentives for undertaking conservation in an attempt to align individuals' economic interests with the wider social interests of environmental protection (Engel, *et al.* 2008; Ferraro and Kiss, 2002). This thesis is comprised of two papers on the practical design considerations required for the successful implementation of such a policy instrument in a developing country context.

The papers present empirical results from research on PES program design in the East Usambara Mountains, Tanzania. The East Usambara Mountains are located in North Eastern Tanzania and form part of the Eastern Arc Mountain Range, an internationally recognized biodiversity hotspot (Brooks, *et al* 2002). Of the Eastern Arc rainforest areas, the East Usambara Mountains are considered to be one of the most biologically important regions with the highest endemic species density (per $100km^2$) of any ecosystem known in the world (Reyes, *et al.* 2006). However, these forests have suffered from past clearing, logging and fragmentation, and remain threatened by environmentally detrimental agricultural practices (Hall, *et al.* 2009; Bjørndalen, 1992). Sixty percent of the original forest cover has been lost, mostly in the past 35 years with rapid deforestation ongoing (Reyes, *et al.* 2006). Although PES programs for the sake of biodiversity conservation do not currently exist in this area, they represent an important policy option for Tanzanian authorities and conservation organizations. The Eastern Arc Mountains Conservation Endowment Fund, for one example, has a stated aim of exploring PES options for conservation efforts in the East Usambaras (EAMCEF, 2006). Such PES programs will be most successful if they take into consideration the preferences of affected landholders.

I consider two key design questions in turn. The first paper asks what type of PES program is most likely to receive the support of East Usambara farmers, and as a corollary, what kind of responses can be expected from farmers under different PES designs. I use a choice experiment to quantify the preferences and willingness to accept (WTA) values held by farmers for hypothetical PES designs in the specific context of the East Usambara Mountains. Policy design attributes considered include the type of payment mechanism, the recipient of payments (a village fund or individual farmers), the amount of payment required (WTA values) and different conditionality regimes. This research thus provides guidance on the specific design characteristics required by a PES program to attract farmer support, and consequently, predicts the farmer response likely to occur under different PES program designs.

The choice experiment design is partially motivated by recent conceptual efforts to categorize the considerable number of existing PES-like instruments into groups representing different 'paradigms'. Van Noordwijk and Leimona (2010) have proposed three such paradigms, each suited to different circumstances, of which I consider two. PES programs can involve payment by ecosystem service (ES) users to ES providers in return for reducing or ceasing actions which would otherwise be environmentally detrimental (described as 'compensation for opportunities skipped', COS). Alternatively, ES users can co-invest in ES providers' activities that have environmental benefits (described as 'co-investment in ecosystem stewardship', CIS). The attributes chosen for the choice experiment represent some of the distinguishing features between these PES paradigms, allowing me to test whether a particular PES paradigm matches farmer preferences in this context.

In the second paper, I turn to a more fundamental question of just how appropriate PES is as a conservation tool given the pre-existing attitudes of ES providers towards the

environment, a question that has been raised by a number of authors (for example, Farley and Costanza, 2010; Jack, 2009; Cardenas, *et al.* 2000). Environmentally beneficial land management actions can be motivated by a variety of factors. These include 'intrinsic' motivation (undertaking a task for its own sake), and 'extrinsic' motivation (undertaking a task for the associated rewards or avoided penalties). These different forms of motivation are known to interact - sometimes negating each other, sometimes complementing each other. Thus when policy makers attempt to encourage pro-environmental behavior by manipulating extrinsic incentives, they can 'crowd out' or 'crowd in' pre existing, intrinsic sources of motivation, and in some cases continue to do so even after the policy incentive has been removed.

Hence, in the second paper, I test for the potential for this effect to exist in the context of forest conservation policy at the East Usambara Mountains study site. An experimental economics technique - a modified dictator game - was used to mimic key features of both government regulations and PES programs. The responses of participating famers to the different stylized policies were analyzed to determine the existence and extent and motivational crowding. I also tested for variation in the behavior exhibited by different farmers within the population. It is plausible that different farmers may respond quite differently to the same stylized policies, with some exhibiting motivational crowding in and others exhibit motivational crowding out.

The combination of these two papers is designed with two objectives in mind. Firstly, it is intended that this research will provide practical guidance for policy makers specifically interested in using incentive type programs to prevent deforestation in the East Usambara Mountains. Current conservation efforts in this region, implemented under the Tanzanian Government's East Usambara Conservation Area Management Programme (EUCAMP) have focused on the declaration and subsequent management of reserves (Ministry of

Natural Resources and Tourism, 1999). While this approach has been at least partially successful in conserving the forests that fall within reserve boundaries, it is unlikely that the small areas of protected land are enough to prevent biodiversity loss (see for instance, Newmark, 2008). In some instances it is thought that the declaration of reserves may have intensified pressure on non-reserve land, and furthermore, contributed to social dislocation and population displacement (Rantala and Vihemäki, 2011; Conte, 2004, p. 157). PES may represent an alternative conservation approach suitable for balancing social and environmental goals, but will only achieve such goals if based on careful, site-specific research. It is hoped that this research will help ensure that any future PES program development in the East Usambaras has a strong empirical base.

Secondly, this research aims to shed light on issues facing PES design more generally. The issue of motivational crowding is likely to be pertinent to most, if not all instances of incentive program design. Furthering our understanding of the conditions under which motivational crowding occurs will help policy designers in a variety of circumstances, as it is now evident that consideration of purely economic incentives is necessary but insufficient for the prediction of a population's holistic response to a policy (Fey and Jengen, 2001). An understanding of a range of incentives is required, as argued by Bowles (2008): "Good policies and constitutions are those that support socially valued ends not only by harnessing selfish preferences to public ends but also by evoking, cultivating, and empowering public-spirited motives."

Finally, this research aims to investigate possible heterogeneity of policy preferences and consequent policy responses amongst a population. It may be possible for PES policy to be targeted at specific parts of a population based on their differing preferences (and hence likely policy response). At the least however, it is worthwhile considering the

extent of preference variation to better understand the likely farmer response to a policy plan.

Following the two papers is a brief concluding chapter, summarising key findings firstly for agencies with a specific interest in conservation of the East Usambara Mountains, and secondly for PES researchers more broadly. I then use these key findings to propose a way forward for PES policy implementation at this site.

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Paper 1: Assessing preferences for payment for ecosystems services (PES) program design: Choice experiment evidence from Tanzania

1. Introduction

The Millennium Ecosystem Assessment (2005) defined ecosystem services as "the benefits people obtain from ecosystems." Such benefits include those from provisioning services (the products obtained from ecosystems such as food, water and fibres), regulating services (the regulation of biophysical cycles such as climate), cultural services (non material benefits such as aesthetics or spiritual values) and supporting services (services which allow for the provision of other services, such as nutrient cycles). Ecosystem services are often key factors in the production of economic value and hence material welfare. However, there is growing acknowledgment that many ecosystem services are undergoing rapid degradation due to overuse and misuse (The Millennium Ecosystem Assessment, 2005). A common reason for this is a lack of institutions that guide the supply and demand for ecosystem services (Balmford, *et al.* 2002; Arrow, *et al.* 2000; Costanza, *et al.* 1997).

The existence of market failure in the regulation and provision of ecosystem services means that the depletion of the environments that provide ecosystem services is often greater than socially optimal, and similarly, the production of ecosystem services by economic agents is less than socially optimal (Ferraro and Kiss, 2002). Ecosystem services are often, although not exclusively, public goods, and their benefits may materialise at different scales, from local (for instance, pollination of crops) to global (carbon biosequestration). Particularly on larger scales, considerable externalities, a lack of well defined property rights and limited information hamper efforts to optimise ecosystem service provision and protection between those who benefit from an ecosystem

service, and those who affect its provision (Engel, *et al.* 2008; Ferraro and Kiss, 2002). Payments for ecosystem services (PES) programs are one potential solution to this problem, which work by using material incentives to encourage environmentally beneficial land management actions by individuals or communities. PES programs seek to alleviate environmental externalities, strengthen property rights and improve information flow regarding the desired levels of ecosystem services. In doing so, PES programs internalize the benefits associated with enhancing or maintaining ecosystem services to ensure land managers (or other providers of ecosystem services) face incentives concordant with the interests of ecosystem service users (Arrow, *et al.* 2000; Pagiola, *et al.* 2005; van Noordwijk and Leimona, 2010).

Although established programs are still rare in developing countries, increasing attention is being paid to how they might be used in such contexts and what kind of design attributes are required for their success (Engel, *et al.* 2008; Pattanayak, 2010). Many commonly used definitions of PES (for example, the widely used definition by Wunder, 2005) are theoretically strict, defining as PES only those instruments meeting a narrow set of criteria based on rigid Coasian principles of externalities, compensation and property rights. However, for PES to be widely successful there is a strong need to adapt PES principles to varied circumstances (Jack, *et al.* 2008; Swallow *et al.* 2009).

An important part of adapting policy to a particular circumstance is taking into account the preferences of those likely affected by the policy's imposition. This paper reports on a choice experiment that quantifies ES providers' preferences for key design attributes of PES, in the East Usambara Mountains, Tanzania. The East Usambaras are recognised as one of the world's most significant biodiversity hotspots, meaning that they support extremely high biodiversity levels yet face considerable threat from deforestation (Brooks, *et al.* 2002). PES may be a suitable policy instrument to alleviate this threat, and

although there are not currently such market-based programs in place in the East Usambaras, conservation authorities and organisations are considering their suitability for this region (EAMCEF, 2006). This paper reports on farmer preferences for key elements of PES program design, including payment type, payment amount and conditionality levels. Willingness to accept (WTA) values for a variety of hypothetical PES programs are presented. In quantifying farmer preferences this paper reports on what kind of responses can be expected from farmers under different PES designs.

The selection of design elements for the choice experiment is informed by the nascent debate over different 'paradigms' of PES. I consider two paradigms recently proposed by van Noordwijk and Leimona (2010): 'compensation for opportunities skipped' (COS), where payment is given for avoided actions which would otherwise be environmentally detrimental, and 'co-investment in ecosystem stewardship' (CIS), where the beneficiary makes an investment in the land management actions of the ecosystem provider that have environmental benefits. I operationalize key distinguishing characteristics of COS and CIS, tailor them to the local context and incorporate them into the set of choice experiment attributes and options. This is intended to test whether a particular PES paradigm matches farmer preferences for this particular context, or whether a hybrid approach is needed.

The questionnaire incorporates several design features intended to reduce the likelihood of hypothetical biases that can otherwise be problematic in stated preference studies. These biases include the occasional tendency for respondents to answer in ways they believe will skew the results, and any subsequent policy, in their favor. Furthermore, there is a tendency for respondents to answer in ways which they believe will receive approval from those conducting the survey, or in ways that reinforce their own moral tendencies. Methods utilized to avoid these biases include cheap talk (Cummings and

Taylor, 1999), and an indirect questioning technique ('inferred valuation') proposed by Lusk and Norwood (2009; 2009a). To my knowledge, this represents the first published application of inferred valuation to WTA estimation in a developing country.

Section 2 describes different approaches to PES and section 3 describes the agri-environmental context of the East Usambara study site. Section 4 presents the methodological approach, including a description of the choice experiment model and explanation of the inferred valuation approach. Sections 5 and 6 present results and concluding remarks respectively.

2. Different Categories of Payment for Ecosystem Services

The term 'payment for ecosystem services' receives broad application to a range of market-based environmental policies (Engel *et al.* 2008). However, a stricter definition provided by Wunder (2005) is generally used in recent documentation of PES. Wunder (2005) defines PES by five characteristics. (1) *It is voluntary:* PES is distinguished from command and control policies by being a negotiated framework between a purchaser and a provider of an ecosystem service. This assumes that providers have real land-use choice. (2) *It is based on a well defined environmental service:* The purchaser must be confident they receive the agreed quantity of the relevant ecosystem service, either through direct measure or through an appropriate proxy. A PES program for a service that is difficult to monitor is unlikely to hold the confidence of purchasers. Given the diffuse, indirect nature of many ecosystem services this can be a serious impediment. (3) PES *involves payment from at least one purchaser*, and (4) *to at least one provider:* A PES differs from other conservation and development policy instruments in that it is a commercial arrangement where both parties benefit from the transaction. Payment and monitoring of service provision often take place through an intermediary such as a

government acting on behalf of taxpayers or businesses. (5) A working PES program is contingent upon the ongoing provision of the ecosystem service in question, and hence payments are *conditional:* they are linked to provision with monitoring to ensure the contract is being upheld.

Few programs currently exist that satisfy all five conditions (Landell-Mills and Porras, 2002; Wunder, 2005). In particular, directly linking the payment to a particular environmental outcome can be difficult to achieve as natural variation, long time lags or complex ecological non-linearities can obscure the contribution of an individual's actions to the final ecosystem service outcome. However, meeting the strict definition of PES given above is not an indication of program design quality, or the likelihood of success. A successful PES must be tailored to the particular socio-economic, political, cultural and biophysical context of the environmental problem in question (Kemkes, *et al.* 2010; Jack, *et al.* 2008). Given this, Muradian *et al.* (2010) proposed a broader definition of PES as "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." While this definition captures the essence of the PES mechanism, more detailed terminology is needed to classify the variety of instruments that could meet such a description.

An attempt at that terminology is provided by van Noordwijk and Leimona (2010), who loosely identified three types of PES, differentiated primarily on the extent of their conditionality. They described conditionality on a spectrum, where payment can be linked to (1) the consequence of an improved ecosystem service (for example, cleaner water), (2) improved system performance (increased tree cover), (3) improved actions (replanting in the runoff zone), (4) improved management plans (an intent to replant in

the runoff zone), or (5) improved management objectives. These conditionality stages, from strongest (level 1) to weakest (level 5), are presented in Figure 1-1.

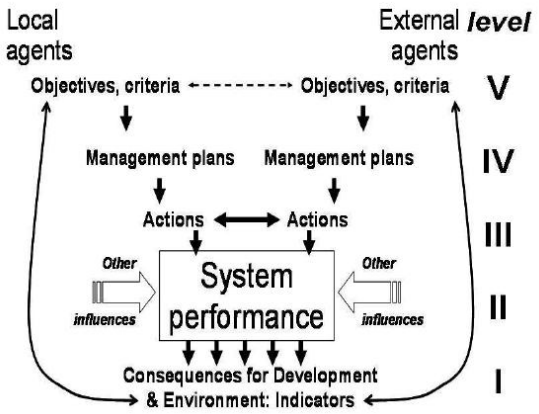

Figure 1-1: Five levels at which agreements on PES programs between local agents as 'ecosystem providers' and external actors as 'ecosystem beneficiaries' can be 'conditional' (Van Noordwijk and Leimona, 2010).

The three types of PES established by van Noordwijk and Leimona (2010) are 'commoditized ecosystem services' (CES), 'compensation for opportunities skipped' (COS) and 'co-investment in environmental stewardship' (CIS).

CES: The strictest form of PES, conditional on actual service delivery (level 1). Recurrent payments may be negotiated directly between beneficiaries and providers (for instance through an auction mechanism) with price set by supply and demand of the ecosystem service in question. CES has no explicit poverty target and is focused primarily on economic efficiency (quantity of environmental improvement per dollar spent). It presupposes well defined, individual property rights.

COS: Landholders are paid (compensated) to accept restrictions on the use of their land by beneficiaries via an intermediary (usually government). COS is conditional on

system performance (level 2) or actions taken (level 3). Rationale for payment is to compensate landholders for giving up a legal and economically attractive land use option that otherwise would degrade ecosystem services. COS may involve poverty targeting via differentiations in payment, hence compensation is set externally rather than negotiated between beneficiaries and providers through a market or auction.

CIS: Beneficiaries (usually via an intermediary) invest in the environmentally beneficial land management actions of landholders. Payment may take the form of individual payments commensurate with the investment needed to undertake the desired land management option or may involve investment in the community such as improved public services. Payment is generally conditional on actions taken (level 3) but sometimes on management plans (level 4) or system performance (level 2). CIS may or may not target a collective of ES providers rather than individuals. This former approach makes it suitable in situations where property rights are not explicitly individualistic or well defined. It utilises community trust and bonds in conjunction with market rewards to achieve the desired environmental goals.

Clearly there is considerable overlap between the paradigms summarized above. It should be noted that van Noordwijk and Leimona (2010) do not so much 'classify' PES as 'typify' PES, in the sense that their groupings necessarily contain some overlap. Alongside the few strict PES programs that match Wunder's (2005) original definition, there are a burgeoning number of PES-like instruments that do not (Wunder, 2007). However, these can be loosely placed in one of the three categories proposed by Van Noordwijk and Leimona (2010). This conceptual exercise is likely to have little influence over the practical design of any particular scheme, but it may help direct the academic

debate over what type of PES best suits a particular context, and furthermore, what exactly a PES program is.

The paradigms of PES are to some extent mirrored by the paradigms described by Farley and Costanza (2010). The latter authors place PES into two categories, an efficiency-focused 'environmental economics' approach and an equity-focused 'ecological economics' approach. Their 'environmental economics' approach is primarily based on the definition provided by Wunder (2005) (described above) which focuses on strictly defining property rights. Externalized benefits are internalized, bringing marginal costs into alignment with marginal benefits to society. The focus is on economic efficiency (greatest quantity of ecosystem services per dollar spent) and not on poverty alleviation (Wunder, 2008). This framework most closely matches the CES paradigm, however has parallels with COS also. The alternative type of PES described by Farley and Costanza (2010) - their 'ecological economics' approach – equally prioritizes environmental outcomes and poverty reduction. It advocates for a variety of payment mechanisms, both market and non-market, and places emphasis on collective institutions and payments. In doing so it is similar to the concept of CIS.

It should be noted that there are few examples of CES in operation in developing countries given the strictness of the conditionality and contractual arrangements required. Van Noordwijk and Leimona (2010) argued that CES is unsuitable in circumstances where property rights are weak or where communities have limited experience participating in services markets. The existence of multiple levels of land management institutions (legal pluralism) as well as unclear property rights can make the establishment of clear responsibilities and incentives problematic (van Noordwijk and Leimona, 2010; Swallow, *et al.* 2010). For this reason the discussion of PES paradigms in this paper is limited to COS and CIS.

In section 4 I operationalize some of the characteristics of the COS and CIS concepts in a series of hypothetical PES programs. These are presented to farmers in a choice experiment framework to ascertain farmer preferences for different program attributes. It should be noted that given the looseness of the currently existing definitions and the evolving nature of the PES debate, I do not attempt to capture the COS and CIS concepts in their entirety. However in assessing farmer preferences for some key components of PES - such as payment type and amount, conditionality levels (see section 4.3) – I am able to draw some conclusions as to the suitability of the COS and CIS categorization.

3. Study Site Description

3.1. The East Usambara Mountains

The Usambara Mountains are located in North Eastern Tanzania (4°48′–5°13′ S and 38°32′–38°48′ E), and form part of the Eastern Arc Mountain Range. This range is comprised of thirteen ancient mountain blocks that stretch from southern Kenya to southern Tanzania. These mountains support rainforest cover in the wetter areas and deciduous woodland in drier areas, with an elevation gradient contributing to a diverse array of forest ecosystems (Burgess, *et al.* 2007; Lovett, *et al.* 2001). The ranges receive more precipitation and cooler temperatures than the surrounding plains and are under the direct climatic influence of the Indian Ocean. Due to relatively stable climatic conditions through recent prehistory (Holocene) as well as ecological isolation due to drier vegetation types on the coastal plain, the Eastern Arc mountains have developed very high levels of species richness (Hall, *et al.* 2009; Lovett, *et al.* 2001).

Of the Eastern Arc Mountains, the East Usambaras are considered to be one of the most important regions biologically with the highest endemic species density (per 100km^2) of any ecosystem known in the world (Reyes, *et al.* 2006). The East Usambaras, as part of

the Eastern Arc, are a recognised 'Global Biodiversity Hotspot', a grouping of the most valuable and vulnerable ecosystems worldwide (Brooks, *et al.* 2002). The East Usambaras further form an important catchment supplying water for the nearby city of Tanga (with a population of approximately 240 000 in 2002).

3.2. The Agro-ecological Issue

The forests across the Eastern Arc and the high biodiversity they support have suffered from past clearing, logging and fragmentation, and remain threatened by environmentally detrimental agricultural practices (Hall, *et al.* 2009; Bjørndalen, 1992). These direct causes of degradation have been facilitated by deeper structural causes, such as land ownership patterns, lack of environmental law enforcement and corruption (Vihemäki, 2009). Approximately 30 percent of the original forested area in the Eastern Arc Mountains remains and 71 endemic or near-endemic vertebrate species are considered endangered (Burgess, *et al.* 2007). In the case of the East Usambaras, 60 percent of the original forest cover has been lost, mostly in the past 35 years (Figure 1-2) with rapid deforestation ongoing (Reyes, *et al.* 2006). It should be noted that the term deforestation as used here means the conversion of original forest to open land (for cropping or grazing). In addition to deforestation, approximately half of what remains has been thinned (degraded), losing biodiversity value although maintaining some carbon benefits. For more on forest definitions for the purposes of PES policy see van Noordwijk and Minang, (2009).

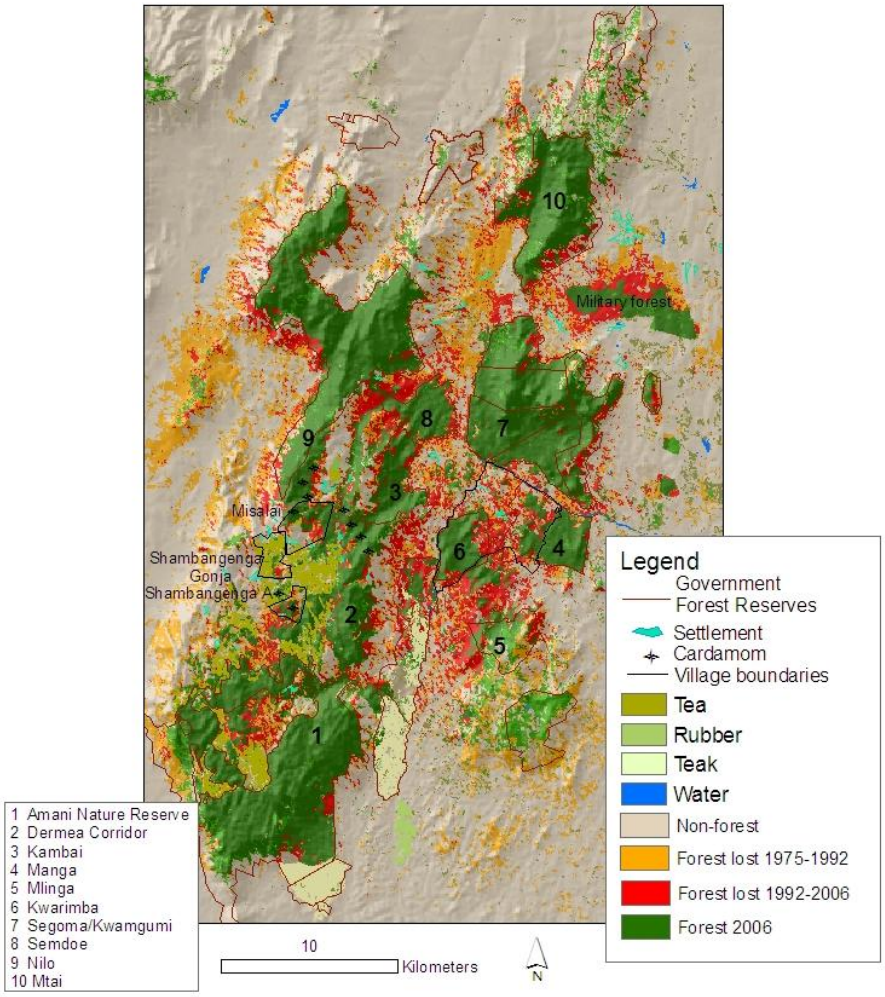

Figure 1-2: Land cover in the East Usambara Mountains as determined from satellite imagery (source: Hall, 2009).

Key to this deforestation process is the cultivation of cardamom *(Elettaria cardamomum),* as part of a series of crop rotations, planted and removed in response to changing soil nutrient status (Figures 1-3). Original forest is thinned in the first instance for the cultivation of this important cash crop grown by over 60 percent of farmers in the region. Cardamom's contribution to the average household budget is approximately 30 percent of income, and it accounts for more than half of total cash crop income (Reyes, *et al.* 2009). Despite the value of this crop, cardamom farmers in the East Usambaras have an average income far below the national average (Reyes, *et al.* 2006).

Cardamom is planted within the standing forest after the understory, mid story and parts of the overstory (selective thinning) have been removed. Productivity of the crop decreases rapidly over a period of 3-7 years due to nutrient depletion. Fertilizing with manure or replacing cardamom plants can allow for a second and subsequent rotations, however in many cases, the remaining overstory is removed and the field is used for cropping. A common conversion is to sugarcane, although conversion to perennial spices (cloves, cinnamon) or annual food crops (cassava, bananas, yams) also occurs in many instances. Like cardamom, these second stage crops also suffer from nutrient deficiencies over time, and eventually many plots are abandoned to woody weeds (*Lantana camara*, *Clidemia hirta*, and *Psidium guajava)* which limit rainforest regeneration.

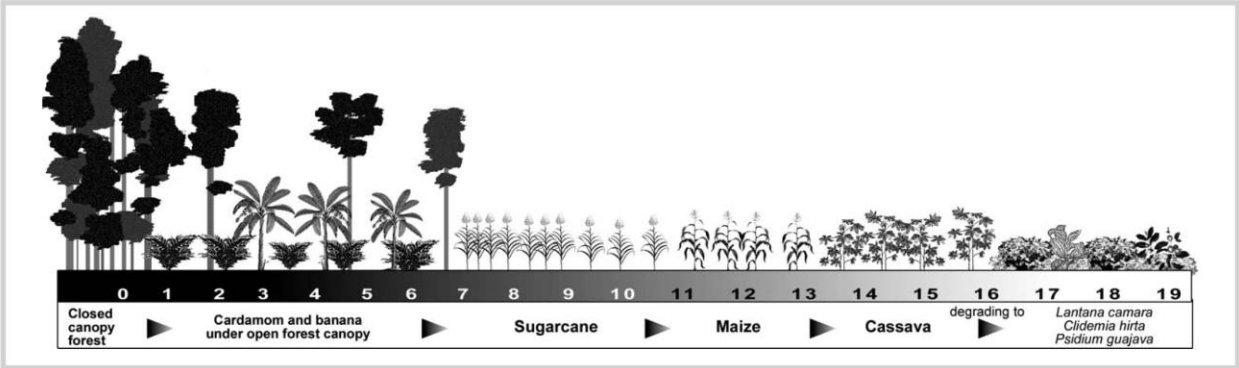

Figure 1-3: The typical sequence of land cover change following the planting of cardamom within the rainforest in the East Usambara Mountains (Reyes, *et al.* 2006).

Of the remaining forest in the East Usambaras approximately 26 percent has already been planted with cardamom, meaning that the process of land conversion is underway. This process is exacerbated by a gradually increasing population, which in conjunction with the pattern of land distribution and management found here, has led to land scarcity (Mwanyoka, 2005).

There are alternative land uses recently proposed that could maintain some degree of ecosystem functionality while allowing for ongoing cardamom production. Although inferior to original forest, maintaining agroforests would be preferable to complete forest cover loss. Leonard, *et al.* (2010) found that agroforests in the East Usambaras support a range of important vegetation species and threatened bird species. Of particular note, 'improved' agroforestry systems may be developed. Such improved systems are thought to have higher biodiversity and carbon sequestration benefits than either conventional cardamom agroforests or open field crops such as sugarcane, and can be maintained indefinitely (Bullock, *et al.* 2011). Improved agroforestry features a fallowing period of three years, followed by the application of fertilizer (manure). Mid storey and over storey species are allowed to regenerate around the cardamom, which is planted in lower density. Yields and subsequent profits are estimated to be lower than those from conventional cardamom agroforestry and sugarcane (Bullock, *et al.* 2011), although the extent of this discrepancy varies considerably due to fluctuations in cardamom and sugarcane prices. Regardless of the exact profit differences however, it is likely that long term maintenance of improved agroforestry requires providing farmers with additional incentives above the profits that are already associated with this farming method. The hypothetical PES programs developed for this study focus on this goal.

4. Data and Methods

4.1. The Choice Experiment Approach

This study uses a choice experiment to quantify preferences for different elements of PES program design. Choice experiments are a stated preference valuation technique where subjects are asked to choose between competing hypothetical goods or outcomes. The hypothetical good/outcome is a package of attributes, each of which can take on a number

of levels which are varied between hypothetical scenarios. Choice experiments can be used to determine the value of the individual attributes that make up the good/outcome and so are suitable for the analysis of preferences for policies which have a number of components. The hypothetical nature of choice experiments means they are also one of the few means of predicting preferences for (and behavior under) polices that have not yet been implemented. Choice experiments are similar to conjoint analysis (which involves ranking or rating hypothetical scenarios) but the use of discrete choice makes them consistent with random utility theory (Adamowicz, *et al.* 1998). A comprehensive overview of choice experiments is provided by Louviere *et al.* (2010).

Although choice experiments have been used extensively in the valuation of environmental amenities (see for instance Hoyos, 2010 for a review), there are only five published examples I am aware of that specifically use a choice experiment to explore policy preferences for land management programs amongst landholders. Ruto and Garrod (2009) used a choice experiment with a latent class model to evaluate farmer preferences for agri-environmental programs in 10 case studies across Europe. They quantified the additional payments required to overcome increased administrative load, longer contract length or more restrictions. Choice experiments were also used by two related studies (Klosowski, *et al.* 2001; Stevens, *et al.* 1999) that evaluated landholder preferences for coordinated forest management in New England. Both studies reported a reluctance to participate in land management programs even with financial payments, however they highlighted those policy attributes (tax incentives, an environmental amenities focus, shorter contract length) as well as landholder characteristics (income) that contributed to higher participation rates. Horne (2006) evaluated Finish landholder's preferences for conservation contracts in non-industrial, privately owned forests. Her choice experiment

showed that more stringent conservation requirements and a longer contract length necessitate higher annual payments, as expected.

Arafin, *et al.* (2009) is the only study to my knowledge that has used a choice experiment to advise environmental policy development in a developing country situation. Their study quantified landholders' preferences for community forest contracts in Sumber Jaya, Indonesia. They reported that landholders would be prepared to accept strict conditions on land use in exchange for the land rights certainty that the program provided. In addition to these choice experiment studies, there are a small number of other studies into PES program preferences which use other stated choice methods such as contingent valuation (Layton and Siikamäki, 2009; Cooper, 2003; Cooper and Osborne, 1998).

These previous studies have demonstrated the utility of choice experiments to the design of PES policy. However it is evident that the potential for this technique is far from fully realized. Even considering a broader array of methodologies, there are only a few studies on the policy attributes of PES that determine participation levels in practice (Ruto and Garrod, 2009).

4.2. Conceptual Model

It is assumed that farmers face a loss of utility due to the conditionalities of a PES contract, and a gain of utility from the associated payment. A farmer is assumed to choose a contract if the net utility from that choice is greater than either no choice or any competing choices. Based on random utility theory, the probability of a farmer making a particular choice is assumed to increase as the utility of that choice increases (Ben-Akiva and Lerman, 1985, pp. 59). The characteristics of the PES contract (attributes) are allowed to take on a variety of levels (Table 1-1). The overall utility derived from a contract is expressed as a utility function:

$$U_i(P_h) = U(Z_h; X_i)$$ Equation 1-1

Where P_h is the h^{th} PES program scenario, $U_i(P_h)$ is the utility derived from that scenario, Z_h is a vector of attributes that make up program P_h, and X_i is a vector of characteristics of the i^{th} farmer. Utility is assumed to be partially a function of profits made by the farmer, which in turn are partially a function of the nature of the PES program, P_h.

The utility function above has a corresponding indirect utility function, $V_i(P_h)$, which has a systematic, observable component $v(P_h)$ and a random unobservable component ε_{ih}:

$$V_i(P_h) = v(P_h) + \varepsilon_{ih}$$ Equation 1-2

The probability, π_{ih} that a particular program *h* will be chosen from the available set of programs C is:

$$\pi_{ih} = \Pr\left[v(P_h) + \varepsilon_{ih} \geq v(P_j) + \varepsilon_{ij};\ \forall\ h \neq j \in C\right]$$ Equation 1-3

And so $$\pi_{ih} = \Pr\left[\varepsilon_{ij} - \varepsilon_{ih} \leq v(P_j) - v(P_h);\ \forall\ h \neq j \in C\right]$$ Equation 1-4

If the unobservable components are identically, independently distributed as type 1 extreme values (Gumbel distributed), the conditional choice probability of selecting alternative *h* is:

$$\pi_i(P_h) = \frac{e^{\mu v(P_h)}}{\sum_{h \in C} e^{\mu v(P_h)}}$$ Equation 1-5

Where μ is a scale parameter, inversely proportional to the standard deviation of the distribution of errors. Note that μ often cannot be separated from the utility function so is normalized to one. Note that this implies that the choice set is assumed to adhere to the 'independence of irrelevant alternatives' property, which means that the relative

probabilities of selection of two options is unrelated to the presence of an irrelevant third option (Hanley, *et al.* 2001). I assume that the utility function is linear:

$$v(P_h) = BZ_h \qquad \text{Equation 1-6}$$

Where B is a vector of marginal utilities for each program attribute, Z_h. The above formulation can be solved using a multinomial logit model (assuming a logistic distribution of errors) using maximum likelihood.

A major limitation of the multinomial logit model is an assumption of homogenous preferences across respondents. This assumption can be relaxed by the use of a random parameters model (or mixed logit model) where utility parameters are estimated along a continuous distribution across individuals. This approach requires a large sample size and varied responses (Boxall and Adamowicz, 2002) and was thus considered less well suited to this exercise. I apply an alternative, latent class analysis. This proposes that there exists a discrete number of preference classes into which individuals have a certain probability of falling into based on socio-demographic or other respondent characteristics (Grafton, *et al.* 2004, p. 270). In equation 1-6, the vector of marginal utilities B, is not specific to an individual. In a latent class approach I assume that individual *i* belongs to a particular segment, *s* of the population:

$$\pi_{i|s}(P_h) = \frac{e^{\mu_s B_s Z_h}}{\sum_{h \in C} e^{\mu_s B_s Z_h}} \qquad \text{Equation 1-7}$$

Where B_s and μ_s are segment specific utility and scale parameters respectively. Membership to a particular segment is based on a latent membership likelihood function based on attitudes, perceptions and socio-demographic characteristics. Like the utility function in equation 1-2, the latent membership function (M_{is}^*) has both an observed ($A_s X_i$) and unobserved component (ϵ_{is}):

$$M_{is}^{*} = A_s X_i + \epsilon_{is}$$ Equation 1-8

Where A_s is a coefficient vector specific to segment *s* that is associated with the observable socio-demographic and psychometric determinants (X_i) of individual *i's* membership. If the errors are assumed to be are identically, independently distributed as type 1 extreme values (Gumbel distributed), the conditional choice probability function mirrors the multinomial logit model above. However this function is dependent on the characteristics of the individual *i*, not on the characteristics of the program's attributes:

$$\pi_{is}(X) = \frac{e^{\mu_s A_s X_i}}{\sum_{s \in S} e^{\mu_s A_s X_i}}$$ Equation 1-9

The product of equations 1-9 and 1-7, over the sum of all segments, gives the joint probability that individual *i* belongs to segment *s* and chooses alternative P_h.

$$\pi_i(P_h) = \sum_{s=1}^{S} \left[\frac{e^{\mu_s A_s X_i}}{\sum_{s \in S} e^{\mu_s A_s X_i}}\right] \left[\frac{e^{\mu_s B_s Z_h}}{\sum_{h \in C} e^{\mu_s B_s Z_h}}\right]$$ Equation 1-10

It should be noted that a latent class model is not based on a predetermined behavioural relationship between an individual's characteristics and their choices, but is a statistical classification process (Boxall and Adamowicz, 2002).

4.3. Experimental Design and Data

The objective of the choice experiment design was to test farmer preferences for key PES components. The initial set of attributes and options was selected to represent the principle elements of the COS and CIS paradigms (as summarized in section 1), however, the chosen attributes are those that are central to the practical task of constructing a PES program of any variety regardless of theoretical constructs and classification schemes. General concepts of conditionality, payment type and opportunity cost were adapted to tangible policy design elements, and the options were refined to meaningful levels based

on extensive pretesting in the East Usambara villages of Shambageda and Kwezitu. This process involved 7 structured interviews and 3 pilot survey rounds with a total of 77 participants. Follow up questions about the questionnaire were also posed to respondents of the pilot study. Interviews and pilot survey rounds were conducted in September of 2010.

The primary payment vehicle is a per acre annual amount paid directly to the farmer for his/her on-farm forest conservation. Although land in Tanzania is formally owned by the state, individual farmers hold title and thus management rights over specific farm plots. Two payment alternatives were also included. The first alternative is a group payment, where the per acre annual amount would be donated to a village fund for use on communal infrastructure (roads, the school, the hall). The group payment represents a collectivist approach to PES, where individuals make a contribution to the welfare of the village as a whole through actions on his/her own farm. It was hypothesized that this might take advantage of existing social norms to encourage land holders to make a contribution by way of farm management.

The second payment alternative is a once off, per acre upfront payment specifically for the purchase of manure fertilizer. This latter approach represents a 'co-investment' between the sponsoring organization and the farmer to improve the productivity of his/her farm. Doing so can avoid the need to clear additional forest or to convert nutrient-depleted agroforest to sugarcane. This is based on the findings of Reyes' (2008) experimental study in which manure application were found to increase cardamom yields by approximately 50 percent. The value of the manure fertilizer payment, approximately USD 140 per acre, was based on the average expected cost of generously fertilizing one acre of cardamom agroforest using livestock manure. The seemingly high cost of

fertilization is due to costs of labor to transport manure to sometimes distant and scattered fields. This cost information was collected during structured interviews with landholders.

Three different levels of conditionality were included. At the least arduous level, farmers are expected to simply fill out a logbook of their farm activities, and hence farmers are simply trusted to abide by the spirit of the program, with the possible chance of an audit of the log book. This was based loosely on a logbook system used in the East Usambara Novella *Allanblackia* project, an ongoing effort to increase cultivation of fruit from *Allanblackia* trees (UNDP, 2009). At the intermediate level, farmers' properties are inspected once per year by a local villager hired by the program, but face no requirements for the health of tree cover or the quantity of understory. At the most arduous conditionality level, farmers face twice yearly inspections from a forestry officer who considers both tree density and species requirements. Table 1-1 shows the full schedule of attributes and levels.

Table 1-1: Attributes and levels presented in hypothetical contracts

Attribute	Description	Levels
Individual payment	Amount of money provided directly to farmer for maintenance of agroforest (per acre payment, annually)	Approximate USD: 0, 21, 50, 176
Collective payment	Amount of money provided to a dedicated village development fund for maintenance of agroforest (per acre payment, annually)	Approximate USD: 0, 21, 50, 176
Upfront fertilizer payment	Whether the program provides a one off, upfront payment for the procurement of fertilizer (value approximately USD 140 per acre)	Approximate USD: 0, 140 (binary variable)
Conditionality - Low	No inspections – farmers are required to keep a log book documenting farm activities which may be audited	Yes, No (binary variable)
Conditionality -	A local villager will be hired by the administrating	Yes, No (binary

Moderate	organization to inspect farmers' farms once per year to ensure no large trees have been removed from forest and agroforest.	variable)
Conditionality - High	A forestry officer from the administrating organization will inspect farmers' farms twice per year to ensure that no large trees have been removed from forest and agroforest. Also will ensure that there are enough saplings for canopy replacement and that trees present are indigenous species.	Yes, No (binary variable)

The payment amounts were selected a priori based on the opportunity cost of maintaining an 'improved agroforest' over a sugarcane plantation. Costs and revenues of the different farming operations were sourced from Bullock *et al.* (2011). Payment amounts were then adjusted during three rounds of pilot surveys to achieve an appropriate distribution of bid acceptance levels. In other words, the initially selected payment amounts were adjusted so that the highest bid was generally accepted and the lowest bid generally rejected so to ensure a statistically robust outcome at the analysis stage.

Contracts were stipulated as lasting for ten years. Premature departure from contracts (i.e. violation of contract conditions) would result in a fine of approximately USD 35 and the cessation of further payments. This amount was chosen so to approximately match the fine currently existing for the infraction of cutting a protected tree species. Farmers were also told that they must enroll all of their owned/managed land into the program if they were to take part. Permitting farmers to enroll only part of the landholdings could allow farmers to geographically shift forest cutting activities while still receiving income from PES, also known as 'on-farm leakage' (Engel, *et al.* 2008).

A split sample treatment was applied to test farmers' responses to a varying payment mechanism. Half of the sample was told that their individual payments would vary from

year to year depending on the price of sugarcane, a key opportunity cost for maintaining forest or agroforest. Although this does not perfectly represent the opportunity cost of the land use restriction (which depends on both the price of sugarcane and cardamom) it provides an approximate representation. This 'dynamic' payment would be higher in years of high sugarcane prices in order to encourage farmers to stay in the program. Similarly, payment would be lower when sugarcane prices were lower as the incentive to leave the program would be diminished. Famers were told that on average their payments would be equal to (approximately) USD 21, 50 or 176, matching the static payment described in Table 1-1.

Although these attributes are similar to those used in existing PES schemes, their selection was partially informed by the recently proposed COS and CIS paradigms, described in section 2. In doing it was hoped that the results would inform not only practical PES program design in the East Usambara context, but also further the discussion over the suitability of this classification system. The primary payment vehicle, a financial incentive targeted directly at the ES provider is more commonly associated with COS type PES programs. The two payment alternatives meanwhile – the manure fertilizer investment and the group payment - are more typically associated with the CIS concept. The manure fertilizer investment aims to encourage agroforest conservation by improving the returns associated with its practice, while the group payment aims to harness farmers' desire, if present, to contribute to the collective village welfare.

A second key difference between CIS and COS is the extent of conditionality (van Noordwijk and Leimona, 2010). COS has a higher burden of conditionality: providers are expected to actually provide the ecological service being paid for, or undertake an action known to reliably provide it. CIS however is not usually conditional on ecological outcomes, but instead on land management actions that are generally concordant with the

desired ecological outcomes or even the intention to undertake certain actions. There is also a higher dependency on trust in the latter paradigm and so strong inspection and enforcement regimes are not included.

Finally, the split sample treatment was applied to assess farmer responses to a price that fluctuates with the (partial) opportunity cost of the land management action (profit from sugarcane), rather than remaining constant year to year. This was a direct test of a literal interpretation of the COS paradigm, that payment is 'compensation for opportunity skipped.' These design elements are simply a selection of characteristics that distinguish between COS and CIS. Further distinction is difficult at present given that these paradigms are only loosely defined, and to some extent overlap. They represent 'typifications', rather than strict 'classifications' of PES programs.

A large number of potential PES scenarios can be constructed from the attributes and options in Table 1-1 ($[4^2*2*3]^2 = 9216$) so the full set of possible combinations was reduced to a set of 32 using an orthogonal fractional experimental design using the Ngene experimental design software package (ChoiceMetrics, 2011). These were arranged in blocks of 4 scenarios consisting of two hypothetical PES programs each and a status quo option ("none of the above"). Inclusion of the status quo reduces the likelihood of forced, spurious choices, and ensures consistency with standard welfare theory (Hanley, *et al.* 2001). Efficient type designs were precluded from use due to a lack of prior marginal utility estimates (ChoiceMetrics, 2011a), unavailable due to time and budget considerations (these would require a comprehensive choice experiment pre-study). Each farmer received one block – four scenarios – and was asked to make a decision on each.

The questionnaire was structured with an introductory section collecting information on the participant's farming practices. This was followed by an information section

explaining the deforestation problem, an explanation of the upcoming choice experiment procedure, and a cheap talk script (see section 4.4). The choice scenarios came next with a series of socio-demographic questions to conclude.

Farmers were questioned in Kiswahili (the national language of Tanzania) in face to face interviews with trained enumerators in September and November, 2010. Interviews were requested with the 'head of household' from households randomly selected from village registries. Surveying took place in the subvillages of Kwezitu village (Antekae (88 farmers), Kisangani (64), Kagare (55) and Gonja (44)) with a small number from nearby Shambageda village (Shambangeda B (11 farmers)). These villages were selected for surveying due to the high proportion of resident farmers engaged in agroforestry, some of the highest proportions of any villages in the East Usambaras. The numbers of households surveyed was approximately 50 percent of the total households in the case of Kwezitu. Participation rates were high with an estimated 90 percent of farmers present prepared to take part. Surveys were undertaken in private and took an average of 42 minutes each.

4.4. Mitigating Hypothetical and Social Desirability Biases

A well known disadvantage of stated preference valuation techniques is the potential for hypothetical and social desirability biases. Hypothetical bias can be defined as the discrepancy between the preferences expressed in a hypothetical survey situation and those expressed in a real market scenario (Little and Berrens, 2004). One type of hypothetical bias is strategic behavior, where respondents give a biased response in an effort to skew results and consequently, any policy influenced by the survey's findings. This is a problem that faces stated preference techniques due to a lack of

consequentiality: respondents are not bound by their response in any way, unlike agents participating in a real market (Bennett and Blamey, 2001; pp. 181).

However, careful survey design can mitigate such biases. For instance, the use of cheap talk scripts, first proposed by Cummings and Taylor (1999) have been shown to reduce the extent of hypothetical bias in stated preference studies (Carlsson, *et al.* 2005). A cheap talk script simply encourages respondents to provide realistic answers. My questionnaire makes use of the following script immediately preceding choice experiment questions.

"Even though the set of conditions described to you are not real and do not commit you to any actions, it's really important that you answer as if this was a real choice with real consequences. Sometimes people say one thing in a survey but when they face the same situation for real, they do something else. Please think really carefully about whether you really would do what you say."

A second and related type of hypothetical bias is 'yea saying,' the tendency to express support for a program without fully considering the trade offs (Bennett and Blamey, 2001; pp. 181). Although choice experiments are less susceptible to 'yea saying' than the other major stated preference technique, contingent valuation (Hanley, *et al.* 1998), it was considered potentially problematic in this context given the enthusiasm for environmental protection expressed during preliminary interviews and pilot surveys. Yea saying is a not uncommon experience in developing country stated preference research (Whittington, 2010).

Yea saying is closely related to social desirability bias, the influence of social norms and the immediate social context on the resulting responses. There is a tendency for some respondents to answer in ways which they believe will receive approval from those

conducting the survey (Maguire, 2009), or to answer in ways that reinforce their own moral tendencies (Nunes and Schokkaert, 2003).

Inferred valuation is a questioning approach that aims to avoid these latter two types of bias by asking respondents to state how much they believe other people would pay (Lusk and Norwood, 2009; 2009a). The basis for using inferred valuation is that an individual does not usually possess specific knowledge of the preferences of the wider population. In the absence of such information, the respondent who is asked to make an inferred valuation must use his/her own value. However, because the question concerns other people's values, and not that of the respondent, there should be no motivation to overstate for the purposes of appearing pro-environmental to the interviewer. Lusk and Norwood (2009) hypothesized (and provided supporting evidence) that inferred values are approximately equal to conventional self-provided values, but adjusted for social desirability bias. The resulting value is more appropriate for policy development.

All respondents were presented with their block of 4 hypothetical choice scenarios twice, firstly framed as direct valuation and secondly as inferred valuation. After answering the 4 choice scenarios for the first time, farmers were told:

"Now we want to know what you think the other farmers in this area would choose. You might think they would make different decisions to you, or you might think they would make the same decisions. Your answers will not affect you or your neighbors' eligibility to participate in any future programs, and like before, will not be linked to your or their identity".

The wording in the inferred valuation questions was identical except referred to 'they' (other farmers in the area), instead of 'you' (the farmer answering the question). Unlike

the dynamic payment treatment, all respondents received both the standard valuation approach and the inferred valuation approach.

5. Results

5.1. Sample Profile

75 percent of the sample was male, indicating the (self identified) prominence with which men act as primary decision makers with regards to farm decisions (Table 1-2). Only one third of participants were born in the village they were living in, possibly a result of past government 'villagization' programmes (*Vijiji*, a policy of rural resettlement as part of Tanzanian socialism, or *Ujamaa*) (Lal, 2010) or due to resource and population driven local migration (Yanda and Shishira, 2009). Self reported income averaged USD 690 per household per year, lower than the Tanzania national average (CIA 2010). 26.9 percent of the sample had in addition an off farm source of income, which for these households averaged an additional USD 455 per year. I am cautious in the use of self reported income given the high variation in responses, and rely instead on a possessions index as a proxy for income. Also, land size serves as a proxy indicator of wealth. Morgan-Brown, *et al.* (2010) found that land size explains 74 percent of variation in annual income in their study of environmental attitudes in the same region. Average land size owned or managed was 6.27 acres, with an average of 2.82 acres of cardamom agroforestry and 0.30 acres of primary forest. These varied considerably over the sample (Figure 1-4). Level of education is not included as a variable for analysis due to limited variation across the sample (91 percent of participants have primary schooling only).

Table 1-2: Summary socio-demographic characteristics of sample

	Mean	St. Dev
Sex (proportion male)	0.75	-
Born in village (proportion)	0.33	-
Age (years)	45	14
No. adults in household	2.64	2.47
No. children in household	2.89	1.92
Self reported annual income (USD)	690	1017
Proportion with off-farm income source	26.9	-
Off farm income (for those with off farm income) (USD)	455	502
Proportion planting:		
Cardamom agroforestry	81.6	-
Yams	90.6	-
Bananas	97.1	-
Other Spices	89.4	-
Cassava	79.6	-
Sugarcane	38.8	-

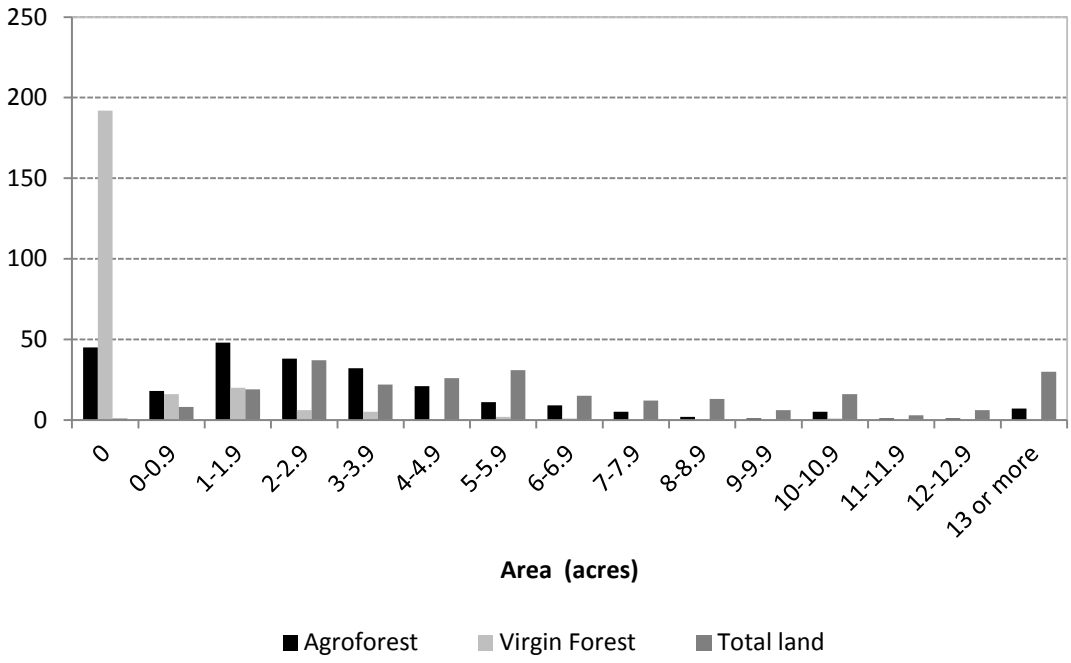

Figure 1-4: histogram of land characteristics amongst farmer sample: area of total land owned or managed, area of land with agroforest and area of land with original forest.

5.2. PES Policy Preferences

Table 1-3 presents separate multinomial logit (MNL) models for the inferred choice experiment scenarios and the direct choice experiment scenarios, as well as for the amalgamated data set.

Table 1-3: Multinomial logit models of preferences for a hypothetical PES program, based on subsamples of questioning method. * = significant difference between treatment and control at α=0.1 level, * = significant at α=0.01 level.**

	Inferred valuation			Direct valuation			All data combined		
	Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error	
Individual	0.064	0.006	***	0.067	0.006	***	0.065	0.004	***
Group	0.009	0.006		0.007	0.006		0.008	0.005	*
Status Quo	0.218	0.137		0.429	0.139	***	0.319	0.097	***
Upfront payment	0.836	0.107	***	0.842	0.112	***	0.837	0.077	***
Conditionality 2	0.098	0.072		0.145	0.076	*	0.119	0.052	**
Conditionality 3	-0.018	0.070		-0.170	0.075	**	-0.088	0.051	*
Conditionality 1[a]	*-0.081*			*0.026*			*-0.032*		
No. obs.	220			200			220		
d.f.	6			6			6		
LLF	-826.878			-761.988			-1591.471		
AIC	1665.757			1535.976			3194.941		

[a]: Implicit coefficient, β_1 which is calculated from effects codes coefficients for conditionality 2 (β_2) and conditionality 3 (β_3). $\beta_1 = -(\beta_2 + \beta_3)$.

A likelihood ratio test is used to check for statistically significant differences between models[1]. The two sub groups are not significantly different ($\chi^2_{\text{d.f=5}} = 5.21$, p-value = 0.39)

[1] This test takes the form $LR = -2(LLF_R - LLF_{UR})$ and is compared to a chi-square distribution with degrees of freedom equal to the number of variables. The unrestricted (UR) model's LLF is the sum of the two part models' LLFs, whilst the restricted (R) model's LLF is provided by a combined model.

suggesting that respondents expect little difference between their responses and the responses of their colleagues. Assuming that the Lusk and Norwood (2009; 2009a) inferred valuation technique is effective in such a context, this result also suggests that any social desirability bias is minimal. Aggregating the data across these two questioning approaches gives a model with similar coefficients but with additional significant variables. Aggregation does not provide additional data given that the direct and inferred valuation questions were based on the same scenarios, and so only models based on the direct valuation questions are used for WTA calculations.

The status quo coefficient for the direct valuation is positive, indicating that the average farmer would require payment to take part in the program, as expected. The amount of payment required differs based on the type of payment mechanism. Of interest is the discrepancy between the marginal utility of individual and group payments. The individual payment provides positive utility in models of both direct and inferred valuation data. However, both data sets suggest group payment has no effect ($p > 0.1$). While this discrepancy between these two payment types was expected, it was not expected to this extent, given the tight community bonds that are often assumed to exist within small villages. If it was to be assumed that the group payment would be significant with a larger sample (a strong assumption), and had a coefficient comparable to that found here, approximately eight dollars spent motivating farmers through a collective payment would be expected to elicit the same response as one dollar spent motivating farmers through an individual payment. Given the lack of significance of this variable in the direct valuation model however, this result is speculative.

The upfront payment for manure fertilizer has a strong effect on likely participation rates. The one off investment payment, which is approximately USD 140 per acre (dedicated to manure fertilizer), has the same predicted effect on participation as an annual cash

payment of USD 84 per acre. This suggests either (or likely both) that farmers have a high discount rate and so prefer resources at the beginning of the contract rather than in installments at the end of each year, and/or that manure fertilizer commands a premium over cash due to difficulties in its procurement. This issue was raised a number of number of times by farmers during pretesting and interviews. But most importantly, the high value placed on the manure fertilizer investment probably represents the expected increase in income due to additional productivity of farmers' agroforests.

The above assessment lumps two treatments together, the dynamic and static payment regimes. In the dynamic payment regime respondents were told that payment would vary year to year, proportional to the market price of sugarcane (which as described in section 4.3 is a key opportunity cost for farmers participating in a PES program). Table 1-4 presents choice models of subsamples of the data based on static, dynamic and combined models respectively. A likelihood ratio test finds a significant difference between the dynamic and static treatments ($\chi^2_{d.f=6}$ = 12.996, p-value = 0.043). The status quo and conditionality variables are only significant in one treatment each, possibly due to the smaller size of subsamples used here. The coefficient for individual payment is lower under the dynamic payment treatment (0.059) than under the static payment treatment (0.075), indicating that the same quantity of money provides less incentive when the payment amount fluctuates year to year.

Group payment is not significant under either treatment, and the status quo is only significant under the dynamic payment treatment. There is a small difference in the marginal utility of the upfront manure fertilizer investment between treatments, with a higher marginal utility under the dynamic payment regime. This may represent a substitution effect: a less reliable payment year to year makes the upfront offer relatively more attractive. This effect is puzzling given that the model overall suggests that the

static payment approach is preferred over the dynamic payment approach. It would appear that preferences are to some extent context dependent: an upfront investment within a dynamic payment framework is more attractive than the same upfront investment in a static payment framework.

Table 1-4: Multinomial logit models of preferences for a hypothetical PES program, based on treatment subsamples. Direct valuation questions used only. * = significant difference between treatment and control at α=0.1 level, * = significant at α=0.01 level.**

	Static payment			Dynamic payment			Combined treatments		
	Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error	
Individual	0.075	0.009	***	0.059	0.009	***	0.067	0.006	***
Group	0.006	0.009		0.009	0.010		0.007	0.006	
Status Quo	0.214	0.191		0.696	0.205	***	0.429	0.139	***
Upfront payment	0.769	0.155	***	0.956	0.166	***	0.842	0.112	***
Conditionality 2	0.230	0.101	**	0.029	0.116		0.145	0.076	*
Conditionality 3	-0.195	0.103	*	-0.139	0.112		-0.170	0.075	**
Conditionality 1[a]	*-0.035*			*0.110*			*0.026*		
No. obs.	111			89			200		
d.f.	6			6			6		
LLF	-406.326			-349.164			-761.988		
AIC	824.653			710.328			1535.976		

[a]: Implicit coefficient, β_1 which is calculated from effects codes coefficients for conditionality 2 (β_2) and conditionality 3 (β_3). $\beta_1 = -(\beta_2 + \beta_3)$.

The models presented above provide tentative evidence for a non linear response to the extent of conditionality[2]. The static, direct model has a significant positive coefficient for

[2] Conditionality variables (which represent mutually exclusive, discrete, policy states) are represented in the model by effects codes. While effects codes are statistically identical to more commonly used dummy variables, dummy variables cannot be correctly interpreted in discrete choice models which include a status quo coefficient. When considering *N* discrete states, *N*-1 representative dummy variables are entered into the model - the N^{th} variable is dropped to prevent

the intermediate level of conditionality, while the high conditionality coefficient is significant and negative. The coefficient on the low conditionality level lies in between these two extremes. A similar pattern is exhibited by the other models presented here (Figure 1-5). Hence there is evidence suggesting that there exists a non linear relationship between utility and the extent of conditionality. An intermediate conditionality level is preferred over both a low conditionality and a high conditionality program, giving an inverted U shape relationship between the level of conditionality and marginal utility. It should be noted that these marginal utilities are relevant only under a policy scenario (i.e. when the status quo is zero), and hence are relative to each other.

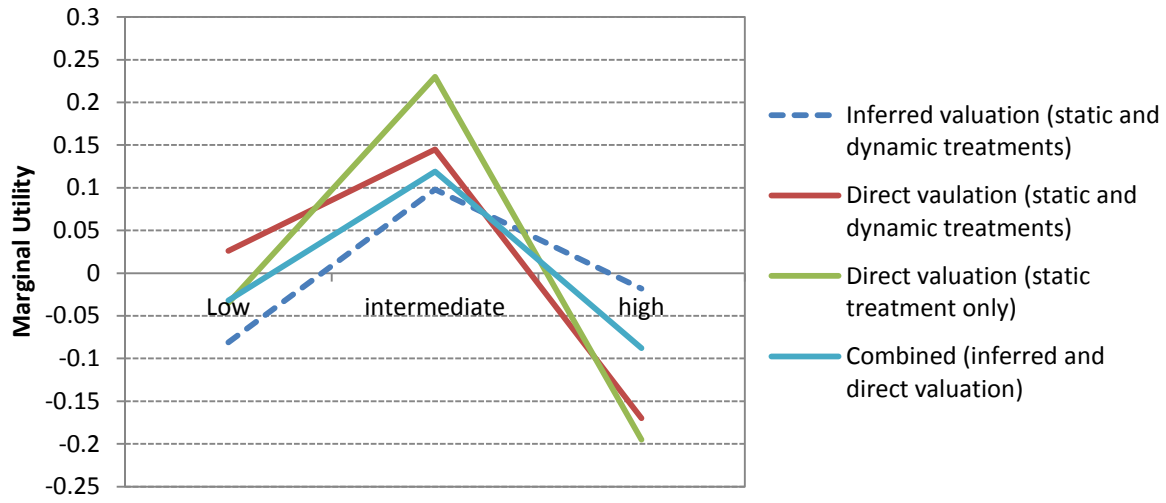

Figure 1-5: Marginal utilities associated with different conditionality regimes, under different treatments (inferred versus direct questioning, static versus dynamic payment treatment). Dash line indicates statistical insignificance.

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perfect colinearity (the 'dummy variable trap'). However this makes it impossible to separate out the impact of the N^{th} discrete state and the status quo coefficient, which are confounded. Effects codes avoid this problem by using a coding specification where the omitted variable is uncorrelated with the status quo. A discussion of this issue is provided by Bech and Gyrd-Hansen (2005).

The lowest level of conditionality relies on self reporting, which while being easiest for farmers is clearly open to abuse. It is likely that the negative response to this approach is due to preferences for policies that cannot be unfairly exploited. The highest level of conditionality, in which payments are tied to specific environmental outcomes (the number and density of indigenous species in the forest) also causes negative marginal utility relative to the intermediate level. This is expected given the additional burden on farmers who must comply with a tougher inspection regime by a forestry officer. The preferred conditionality level is between these extremes.

Willingness to accept (WTA) values can be calculated for different elements of program design by taking the ratio of an attribute's marginal utility to the marginal utility of money (the primary payment vehicle) to determine the marginal rate of substitution between the attribute and money (Hanneman, 1984). This process can be extended to determine the overall WTA required to induce participation by subtracting the marginal utilities of program attributes from the marginal utility of the status quo option[3]. The status quo coefficient represents the marginal utility of not participating in a program and is required for WTA calculations in scenarios where non-participation is an option (all

[3] In line with the majority of WTA calculations presented in the literature, I assume that respondents have a linear marginal utility of money over the levels of payment considered in the choice experiment. Doing so renders the inclusion of income data unnecessary in the model, useful in circumstances where income cannot be measured with high precision. I test the suitability of this assumption by modelling the data with discrete payment variables (those presented in the scenarios, 0, 21, 50 and 176). A straight line plotted through the resulting marginal utilities has a relatively high R^2, (0.85) allowing me to conclude that an assumption of linear marginal utility of money is likely reasonable. It should be noted that this might not hold for considerably different payment amounts (very large payments, for instance).

voluntary programs). For determining the median WTA value required to induce participation in a program I use the dynamic treatment model and the combined model (Table 1-3) as the static treatment model alone does not find a significant status quo coefficient.

There is a considerable discrepancy in WTA amounts between the dynamic treatment and the combined treatment model (Table 1-5). Without a manure fertilizer investment and with a moderate conditionality regime, a USD 28 per acre per year payment is required to convince the median farmer to enroll. If the payment from year to year varies in line with the opportunity cost of maintaining the forest (or at least part of it, the price of sugarcane), the required payment is USD 79, even if both payment regimes provide the same amount on average. While I am unable to calculate the WTA amount for a static payment amount alone due to an insignificant status quo coefficient, the mixed treatment model amount (USD 28) provides a likely upper bound amount for this treatment.

The impact of the manure fertilizer investment is dramatic, causing WTA to become negative. Hence the upfront manure fertilizer of value USD 140 per acre is in itself enough to convince the median farmer to enroll. Again the effect of more stringent conditionality is evident. The highest level of conditionality raises WTA from USD 28 for the moderate conditionality level to USD 60 per acre per year, in the case of the combined treatment model.

Table 1-5: Willingness to accept amounts (per acre, per year for a 10 year contract) based on the direct questioning method, using dynamic treatment and combined treatment models respectively (Table 1-4).

		Dynamic treatment		Combined treatments	
	Conditionality	Median	Std. Error	Median	Std. Error
No upfront payment	Moderate	78.6	19.5	28.3	14.9
	High	78.6[a]	19.5[a]	59.6	14.0
Upfront payment	Moderate	-29.4	22.9	-55.5	16.9
	High	-29.4[a]	22.9[a]	-24.2	15.5

[a]: No significant difference between high and moderate conditionality regimes for this model.

5.3. Heterogeneity of Preferences

These WTA results represent the median preferences of participants as a whole, and hence assume that preferences are homogenous. However, it is possible that there exists a range of preferences amongst participants for which it may be possible to categorize into discrete classes representing the main 'types' of participant. Latent class analysis, a post hoc statistical classification process, is used for this (see section 4.2). A latent class analysis is not based on a predetermined behavioural relationship between an individual's characteristics and their choices, but identifies such relationships from their choices.

Selection of the number of classes is not guided by formal criteria, however a number of authors (for instance, Boxall and Adamowicz, 2002; Scarpa and Thiene, 2005) recommend class selection based on log likelihood statistics and information criteria[4], and

[4] Information criteria are log likelihood scores with an adjustment for degrees of freedom. The AIC (Akaike information criterion takes the form $AIC = -2\ln(L) + 2q$, where L is the log likelihood and q is the number of parameters. A variant is the BIC (Bayesian information criterion) which takes the form $BIC = -2\ln(L) + \ln(N)q$ where N is sample size. Smaller information criteria are preferred (Cameron and Trivedi, 2005).

plausibility of results given the size of membership classes and the size of standard errors. Some analyst judgement is required. I selected a 2 class model: higher class models had very high standard errors, likely due to the over parameterization of a small dataset. Table 1-6 shows results for a latent class analysis of the direct valuation data.

Table 1-6: Multinomial logit models of preferences for a hypothetical PES program with two latent classes (based on direct questioning data). * = significant difference between treatment and control at α=0.1 level, * = significant at α=0.01 level.**

	Parameters for class 1			**Parameters for class 2**		
	Coef.	Std. Error		Coef.	Std. Error	
Individual	0.113	0.113	***	0.085	0.026	***
Group	0.026	0.009	***	-0.005	0.038	
Status Quo	-0.686	0.257	***	4.056	0.908	***
Upfront payment	1.518	0.182	***	0.845	0.559	
Conditionality 2	0.207	0.088	**	0.421	0.654	
Conditionality 3	-0.231	0.088	***	-0.153	0.707	
Conditionality 1[a]	*0.025*			*0.332*		
Average Class Probabilities	0.787			0.213		
Class probability model (class 1)						
Constant	2.086	0.729	***			
treatment	-0.559	0.427				
Land area (acres)	0.048	0.044				
Sex (male = 1)	-1.156	0.568	**			
Age (years)	-0.003	0.007				
Born in Village	0.737	0.427	*			
No. Children	0.001	0.002				
LLF	-589.119					
McFadden Pseudo R2	0.329702					
AIC	1216.237					
No. obs.	800					
d.f.	19					

[a]: Implicit coefficient, β_1 which is calculated from effects codes coefficients for conditionality 2 (β_2) and conditionality 3 (β_3). $\beta_1 = -(\beta_2 + \beta_3)$.

Immediately apparent is a strong bifurcation of the status quo coefficient. Class 1 displays a negative coefficient, indicating that members of this class are prepared to enter into the contract without payment. Class 2 has a large positive status quo coefficient, indicating that members of this class require high levels of compensation to join, and are on the whole reluctant to take part. Class 2 is the smaller of the two classes with 21 percent of respondents. The average of these two models, weighted by the class probabilities, is the whole model reported upon above (Table 1-4). Hence the skepticism shown by members of class 2 is responsible for the overall result of a negative status quo coefficient.

The treatment variable was included as an explanatory variable in the latent class analysis, however was not found to be significant ($p > 0.1$). Although a randomly assigned treatment obviously cannot impact the socio-demographic characteristics of a respondent, it can elicit behavior that appears similar to that associated with a particular set of socio-demographic characteristics (that associated with a particular class). This highlights an important feature of latent class analysis - the classes are probabilistic, meaning that a particular socio-demographic characteristic increases the probability of belonging to a certain class, but does not determine it absolutely. This sets latent class analysis apart from simple interaction terms entered directly into a standard multinomial logit model.

Class 1 is defined by preferences similar to those reported in the whole model. However, in addition to the individual payment, group payment is shown to have a significant effect (although provides only 23 percent of the utility of the individual payment per dollar). The manure fertilizer investment coefficient remains strongly positive and a preference for a moderate level of conditionality (compared to a high or low level of conditionality) remains. Class 2 on the other hand is defined simply by strong resistance to PES. In

addition to the strong preference for the status quo, the marginal utility of the individual payment is reduced meaning that additional payment would be required to induce participation by members of this class.

With regard to specific socio-demographic characteristics, this study finds only sex and village of birth to have a significant impact on class membership. Males are more likely to fall into class 2, showing the strong aversion to PES. Those born in their current village of residence (lifelong inhabitants) were more likely to fall into class 1, showing strong acceptance of PES. It is likely that a larger dataset would present greater insights into the impact of particular variables.

6. Discussion and Conclusions

Six notable results arise from analysis of the choice experiment: (1) the surprisingly high value of the manure fertilizer investment, (2) the ineffectiveness of the group payment, (3) non-linear preferences for conditionality, (4) the preference against a dynamic payment, (5) the strong preference heterogeneity found in the sample, and (6) the lack of discrepancy between the direct valuation and inferred valuation.

A one-off co-investment in a farm input (manure fertilizer in this case) elicited surprisingly large support for the hypothetical PES programs. The investment, worth USD 140 per acre, was enough to persuade the median farmer to accept a hypothetical program without additional yearly PES payments for the life of the 10 year contract. With regard to WTA, the per acre upfront investment was equivalent to approximately USD 84 per acre per year, which if considered purely in financial terms indicates a discount rate of over 50 percent. However the majority of the value of the upfront payment is thought to be due to the expected productivity increases of the investment, not from the market

value of the input itself. Secondly, it is plausible that there exists an appreciation of the investment as a partnership, a value over and above its purely financial worth.

It should be noted that large upfront payments and other irreversible benefits (such as land tenure provision) are generally not considered incentive compatible due to the loss of leverage once benefits are handed over (Wunder, 2007). In this case however, the manure fertilizer investment attempts to avoid this by providing an ongoing incentive (a more productive agroforest for a number of years after fertilization) that is to some extent 'locked' into a particular land use choice (agroforestry). The 'reward' for agroforest maintenance is via additional productivity, not via the market value of the input itself.

The group payment was highly ineffective at promoting hypothetical participation. Making land management changes for the sake of collective welfare does not appear to represent an appealing prospect to farmers. On the contrary, individuals were effectively motivated by relatively small annual cash payments, direct to the individual farmer. I conclude that the group payment was eight times less effective than the individual payment (and possibly not effective at all), however this number is speculative given the lack of statistical significance of this variable in most models.

Preferred levels of conditionality may be non-linear. Farmers were most likely to participate in a program which held them to account with regard to their actions, but not with regard to their environmental outcomes (a more stringent standard and costlier for the farmer to comply with). Counter intuitively, participants showed preference against the lowest level of conditionality - that based simply on trust and intentions rather than a physical inspection for compliance. It is likely that although the lowest level of conditionality is the easiest for farmers to comply with, they do not believe such a regime is plausible or represents good policy. It is possible that farmers who support the goals of

a policy (for instance, prevent deforestation) will base their preferences not only on what the policy can do for them (the payment) but also in terms of whether it is likely to meet its goals.

A static payment rate is preferred to a dynamic payment that fluctuates with the (partial) opportunity cost of the land management action. This is despite the supposed equity of payment amount over time. The uncertainty of a fluctuating price necessitated a large premium to encourage participation. The envisaged purpose of a fluctuating price was to prevent farmers from dropping out during periods of high opportunity cost, and to reduce program expenditures during times of low opportunity cost. However, the complexity and the additional risk associated with such a payment mechanism means that its implementation would require additional compensation.

This study shows mixed farmer support for elements of both a 'compensation for opportunities skipped' (COS) type PES paradigm, and for a 'co-investment in ecosystem stewardship' (CIS) type PES paradigm. There was no standout preferred approach, demonstrating that the design of PES should be tailored closely to local preferences quantified in advance of policy implementation. The varied response to the different payment types indicates that both COS and CIS type schemes could be successful in motivating farmer support in this instance. The unsurprising effectiveness of a direct financial incentive targeted directly at the farmer supports a COS type program, which typically utilize individual pecuniary incentives such as this. However, the one-off manure fertilizer investment elicited surprisingly large support for the hypothetical PES programs also, suggesting that such a CIS type program would be successful also, at least in terms of farmer participation. The insignificance of the group payment variable meanwhile suggests that such collective incentives – often featured in CIS type programs – would need considerable modification to play a useful role.

Secondly, the non-linear expected response of farmers under increasing conditionality represents support for a COS type program, which generally features a higher level of conditionality than CIS type programs. Based on the results of this study it is wrong to assume that the simplest, easiest conditionality regime will always be most preferred. Finally, the strong preference for a static payment rate relative to a dynamic payment rate also suggests support for a CIS type scheme. This split sample treatment was a direct test of a literal interpretation of the COS paradigm, that payment is 'compensation for opportunity skipped.' Overall, this demonstrates that for the case of the East Usambaras, farmers preferred programs that combine a mixture of elements from different PES paradigms. This highlights the need to test preferences for design elements drawn from a range of approaches. It cannot be assumed that one particular approach will suit a given situation in its entirety.

Within a population there is likely to be substantial heterogeneity of preferences. I found evidence for the existence of a subsample of environmentally minded farmers who would enroll without payment, while another subsample would resist participation at all but very high rates of payment, regardless of other program attributes. To my knowledge there is only one published study that has likewise used latent class analysis for the assessment of preferences for PES programs. Ruto and Garrod (2009) found two distinct classes in their sample of respondents questioned on preferences for agri-environmental payment programs at ten sites across Europe. Puzzlingly, they omit the status quo coefficient so their results are not directly comparable to mine; however the large difference in the coefficient on the payment bid suggests that they likewise found one sample segment (a 'low resistance' group) far more prepared to participate than the other (a 'high resistance' group).

With regard to specific socio-demographic characteristics, this study found only sex and village of birth to have a significant impact on class membership. Males are more likely to fall into class 2, showing strong aversion to PES. Those born in their current village of residence (lifelong inhabitants) were more likely to fall into class 1, showing strong acceptance of PES. It is likely that a larger dataset would present greater insights into the impact of particular variables.

In contrast, Ruto and Garrod (2009) found farmers with larger holdings more likely to participate, presumably because the per hectare payment method proportionately benefits larger farmers over smaller farmers. Other factors predicting membership in their low resistance group included higher levels of education, greater age and higher levels of environmental consciousness, findings which are common in the small literature available (see for instance Wynn, 2001). These results concerning specific socio-demographic variables were on the whole not replicated by my study. Education was not included in the model due to limited variation across the sample, and attitudinal type information such as environmental consciousness was considered problematic due to potential endogeneity.

Finally, the lack of difference between the direct valuation and inferred valuation approaches was a surprising result. Lusk and Norwood (2009; 2009a) demonstrated that inferred valuation can be an effective technique to mitigate 'social desirability bias', a type of hypothetical bias sometimes problematic in stated preference studies. However, the lack of discrepancy between models estimated using the direct valuation scenario responses and the inferred valuation scenario responses indicates that either social desirability bias is minimal in this case, or that these farmers failed to respond to the mitigating technique. To the best of my knowledge, this is the first application of the

Lusk and Norwood approach (2009; 2009a) in a developing country, natural resource management context.

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Paper 2: Forest conservation policy and motivational crowding: Experimental evidence from Tanzania

1. Introduction

Payment for ecosystem services (PES) is a type of market-based environmental policy approach where behavior is incentivized by a reward rather than forced by regulation. Such a method of achieving environmental conservation goals is becoming increasingly popular amongst regulatory agencies and other environmentally concerned organizations (Kemke, *et al.* 2010; Jack, 2009; Engel, et al, 2008; Ferraro and Kiss, 2002). While there are considerable theoretical advantages of PES over more traditional command and control or persuasion policy approaches (Pagiola, *et al.* 2005), the feasibility of this policy approach is highly dependent on the particular socio-economic, political, cultural and biophysical context in question (Kemkes, *et al.* 2010; Jack, *et al.* 2008).

One of those contexts that must be considered is the affected community's prevailing environmental attitudes and behavioral incentives. The imposition of new incentives may in some cases interact with the pre-existing incentive structure that governs behavior. This occurs due to the existence of two distinct sources of motivation: extrinsic and intrinsic (Frey and Jengen, 2001). Actions may be motivated 'extrinsically', by rewards, where the goal of the behavior is to earn a reward or avoid a penalty. Alternatively, actions may be motivated 'intrinsically', where the agent undertakes an action simply for the enjoyment, interest or sense of duty that it entails. He/she receives no apparent rewards and avoids no penalties (Pelletier, *et al.* 2006; Deci, 1971). Market-based policies attempt to manipulate behavior by providing material incentives, a form of extrinsic motivation. Likewise, regulatory approaches change extrinsic motivation by threatening fines or sanctions for non-compliance (Fehr and Rockenbach, 2003). In doing so, the new

extrinsic motivators (such as payments) could either undermine or reinforce the existing intrinsic motivators. This phenomenon is known as 'motivational crowding' (Bowles, 2008).

If the relationship between these different types of motivations is not simply additive then a PES program could provide an outcome not predicted by standard economic theory – the relative price effect (Frey and Jengen, 2001; Bowles, 2008). If the interaction is detrimental, it is likely that the policy will under-achieve the expected environmental benefit, or lead to a net negative environmental effect ('crowding out'). Alternatively, it is possible that different forms of incentives could reinforce positively ('crowding in'). Of particular concern for policy designers is the tendency for motivational crowding effects to linger longer than the policy itself (Reeson and Tisdell, 2008; Gneezy and Rustichini, 2000). Hence a policy that makes use of a particular reward or regulation could alter preferences and hence 'crowd' in or out intrinsic motivation long after the original stimulus has been removed. Henceforth this effect is referred to as *persistent* motivational crowding.

There is a considerable literature on this phenomenon, reviewed briefly in section 2, which suggests possible causal mechanisms, as well as the contexts in which motivational crowding occurs. This literature is extensive, however conclusions remain mixed and its application to policy limited. This is partly due to the high variability in the nature and magnitude of motivational crowding: changes in policy design and context can deliver substantially different motivational crowding outcomes.

This paper thus makes three contributions to the study of motivational crowding and its application to environmental policy. Firstly I test for potentially problematic motivational crowding in the context of environmental conservation in a developing country, an

application which has received little previous research. The context is the East Usambara Mountains, an area of mountain rainforest in North East Tanzania and a site of considerable environmental importance due to an unusually high level of biodiversity (Reyes, *et al.* 2006). Past efforts to conserve the remaining forest area have focused on land use restrictions and the formation of government administered nature reserves. This approach has had negative social and economic consequences for local communities (Rantala and Vihemäki, 2011; Conte, 2004, p. 157). Conservation of the remaining forests must be balanced with consideration for the local population that derive livelihoods from agriculture and use of the forests. PES may be a suitable tool for achieving this balance, but before it can be applied, investigation into potentially detrimental motivational crowding is required.

Secondly, this research tests for motivational crowding using an experimental design distinctly different from previous field experiments. I use a modified dictator game which mimics some key characteristics of PES for voluntary forest conservation. I also use this game to simulate the effects of a government regulation which mimics enforced forest conservation, and compare the extent of motivational crowding under both policy regimes. Of the three previous field experiments on motivational crowding in a developing world context, Cardenas, *et al.* (2000) and Vollan (2008) used a common pool resource game, suited, naturally, to common pool resource problems, while Jack (2009) used a transfer investment game, suited to instances of a clearly identified beneficiary. The reasons for my alternative approach are discussed in section 3.

Thirdly, this study tests for differences in motivational crowding *within* a sample of landholders. I demonstrate empirically that both crowding in and crowding out can coexist in a relatively homogenous population of farmers, and that the population subsets exhibiting these behaviors can be identified from socio-demographic and land

management characteristics. Recognizing and quantifying the likely diversity of responses to a policy is important for the assessment of its predicted effectiveness. Furthermore, information may allow for the targeting of environmental policy to subsets of a population. A quantification of such heterogeneity has been published in only a few cases (for instance, Clayton, 2010), and not in a developing world context. In general, there is a recognized need for field studies into motivational crowding for the purposes of guiding policy design (Cardenas and Carpenter, 2008; Frey and Jengen, 2001).

2. Review of Literature

There are an increasing number of studies focused on the non-economic impacts of PES programs, part of a larger body of literature exploring the interaction between extrinsic incentives and intrinsic incentives. Motivational crowding out occurs when an increase in extrinsic incentives, such as those delivered by a PES program or regulation, reduce the supply of the good of interest (such as an environmental good) because it has displaced a formerly more effective intrinsic motivator (Frey and Jegen, 2001; Frey and Oberholzer-Gee, 1997). This effect diminishes the power of the dominant principle of economics and economic-based policy, the relative price effect (see for instance, Becker, 1976; Lazear, 2000), and hence has the potential to diminish the effectiveness of the poorly designed PES program. Motivational 'crowding in' is also possible in some circumstances, when multiple sources of motivation reinforce each other to deliver an amplified supply of the behavior in question. The term 'crowding' is used here to refer to both motivational 'crowding out' and 'crowding in'.

Discussion of motivational crowding is found firstly in the social cognitive psychology literature and later in the behavioral economics literature (predominantly laboratory studies). Most recently, there have been a small number of studies in the applied

environmental economics literature attempting to determine the significance of motivational crowding for policy. Empirical, field based studies are limited. This brief review considers first theoretical explanations for crowding and secondly, empirical lab and field based evidence for its existence.

2.1. Theoretical Motivation

Reasons for the mixed effects of externally delivered rewards on behavior are described in the social cognitive psychology literature. Early explanations proposed that there exists a difference between external and internal motivations, the latter being present in cases where an activity is inherently rewarding (Deci, 1971). When motivations are perceived as being under external control, this can undermine the sense of personal interest, motivation and agency associated with the intrinsic reward (DeCharms, 1972). This idea developed into 'cognitive evaluation theory' stating that intrinsic motivation requires our psychological need for autonomy of choice to be supported (Deci and Ryan, 1985; p. 87). This states that external motivation viewed by the subject as enabling (e.g. praise) can cause crowding in, while external motivation seen as restricting (e.g. regulation, and in some cases, financial incentives) can cause crowding out. Reasons for this have been attributed to two psychological processes (as described in Frey and Jegen, 2001). *Impaired self determination* occurs when individuals feel they are compelled to act in a particular way by outside intervention (such as a payment or regulation). Individuals may feel over-justified if they maintain also their original intrinsic motivators. Secondly, outside intervention may *impair self esteem*, by removing the positive acknowledgement associated with pro-social behavior.

While the social psychology literature focuses predominantly on the enjoyment of a task as the fundamental intrinsic value, the economics literature has taken a broader approach

by considering social reputation, altruism, reciprocal fairness and adherence to social norms also (Clayton, 2010; Vatn, 2005). The implications of motivational crowding for economic incentive theory and practice are considerable: the phenomenon of incentives that lead to contrary responses challenges the neoclassical characterization of behavior. For instance, standard utility theory cannot explain crowding out unless two modifications are made. Firstly, *social preferences* must enter the utility function to account for the way in which altruism, fairness and social reputation affect an individual's behavior, and secondly, *endogenous preferences* are required to account for the way in which preferences are shaped by the institutional setting (Shogren, *et al.* 2010; Bowles, 1998). The result of these required changes is that the neoclassical concept of *separability* must be relaxed. Separability asserts that different types of motivation (intrinsic, extrinsic) are independent. Motivational crowding, however, results when different forms of motivation interact (Bowles, 2008).

In addition to adopting impaired self determination as a potential causal mechanism from the psychology literature (described above), the economics literature contains other proposed mechanisms for motivational crowding. Bowles (2008) summarized these as framing effects, information content effects and endogenous preferences. Framing hypothesizes that policy or institutional context sends signals as to the most appropriate behavior. Profit maximizing behavior, for instance, may result from the imposition of a market (Clayton, 2010). Similarly, the information content effect refers to the hypotheses that interventions convey information about the nature of a task, or assumptions held by the policy administrators. For instance, regulations could signal that agents are perceived to be untrustworthy, reducing agents' inclination to trust one another. Finally, endogenous preference effects (introduced above) are the persistence of these influences on behavior over time, even if the original stimulus has been removed (Bowles, 2008).

Hence the imposition of a market context could signal that profit maximizing behavior is appropriate, an impression that remains beyond the life of the institution itself. This is particularly important from a policy perspective, given that PES to date has often been applied for limited periods in pilot projects, based on finite funding arrangements (Pagiola, *et al.* 2007; Farley and Costanza, 2010). The commencement and subsequent cessation of payments could leave long-term conservation attitudes and practices worse off than in the absence of the payments policy. It should be noted that this is a theoretical, and laboratory observed possibility which has not been documented substantially in the field for environmental policy.

2.2. Empirical Evidence

Laboratory tests have examined these theories with mixed results. In the psychology literature, for instance, a number of meta-analyses (see for instance, Cameron, *et al.* 2001; Deci, *et al.* 1999) have reviewed a large number of empirical studies and concluded that motivational crowding is highly context specific. Deci, *et al.* (1999) drew some broad conclusions, stating that external rewards are more likely to have crowding out effects when they are performance contingent, expected by the agent, monetary and competitive.

The economics literature on crowding out is less extensive, however there are examples of laboratory, survey and field investigations (for a review see Frey and Jegen, 2001). Gneezy and Rustichini (2000) provided a seminal example of crowding out in a field experiment using day care centres in Israel. To encourage parents to collect their children from day care on time, a monetary fine was applied to parents in instances of late collection. The fine had the effect of increasing tardiness, and furthermore when the fine was removed, tardiness remained. The assumption is that the imposition of a monetary incentive shifted attitudes permanently, an example of endogenous preferences.

There are few examples of research into motivational crowding with specific reference to environmental management. A developing-world example, in rural Columbia, is provided by Cardenas, *et al.* (2000) who found that a weakly enforced regulation displaced traditional social cooperation in the case of exploiting fuel wood supplies from a common pool resource. Another example is provided by Jack (2009) who used field experiments to test upstream landholders' investment decisions in a PES framework where payment comes from downstream landholders, in Nyanza Province, Kenya. She found that when an enforcement mechanism was in place (compelling downstream landholders to compensate upstream landholders for their investment), the investment made by the upstream landholders was lower than when altruism and pro-social motives were relied on exclusively.

These examples used a sanction (such as a fine) as opposed to a reward to motivate behavior. A PES program uses rewards, and so testing for motivational crowding under such situations is likely required for a better understanding of the consequences of PES. To my knowledge, only one economics field experiment has used rewards as opposed to sanctions in a PES simulation. Vollan (2008) compared the impact of rewards, sanctions and open communication on a common pool resource game. He found a crowding-out effect associated with sanctions in high trust environments, but no crowding-out effects from rewards, although the latter mechanism was less effective in low trust environments.

Hence the interaction between different sources of motivation represents a key design issue for any behavior-inducing policy instrument. There is little research on this interaction in the PES context. The paucity of research on this question, particularly field research with actual land managers, is acknowledged by Cardenas and Carpenter (2008) in their review of environmental management and the crowding out of incentives.

3. The Dictator Game

The experimental design used was a variant of the Dictator Game (DG). The dictator game is the simplest of commonly used economics experiments as it involves only a single decision (per round). In the standard DG one participant, the dictator, is presented with an endowment, and asked to divide the endowment between himself/herself and a recipient. The recipient is generally unknown to the dictator, and the dictator faces no consequences for his/her decision. The dictator game is not a game in the game theoretic sense as it does not involve any responsive or dynamic strategy (Bolton, *et al.* 1998).

A standard economic assessment (the canonical model) of the DG would suggest that dictators should take all the money for themselves. However, repeated observations do not bear this out (Bolton, *et al.* 1998; Oberholzer-Gee and Eichenberger, 2008; Henrich *et al.* 2001). Transfers are generally plentiful and it is common for over 50 percent of dictators to give some money to the recipient (Bardsley, 2008; Guala and Mittone, 2009). Average quantities given away are about 20 percent of the total, although there is large variation between populations. For instance, Henrich *et al.* (2001) found modal offers between 10 and 50 percent when played with three diverse societies in three countries (Tanzania, Kenya and Bolivia). In these and other studies, behavior does not conform to strict self interest.

This variability has led to questions as to the suitability of using the dictator game to investigate fundamental theories of behavior such as rational choice (Guala and Mittone, 2009). Variations in game design lead to quite different outcomes. For example, giving dictators the opportunity to take money from the recipients leads to a reduction in the amount given (Bardsley, 2008). However, this does not detract from the usefulness of the DG for studying the effects of stylized policy contexts on behavior (Guala and Mittone,

2009), as assessing the behavioral response to a change in the game setup is indeed the objective.

The DG also better represents the situation faced by providers of a diffuse environmental service, such as biodiversity conservation. In such situations, not only does an individual farmer fail to internalize the value of the environmental benefit of their decision, but the farming community as a whole fails to capture the full benefit of their collective decisions. This is because the benefit of biodiversity conservation is highly diffuse, arguably benefiting a global community of environmentally concerned individuals and organizations. Even the provision of clean water primarily benefits residents in distant towns who rely on the catchment for municipal water supplies. Thus pro conservation decisions entail a sacrifice; they are not strategic decisions to increase overall profits such as in a common pool resource problem. This is a different policy problem to that confronted by previous research, which has focused on stylized common pool resource problems (Vollan, 2008; Cardenas, *et al.* 2000) or on stylised cases of environmental problems with a clearly identified beneficiary (Jack, 2009). Hence I considered the common pool resource game and the investment game unsuitable for representing the problem present in the East Usambaras. The dictator game, however, measures the extent to which farmers will sacrifice their own profit for the sake of others. Determining how this changes under different policy simulations can provide insights on the possible behavioural responses to different kinds of real policy.

4. Study Site Description

4.1. The East Usambara Mountains

The study site is described in detail in section 3 of paper 1 of this thesis, so only a brief summary is provided here. The Usambara Mountains are located in North Eastern

Tanzania (4°48′–5°13′ S and 38°32′–38°48′ E), and form part of the Eastern Arc Mountain Range. These mountains support areas of rainforest cover with high levels of species richness (Hall, *et al.* 2009; Lovett, *et al.* 2001). Of these areas, the East Usambaras are considered to be one of the most important regions biologically with the highest endemic species density (per 100km^2) of any ecosystem known in the world (Reyes, *et al.* 2006).

4.2. The Agro-ecological Issue

The forests of the East Usambaras have suffered from past clearing, logging and fragmentation, and remain threatened by environmentally detrimental agricultural practices (Hall, *et al.* 2009; Bjørndalen, 1992). 60 percent of the original forest cover has been lost, mostly in the past 35 years with rapid deforestation ongoing (Reyes, *et al.* 2006).

Key to this deforestation process is the cultivation of cardamom as part of a series of different crop rotations, planted and removed in response to changing soil nutrient status (Figure 1-3). Original forest is thinned in the first instance for within-forest cultivation of cardamom *(Elettaria cardamomum)*, an important cash crop for the area's farmers. Over time, the remaining tree cover is removed and the field is used for cropping. A common conversion is to sugarcane, although conversion to perennial spices (cloves, cinnamon) or annual food crops (cassava, bananas, yams) also occurs in many instances. Like cardamom, these second stage crops also suffer from nutrient deficiencies over time, and eventually many plots are abandoned to woody weeds (*Lantana camara*, *Clidemia hirta*, and *Psidium guajava)* which limit rainforest regeneration.

Of the remaining forest in the East Usambaras, approximately 26 percent has already been planted with cardamom, meaning that the process of land conversion is underway.

This process is exacerbated by a gradually increasing population, which in conjunction with the pattern of land distribution and management found here, has worsened the problem of land scarcity (Yanda, and Shishira, 2009).

Policy intervention to protect the remaining forest could occur at several stages. Farmers could be encouraged to maintain existing stands of original forest. However, only small areas of original forest remain. Alternatively, farmers could be encouraged to maintain existing agroforest operations instead of converting to open land crops (such as sugarcane). Managed, complex agroforestry systems may be developed as an alternative to the conventional cardamom agroforestry operations, which would have some biodiversity and carbon benefits. Although inferior to original forest, such an arrangement would be preferable to complete forest cover loss. Leonard, *et al.* (2010) found that agroforests in the East Usambaras support a range of important vegetation species and threatened bird species, although it should be noted that the more intensively cultivated agroforests are less biologically diverse than less intensively cultivated agroforests (Hall, *et al.* 2010).

The principles of motivational crowding investigated in this paper apply to both points of intervention, conservation of original forest or conservation of complex agroforest systems. As explained in section 5.1, farmers played a highly stylized experiment which featured a simple dichotomous choice for each land parcel, forest or sugarcane. It is thus not important to describe the exact characteristics of a potential PES or regulation intervention, except to recognize that the central issue of motivational crowding is likely to be relevant to policy designers regardless of the exact type of forest targeted.

5. Data and Methods

5.1. Experimental Approach

250 participants were randomly selected from village registries in the villages of Kwezitu and Shambangeda, which together are comprised of 6 sub villages (Antekae, Kisangani and Kagare in Kwezitu Village; Shambangeda A, Shambangeda B and Gonja in Shambangeda Village). Participation was conditional on being a farmer (land owner or manager) with primary or joint decision-making responsibility for a plot of land located somewhere in the district. Acceptance of invitations was high (> 90 percent of available, invited farmers).

Ten farmers at a time took part in each 3 hour session. Farmers were divided randomly into two groups, one a group of dictators and the other a group of passive recipients. Each dictator farmer was then presented with a stylized farm, consisting of 6 cards each associated with a cash value of between TZS 20 and 60 (Tanzanian shillings, 1500 TZS equals approximately one U.S. dollar). The total value of each 'farm' (which served as the original endowment) was thus between TZS 190 and 250 (USD 0.13-0.17). Dictator farmers were then asked which cards they wished to donate to the recipient farmer group (if any) and which they wished to keep for themselves. The transfer of cash was thus anonymous and due to the use of groups was not associated with any one individual. (Game administrators were privy to individual decisions and payouts however). Confidentiality of decisions was maintained by facing farmers away from each other. Payment amounts were chosen so as to provide a reasonable payout at the end of the session, generously more than the equivalent expected earnings from a half-day's work on the farm.

Farmers played this standard setup for 8-10 repetitions, before a 'policy' was introduced without warning. The slight variation in the number of rounds (8-10) was to prevent participants from anticipating the conclusion of the period. The policy took the form of either one of two reward schemes (imitating the basic principles of PES) or one of two sanction schemes (imitating the basic principles of environmental fines). The policy period continued for a further 8-10 rounds before the game reverted without warning to the initial setup for a final 8-10 rounds. Research assistants were not advised as to when and what the policy changes would be before they were announced to the group as a whole. A number of farms with slightly different (randomly distributed) endowments were used, so each dictator farmer played a different farm in each round. This ensured farmers had to consider their decision and associated tradeoffs each time, rather than simply repeating a past play. Figure 2-1 presents a flowchart representing the essential elements of the game design.

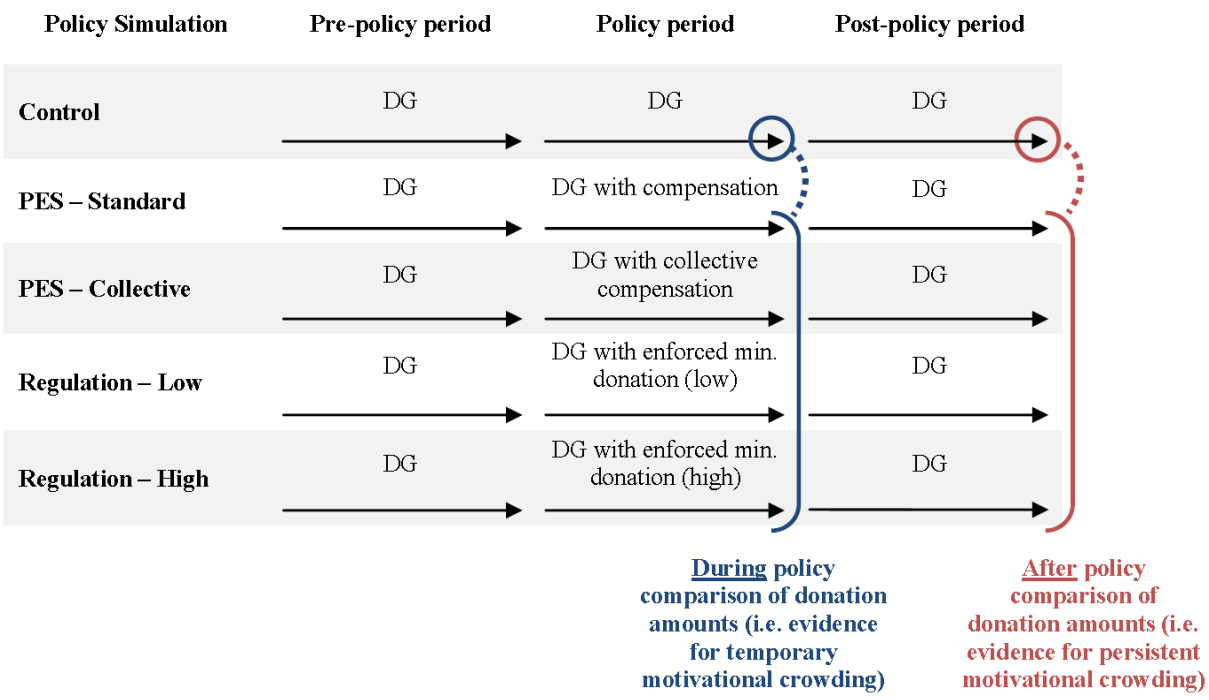


Figure 2-1: Flowchart of game setup. There is one control group and four treatment groups, the latter of whom are subjected to a policy simulation in the policy period. Amounts donated in each treatment are compared to the control to assess for motivational crowding resulting due to the policy simulation, either while policy simulation is in place, or after.

The standard PES program provided dictator farmers with compensation for each card they donated to the recipient group at a flat rate equal to the average value of the cards (TZS 40). In the collective PES program, the same reward was placed in a central pool and divided equally between decision making farmers at the end of each period. In both cases, the endowment donated to the recipient group was equal to the value of the cards as in the standard procedure. The regulation treatments required a minimum donation to be made in order to avoid risking a penalty. In the 'high-regulation case, a donation of TZS 140 was required while in the 'low-regulation' case a donation of TZS 50 was required. This amounted to 55-75 percent and 20-26 percent of endowments respectively (variation due to different endowment amounts).

The penalty consisted of a fine equal to twice the discrepancy between the amount donated and the required donation (TZS 140 or 50), if any. Two dictator farmers (out of the total of five) in each round were randomly selected (by hat draw) for auditing, and if found to be in violation of the minimum requirement, were fined. Although all participants were aware of who was being audited, the result of that audit (the imposition of a fine or otherwise) was kept confidential. Although the penalty was double the payment discrepancy, the chance of audit was less than half (40 percent). Hence the expected value of compliance was set slightly lower than the expected value of non-compliance.

This probability of audit was deliberately higher than other published studies. (For instance, Vollan (2008) used 20 percent, Cardenas *et al.* (2000) used 6.25 percent and Velez *et al.* (2010) used 10 percent in their experimental studies of motivational crowding from environmental polices). The higher proportion was used firstly to improve the robustness of conclusions (a stronger regulation sends a clearer signal of control and is thus more likely to violate *self determination*, see section 2.1). Secondly, there is a recent history of well enforced environmental legislation in the East Usambaras, particularly since the creation of the Amani Nature Reserve in 1997. Researchers typically use a partial enforcement rate to simulate the low quality of enforcement typical of environmental regulation in developing country contexts (Cardenas, *et al.* 2000). However, the success of enforcement and the widespread understanding of regulations (as determined through discussions with landholders and local forest officers) in this area meant that a higher likelihood of auditing was considered more suitable.

Donation amounts were conveyed to the passive group every 2-3 rounds, although the reaction of recipients was not visible to the dictators. Payouts were made confidentially at the end of the three hour session. The average payout was TZS 5200 (approx USD 3.70).

(For comparison, the local daily wage rate for farm labor was estimated to be TZS 2000 in 2009 (Bullock, *et al.* 2011)).

5.2. Sample Profile

A short questionnaire (approx 5 minutes) was administered at the conclusion of the experiment but prior to payment, which collected simple demographic (Table 2-1), land use (Figure 2-2) and attitudinal information (Figure 2-3). Data was only collected from dictator farmers (the game's decision makers).

Table 2-1: Summary demographic characteristics of sample (active participants).

	Kwezitu (N=70)		Shambangeda (N=55)	
	Mean	**St. Dev**	**Mean**	**St. Dev**
Sex (proportion male)	0.69	0.47	0.62	0.49
Age	44	12.5	46	15.6
Born in village (proportion)	0.29	0.46	0.36	0.49
No. adults in household	3.11	1.70	3.25	1.47
No. children in household	2.90	1.90	2.84	1.56
Self reported annual income (USD)	888	915	663	752

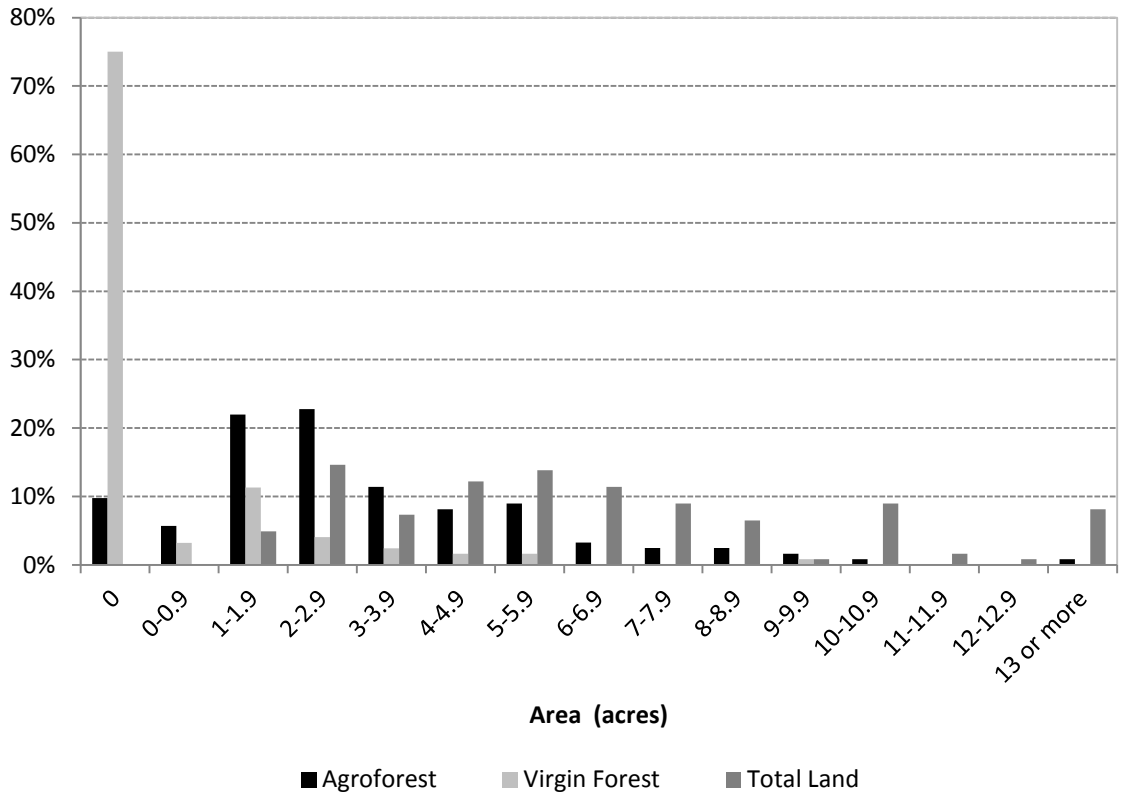


Figure 2-2: Histogram of land characteristics amongst farmer sample: area of total land owned or managed, area of land with agroforest and area of land with original forest.

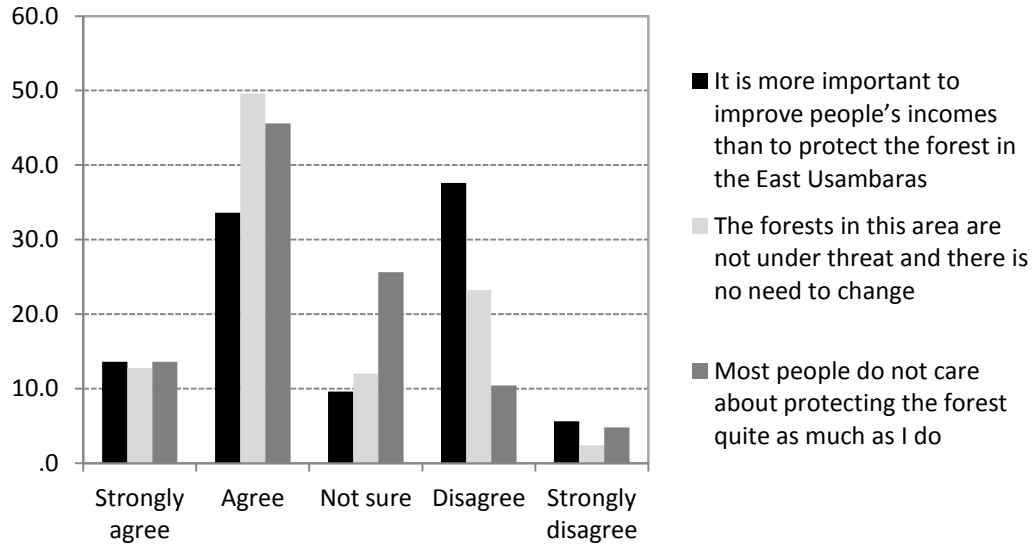


Figure 2-3: Distribution of responses to attitudinal questions in follow up questionnaire (Likert scale).

Approximately two thirds of the sample was male. Only one third of the sample were born in the village (Shambangeda or Kweizitu) they were living in, possibly a result of past government 'villagization' programs (*Vijiji*, a policy of rural resettlement as part of Tanzanian socialism) (Lal, 2010) or due to resource and population driven local migration (Yanda and Shishira, 2009). Self reported income averaged USD 790 per household per year, lower than the Tanzania national average (CIA 2010). I am cautious in the use of self reported income given the high variation in responses, and rely instead on a possessions index for analysis. Morgan-Brown, *et al.* (2010) found that land size explained 74 percent of variation in annual income in their study of environmental attitudes in the same region. Average land size owned or managed was 6.3 acres, with an average of 2.8 acres of cardamom agroforestry and 0.53 acres of original forest. These vary considerably over the sample (Figure 2-2).

Motivational crowding is relevant only when non-monetary incentives for pro environmental behaviors exist prior to the imposition of incentive based policy. However, results on environmental attitudes from the follow up questionnaire are ambiguous (Figure 2-3). There is an approximately even split between those who do and do not believe that "It is more important to improve people's incomes than to protect the forest in the East Usambaras." A majority (62 percent) of participants agreed that "The forests in this area are not under threat and there is no need to change." A majority (59 percent) considered themselves superior environmental managers however, agreeing that "Most people do not care about protecting the forest quite as much as I do". This suggests a mixed picture at best.

However more tangible evidence comes in the form of environmental initiatives and action that demonstrate pro environmental values, such as those documented by Morgan-Brown, *et al.* (2010) in their assessment of a local integrated conservation and

development project. There is a history of conservation work in the area from a number of different organizations, both government and non government. These have stressed the importance of forests initially for water catchment and later for biodiversity values (Vihemäki, 2005). The East Usambaras are an area where the Government has implemented joint forest management, where voluntary village-based committees help set and enforce local environmental regulations. Furthermore, the area has received considerable attention from non-profit organizations due to recognition of the high biodiversity values present (Vihemäki and Leonard, 2010). Not surprisingly given this history of attention from government and other organizations, environmental awareness amongst farmers is high. At least some of this awareness has translated into improved environmental management, improvements that in many cases have been achieved without direct incentives or coercion (Vihemäki, 2009). Overall there is evidence for some pro-environmental attitudes and consequent intrinsically motivated land management actions by farmers in the region.

5.3. Empirical Analysis

The experimental procedure gives panel data that can be analyzed using a difference in differences model (see Cameron and Trivedi, 2005, p. 55). This compares an outcome before and after a policy change, taking into account non-policy related changes over time. I specify the model as:

$$y_{ip}^{j} = \alpha_0 + \alpha_1 P_1 + \alpha_2 P_2 + \alpha_2 T_j + \beta_1 P_1 T_j + \beta_2 P_2 T_j + \varepsilon_{ip}^{j} \qquad \text{Equation 2-1}$$

Where y_{ip}^{j} is the generosity (amount of endowment donated) by individual i in policy period P (where P is pre-policy, during-policy or post-policy) under treatment regime j (PES, PES – Collective, Regulation-High, Regulation-Low). P_1 and P_2 are dummy variables that distinguish between the three policy periods (1 = during-policy, 2 = post-

policy). T_j is similarly a dummy variable where $T_j = 0$ for the control subjects and $T_j = 1$ for subjects in treatment j. This implies, for the treatment group during the policy that:

$$y_{i1}^{j} = \alpha_0 + \alpha_1 P_1 + \alpha_2 T_j + \beta_1 P_1 T_j + \varepsilon_{i1}^{j} \quad \text{Equation 2-2}$$

And for the same group pre-policy:

$$y_{i0}^{j} = \alpha_0 + \alpha_2 T_j + \varepsilon_{i0}^{j} \quad \text{Equation 2-3}$$

Hence the additional effect on the donated amount due to the policy is given by β_1. Any differences between the treatment groups except the policy implemented is controlled for by α_2. Given that the treatment group was selected randomly I expect this to be insignificant. The policy dummy variables alone (P_1 and P_2) control for any change in generosity over time unrelated to the imposition of the policy to the treatment group. This manifests in a slight decrease over time.

Heterogeneity within the sample was investigated using latent class analysis. Due to the panel nature of the dataset, exogenous explanatory variables are not required to control for variations in donation amounts. However, the resulting model from the above three equations assumes that the vector explaining policy impact, β_k, is homogenous across individuals. One method for introducing heterogeneous preferences into the model would be to include socio-demographic variables explicitly (known sources of taste heterogeneity). However, it is also possible to consider the inclusion of unobservable sources of heterogeneous preferences using latent class analysis. This approach is more suitable for my purposes given the lack of prior knowledge on the impact of socio-demographic variables on dictator game giving.

In latent class analysis, an unknown number of discrete classes are assumed to exist in the population each with its own set of estimable parameters (Grafton, *et al.* 2004, p. 270; Boxall and Adamowicz, 2002). In the above three equations, the coefficient vector (β) is the same for all individuals. However, in the latent class approach, each individual *i* belongs to a particular segment, *s* of the population with a segment-specific coefficient vector.

Membership to a particular segment is based on a latent membership likelihood function based on attitudes, perceptions and socio-demographic characteristics. The latent membership function (M_{is}^{*}) has both an observed ($A_s X_i$) and unobserved component (ϵ_{is}):

$$M_{is}^{*} = A_s X_i + \epsilon_{is} \qquad \text{Equation 2-4}$$

Where A_s is a coefficient vector specific to segment *s* that is associated with the observable socio-demographic and psychometric determinants (X_i) of individual *i's* membership. If errors are assumed to be are identically, independently distributed as type 1 extreme values (Gumbel distributed), the probability of individual *i* falling in segment *s* is given by a multinomial logit:

$$P_i(segment\ s|X_i) = \frac{e^{A_s X_i}}{\sum_{s \in S} e^{A_s X_i}} \qquad \text{Equation 2-5}$$

Note that this function is dependent on the characteristics of the individual *i*, not on the period, treatment or other game parameter. It is possible (indeed likely) that each segment provides a different vector of coefficients (β_s) explaining donation amounts.

Selection of the number of classes is not guided by formal criteria (Boxall and Adamowicz, 2002; Scarpa and Thiene, 2005) but instead by information criteria[5] (AIC and BIC) and log likelihood statistics. Considering the plausibility of results given the size of membership classes and the size of standard errors is also important.

Variables included in both standard and latent class models are presented in Table 2-2. Note that education levels were not included in the final model as the vast majority of participants (89 percent) had identical formal education levels (completion of primary schooling only). In all analyses, the first observation in each set (i.e. the first of each 8-10 round sets) was dropped to avoid any spurious choices made while participants became accustomed to the game setup.

[5] Information criteria are log likelihood scores with an adjustment for degrees of freedom. The AIC (Akaike information criterion takes the form $AIC = -2\ln(L) + 2q$, where L is the log likelihood and q is the number of parameters. A variant is the BIC (Bayesian information criterion) which takes the form $BIC = -2\ln(L) + \ln(N)q$ where N is sample size. Smaller information criteria are preferred (Cameron and Trivedi, 2005).

Table 2-2: Variables included in difference in differences and latent class models, hypothesized as significant determinants of amount donated in dictator game.

Variable	Description	Response Range
Policy	Dummy variable. Signifies during-policy period of the experimental game (8-10 rounds). Policy is applied to the treatment group.	1 = policy period 0 = not policy period
Post Policy	Dummy variable. Signifies post-policy period of the experimental game (8-10 rounds). Policy is not being applied to treatment group.	1 = post-policy period 0 = not post-policy period
Treatment	Dummy variable. Participant is a member of the treatment group.	1 = member of treatment group (faces policy) 0 = member of control group (does not face policy)
Land	Continuous variable. Land area owned or managed by participant.	Acres
Sex	Dummy variable. Male/Female	1 = male 0 = female
Age	Continuous variable. Participant's age.	Years
Local to Village	Dummy variable. Participant was born in the village currently lived in.	1 = born in village 0 = not born in village
No. Children	Continuous variable. Number of children in participant's household.	Number of children
Possessions Index	Categorical variable. Number of possessions owned by participant's household selected from a set list (radio, motorcycle, mobile phone, cow, bicycle, television).	Index, 0-6 based on number of list items owned

6. Results

6.1. Immediate Impact of Policy Scenarios on Game Contributions

Difference of difference models for each of the four treatments (standard PES, collective PES, high regulation and low regulation, as described in section 5.1) show the impact of the policy treatment on donation amounts both during and after the policy period (Table 2-3). Three of the four policy types had a significant effect on the amount donated in the

policy period of the experiment. Standard PES and both regulation regimes were successful at eliciting higher donations, however, to varying degrees. The difference in donated amounts *during the policy period* between the treatment group and the control group (referred to hereafter as the 'premium'), ranged from 6.3 percent under the Standard PES treatment to 22.5 percent under the high regulation treatment.

The collective PES treatment, however, exhibited no statistically significant increase in donations during the policy period. This was likely due to a free rider effect, given that in this policy treatment participants could keep their own endowment yet still receive a share of payment for the group's contributions. It seems most plausible that such free riding, and not motivational crowding, is responsible for this effect. I base this conclusion on a comparison with the standard PES treatment, which did stimulate statistically significant additional donations. The two PES policy treatments were identical in all respects apart from the distribution of rewards (collective versus individual).

Table 2-3: OLS estimates of difference in differences models for four simulated policy treatments.

	Standard PES			**Collective PES**			**Regulation - High**			**Regulation - Low**		
	Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error	
Constant	0.369	0.016	***	0.369	0.016	***	0.369	0.016	***	0.369	0.017	***
Policy	-0.020	0.022		-0.020	0.023		-0.020	0.022		-0.020	0.024	
Post Policy	-0.044	0.022	**	-0.044	0.023	*	-0.044	0.022	*	-0.044	0.024	*
Treatment*Policy	0.063	0.031	**	0.028	0.034		0.225	0.035	***	0.094	0.037	**
Treatment*Post Policy	-0.017	0.031		0.026	0.034		0.103	0.035	***	0.065	0.037	*
Treatment	0.014	0.022		-0.020	0.024		-0.043	0.025	*	-0.001	0.026	
Adjusted R-squared	0.020			0.000			0.066			0.015		
Log likelihood	56.07			-9.029			21.72			-45.291		
Number of observs.	1392			1272			1128			1152		
Degrees of freedom	1386			1266			1122			1146		

The magnitude of the responses to the policy treatments also warrants some discussion. The Standard PES policy generated a relatively small increase in the amount donated, 6.3

percent, even though the total amount of compensation amounted to 42 percent of the endowment on average (from 28 percent to 61 percent depending on the particular endowment faced in a given round). Hence a participant could donate up to 42 percent of his/her endowment on average without facing any personal financial loss, a sum very close to that actually donated (average of 41 percent) under the Standard PES policy. From this it would appear that the altruism demonstrated in the pre-policy period and by the control group (in their donations of approximately 35 percent of endowment) was replaced by financially incentivized 'donations' with only marginal altruistic donations remaining (donations beyond those which compensation was received for). This suggests that extrinsic incentives (money) and intrinsic incentives (altruism, sense of responsibility to recipient farmers) in this context are severely non-additive, as defined by Bowles (2008).

Both regulation treatments had a positive effect on donations during the policy period. The donation amount required in order to comply with the 'regulation' was TZS 140 in the high regulation case and TZS 50 in the low regulation case, representing 48-56 percent and 17-20 percent of the endowment respectively. Hence in the high regulation case, the requirement was designed to be 'binding' in the sense that it would be higher than what participants on average contributed voluntarily (participants in the control group, for instance, gave an average of 35 percent of their endowment). The low regulation treatment requirement however, was designed to be less than the amount contributed voluntarily on average. A further design feature incorporated into both regulation treatments was that the expected value of compliance was slightly less than the expected value of non-compliance (see section 5.1).

From this, two noteworthy results arise. Based on the expected value alone I would expect neither regulation policy to have an impact from a purely self-gain perspective. As

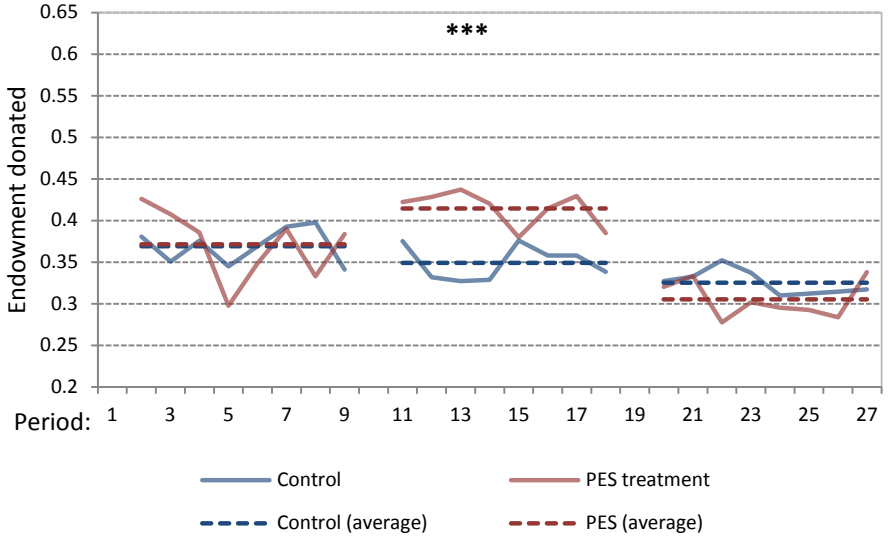
the fine imposed is 200 percent of the donation discrepancy (the difference between the donation and the amount required) yet the chance of auditing is only 40 percent, the net value of non compliance is 120 percent of the expected value of compliance. This positive response can only be explained by additional non-pecuniary influences, such as a desire to conform to social norms or to appear cooperative with the experiment's administrators. However, participants did not only comply with these regulations - in the case of low regulation they went well beyond its requirements. Although the low regulation demanded only 17-20 percent of the participant's endowment, average contributions were 44 percent of the endowment, significantly higher ($p < 0.01$) than the control group (which had average contributions of 35 percent). Hence there is some evidence of *motivational crowding in* as a result of the regulation policy simulations. Donation amounts were higher than they would have been under either strict compliance with the regulation, or under altruism alone (as indicated by comparison with the control).

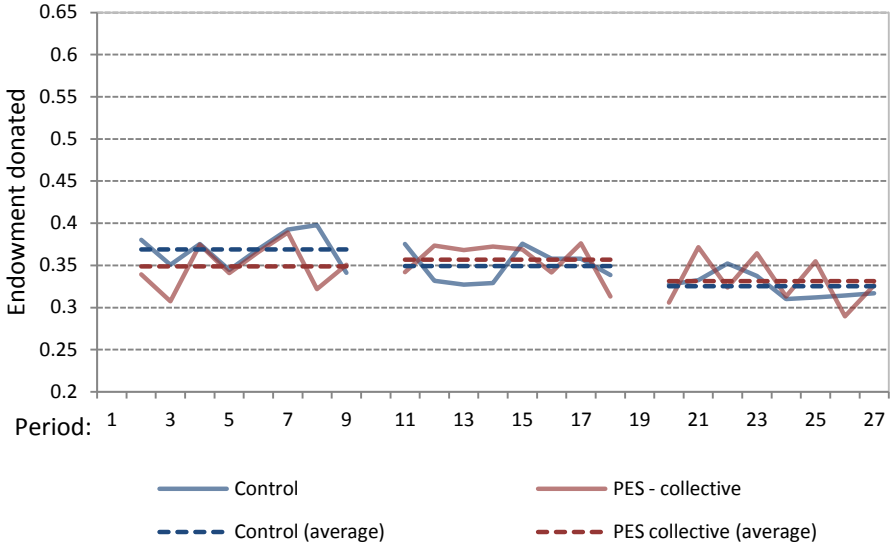
6.2. Durable Impact of Policy Scenario on Game Contributions

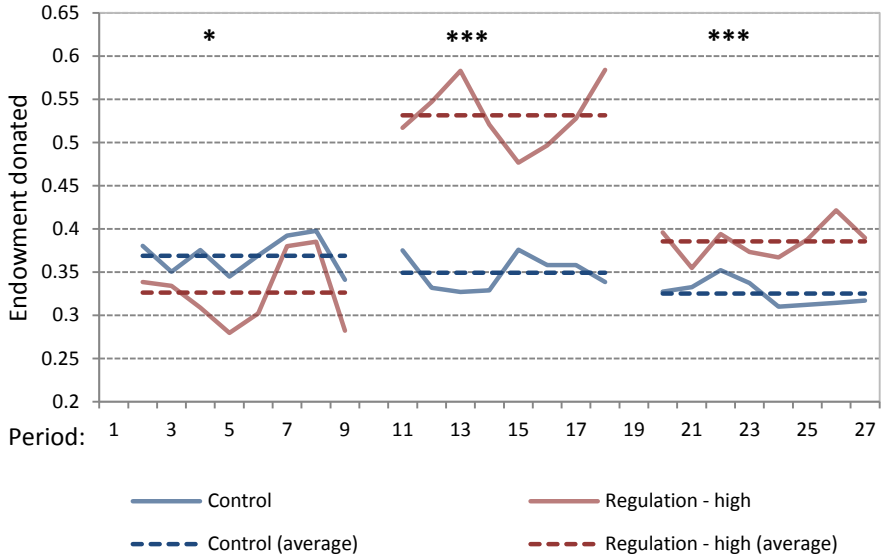
The variable [treatment*post policy] remained insignificant under both PES policy scenarios and hence there is no evidence for persistent motivational crowding out in this game context. Following the policy period for PES treatment groups, amounts donated returned to a level comparable to that under the control treatment. In the case of the regulation treatments, amounts donated fell from their peak achieved during the policy period, however remained at levels significantly higher ($p < 0.05$) than the control. The high regulation policy delivered an ongoing 10.3 percent premium while the low regulation policy delivered an ongoing 6.5 percent premium. The period in question lasted for approximately the same length as the policy period (8-10 rounds), and while it is not possible to claim that preferences have changed permanently, there is no sign of a decrease in this effect over the span of the post policy period. This suggests there has

been an endogenous preference change that has caused a crowding in of intrinsic motivation.

In the case of high regulation, the treatment variable (non-interacted) is also significant ($p < 0.1$) and negative. This indicates that the high regulation treatment group donated significantly less (4.3 percent) than the control group across all periods, despite the random designation of participants into groups. This accounts for the significant difference in the first period for the high regulation group. This does not detract from the above conclusions, however, as a 4.3 percent shift upwards of donation amounts for this treatment (normalization) would augment the crowding in effect already suggested, rather than counteract it. The results reported in this section are evident in Figure 2-4 which presents graphically the average proportion of endowment donated under each treatment across time.







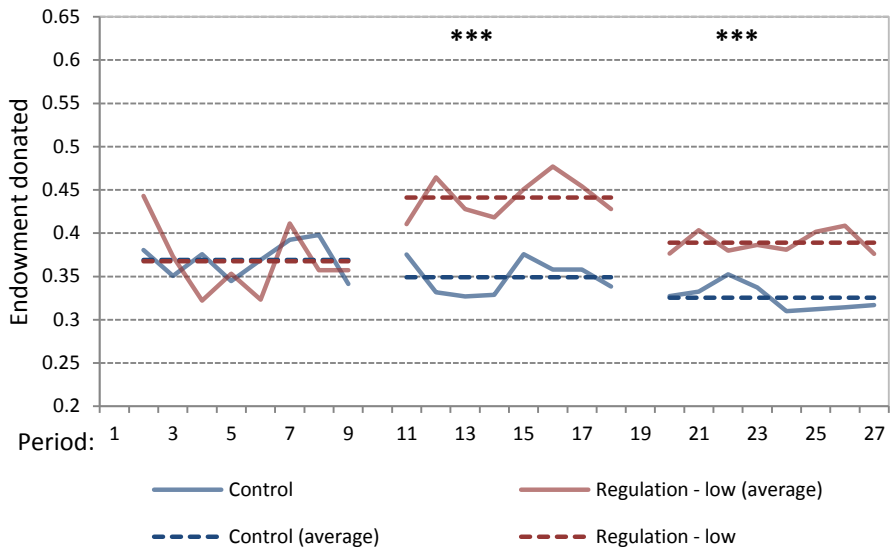


Figure 2-4: Comparison of treatments to control groups across periods. First section: pre policy, second section: during policy, third section: post policy. Y-axis is the proportion of endowment donated to the recipient group in each round. * = significant difference between treatment and control at α=0.1 level, * = significant at α=0.01 level.**

6.3. The Impact of Heterogeneous Preferences

The results presented above consider each participant to have identical unobserved preferences (i.e. an independent and identically distributed error term). To the extent to which the sample is drawn randomly from the population, this is a fair assumption for the purposes of predicting the response likely to be made by the population in total. However, the collection of demographic, land use and attitudinal information allows us to explore responses made by subsections of the sample also. Latent class models (described in section 5.3) were constructed for this purpose using the variables described in Table 2-2, and the most robust estimations chosen based on diagnostic statistics ex post estimation. Diagnostic statistics for these models are presented in (Table 2-4).

Table 2-4: diagnostic statistics for choosing between 2, 3 and 4 class latent class models

	Standard PES			Collective PES			High Enforcement			Low Enforcement		
Number of Classes	**2**	**3**	**4**	**2**	**3**	**4**	**2**	**3**	**4**	**2**	**3**	**4**
Log Liklihood Function	172.48	353.11	345.81	147.08	261.70	300.06	171.68	400.91	305.94	156.22	244.61	-
Akaike Info. Criter	-302.97	-636.22	-611.62	-252.15	-453.39	-502.11	-301.35	-703.82	-513.87	-270.44	-419.21	-
Bayes Info. Criter.	-192.96	-452.88	-354.93	-144.04	-273.20	-249.84	-195.76	-555.83	-267.49	-164.40	-242.49	-
Class Probabilities												
Class 1	0.27	0.62	0.41	0.55	0.18	0.02	0.62	0.66	0.74	0.33	0.24	-
Class 2	0.73	0.00	0.58	0.45	0.77	0.94	0.38	0.01	0.46	0.67	0.76	-
Class 3	-	0.38	0.00	-	0.05	0.94	-	0.33	0.21	-	0.00	-
Class 4	-	-	0.01	-	-	0.00	-	-	0.03	-	-	-

I use a panel linear regression latent class model with two classes (Table 2-5). Three and four class models were inferior based on the log likelihood scores, redundant classes (containing a small or zero proportion of the sample) and in some cases inflated standard errors. Given the relatively small sub-sample sizes for individual treatments this result is expected. Two class division of the sample is likely to be most robust.

Immediately apparent are divisions in the sub-samples, with each class showing markedly different responses to the policy treatments. In the case of the standard PES treatment, 27 percent of the sample (class 1) shows no statistically significant ($p < 0.1$) response to the treatment, either during its application or in the post-policy period. The majority of the sample (class 2, 73 percent), however, shows a negative response (motivational crowding out) in the post-policy period as well as a tendency to donate more in general. These more nuanced results are obscured by analysis in aggregate (Table 2-3) which shows no evidence of significant motivational crowding in the post policy period. This should not be confused with the evidence for crowding out found under the standard PES policy simulation *during* the policy period.

Table 2-5: Panel linear regression latent class model with two classes. * = significant difference between treatment and control at α=0.1 level, * = significant at α=0.01 level.**

	PES			PES - Collective			Enforcement - High			Enforcement - Low		
	Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error		Coef.	Std. Error	
Latent Class model 1												
Constant	0.694	0.035	***	0.492	0.028	***	0.485	0.028	***	0.576	0.025	***
Policy	0.014	0.041		-0.011	0.032		-0.022	0.033		0.026	0.038	
Post Policy	-0.122	0.035	***	-0.075	0.034	**	-0.083	0.034	**	-0.088	0.038	**
Treatment*Policy	-0.002	0.058		-0.006	0.051		0.084	0.053		-0.020	0.073	
Treatment*Post Policy	0.026	0.054		0.015	0.054		0.207	0.056	***	0.108	0.072	
Treatment	-0.022	0.038		0.038	0.034		-0.058	0.039		0.113	0.044	**
Sigma	*0.171*	*0.018*	***	*0.236*	*0.013*	***	*0.241*	*0.010*	***	*0.217*	*0.012*	***
Latent Class model 2												
Constant	0.246	0.016	***	0.206	0.016	***	0.184	0.013	***	0.234	0.014	***
Policy	-0.009	0.019		-0.009	0.021		-0.006	0.017		-0.012	0.018	
Post Policy	-0.009	0.020		0.000	0.022		0.011	0.018		-0.010	0.018	
Treatment*Policy	0.032	0.025		0.029	0.028		0.426	0.029	***	0.117	0.027	***
Treatment*Post Policy	-0.058	0.026	**	0.038	0.029		-0.064	0.027	**	0.026	0.026	
Treatment	0.033	0.018	*	-0.073	0.021	***	0.000	0.019		-0.047	0.018	**
Sigma	*0.139*	*0.007*	***	*0.104*	*0.006*	***	*0.084*	*0.006*	***	*0.124*	*0.005*	***
Probabilities for class membership (class 1)												
Constant	-1.530	0.544	***	-2.433	0.595	***	-2.817	0.675	***	-1.929	0.594	***
Land area (acres)	-0.001	0.001	**	-0.029	0.025		-0.002	0.001		-0.067	0.035	*
Sex (male = 1)	0.381	0.181	**	1.139	0.205	***	0.205	0.237		0.437	0.215	**
Age (years)	0.009	0.006		0.022	0.009	***	0.058	0.012	***	-0.004	0.009	
Born in Village	0.351	0.198	*	0.298	0.230		-0.030	0.254		-0.158	0.280	
No. Children	-0.074	0.053		0.118	0.052	**	-0.014	0.070		0.356	0.082	***
Possessions Index	-0.008	0.067		0.227	0.103	**	0.225	0.097	**	0.239	0.083	***
Prior class probabilities at data means for LCM variables												
Class 1	0.27			0.55			0.62			0.33		
Class 2	0.73			0.45			0.38			0.67		
Diagnostic Statistics												
No. Obs.	1391			1272			1128			1152		
Deg. Freedom	21			21			21			21		
Log likelihood function	172.484			147.076			171.675			156.219		
AIC	-302.967			-252.151			-301.350			-270.437		
BIC	-192.959			-144.036			-195.758			-164.403		

The distinction between classes is more marked in the case of the regulation treatments. The high regulation policy appears to be particularly polarizing, with class 1 (62 percent

of subsample) exhibiting motivational crowding in during the post-policy period and class 2 (38 percent of subsample) exhibiting motivational crowding out. The motivational crowding in effect is particularly strong, with a 20.7 percent increase in amount donated over the control group. The crowding out effect is milder, at -6.4 percent. The net effect for the whole treatment is motivational crowding in (Table 2-3). The low regulation treatment has a less marked bifurcation. Class 1 (33 percent of subsample) shows no response during or after the policy imposition, while class 2 (67 percent of subsample) is responsible for the positive response during policy imposition that is evident in the aggregate results. In the case of collective PES, neither class shows any evidence of response during or following policy imposition.

The specific size and behavior of each class is of less interest than the more general observation that such distinct classes coexist within an apparently homogenous population. Individuals in a treatment group can have opposite responses to the same change in game parameters, despite being fairly similar in terms of wealth and education, cultural background and farming practices. With regard to income, 80 percent of the sample self reports an annual income of under USD 880, and 88 percent of the sample nominates primary school as their highest level of education. More than 80 percent of farmers have a mixed farm with agroforest, bananas, cassavas, yams and other spices as the predominant crops. Farm sizes tend to be fairly small with 80 percent of farmers owning or managing less than 10 acres (see section 5.2).

I also calculate probabilities of an individual falling in one class or another based on a suite of socio-demographic variables. Alternative specifications with regard to explanatory variables were developed also to test the robustness of the final model. Coefficients and significance levels were largely unchanged under different specifications, suggesting reasonably robust results. A summary of the characteristics of

each class and types of participant most likely to associate with each class is presented in Table 2-6. It should be noted that in this table the latent classes identified are independent across treatments, and hence there is no relationship between latent class 1 for one treatment and latent class 1 for another treatment.

Table 2-6: socio demographic characteristics associated with each latent class of respondents for three different treatments. Collective PES is omitted here due to limited notable results.

	Standard PES	**Regulation - High**	**Regulation - Low**
Latent Class 1	**No policy response** **No post-policy response** **No change in donation amounts**	**No policy response** **Positive post-policy response** **No change in donation amounts**	**No policy response** **No post-policy response** **Higher donation amounts**
	Smaller land owners/managers *Male* *Born in village*	*Older* *More possessions (wealth proxy)*	*Smaller land owners/managers* *Male* *More children in household* *More possessions (wealth proxy)*
Latent Class 2	**No policy response** **Negative post-policy response** **Higher donation amounts**	**Negative policy response** **No post-policy response** **No change in donation amounts**	**Positive policy response** **No post-policy response** **Lower donation amounts**
	Larger land owners/managers *Female* *Not born in village*	*Younger* *Less possessions (wealth proxy)*	*Larger land owners/managers* *Female* *Fewer children in household* *Less possessions (wealth proxy)*

7. Discussion and Conclusions

There are few field-experiment type studies with which to compare to these results, and those that are available differ with respect to experimental design. Vollan (2008) likewise tested for motivational crowding due to rewards and penalties but used a common pool resource game, played with pastoralists in rural Namibia and South Africa. He found evidence of crowding out from penalties (which he considered a 'restrictive' intervention) but never from rewards (which he considered an 'enabling' intervention). My findings corroborate the latter, but differ markedly from the former. Another common pool

resource game by Cardenas, *et al.* (2000) also found crowding out as a result of command and control, in their stylized game played with firewood collectors in rural Columbia. Their field experiment compared the choices made between participants who were forced to make particular choices by external regulation, and participants who were allowed to negotiate an outcome amongst themselves without external regulation. The former group's choices initially followed the external directive but deviated away from it over time. A third study suitable for comparison is by Jack (2009), who used an investment game with Kenyan farmers to investigate crowding effects possible under different watershed management regimes. Evidence for crowding out was found when a regulation was used to enforce donation amounts, again contrary to this study's findings.

However, it is important to note that the game designs utilized in these three studies differ markedly from the approach applied here. Firstly, a common pool resource game was not used in this study due to the nature of the agri-environmental problem in question. Here, farmers do not gain a personal benefit from any collective effort to limit their negative action (deforestation), as might pastoralists who agree to limit stocking rates on a common grazing area for instance (as in Vollan, 2008). Secondly, this game explicitly tested for a policy treatment effect in periods after the removal of the policy treatment, as opposed to simply the impact of the enforcement on decisions made under the policy itself. To my knowledge, Jack (2009) provides the only published study in the natural resource management literature that considers a lingering motivational crowding effect beyond the policy treatment.

Moreover, there is theoretical support for regulations and sanctions causing motivational crowding in, as observed here. In cases where the regulations are 1) considered fair, and 2) considered likely to encourage others to behave in a socially beneficial manner, enforcement may attract the support of agents who are more comfortable operating in a

fair and controlled policy environment (Reeson and Tisdell, 2008; Fehr and Rochenbach, 2003). I hypothesize (although cannot test) that farmers were comfortable with the required donation amounts under the regulation regimes, likely due to the fact that they prevented free riding. It ensured that the passive group - members of whom are likely friends and acquaintances of those in the dictator group - received some payment, and that all members of the dictator group contributed to that payment.

Two additional results are noteworthy with regard to the regulation treatments. Neither regulation policy is worth obeying from the dictator farmer's pure self-gain perspective, given that the expected value of non compliance is greater than the expected value of compliance (see section 5.1). The fine imposed is 200 percent of the donation discrepancy (the difference between the donation and the amount required) yet the chance of auditing is only 40 percent, so the net value of non compliance is 120 percent of the expected value of compliance. It is likely that the positive response to the regulation arises due to non-pecuniary influences, in particular the desire to appear cooperative with the experiment administrators, and simply because abiding by rules fulfils a desire to conform to social norms. Cohen (1999) in his review of environmental regulations discusses this effect and notes its importance for regulation compliance, even in developed world policy contexts with highly formalized institutions.

Furthermore, participants not only complied with these regulations, they went considerably beyond them. The low regulation demanded 17-20 percent of the participant's endowment, yet average contributions were 44 percent of the endowment, significantly higher ($p < 0.01$) than the control group (which had average contributions of 35 percent). Hence the framing effect, which suggests that policies signal administrators' expectations and hence shape behavior, does not appear to have been detrimental in this case. Motivation under this treatment is thus to some extent additive, but again far from

linearly so. A similar finding is reported by Velez *et al.* (2010) who found a positive effect resulting from a very minor fine in their common pool resource game, played with Columbian fishers.

In summary, there are three conclusions stemming from these results of relevance to policy makers. Firstly, with specific regard to deforestation in the East Usambara Mountains, neither a stylized PES nor regulatory regime was associated with *persistent* motivational crowding out. There was no evidence found for a weakening of intrinsically motivated donations following the imposition and removal of a policy simulation. In fact, for the cases of the regulation treatments, there is evidence of persistent motivational crowding in, where donation amounts remained high even after the policy simulation had concluded. However, there was some evidence for motivational crowding out *during* the standard PES policy simulation. The increase in donations was far smaller than would be expected had intrinsic and extrinsic motivations been strictly additive. However, to some extent this effect is to be expected under any policy imposition, and is arguably of less concern than a *persistent* motivational crowding effect.

Disparities between the experimental situation and a real policy are certainly large, and hence these results alone are insufficient grounds on which to base a new, full scale policy. One important disparity is the difference in beneficiary group in the game compared to that in reality. Farmers in the game made a sacrifice for the sake of other farmers whom they likely knew. In reality, however, farmers practicing conservation at the expense of profits are making a sacrifice for an environmentally concerned global community. Within the limits set by this and other experimental stylizations, however, these results provide tentative, positive support for external intervention. A stylized PES policy increased the amount of money donated in a modified dictator game but left no post-policy impact.

Two levels of stylized regulation policies likewise achieved the desired increase in the amount of money donated during the policy, and furthermore caused a significant increase in the amounts donated in the post policy period. Notable was the way in which the regulation itself was more significant than the level stipulated, with even an inconsequential requirement impacting on donation behavior.

More fundamental to the broader study of motivational crowding beyond this particular context, however, is the finding that a particular game or policy situation can invoke significantly different responses from subsets of the same population, even when that population is relatively homogenous in terms of key socio-demographic characteristics. I found that a high level regulation caused persistent motivational crowding in and motivational crowding out simultaneously, and even a low level regulation caused a split in responses. Given that a individual's likelihood of falling into either a crowding in or crowding out subsample can be partially explained based on his/her socio-demographic characteristics, It may be possible that policy can be targeted to particular subsections of a population who are most likely to respond in the desired manner. This would be a complex endeavor however so more detailed research is required before such a possibility could be realized.

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Overall Conclusions and Policy Recommendations

The research reported in this thesis is intended to meet two aims. Firstly, it is hoped that it will provide practical guidance for policy makers specifically interested in using incentive type programs to prevent deforestation in the East Usambara Mountains and the wider Eastern Arc region. Secondly, it is hoped that this research furthers applied 'payment for ecosystem services' (PES) knowledge by drawing some broader conclusions about the use of particular PES types and the likelihood of motivational crowding effects. Hence this concluding chapter is written with two different types of readers in mind. Section 1 is aimed to provide assistance to those with a specific interest in the conservation of the East Usambara forests. Section 2 is aimed at researchers and policy makers who are interested in the broader implications of this particular empirical case study.

Section 3 then draws on the key findings of section 1 and 2 to propose a way forward for conservation policy in the East Usambaras. A pilot PES program is proposed with characteristics informed by these results and previously published studies. Section 3 also discusses the international and national policy context, in particular REDD+, which is likely to be a potential source of funding for PES in the East Usambaras. Finally, a number of study limitations are discussed in section 4.

1. Lessons for PES design in the East Usambara Mountains.

There are a number of key findings from this research of relevance to the designer of a potential East Usambara PES program. I discuss firstly farmer preferences for payment types and amounts (willingness to accept values), and secondly, preferences for different conditionality levels. Thirdly, I present a summary of results regarding motivational crowding, and the evidence for and against this effect under a range of policy options.

Finally I consider the implications of the considerable variation in preferences that exist within the farming community. This is relevant both to preferences for program design and the question of motivational crowding potential.

At the outset, however, it is important to note the characteristics of the hypothetical PES programs from which these results were derived. Conclusions are based on a choice experiment which was intended to realistically mimic a program that could incentivize the maintenance of improved agroforestry (see section 4.3 in paper 1). Farmers were told that they had an option of entering a ten year contract which required the preservation of canopy trees and in some cases a certain amount of understory vegetation. Premature departure from the contract (i.e. a violation of conditions) would result in a fine of approximately USD 35 and the cessation of further payments. Farmers were also told that they would have to enroll all of their owned/managed land into the program. Partial enrollment could allow farmers to simply shift deforestation to other parts of their farm while still collecting payments (on-farm leakage). It should be noted that the results summarized here, particularly the quantitative 'willingness to accept' (WTA) amounts, are a product of this hypothetical program design. Departure from this particular PES model would reduce the relevance of these results - however, there are additional qualitative conclusions that are likely to be relevant across a wide range of models.

Key Finding 1.1: The nature of payment greatly influences the required amount of payment.

The choice experiment compared three hypothetical payment types, a direct payment to individual farmers, a group payment to a special village development fund, and a dedicated once-off 'co-investment' payment for organic manure fertilizer. All payments

were quoted in per acre terms and were to be paid annually for the life of the ten year contract (with the exception of the once-off manure fertilizer investment).

Both the manure fertilizer investment and the individual, annual cash payment were found to be effective at motivating hypothetical participation in a PES scheme. The group payment proved highly *ineffective* at promoting hypothetical participation. The investment, worth USD 140 per acre, was enough to persuade the median farmer to accept a hypothetical program without additional yearly PES payments for the life of the 10 year contract. This is likely due to three reasons. Firstly, the expected financial benefits from manure fertilizer due to improved agroforest productivity is likely greater than the value of the manure fertilizer itself (Bullock, *et al.* 2011; Reyes, 2008). Secondly, manure is difficult to procure (due to supply and transportation limitations) and hence valuable. Thirdly, it is plausible that there exists an appreciation of the investment as a partnership, a value over and above its purely financial worth. The high value placed on the manure fertilizer investment is indicated directly by the WTA results. To elicit an equivalent response using standard cash payments only, a program would have to pay approximately USD 84 per acre annually over the life of the ten year contract.

It should be noted that large upfront payments and other irreversible benefits (such as land tenure provision) are generally not considered incentive compatible due to the loss of leverage once benefits are handed over (Wunder, 2007). The manure fertilizer investment used in this instance may avoid this by providing an ongoing incentive (a more productive agroforest for a number of years after fertilization) that is to some extent 'locked' into a particular land use choice (agroforestry). However, the risk of upfront payments should be considered by the PES designer. It is conceivable that a modification of the proposal here would be suitable, for instance, periodic provision of the manure fertilizer investment throughout the life of the contract.

The individual cash payment, made per acre annually was effective at motivating hypothetical participation as expected. As shown in Table C-1, median WTA under a moderate conditionality regime (discussed in key finding 1.3) was approximately USD 28 per acre, per year (under the combined treatment model – see section 5.2 in paper 1 for details). With the manure fertilizer investment, annual cash payments are not required to motivate participation.

Table C-1: Willingness to accept amounts (per acre, per year for 10 year contract) based on direct questioning method. Two models are used in calculating these figures, the model based on the dynamic treatment data, and the model based on both static and dynamic treatment data (Table 1-4).

		Dynamic treatment		Combined treatments	
	Conditionality	Median	Std. Error	Median	Std. Error
No upfront payment	Moderate	78.6	19.5	28.3	14.9
	High	78.6[a]	19.5[a]	59.6	14.0
Upfront payment	Moderate	-29.4	22.9	-55.5	16.9
	High	-29.4[a]	22.9[a]	-24.2	15.5

[a]: No significant difference between high and moderate conditionality regimes for this model.

The group payment, on the other hand, was highly ineffective at promoting hypothetical participation. Under this hypothetical payment type, farmers were told that the per acre, annual amounts would be deposited into a dedicated village fund for use on communal infrastructure (roads, the school, the hall). The group payment represents a collectivist approach to PES, where individuals make a contribution to the welfare of the village as a whole through actions on their own farm. It was hypothesized that this might take advantage of existing social norms to encourage land holders to make a contribution by way of farm management. However, this payment's effect was insignificantly different from zero in most model estimations. At most, this payment may have had a very small effect (as suggested by one aggregated data model), with an effect one eighth the size of

that of the standard individual payment. However this number is only weakly supported by the data collected in this study.

Key Finding 1.2: The institution used to manage collective funds shapes farmer attitudes.

Early pilot versions of the questionnaire referred to the 'Village Development Fund' (VDF) as the recipient of the group payments. This existing fund receives payments from higher levels of government and is supposed to fund village infrastructure. However interviews undertaken during preliminary stages of data collection suggested that its management is viewed skeptically. Versions of the questionnaire that mentioned the VDF gave model estimations with significant negative coefficients for the group payment, meaning that payment actually *decreased* the likelihood of farmer participation. This effect reversed in later questionnaire versions when the VDF was replaced by a hypothetical "new, special fund [which would] spend the money on things like the school, the road or the dispensary. Furthermore, "The Environmental Organization would check to make sure that the money is correctly spent." Insights gained through structured interviews supported the hypothesis that mistrust of the existing VDF's management was influencing the response to the group payment proposal.

Key Finding 1.3: There is a tradeoff between the conditionality level and payment required to encourage participation.

Table C- 2 contains a description of conditionality levels, and the associated enforcement regimes, tested in the choice experiment. To attract participation from 50 percent of farmers, a program with moderate conditionality requires payment of approximately USD 28 per acre per year, while a program with high conditionality requires approximately USD 60 (for a program without a manure fertilizer investment). This difference is

unsurprising – the conditions associated with the high conditionality requirement (for instance the need to protect some understory) inhibit the ability of the farmers to maximize profit from their agroforest, and is a more onerous responsibility in general (for instance, two inspections per year). The environmental benefits of a program with these restrictions is likely to be higher, however. A comparative study on plant species richness by Hall *et al.* (2010) demonstrated the biological value of a less intensively managed ecosystem, and also the biodiversity benefits of protection from invasion by non-native species (in particular *Maesopsis eminii).* The policy designer must make a trade-off between program expense and biological benefits.

Key Finding 1.4: Preferred levels of conditionality may be non-linear.

Conditionality is a defining characteristic of PES: payment is conditional on some defined performance criteria that must be met by the ecosystem service providers (Wunder, 2007). The choice experiment presented farmers with one of three levels of conditionality (Table C- 2).

Table C- 2: Levels of conditionality presented in hypothetical contracts

Conditionality - Low	No inspections – farmers are required to keep a log book documenting farm activities which may be audited.
Conditionality - Moderate	A local villager will be hired by the administrating organization to inspect farmers' farms once per year to ensure no large trees have been removed from forest and agroforest.
Conditionality - High	A forestry officer from the administrating organization will inspect farmers' farms twice per year to ensure that no large trees have been removed from forest and agroforest. Also will ensure that there are enough saplings for canopy replacement and that trees present are indigenous species.

I find evidence for a non-linear response to the extent of conditionality. Farmers were most likely to participate in a program which held them to account with regard to their actions (conditionality - moderate) and less likely to participate in a program which held them to account with regard to environmental outcomes (conditionality – high). The latter is a more stringent standard and hence costlier for the farmer to comply with. Surprisingly however, participants showed a preference against the lowest level of conditionality which was based simply on trust and intentions rather than a physical inspection for compliance.

It is hypothesized that although the lowest level of conditionality is the easiest for farmers to comply with, they do not believe such a regime is plausible or represents good policy. It is possible that farmers who support the goals of a policy (for instance, to prevent deforestation) will base their preferences not only what the policy can do for them (the payment) but also in terms of whether it is likely to meet its wider social goals.

Section 1 in paper 1 contains a brief description of the different conditionality levels typically used in PES policy (based on van Noordwijk and Leimona, 2010).

Key Finding 1.5: A constant annual payment is preferred to a variable payment.

I tested a payment version where the payment amount tracked a key opportunity cost of the desirable land management action, the price of sugarcane (a common land use alternative to forest and agroforest, see Figure 1-3 in section 3.2 of paper 1). Half of the sample was told that their individual payments would vary from year to year, following the price of sugarcane. The envisaged purpose of such a fluctuating price was to prevent farmers from dropping out during periods of high opportunity cost, and to reduce program expenditures during times of low opportunity cost. Famers were told that on

average their payments would be equal to (approximately) USD 21, 50 or 176, matching the static payment.

Despite the supposed equity of payment amount over time, the static payment was strongly preferred. As shown in Table C-1, median WTA under a variable payment is approximately USD 79 per acre annually (with a moderate conditionality regime and no upfront fertilizer provision). However this falls to at least USD 28 under a static payment regime. It is likely that the complexity and the additional risk (unsteady income) associated with such a payment mechanism is a determent to many farmers surveyed.

Key Finding 1.6: There is some evidence for limited pro-environmental attitudes amongst farmers in the East Usambaras.

Although this concluding section has focused on the specifics of PES design up to this point, it is important to recognize that PES is one of a number of different conservation approaches available. Appealing to the pro-environmental attitudes held by farmers is a component of many non-market conservation approaches, for instance environmental education. Although non-market approaches are not the focus of this thesis, I document tentative evidence of environmental attitudes held by farmers which may be useful to policy makers.

There is an approximately even split between those farmers surveyed who agreed and those who disagreed with the statement "It is more important to improve people's incomes than to protect the forest in the East Usambaras." A majority (62 percent) of participants agreed to some extent that: "The forests in this area are not under threat and there is no need to change." A majority (59 percent) considered themselves superior environmental managers however, agreeing that "Most people do not care about

protecting the forest quite as much as I do". This suggests, at best, a mixed picture of environmental attitudes (Figure C- 1).

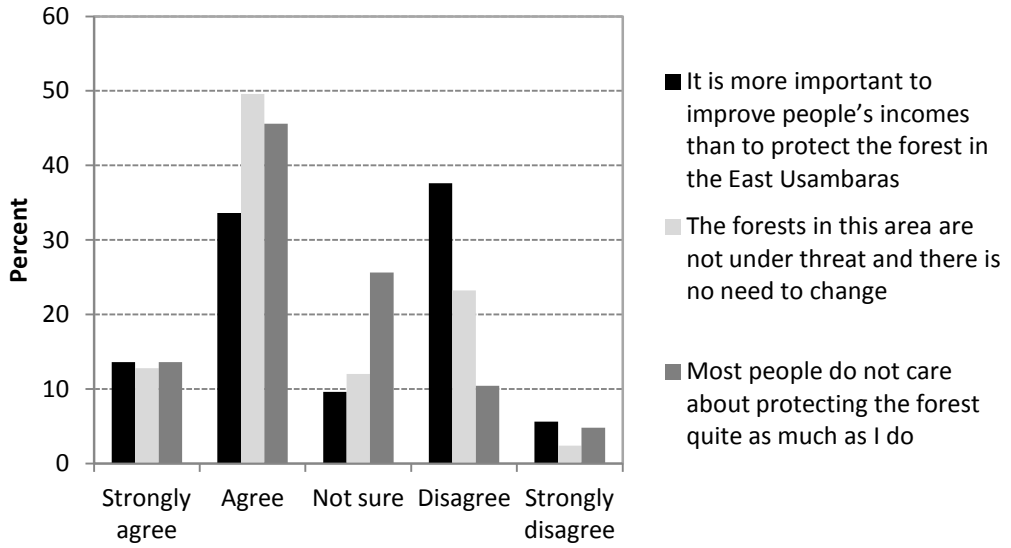

Figure C- 1: Distribution of responses to environmental attitudes questions (Likert scale)

There are a small number of other studies undertaken in the East Usambara area that have collected similar information on environmental attitudes. For instance, Morgan-Brown, *et al.* (2010) measured the incidence of pro-environmental behaviors such as environmental committee membership, tree planting and reporting of illegal tree cutting. They found these behaviors, as well as pro-environmental attitudes, are positively correlated with participation in a local integrated conservation and development project (butterfly farming). The incidence of these behaviors and attitudes is not surprising, given the history of conservation work in the area from a number of different government and non government organizations. These have stressed the importance of forests both for water and biodiversity values (Vihemäki, 2005). The East Usambara Mountains are an area where the Government has implemented joint forest management, in which voluntary village-based committees help set and enforce local environmental regulations.

Another recent study (Mwanyoka, 2005) found that 80 percent of farmers claim to participate in forest and water conservation practices. Over 70 percent claimed to be aware that the East Usambara forests were instrumental in providing consistent water supplies for Tanga. More generally, 95 percent were able to explain the environmental benefits of forest protection. However, Mwanyoka (2005) concluded that this knowledge does not always translate to active interest or participation.

Key Finding 1.7: An individual payments type PES elicited a larger response than a collective based PES. Regulation type approaches were also effective (in a game situation).

I used experimental economics techniques (a modified dictator game) to test farmer responses to four stylized policy types in a field laboratory. The stylized policies tested included: (1) an individual payments type PES (standard PES), where farmers were compensated for any contribution they make to a public good, (2) a collective type PES where a group of farmers were compensated as a whole for their contributions, (3) a low level regulation, where a farmers were told they must contribute a (small) given amount to the public good, and (4) a high level regulation, where the required amount of contribution was much higher. The PES type policies are examples of incentive based-policy, while the regulation based polices are examples of more traditional command and control policy. Details on each are documented in section 5.1.

The standard PES elicited a 6.3 percent increase in donations (representing pro-environmental behavior) while the strictest regulation policy elicited a 22.5 percent increase. The collective PES treatment was ineffective, likely due to a free rider effect.

Interestingly, I would expect neither regulation policy to have an impact from a purely self-gain perspective based on the expected value of the game strategies available to the

participant farmers. The expected value of non compliance is 120 percent of the expected value of compliance. Hence the positive response to the regulation likely arises due to non-pecuniary influences, in particular the desire to appear cooperative with the experiment administrators, and simply because abiding by rules can fulfil a desire to conform to social norms. This effect has been documented in environmental policy compliance research previously (see for instance Cohen, 1999).

These results suggest that both incentive and command and control policies are likely to be effective in conserving forests (with the exception of the collective PES), providing that farmer responses to these stylized policies approximate responses to real policies. It is important to note that the field laboratory experiment is highly stylized: the actual public good in the experiment is money provided to a group of passive recipient farmers (representing 'society'), rather than a real environmental good. The experiment thus assumes that farmers see forest conservation as generating a public good, a notion generally supported by Key Finding 1.6. This assumption is most relevant for conclusions on motivational crowding effects (Key Finding 1.8, below).

Key Finding 1.8: Motivational crowding effects were found to be minimal under both a PES and command and control approach in a game situation.

Motivational crowding occurs when different forms of motivation interact, and has important implications for incentive based policy. Environmentally beneficial land management actions can be motivated by a variety of factors, both 'intrinsic' (for the value of the task itself) and 'extrinsic' (for the rewards or avoided costs associated with the task). When policy makers attempt to encourage pro-environmental behavior by manipulating extrinsic incentives (policy), they can 'crowd out' or 'crowd in' pre-

existing, intrinsic sources of motivation. This occurs because extrinsic motivation, such as PES program payments, can in some cases displace pre-existing intrinsic motivation, such as a sense of stewardship over the local environment. Some authors have suggested that a substantial motivational crowding effect could lead to perverse, detrimental consequences of policy intervention (see for example, Farley and Costanza, 2010; Jack, 2009; Cardenas, *et al.* 2000). The occurrence of motivational crowding can sometimes persist beyond the life of the policy itself, due to a change in attitudes in response to the new policy environment.

The four stylized policy types introduced in Key Finding 1.7 were tested for potential motivational crowding effects by comparing results made by treatment and control groups of farmers (see section 5.1 in paper 2 for details). Table C-3 summarizes the results.

Table C-3: Summary of motivational crowding results under different stylized policy simulations both during and after policy imposition (in game situation). Table indicates whether policy induced the desired response (effective or otherwise at motivating additional donations), and whether motivational crowding was observed.

Stylized Policy Simulation	During policy simulation (i.e. evidence for temporary motivational crowding)	After removal of policy simulation (i.e. evidence for persistent motivational crowding)
PES (standard)	• Effective at motivating additional donations • Evidence of temporary motivational crowding out (-)	• No evidence of persistent motivational crowding
PES (collective)	• Ineffective at motivating additional donations	• No evidence of persistent motivational crowding
Regulation (low)	• Effective at motivating additional donations • Evidence of temporary motivational crowding in (+)	• Evidence of persistent motivational crowding in (+)
Regulation (high)	• Effective at motivating additional donations	• Evidence of persistent motivational crowding in (+)

The Standard PES policy simulation generated an increase in the amount donated that was far less than the amount of compensation, indicating that preexisting intrinsic motivation was partially (although not completely) replaced by the monetary reward. This does not rule out PES as a suitable instrument - indeed this effect is to be expected to some extent - however it undermines the cost effectiveness of the policy. No evidence for persistent motivational crowding (that in the post-policy period) was found.

Surprisingly, given the results of other studies (Cardenas, *et al.* 2000; Vollan, 2008; Jack, 2009), I found no evidence suggesting motivational crowding out due to the command and control policy simulations. In fact, the regulation seems to have crowded in higher

donation amounts post policy simulation, when the regulation was no longer in effect. This may be due to a framing effect, which occurs when a policy signals administrators' expectations or a social norm, and hence shapes behavior.

Finally, the low regulation treatment appeared to cause motivational crowding in during the policy simulation. Although the low regulation demanded only 17-20 percent of the participant's endowment, average contributions were 44 percent of the endowment, significantly higher than the control group (which had average contributions of 35 percent).

To conclude, motivational crowding effects were found to be relatively benign in this experiment for both incentive and command and control type policies. Although motivational crowding was found to occur under the standard PES, it did not persist beyond the life of the policy. The regulation type policies were found to have a net positive effect on behavior, both during and after the policy simulation. These results were somewhat surprising.

2. Conclusions for PES researchers more broadly

The preservation of the forests of the East Usambara Mountains is of global significance in itself (Brooks, *et al.* 2002). Furthermore, these results have implications for PES practitioners and researchers working on other conservation sites. In this section I summarize some of the broader lessons from this research. Firstly, I found that one particular PES paradigm was not overwhelming endorsed over another by farmers, demonstrating the need to mix and match elements from different PES paradigms for a specific context. Secondly, the conditions under which I found evidence for motivational crowding were contrary to previous studies, indicating the need for more research on this

phenomenon. Thirdly, I demonstrated the magnitude of preference heterogeneity that can exist within a relatively heterogeneous farmer community.

Key Finding 2.1: **No one PES paradigm was preferred outright by farmers, instead a mix of design elements gave the most preferred policy.**

Since Wunder (2005) first articulated his relatively theoretically 'pure' PES definition, there has been a discussion attempting to categorize, or 'typify' the range of PES-like instruments into different types or paradigms. In this research I focused on a recent classification system of PES proposed by van Noordwijk and Leimona (2010). The two paradigms I consider are 'compensation for opportunities skipped' (COS), where payment is given for avoided actions which would otherwise be environmentally detrimental, and 'co-investment in ecosystem services' (CIS), where the beneficiary makes an investment in the land management actions of the ecosystem provider that have environmental benefits. I also note the parallels between their classification and the environmental economics – ecological economics dichotomy of PES classification offered by Farley and Costanza (2010).

The overarching finding is that farmers show preference for programs that combine a mixture of elements from different PES paradigms. Evidence for the necessity of a mixed approach is clear in the strong support for the manure fertilizer investment, representing support for a CIS approach, which sits alongside support for individual payments (associated more with a COS approach). A group payment (associated more with a CIS approach) was ineffective at promoting hypothetical participation. A dynamic payment (testing preferences for an opportunity cost-based payment system, a literal interpretation of COS) did not receive farmer support.

Key Finding 2.2: Evidence for motivational crowding out was minimal from both PES and command and control policy simulations (in a game situation), contrary to previous studies.

Some evidence for motivational crowding out was found under the standard PES treatment, however it did not persist beyond the life of the policy simulation itself. The regulation treatments, both high and low, also did not cause motivational crowding out. On the contrary, they appear to have caused motivational crowding in beyond the life of the policy simulation.

This conclusion differs from the findings of previous authors who have used field laboratory experiments to study natural resource management issues in a developing country context. Vollan (2008) found evidence of crowding out from a regulation but not from rewards (PES) in his common pool resource game with pastoralists in South Africa and Namibia. Cardenas, *et al.* (2000) also found crowding out as a result of direct regulation, in their common pool resource game played with firewood collectors in rural Columbia. Jack (2009) used an investment game with Kenyan farmers to investigate crowding effects possible under different watershed management regimes. Evidence for crowding out was found when a regulation was used to enforce donation amounts, again contrary to this study's findings.

Despite the differences I believe these results warrant consideration. I used a different experimental game (a modified dictator game) than these earlier studies, which to the best of my knowledge has not been used for exploring motivational crowding issues and PES before. However, I believe that this modified dictator game better captures the key characteristics of PES as applied to on-farm forest conservation (see section 3 in paper 2 for details). It is possible that the nature of motivational crowding is different in common

pool resource problems. Further research comparing the motivational crowding effects of using different experimental setups within the same population might help clarify this. Secondly, to the best of my knowledge I provide here only the second study in the natural resource management literature that considers a persisting motivational crowding effect beyond the policy treatment (after Jack, 2009).

It should also be noted that there is theoretical support for the regulatory treatment to cause motivational crowding in, as observed here. In cases where the regulations are 1) considered fair, and 2) considered likely to encourage others to behave in a socially beneficial manner, enforcement may attract the support of agents who are more comfortable operating in a fair and controlled policy environment (Reeson and Tisdell, 2008; Fehr and Rochenbach, 2003). Clearly more research into the conditions under which motivational crowding occurs would be useful. Extending field laboratory type games to more realistic situations would be particularly beneficial to policy designers.

Key Finding 2.3: **A game or policy situation can invoke significantly different responses from subsets of the same population, even when that population is relatively homogenous in terms of key socio-demographic characteristics.**

The aggregate response of farmers to different policy simulations is given in Table C-3. However, these results obscure the varied responses of subsections of each treatment group. I used latent class analysis to divide each treatment group into subsamples whose members exhibit similar behavior. For instance, in the case of the standard PES treatment, 27 percent of the sample showed no statistically significant response to the treatment, either during its application or in the post-policy period. The majority of the sample (73 percent), however, showed a negative response (motivational crowding out)

in the post-policy period as well as a tendency to donate more in general. These more nuanced results are obscured by analysis in aggregate which shows no evidence of significant motivational crowding in the post-policy period.

The distinction between the subsamples is even more marked in the case of the regulation treatments. In the case of high regulation, 62 percent of the treatment group exhibited motivational crowding in during the post-policy period and 38 percent of subsample exhibited motivational crowding out. The aggregate effect was thus motivational crowding in.

The specific size and behavior of each class is of less interest than the more general principle that such distinct classes coexist within a relatively homogenous population. Individuals in a treatment group can have opposite responses to the same change in game parameters, despite being fairly similar in terms of wealth, education, cultural background and farming practices. Evidence for this relative homogeneity is presented in section 6.3 of paper 2.

A similar analysis was performed on the choice experiment data. I found that the sample was strongly partitioned into a 'low resistance to PES' subsample and a 'high resistance to PES' subsample.

There are few other studies that explicitly examine this heterogeneity (see for example, Clayton, 2010; Ruto and Garrod, 2009). Given that an individual's response can be partially explained based on his/her socio-demographic characteristics, it may be possible that policy design can be targeted to particular subsections of a population who are most likely to respond in the desired manner. This would be a complex endeavor, however, so much more detailed research is required before such a possibility could be realized.

3. The Way Forward for Conservation Policy in the East Usambaras

This section aims to synthesize the key findings above into tangible advice for conservation policy practitioners in the East Usambaras. There are two components to this, the first of which is a brief synopsis of the national and international policy landscape. The development of REDD+ (reduced emissions from deforestation and forest degradation) policy mechanisms is central to this, as it is likely that PES activities in the East Usambaras would fall under the evolving REDD+ rubric, and crucially, be supported by REDD+ funding initiatives. PES is a recognized as a key method of achieving REDD+ goals due to its emphasis on conditionality. Secondly, I use the key empirical conclusions to propose promising conservation options for the East Usambaras, and comment on how they can be achieved given the current state of policy and knowledge.

3.1. REDD+ and the State of PES in Tanzania

Forest protection for emissions reductions purposes was first included in the UNFCCC (United Nations Framework Convention on Climate Change) dialogue in 2005. Its role in discussions has increased in scope, scale and prominence since, and its shorthand term, REDD+, is now institutionalized internationally (Cerbu, *et al.* 2011). COP15 in 2009 saw nations pledge to commit to immediate and substantive action on REDD+ in Article 6 of the Copenhagen Accord: "We recognize the crucial role of reducing emissions from deforestation and forest degradation and the need to enhance removals of greenhouse gas emissions by forests and agree on the need to provide positive incentives to such actions through the immediate establishment of a mechanism" (UNFCCC, 2009). The expansion of REDD+ over time has elevated the status of REDD+ co-benefits, such as poverty alleviation and biodiversity (Campbell, 2009), benefits of considerable importance in making the case for REDD+ intervention in the East Usambaras.

Several agencies have implemented programs to prepare countries for the large scale operation of REDD+ mechanisms, such as the United Nations' UN-REDD and the World Bank's Forest Carbon Partnership Facility. Tanzania is one of four countries that have reached the 'implementation' stage of the UN-REDD program, via USD 4.2 million of investment in administrative and monitoring capacity (UN-REDD, 2011). In addition, there are a number of bilateral agreements between governments of industrialized nations and governments of tropical developing nations specifically for REDD+ program preparation and implementation. Of particular note is the Government of Norway's International Climate and Forest Initiative, which has allocated USD 83 million to REDD+ activities in Tanzania over a five year period (NORAD, 2011). The potential availability of REDD+ resourcing is thus substantial.

REDD+ developments are highly relevant to conservation efforts in the East Usambaras for three reasons. Firstly, the funds available for REDD+ activities are substantial and already available. Secondly, the REDD+ emphasis on conditionality and incentive based policy means that PES is well suited to achieving REDD+ aims. The Eastern Arc Mountains Conservation Endowment Fund, for one example, is exploring PES options for their priority conservation efforts in the East Usambaras (EAMCEF, 2006). Thirdly, the recent inclusion of 'co-benefits' into the REDD+ framework means that the conservation opportunities in the East Usambaras closely match the priorities of funding agencies.

However, as yet there are no existing PES programs in the East Usambaras. In fact, to my knowledge there are only two operational PES programs in Tanzania, both operating on a small scale only. These are a trial 'payment for watershed services' scheme, recently implemented in the Ruvu subcatchment, Uluguru Mountains (also part of the Eastern Arc) (see Yanda and Munishi, 2007; Lopa, 2008; Fisher, *et al.* 2010), and a wildlife

management agreement between a group of wildlife tour operators and farmers in the rangelands adjacent Tarangire National Park (see Nelson, 2010). Despite the progress in developing REDD+ administrative capacity in Tanzania, there is no overall PES framework for natural resource management in the country at present (Fisher, *et al.* 2010). The lack of PES policy experience in Tanzania represents an impediment to successful program implementation, and careful prior research into program feasibility and design is required before benefits are likely to be realized. It is hoped that this research contributes to this goal.

3.2. Designing PES in the East Usambara Mountains: Next Steps

In concert, the key findings presented in this chapter indicate the possibilities open to policy makers attempting to halt deforestation whilst respecting the economic needs and aspirations of the East Usambara farming communities. These findings complement previous research efforts undertaken in this region, and *relative* to other sites in sub Saharan Africa, the knowledge base required for policy implementation is well progressed here. Although substantial uncertainties remain, a pilot PES program is likely feasible. The following points propose key design elements for a pilot PES based on the key findings presented above, complemented with insights from the literature.

a) Quantification of Environmental Benefits

Establishment of PES requires quantification of the ecosystems services that would flow from such programs. There has been considerable documentation of these benefits in the East Usambaras. Given that this thesis is focused primarily on the economics of PES design, only a few examples are provided here. Munishi and Shear (2004) calculated the carbon value of forests in the East Usambara region (approximately 517 tonnes of carbon per hectare in tree biomass, and 418 tonnes of carbon per hectare in soils), data important

for the accurate accounting of REDD+ type funding. Leonard *et al.* (2010) and Hall *et al.* (2010) reported on the biodiversity values of different land use types, including forests, agroforests and open fields. Fisher, *et al.* (2011) and Bullock *et al.* (2011) reported on the opportunity costs of forest conservation in their calculations of profitability of different agricultural activities. Bullock *et al.* (2011) in particular are highly detailed. These data indicate the quantity of 'ecosystem services' that can be expected from particular PES program configurations, and need to be compiled for each PES program option.

As an aside, it should be noted that the forest definition adopted in the Tanzanian national REDD+ framework is insufficient for conservation of the East Usambara forests. Van Noordwijk *et al.* (2009) reported that areas could still meet the national forest definition if up to 88 percent of trees were removed, resulting in a loss of 87 percent of stored carbon, and considerable biodiversity benefits. The existing biological research should be utilized to devise a forest definition suitable for true conservation in the East Usambaras.

b) Payment Mechanism

It is likely that a combination of individual payment and manure fertilizer investment would be most successful at attracting participation. Although the investment was sufficient in itself to encourage participation, an additional cash payment may be required to keep farmers within the program if cardamom prices fall. It should be noted that cardamom prices were very high at the time of this study - approximately 30 000 TZS per bucket of green cardamom. It may also be more appropriate to supply the manure fertilizer investment at regular intervals throughout the contract length, so as to maintain productivity over time and to maintain the strength of the incentive to honor the conservation contract.

Support for the manure fertilizer investment payment approach is provided by Fisher, *et al.* (2011), who reported that REDD+ in Tanzania is likely to fail unless agricultural intensification policies (such as fertilizer provision) are pursued in addition to straight payments. They reported that although this adds to the expense of a PES program, it could reduce leakage and deliver poverty alleviation benefits. The benefits of investing in African smallholders' soil fertility are also promoted by Sanchez (2002).

c) Conditionality and Enforcement

From a farmer-preference perspective, I find support for the use of an intermediate or strong conditionality requirement (with a corresponding intermediate or strong enforcement regime). A lower level of stringency was not found to improve participation. Given that illicit environmental activity is not uncommon in this area, the monitoring regime will be important to ensure the goals of the program are met. One of the limitations of this study is that it did not distinguish between preferences for conditionality and preferences for the enforcement regime. However, the combined moderate conditionality and moderate enforcement option (see Table C- 2) elicited the greatest response from farmers. Given that higher conditionality will generally require a higher level of monitoring, I argue that this conflation is reasonable given the inevitable time and budget limitations of field research.

Policy designers will need to consider the treatment of original forest in a PES program. Payment for agroforest could see farmers increase cultivation in previously untouched forest areas in order to earn payments for those areas also. To prevent this, payment will need to be supplied both for original forest and for agroforest. Given that even under such a regime, a profit discrepancy will still exist between the cultivated agroforest and the uncultivated original forest, either regulations or a payment differential will need to be

utilized. This is unlikely to have a large effect on the overall PES budget given that original forest is already fairly rare on farms (see Figure 2-2).

Some form of ground inspection will be required in addition to satellite imagery monitoring. Satellite imagery has difficulties distinguishing between agroforest and original forest, and also is limited by the high levels of cloud cover over the East Usambaras (Hall, 2006). The ground inspections could also play an outreach role in addition to simply policing the program, informing farmers of their contract responsibilities, collecting feedback and promoting improved farming techniques.

It will likely be necessary to insist that farmers enroll the totality of their landholdings in the region when joining the PES program. Permitting part enrollment could allow farmers to geographically shift forest cutting activities while still receive income from PES, an occurrence known as 'on-farm leakage' (Engel, *et al.* 2008).

d) Group Payments and Bonus Payments

The group payment – for village infrastructure - was highly ineffective and is not recommended in the form tested in this study. One unexplored option, however, would be a 'collectively conditional' group payment. For instance, a group payment to a village fund could be conditional on a certain proportion of the enrolled farmers meeting the terms of their contract. Or, a bonus payment could be made to individuals based on the performance of the group. Such a mechanism was trialed in an Australian pilot scheme where farmers could buy and sell 'salinity credits' in order to meet salinity reduction targets (Connor, *et al.* 2008). Farmers received a 'community performance bonus' when the group as a whole met an overall target, and thus harnessed social incentives in parallel to financial incentives. It may be possible to motivate farming communities in the East Usambaras by using a similar collective incentive, although the scale on which such an

incentive would apply (for instance, sub-village, village district etc) would require careful consideration.

In addition, achieving environmental benefits such as species conservation often depends on the spatial pattern on protected land, requiring coordinated effort across multiple farms (Nelson, *et al.* 2008). Collective bonus payments, or 'agglomeration bonuses' could be used to achieve this, where landholders receive an additional payment or increased payment if adjacent farms enter into the PES program (see for instance, Parkhurst, *et al.* 2002). Although such collective bonus payments are not the focus of this research due to the normal limitations of time and finances (and hence are not reviewed in depth here), they may merit consideration as part of a pilot PES for the East Usambaras.

4. Research Limitations

This final section outlines some weaknesses in the research presented in this thesis, and makes suggestions for how future studies, either in the East Usambaras or elsewhere, could improve on these.

A fundamental limitation of stated preference studies - such as the choice experiment utilized in paper 1 - is their hypothetical nature. Willingness to accept values calculated in such ways are generally considered approximately indicative only, given the lack of incentive compatibility inherent in stated preference studies. Because it is the stated hypothetical response rather than a real response that is being measured, it is influenced by biases such as strategic behavior, yea-saying and social desirability bias (section 4.4 in paper 1 contains a discussion on these biases) (Grafton, *et al.* 2004, p 259). A number of survey design techniques exist that can mitigate these biases. Two of these techniques, 'cheap talk' and inferred valuation, were incorporated into this study's questionnaire. However, to establish a more accurate assessment of WTA a conservation auction is

required, where land managers bid for funding to provide the ecosystem service in question (see for instance Jack, *et al.* 2008). A conservation auction can be undertaken as part of a pilot program.

However, the stated preference approach used here is vastly cheaper and faster than a conservation auction, and thus it was considered the most appropriate method for providing an initial assessment. Choice experiments are themselves complicated however, and improvements could be made to the design utilized here. All choice experiments are limited by the ability of respondents to consider multiple attributes simultaneously, and make responses that truly reflect their preferences on all elements of the program. It was decided that 4 attributes was appropriate given the amount of information that had to be imparted to explain each, and given that keeping the questionnaire process under 1 hour in duration was thought prudent. However, the advantage of an additional attribute could be the separation of monitoring and conditionality properties of the programs. I blended these, given that stronger monitoring is naturally associated with higher conditionality given the more onerous conditions that have to be met. However, it would be interesting to see the effect of different types of monitoring regimes independently from the additional conditions associated. For instance, there may be a significant difference in preferences arising from inspections administered by different types of organizations/agencies.

Given that the inferred valuation results did not differ materially from the direct valuation results, future choice experiments in this area can likely put aside this method. This would expand considerably the number of choice scenarios that could be posed to respondents within a reasonable interviewing timeframe, or, allow for a more complex choice experiment design.

Other minor adjustments that may have improved the strength of results include a tighter description of the manure fertilizer investment. Telling farmers that the administering organization would provide the manure fertilizer directly, rather than providing cash for that purpose, could have removed any ambiguity surrounding this attribute. Similarly, it is possible that a larger fine for violation of the contract terms would have been appropriate given the expected income from program participation.

There is a need to explore further the motivational crowding issue, in particular, the extent to which these stylized results are applicable to real policies. This could be achieved by undertaking a pilot - such as that described in section 3.2 - or, a true field experiment. A true field experiment, as opposed to the stylized field-laboratory experiment reported on here, would require farmers to undertake real land management actions in return for payments. As stated in paper 2, the results I present are insufficient in themselves for the complete ruling out of motivational crowding concerns, although they provide one strand of evidence towards that end.

More broadly, a larger sample size might have elicited more statistically robust results. In particular, the relatively small sample sizes (220 participants in the choice experiment, 125 *active* participants in the field laboratory experiment) likely hindered the resolution of the latent class analyses. Like all such field studies, this research faced time and budgetary constraints which prevented the use of a larger sample.

5. Final Remarks

The spectacular levels of biodiversity found in the East Usambara Mountains means that protection of the region's forests is a national and international conservation imperative. Previous Government policies have recognized this, and conservation attempts via the creation of new reserves have successfully conserved some areas of forest. However,

there are concerns that the creation of exclusionary reserves has caused social and economic disadvantage in already poor communities, and furthermore, may have displaced deforestation rather than prevented it. Moreover, there are increasingly limited opportunities for new, large forest reserves.

However, increased funding from REDD+ type programs means that on-farm incentive based polices, such as PES, may be possible. PES is one potential means of achieving conservation while minimizing social tension and economic disadvantage. PES designs can also include explicitly pro-poor biases if required. Such a policy is becoming increasingly feasible given the considerable amount of research that has taken place in the East Usambaras.

If such a policy was to be introduced, it is important that policy makers know in advance the likely behavioral response of farmers, and hence how much conservation is likely to be achieved for a given program budget. This research has aimed to contribute to this understanding, by quantitatively documenting the policy preferences of farmers. It should be noted that this research does not comment in any detail on the efficacy of PES relative to alternative policy approaches (such as environmental education, compulsory land acquisitions or regulatory approaches, for example). However, if PES is considered appropriate, this research guides the design of such a program. This research also serves to document the views of local communities. It is vital that local farmers, who have the most at stake in this issue, are fully part of the policy design and implementation process.

Alarming as the rate of deforestation may be in the East Usambaras, there is some cause for optimism. The need to protect this global environmental treasure is increasingly being recognized, and international financing may be available should the Tanzanian Government wish to take advantage of it. The people who live alongside these forests

also recognize the importance of their local environment to their long term farming prospects. Tanzanians, with assistance from the international community, thus have the opportunity to protect this globally recognized environmental jewel for perpetuity, and with careful policy design, can simultaneously improve the livelihoods of the East Usambara Mountains' people.

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Appendix 1: Choice Experiment General Questionnaire

Note that an example of a choice set is presented in appendix 2.

Date: _____ subvillage: _____ Interviewer: _____

Start time: _____ End time: _____ Any Problems: _____

Part 1: Introductory Script

"Hello. My name is _____ (interviewer) and I am working on a project for a research organization called ICRAF. I would like to speak to the head of this household about his/her farming practices. Am I speaking to the right person?"

No: *Ask to speak to head of household. If head of household is unavailable, ask for a suitable time to return*

Yes: *Go on to next section*

"I would like to ask you some questions about your farm. It is completely confidential and I do not record your identity. It will take about 50 minutes and your answers will help our research in improving forest management in this area. All I would like from you is your opinion. Are you interested in participating?"

No: *Thank the interviewee and leave*

Yes: *Thank the interviewee and go on to next section*

Part 2: Obtain Consent

See the Study Information and Consent Form

Part 3: Introductory Questions about Your Farm

“To start, I would like to ask a few questions about your shamba.”

1. “How much land do you manage or own?” _____ (acres)
2. “How much of this land is covered by original forest?”

   _____(acres/proportion - circle
3. How much of this land is covered by cardamom agroforestry _____

   (acres/proportion - circle)
4. How long have you or previous farmers been cultivating your particular area of

   agroforest land? _____ (years)
5. “What other crops do you plant?”

□Yams □ Bananas □Other spices

□Cassava □ Sugarcane □Others_____

6. “In what way do you benefit from the forest and agroforest on your land?

□Fuelwood □ Timber for building □Allanblackia fruits

□Others_____

7. Please rank these crops in order of profitability for your farm:

   Cardamom agroforestry ____

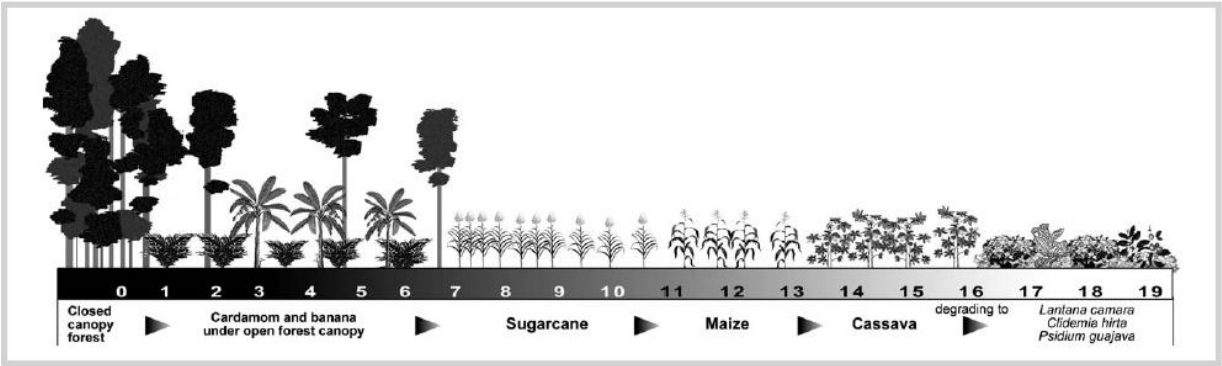
   Sugarcane ____

   Perennial spices ____

Part 4: Forestry Program Background

In the next part of this questionnaire, I want your opinion about forest management. Later on I will tell you about some possible tree management programs, then I will ask you what you think of them.

But firstly I want to talk about agriculture. Here is a diagram that shows the typical progression of agriculture in this area. It may not be exactly the same as your own experiences, but parts of it are probably similar.



A lot of forest is being cut down in the East Usambaras because farmers find that their cardamom plants do not produce well after 7-10 years. At this time they can make more money by cutting the remaining trees and planting spices, sugarcane or food crops.

Does this sound right to you? (Yes/No)

This is a problem because the forests in the East Usambaras are some of the most precious anywhere in the world. Many species found here are found nowhere else. The forest also protects the the flow of water in the Zigi River, that provides Tanga with water.

Did you know that this area is well known for its natural environment? (Yes/No)

Local farmers and some research organizations have found that if you add manure and leave the land fallow for some years, additional rotations of cardamom can be planted. This means that the agroforest does not have to be removed.

However, the yields from the additional cardamom rotations are not as good as the original cardamom yields. Also, farmers might be able to make more money by cutting down the agroforest and planting sugarcane or other open-land crops.

Despite this, we want to know if you would be interested in leaving the agroforest standing. You could keep planting cardamom underneath the trees, but you would have to leave all of the trees.

Your profits might be less than if you planted sugarcane or other open-land crops. Because of this, some environmental organizations that work in the area are thinking about the possibility of providing some payment to farmers who agree to protect their trees. This is just an idea at this stage; there is no firm commitment to any new forest program. We just want to know what you might choose to do if such a program was implemented.

Do you understand that this is simply an idea; there are no firm commitments to do this any time soon? (Yes/No)

In a minute I am going to ask you what you think about this idea. There are no right and wrong answers. Please choose whatever seems most reasonable to you. For example I will be asking you if you are willing to conserve trees under a given conditions and it is okay to say NO if the conditions do not sound reasonable to you. Your answers will not affect your eligibility to participate in any future programs, and in fact, will not be linked to your identity at all.

Do you understand that there are no right or wrong answers? (Yes/No)

Even though the set of conditions described to you are not real and do not commit you to any actions, it's really important that you answer as if this was a real choice with real

consequences. Sometimes people say one thing in a survey but when they face the same situation for real, they do something else. Please think really carefully about whether you really would do what you say.

Part 5: Management Option Questions.

Suppose that if you enrolled in the tree conservation program, you would have to agree not to cut down any of the tall trees on your cardamom agroforest for ten years. This means that you could continue growing cardamom but you couldn't plant any sugarcane or other open-land crops on that land.

However, you would get paid to make up for this. You would be paid in cash, once a year in June or July by a person who works for a local environmental organization. You would be paid every year for the ten year contract period. The money will come from an International Environmental Organization.

Farmers with more land covered by cardamom agroforest would get paid more than farmers with less because payment would be per acre. The agreement would apply to your whole shamba, not just part of it.

If you were in the program, you would have to agree not to cut down any of the tall trees on your cardamom agroforest *for ten years*. If you cut down trees before the ten year contract finished, you would miss out on any remaining payments, and may have to pay a fine of 50 000 Sh.

If respondent has no cardamom agroforestry, tick this box and go to section 6. ☐

(Go to scenario questions, phrased as "you")

		Responses to scenario questions (phrased as "you")			
Block:	_____	Number 1:	_____	Number 3:	_____
Treatment:	_____	Number 2:	_____	Number 4:	_____

Part 6: Management Option Questions (Inferred Valuation)

Now we want to know what you think the other farmers in this area would choose. You might think they would make different decisions to you, or you might think they would make the same decisions. Your answers will not affect you or your neighbors' eligibility to participate in any future programs, and like before, will not be linked to your or their identity.

(Go to scenario questions, phrased as "they")

		Responses to scenario questions (phrased as "they")			
Block:	_____	Number 1:	_____	Number 3:	_____
Treatment:	_____	Number 2:	_____	Number 4:	_____

Part 7: Follow Up Questions

1. Respondent sex: Male/Female
2. "What is your age?" _____ (years)
3. "What is your highest level of education?": (Tick √ highest level achieved)

□No schooling □ Primary school □Ordinary level □Advanced level

□Diploma College degree

4. "Were you born in this village?" Yes/No
    a. (If no) For how many years have you lived here? _____(years)

5. How many adults live in your household? _____
6. How many children live in your household? _____
7. How many household members work in agriculture? _____
8. Does your household make money other than from farming? _____ (Tsh)
9. In an <u>average</u> year, how much money does your household make in total? _____ (Tsh)
10. In a <u>good</u> year, how much money does your household make in total? _____ (Tsh)
11. In a <u>bad</u> year, how much money does your household make in total?_____ (Tsh)
12. Do you have any of the following items?

□Radio	□ Motorcycle	□mobile phone
□Cow	□ Bicycle	□TV

Those are all of my questions. Thank you very much for your help today, your answers are very valuable for our research.

(Present small gifts)

If you have any questions about this research, remember you can contact David Kaczan *(point out the address and number on the information form which is left with the respondent).* Good bye.

Appendix 2: Example Choice Scenario

Suppose you have the following two options for a new tree conservation program, each has different conditions. I would like to know whether you prefer the first option, the second option or nothing at all.

Option 1:

You/They are paid ***xx*** Tsh per acre per year, providing that you keep all of your agroforest. The payments will be given directly to you/them, in cash, in June or July.	There will not be any payments to the village from this programme, whether you/they participate or not.	You/They will be given 200 000 Tsh per acre of agroforestry to pay for fertilizing your cardamom. You/They will be paid this only once, upon joining the program.	A forestry officer from the environmental organization will visit your/their farm twice per year to make sure that no large trees have been removed. The forestry officer will also check to make sure there are enough small saplings to one day replace the big trees, and will make sure that the trees present are indigenous species. If any large trees have been removed, or if there are no saplings present your/their payments will stop and you may be fined. The contract length is ten years.

Option 2:

You/They are paid ***xx*** Tsh per acre per year, providing that you keep all of your agroforest. The payments will be given directly to you/them, in cash, in June or July.	***zz*** per hectare, per year, would be given to a new, special fund for spending in this village. They would spend the money on things like the school, the road or the dispensary. The Environmental Organisation would check to make sure that the money is correctly spent. This money is extra money, on top of any payment you/they would personally receive.	You/They will not get any upfront payment.	There will be no inspection, but you/they will be asked to keep a log book of any changes you make to your agroforest. Your/their log book may be audited in some years. The contract length is ten years.

Or, none at all:

You do not receive payment because you are not in the tree conservation program		You/They will not get any upfront payment.	There will be no visits from a forestry officer and you are free to continue farming in any way you choose.

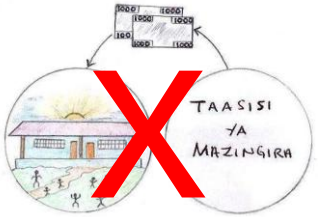
Which of these options do you prefer? The first, the second, or none at all?

Block 1, Treatment 1, Number 1

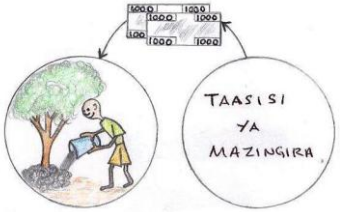
Appendix 3: Choice Scenario Picture Set (Accompanying Choice Scenario)

1:

Sh. *xx* per year, per acre



Sh. 0 per year, per acre

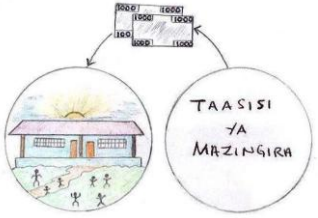


Sh. 200,000 per acre, once only

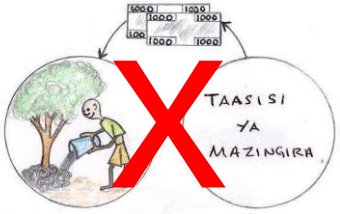
Inspection

2:

Sh. *zz* per year, per acre



Sh. *zz* per year, per acre



No once-off payment

No inspection

3: No program, you can continue farming any way you choose