Cooperation in Environmental Protection

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Dipl.-Volksw. Dirk Röttgers,

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Erstgutachterin:	Prof. Dr. Ulrike Grote Institut für Umweltökonomik und Welthandel Wirtschaftswissenschaftliche Fakultät der Gottfried Wilhelm Leibniz Universität Hannover
Zweitgutachter:	Prof. Dr. Hermann Waibel Institut für Entwicklungs- und Agrarökonomik Wirtschaftswissenschaftliche Fakultät der Gottfried Wilhelm Leibniz Universität Hannover
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List of Abbreviations

AIC	Akaika information criterion
BIC	Bayesian information criterion
BL	Baseline
BMBF	Bundesministerium für Bildung und Forschung / Federal Ministry for Education and Research
CAIT	Climate Analysis Indicator's Tool
CDM	Clean Development Mechanism
CEPII	Centre d'Etudes Prospectives et d'Informations
CER	Certified emission reduction
CERPA	Certification of Protected Areas
CIA	Central Intelligence Agency
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CPR	Common-pool resource
CT	Cheap talk
Dist	Distance
DNA	Designated national authorities
DVLS	Dummy variable least squares
ERU	Emission reduction units
ESS	Ecosystem service
ETS	Emission trading scheme
EU	European Union
FDI	Foreign direct investment
FONA	Forschung Naturschutz / Research for Sustainable Development
GDI	Green development initiative
GDP	Gross domestic product
GDP pc	Gross domestic product per capita

GDP PPP	Gross domestic product purchasing power parity
IMR	Inverse Mill's ratio
IMF	International Monetary Fund
MBI	Market-based instrument
N	Number of observations
NE	Nash equilibrium
NNF	Namibian Nature Foundation
ODA	Official development assistance
OECD	Organization for Economic Co-operation and Development
POLES	Polar exchange at the sea-surface
REDD	Reducing Emissions from Deforestation and Forest Degradation
SE	Strong enforcement
SO	Social optimum
TARIC	Integrated Tariff of the European Communities
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
WAWI	Institute for Water Resource Management
WE	Weak enforcement

Zusammenfassung

Die Milleniumsentwicklungsziele und andere verwandte Maßnahmen wie das Übereinkommen über die biologische Vielfalt und das Kyoto-Protokoll stellen die Welt vor eine Herausforderung, die nur durch Kooperation gemeistert werden kann. Kooperative Politik ist notwendig von der höchsten Ebene, also internationaler Politik und Abkommen, über regionale und nationale Abmachungen und Bestimmungen, bis hin zur lokalen Ebene, auf der Politik konkret umgesetzt wird. Um einige Lücken im Verständnis der in Frage kommenden Politikinstrumente zu schließen, betrachtet die vorliegende Dissertation einige Schlüsselthemen des Umweltschutzes mit Implikationen für marktbasierte Instrumente. Die fünf verschiedenen Forschungsthemen sind 1) der EU Bioenergiehandel, 2) der Clean Development Mechanism (CDM), 3) ein Vergleich der Effektivität von Produktzertifizierung, Ökosystemzertifizierung und Ausgleichshandel in Feuchtgebieten, 4) internationale marktbasierte Instrumente für afrikanische Schutzgebiete und 5) die Entscheidungsfindung lokaler Akteure in ländlichen Ökosystemen von Entwicklungsländern.

Bioenergiekonsum, -produktion und -handel sind in den letzten Jahrzehnten stark angestiegen, hauptsächlich durch Nachfrage in EU-Ländern und den USA. Dabei ist es in der EU fraglich ob diese Handelsströme hauptsächlich von EU-Handelspolitik oder gezielter Bioenergiepolitik verursacht werden. Eine sektorspezifische Analyse, die die Struktur der Bioenergieindustrie mit einbezieht, ist notwendig, um den Einfluss dieser zwei Politikfelder einzuschätzen. Ein häufig angewandtes Instrument zur Analyse einer solchen Handelssituation ist das Gravitätsmodell, das auch hier benutzt wurde. Wegen null-inflationierter Daten wurde dieses Modell durch den Heckman-Ansatz ergänzt. Zusätzlich wurden eine räumliche Gewichtung und Anderson & Van Wincoops multilateraler Widerstand einbezogen. Die Ergebnisse zeigen, dass sich der Effekt der Beimischungsquote positiv auf den Handel auswirkt, andere Maßnahmen wie Investitionssubventionen aber keinen Effekt haben und Handelsintegration sogar einen negativen Effekt auf den Handel zwischen EU-Ländern hat. Dieses Ergebnis zur Handelsintegration kann durch den erschöpften europäischen Roh- und Zwischenproduktmarkt für Biodiesel in der EU erklärt werden. Das Ergebnis bleibt selbst dann robust, wenn für die Struktur der Industrie kontrolliert wird.

Bioenergiegesetze wie die Beimischungsquote sind nur einige der EU-Maßnahmen zur Verminderung von Treibhausgasen. Den zugehörigen internationalen politischen Rahmen bildet das Kyoto-Protokoll. Im Einklang mit dem Protokoll hat die EU den EU-

Emissionshandel eingeführt, der als eine von vielen grünen Maßnahmen Partnerschaften zwischen Akteuren in Industrie- und Entwicklungsländern für Projekte zur Treibhausgasvermeidung hervorbringen soll. Durch internationale Kooperation in diesen CDM-Projekten sollen Entwicklungsländer die Möglichkeit bekommen, ihre Wirtschaft rechtzeitig auf nachhaltiges Wachstum umstellen zu können. Allerdings haben bisher gerade die ärmsten der Entwicklungsländer nur wenige CDM-Projektpartnerschaften: Afrikanische Länder haben nur an zwei Prozent aller CDM-Projekte Anteil. Die vorliegende Dissertation untersucht, warum dies so ist, indem ein Gravitätsmodell die Determinanten der Certified-Emission-Reduction-Ströme zwischen den Projektfinanziererländern und den Projektländern untersucht. Die besondere Rolle ausländischer Direktinvestitionen (FDI), offizieller Entwicklungshilfe (ODA) und des Handels werden in diesem Kontext gesondert betrachtet. Die Ergebnisse zeigen, dass FDI, ODA und Handel einen positiven Einfluss auf Projektanbahnung haben, auch dann wenn für Determinanten dieser Faktoren kontrolliert wird. Eine Unterscheidung in der Analyse zwischen jeweils ersten Projekte und der Menge der erzeugten Emissionszertifikate ergibt zwei zusätzliche Ergebnisse: 1) FDI und Handel tauschen ihre Bedeutung für Projektanbahnung und 2) das spezifische Versagen afrikanischer Staaten liegt darin, Erstprojekte einleiten zu können. Das weißt auf ein Versagen im Prozess der Projektgestaltung als Grund für die geringe Anzahl afrikanischer Projekte im Vergleich zu anderen Entwicklungsländern hin.

Der CDM, einschließlich der mit ihm verbundenen Mechanismen, ist eins von vielen marktbasierten Instrumenten, die zum Umweltschutz eingesetzt werden. Neben Ausgleichshandel wie dem CDM sind einige andere neuere marktbasierte Instrumente geeignet, um sich entwickelnden Regionen zu helfen. Diese Regionen können durch neuere marktbasierte Instrumente internationale Partner finden, ohne diese sich auf ihre Regierung und hiesige Institutionen verlassen zu müssen. Vor dem Hintergrund von Projekten in Feuchtgebieten werden die folgenden drei für internationale Zusammenarbeit für Ökosystemschutz vorgeschlagenen Instrumente in der vorliegenden Dissertation untersucht: 1) Produktzertifizierung für feuchtgebietbasierte Güter 2) der ‚Wetland Mitigation Trading' genannte Ausgleichshandel und 3) Ökosystemzertifizierung. Ein Modell der komparativen Statik wird angewendet, um die Eignung dieser drei marktbasierten Instrumente zu untersuchen. Am Beispiel von Landwirtschaft und Gewässerbewirtschaftung zeigen die Ergebnisse ein Potential aller drei Instrumente, die Wohlfahrt innerhalb des Ökosystems zu erhöhen. Allerdings hat Produktzertifizierung den Nachteil, dass es von starken

Interdependenzen unter den Ökosystemdienstleistungen beeinflusst wird. Wetland Mitigation Trading und Ausgleichshandel sind in diesem Modell optimale Lösungen, solange Ökosystemdienstleistungen entsprechend quantifiziert werden können und Transaktionskosten nicht prohibitiv sind.

Solche marktbasierten Instrumente werden selbstverständlich nicht nur als theoretische Politikmaßnahmen betrachtet, sondern finden auch praktische Anwendung. Zum Beispiel stellen existierende marktbasiert Instrumente eine Auswahl an Maßnahmen zum Management und zur Finanzierung von Schutzgebieten dar. Viele Schutzgebiete in Entwicklungsländern sind allerdings nach wie vor stark unterfinanzierte ‚Papierparks', die den Ressourcen, die sie beinhalten nur ungenügenden Schutz zukommen lassen. Mit einem Fokus auf Schutzgebiete in Subsahara-Afrika untersucht die vorliegende Dissertation Möglichkeiten und Hürden für einen internationale Kooperation unter Einbeziehung marktbasierter Instrumente zur Schutzgebietfinanzierung. Geringe Effektivität, hohe Transaktionskosten und beschränkte Effizienz haben dazu geführt, dass bisher nur relativ wenige internationale marktbasierte Projekte in Subsahara-Afrika zustande gekommen sind, verglichen mit Asien und Lateinamerika. Die gegenwärtige Umorientierung von einem Schutzzonenmanagementsystem der ‚Zahlungen und Zäune', das auf nationalen Regierungsorganisationen basiert, hin zu integrierten Konzepten der nachhaltigen Nutzung erlauben eine bessere Integration internationaler marktbasierter Instrumente in Schutzgebietkonzepte.

Internationale Kooperation dieser Art wird jedoch keine guten Ergebnisse erzielen können, wenn das Management vor Ort nicht funktioniert. Kooperation unter lokalen Akteuren müssen internationalen Bemühungen folgen, wenn internationale marktbasierte Instrumente erfolgreich sein sollen. In Entwicklungsländern ist diese Kooperation vor Ort oft ein Fall von Management in der Gemeinschaft. Auch wenn die Literatur zur Ökonomie des Verhaltens von Gemeinschaften im Angesicht von Allmendeproblemen weitläufig ist, wurde das Zusammenspiel zwischen Gruppenzusammenhalt, Governance und einem realistischerem Framing von Experimenten noch nicht ausreichend untersucht. Da Faktoren dieser Kategorien die Interpretation von Experimentergebnissen beeinflussen, untersucht die vorliegende Dissertation wie Teilnehmer in Allmende-Experimenten in Gegenwart dieser Faktoren kooperieren. Die Ergebnisse dieser Untersuchung zeigen, dass die Stärke von Regeln in einem Experiment die Relevanz von Gruppenkonformität für die Entscheidungsfindung bestimmen kann. Tatsächlich verliert der wichtigste Indikator für Konformität in den Experimenten in Gegenwart starker Regeln seine Relevanz. Andere Formen der Orientierung wie persönliche

Beziehungen und Meinungsführerschaft behalten ihre Relevanz, selbst in Gegenwart starker formeller Regeln. Des Weiteren zeigen die Experimente, dass Framing, wenn es realistischer die tatsächlichen Umstände eines Ökosystems abbildet, einen entsprechenden Einfluss hat. Dies impliziert die Möglichkeit, Experimente für spezifischere Untersuchungen anzupassen: Falls Experimente konkrete Informationen über lokale Situationen oder sogar Hinweise für Kapazitätsbildung liefern sollen, dann können diese auf lokale Gegebenheiten angepasst werden und damit bessere Informationen liefern.

Schlagworte: Marktbasierte Instrumente, Bioenergie, Clean Development Mechanism, Afrika, Ausgleichshandel, Ökosystemleistung, ökonomische Experimente

Abstract

The Millennium Development Goals (United Nations, 2000) and, by extension, such efforts as the Convention on Biological Diversity and the Kyoto Protocol (Kyoto Protocol, 1997), present mankind with a challenge that can only be overcome through cooperation. Cooperative policies are necessary from the highest level, i.e. international policies and treaties, to regional and national agreements, down to the local level, where policies are actually enacted. To close some gaps in the understanding of applicable policy instruments, this dissertation looks at a few key topics of environmental protection with implications for market-based instruments. The five different research areas are 1) EU bioenergy trade, 2) Clean Development Mechanism (CDM), 3) comparison of the effectiveness of product certification, ecosystem certification and offset mechanisms in wetland ecosystems, 4) international market-based instruments for African protected areas and 5) local stakeholder decision making in rural ecosystems of developing countries.

Bioenergy consumption, production and trade have been increasing worldwide in the recent decade, mostly due to demand from EU countries and the USA. Taking the example of the EU, it is questionable if these trade flows are caused mainly by EU trade rules or targeted bioenergy policies. A sector-specific analysis taking industry patterns into consideration is necessary to evaluate the impact of these two policy areas on trade flows. A common way to analyze trade flows is the gravity model, which is employed here. Because of zero-inflated trade data, the model is expanded using the Heckman approach and augmented by spatial weights and Anderson & Van Wincoop's controls for multilateral resistance. The obtained results suggest that while the mandatory biofuel blending quota has a positive impact on trade, investment subsidies cannot be shown to have any effect and trade integration might even have a trade inhibiting effect among EU members. The surprising latter result can be explained by an exhausted domestic European market for raw and intermediate materials for biodiesel and proves stable even when controlling for sector specific variables.

Enacting bioenergy policies like the mandatory biofuel quota is one of many EU policies to curb greenhouse gas emissions and combat climate change. The corresponding international policy framework is the Kyoto Protocol. In line with the Protocol, the EU created its EU Emission Trading Scheme, which, among other green measures, encourages partnerships between stakeholders in industrialized and developing countries for greenhouse gas avoidance projects. Through international cooperation within these CDM projects, developing countries have the possibility to adjust their economy to grow sustainably. However, the poorest

developing countries have only few CDM project partnerships: African countries take part in only two per cent of all CDM projects. This dissertation finds out why that is by using a gravity model to analyze flows of Certified Emission Reductions (CERs) between host and financier countries. The special roles of foreign direct investments (FDI), official development aid (ODA) and trade are scrutinized closely in this context. Findings show that FDI, ODA and trade have a positive influence on project attraction, even when holding determinants of these factors constant. A distinction between mere CER flow existence and CER flow size yields two additional results: FDI and trade switch places in importance as determinants for project attraction and the specific failure of African countries is the initial attraction of investors. This points to an inadequacy in the initial process of project generation as reason for Africa's lack of projects in comparison to other developing regions.

The CDM, including its underlying and flanking mechanisms, is one of many possible market-based instruments (MBIs) for environmental protection. Next to offset mechanisms like the CDM, some newer forms of MBIs are particularly suited to help developing regions find international partners without having to rely on their government and their country's institutions too much. Employing the background of wetland-based projects, the following proposed instruments for international ecosystem protection partnerships are analyzed: 1) product certification for wetland-based goods, 2) an offset mechanism called wetland mitigation trading and 3) ecosystem certification. A static optimization model analyzes the applicability of these three MBIs. Taking the example of agriculture and aquaculture, findings suggest a potential to increase welfare for all three instruments. However, product certification suffers from drawbacks owing to strong interdependencies between the ecosystem services. Wetland mitigation trading and ecosystem certification are first-best choices within this model as long as ecosystem services can be quantified properly and transaction costs are not prohibitive.

Such MBIs are of course not only considered as theoretical policy measures, but also implemented practically. For example, the set of existing MBIs provides a choice of instruments for managing and financing Protected Areas (PAs). Many PAs in developing countries are severely underfinanced 'paper parks', though, which offer only scant protection for the resources they contain. Focusing on sub-Saharan African (SSA) PAs, this dissertation reviews opportunities for and obstacles to international cooperation for the use of MBIs to provide supplemental financing of PAs. Low effectiveness, high transaction costs and limited efficiency have resulted in relatively few international MBI projects in SSA compared to Asia

or Latin America. The current shift from state-based ‘fines and fences’ PA management towards integrated sustainable use concepts will allow for a better integration of international MBIs into PA concepts, as exemplified by Climate, Community and Biodiversity Alliance (CCBA) certified PAs.

This international cooperation will not yield results though, if local management fails. Local cooperation efforts have to follow international cooperation for international MBIs to succeed. In developing countries this local cooperation is often a matter of community management. Though behavioral economics literature on communities facing a common-pool resource dilemma is vast, the interplay between group cohesion, governance and a more realistic framing of an experiment has not been fully explored yet. Because factors of these categories influence the interpretation of experimental results, this dissertation analyzes how participants in common-pool resource experiments cooperate in their presence. Results show that the strength of rules in an experiment can determine the relevance of group conformity for decision making: The most important indicator for conformity in the experiment loses relevance in the presence of strong rules. Other forms of guidance like personal relationships and leadership retain relevance, even in strong rules settings. Furthermore, the experiments show that framing similar to real circumstances changes results in the field. This implies the possibility to tailor experiments to their specific use: If they are meant to give concrete information on the situation on the ground or even help with capacity building, they can be adapted to the relevant local situation.

Keywords: Market-based instruments, bioenergy, clean development mechanism, Africa, offset mechanism, ecosystem service, economic experiment

1 Introduction

1.1 Motivation and background

As prominently reflected in goal 7 of the Millennium Development Goals (United Nations, 2000) as well as other large scale efforts like the Kyoto Protocol and the Convention on Biological Diversity, environmental protection has become a topic demanding global answers. The world economy is built on the use of natural resources like fossil fuels, local ecosystems or the atmosphere. However, market failures attributed to the distribution and utilization of these resources resulted in the decline in the quality and quantity of natural resources. To halt this decline environmental policies are needed at all levels: From international to the local level. The policy interventions recommended by environmental economists are often market-based instruments (MBIs), like taxes, subsidies and, more recently, offset mechanisms and certification schemes. As these policies have to permeate all political levels and cross national borders, successful policy measures will have to be flexible.

MBIs have to be able to facilitate cooperation between all kinds of partners – governmental, non-governmental, companies, consumers, local stakeholders, developed and developing countries – at all kinds hierarchical levels – international, national, regional and local. Simply, policies need to be more than national measures. However, attempts to create international policies constantly run into political opposition (Angelsen, 2008; Hulme, 2009) or fail for reasons inherent to the policies themselves (Babiker, 2005; Duffy, 2006; Kuik & Gerlagh, 2003). Analyzing the applicability and effectiveness of environmental policies and their interplay with the cooperation of stakeholders, from the local to the international level, is the topic of this dissertation.

The first of these analyzed policies, which chapter 2 examines, is the EU reaction to the increasingly pressing problem of energy security and climate change mitigation. As one policy measure, the EU decided to bolster the biofuel industry (Florin & Bunting, 2008). The main policy instrument for an increase in biofuel use is a mandatory biofuel blending quota (Schnepf, 2006). While some of the newer EU member countries increased their production capacities as a reaction to the new legislation (European Biodiesel Board, 2008), a substantial amount of biofuel raw material had to be imported from outside of the EU; i.e. it takes international cooperation in bioenergy production to satisfy the demand caused by production increases. In fact, the increase in trade of canola oil for non-food use, the main raw product this research looks at, was almost solely due to an increase in EU imports (FAOSTAT, 2009).

Another environmental protection measure against climate change the EU takes part in, is the Kyoto Protocol. Under the provisions of the Kyoto Protocol, the Clean Development Mechanism (CDM) helps developing countries to partake in climate change mitigation by granting tradable emission credits to project developers who prove a reduction in emissions (Kyoto Protocol, 1997). This mechanism is the focus of chapter 3. About 80 per cent of these CDM projects are the result of collaborations between partners in an eligible developing country and a counterpart in an industrialized country (UNFCCC, 2010). African countries hold a surprisingly small share of existing CDM projects. This is true even when African countries' economic capability, total emissions or other factors identified in literature as important to CDM partnerships like ODA, trade and FDI (Dinar, Rahman, Larson, & Ambrosi, 2008; Dolšak & Bowerman Crandall, 2007; Winkelman & Moore, 2011) are considered.

Although CDM as an MBI has had limited success, there may be other MBIs that could be more applicable to Africa and its ecosystems. In its analysis of MBIs for ecosystem protection, chapter 4 especially considers wetland ecosystems. Wetlands have a far-reaching impact on the global ecosystem due to their many ecosystem services (ESS), despite covering less than 10 per cent of the Earth's landmass (McCartney, Rebelo, Senaratna Sellamuttu, & de Silva, 2010; Mitsch & Gosselink, 2007). Accordingly MBIs minding the complexity in these ecosystems are necessary and need to be evaluated.

However, even beyond the case of wetlands and beyond what official statistics let on, protected areas (PA) are endangered. As the overview chapter 5 shows, especially in sub-Saharan African countries protection is usually carried out by state organizations which often do not have full or even any control over enforcing environmental protection (Duffy, 2006; Wilkie, Carpenter, & Zhang, 2001). Better protection mechanisms are needed. However, the appropriate mechanism is not only determined by the different enforcement measures but also by the institutional and social environment, as well as the way of financing projects. These complex dynamics of institutional, social and financial constraints may lend themselves to an MBI solution. State-led instruments usually do not offer the opportunity to find financing partners from other countries. Innovative MBIs which can do that exist though. They could combine setting the incentives right, which a command and control measure might fail to do, and providing finances in the same cooperative scheme. However, domestic financers as well as those from abroad need to be sure of the effectiveness of innovative MBIs even in sub-Saharan circumstances.

As much as a project is dependent on finances, though, it is dependent on local stakeholders as well. As chapter 6 shows, local stakeholders' decision making and especially their reaction to their own environmental problems are key to enacting policies on the ground. No MBI can work properly if stakeholders do not react to incentives in the way anticipated by policy makers. To successfully implement MBIs in rural communities, the instruments have to fit communal societies. Innovative MBIs need to be constructed so that the existent cooperative institutions can be interwoven with new structures.

1.2 Research objectives

The overarching objective of this thesis is an analysis of cooperation in the production and trade of environmental goods and services and the policies which facilitate that. The research assists efforts of environmental protection which go beyond national and regional political measures by providing research on alternative policy measures. In this context, the research questions of this thesis are:

1. How do EU policies influence international trade of bioenergy? (Chapter 2)
2. What facilitates the coordination in CDM projects between industrialized and developing countries? (Chapter 3)
3. According to theory, which market-based instruments are best used for ecosystem protection in the presence of complex ecosystem interactions? (Chapter 4)
4. What market-based instruments for ecosystem protection are applicable to the situation in sub-Saharan Africa? (Chapter 5)
5. What are the drivers in a community to adopt policies for ecosystem protection? (Chapter 6)

These five research questions will be answered in chapters 2-6. Chapter 2 starts with an analysis of the impact of EU bioenergy regulations on trade of intermediate goods for biofuel production to answer question 1. Chapter 3 provides an analysis of partnerships between actors in different countries for Clean Development Mechanism (CDM) projects to answer question 2. It specifically focusses on the lack of African CDM projects. To answer question 3, chapter 4 deals with an analysis of MBIs for ecosystem protection. Though the results are generalizable to other ecosystems, the analysis is geared towards wetland protection. Chapter 5 contains an overview of existent international MBI schemes and focusses on MBIs which are applicable to sub-Saharan African countries, and so answers question 4. To answer question 5, chapter 6 analyses behavior of local actors and reevaluates common-pool resource governance measures and, more generally, the experimental method as evaluation tool. The common-pool resource experiments were conducted in the Namibian nature conservancy Sikunga.

1.3 Methods

This dissertation contains a number of methods for the evaluation of environmental policy measures. Methodologically, chapters 2 and 3 are based on the gravity model. This model is well suited to analyze any flow between two entities, for example, the trade in bioenergy raw material, which is the topic of chapter 2. The gravity model is an established and valid method for trade analysis. It is based on the original economic models of Tinbergen (1962) and Pöyhönen (1963) and the theoretical backing of its use have been provided by Anderson (1979), Bergstrand (1985, 1989) and Deardorff (1998). Some additions have been made to the model over time, which are necessary in the bioenergy context as well. Since the bioenergy trade analysis is an analysis of a specific good, the data set suffers from what is commonly called a zero-inflation: Many potentially trading pairs of countries do not trade bioenergy raw materials. In response, the gravity model is estimated using a two-step Heckman procedure, as advised by Linders & de Groot (2006). More recently highlighted concerns about gravity trade analysis by Anderson & van Wincoop (2003) are multilateral resistance and suspicions of spatial autocorreletation. These two problems are countered by the appropriate methods described in Behrens et al. (2007) and Porojan (2001), and applied in chapter 2.

For the analysis of CDM project partnerships in chapter 3, however, a simpler gravity model suffices. While there are no multilateral resistance and spatial autocorrelation problems, the CDM data demands a panel analysis. Accordingly the regressions of chapter 3 use dummy variable least squares (DVLS) to yield fixed effects results.

As opposed to the empirical analysis of chapters 2 and 3, chapter 4 analyses the effectiveness of certain MBIs on a theoretical basis. The comparative statics analysis starts by formulating a utility function for a wetland holder. This utility function is then extended with a term capturing the externalities of using the ecosystem as an input to production. These equations respectively represent the privately and socially optimal use of the ecosystem. The difference between the two is discussed based on results from comparative statics. Once the privately and socially optimal use of the ecosystem is established, these equations operate as a baseline. This baseline is then compared to a maximization of private utility under the regime of three different MBIs.

Chapter 6 returns to empirical analysis. It blends the two empirical methods of experimental field analysis, which follows on from the influential work of Ostrom and colleagues (Gardner, Ostrom, & Walker, 1990), and regression analysis. Each of the two methods covers one layer of behavior. The experiment reveals data on the cooperation within the groups of participants when faced with the potential overuse of a common pool resource. Following the call of Anderies et al. (2011), as a methodological improvement the experiments presented here were purposely framed with different environmental contexts to analyze the difference in reaction of participants. To gain more detailed insight into the method of common pool resource experiments, I combine the experimental results with regression analysis, following the Tobit specification of Velez et al. (2009). Regression results help illuminate the impacts of framing and the observed participant motivation factors beyond just the simple descriptive and purely experimental data. The focus of this analysis of factors for decision-making is on rules, conformity (Hayo & Vollan, 2011) and framing.

1.4 Results

Chapter 2 answers the question, what influence EU policies have on trade flows; specifically if trade regulations, environmental regulations or solely industry patterns are the drivers of trade. Results of the gravity model analysis show that trade integration within the EU has a counter-intuitive, negative effect on the trade of canola oil for biofuel use. This effect is due to the import pull of the whole union. Although the EU wide pro-biofuel policy also spurs intra-EU trade, the EU consumes much more canola oil that it can produce on its own and therefore needs to import considerable volumes. This result is stable even in the presence of a proxy for production costs. Accordingly, also the main political policy, a mandatory biofuel blending quota, has a positive impact on trade: The higher the quota, the more a country trades. Further, the regression reveals that the value chain backs up this picture of the EU biodiesel sector: More home production of raw materials leads to less dependence on trade and therefore less import. Higher consumption leads to a stronger dependence and more imports. Introducing market-based policy instrument variables shows that they do not have an impact. The strong regulation through the quota determines the market, for better or worse, and renders additional instruments insignificant.

As for research question 2 on the factors of African CDM project partnerships, results of the gravity model in chapter 3 show that the reasons for project partners to engage in CDM projects are different from the reasons for the size of the accumulated certificates of CDM projects: The specific shortcoming of African countries is a lack in initial attraction of financiers. Once African countries have their initial project, they attract projects and thus CER production based on the same measurable macroeconomics factors as other CDM-eligible countries. This points to an inadequacy in the initial process of project generation as one reason for Africa’s small share of projects. As far as the full amount of certificates from projects is concerned, after controlling for the selection bias in the initiation process, having an African country in the pair of partners does not make a difference to how many certificates are created between the two countries. Further, the selection and the outcome equation show a difference with respect to two determinants: While the amount of Foreign Direct Investment (FDI) between two partners determines project initiation, trade seems to swap with FDI as a determinant as soon as the amount of certificates is concerned. The conclusion is that initial CDM projects are much more dependent on the immeasurable factors captured by FDI than is increasing the number of projects (and therefore certificates). For an increase, trade seems to matter, while FDI does not. Since there is no reason to suspect that engaging in trade itself has a causal effect, the conclusion is that trade serves as a proxy for its immeasurable determinants like personal and institutional relationships, just as FDI does for an initial project between a pair. Accordingly this research supports past policy decisions to increase cooperation at the political level for project initiation. Partnership facilitation is especially important where new projects are concerned (Hinostroza, 2008), and the conclusion of research on CDM’s dependency on present technical, procedural and institutional capabilities (Desanker, 2005; Ellis, Winkler, Corfee-Morlot, & Gagnon-Lebrun, 2007; Karani, 2002; Michaelowa, 2003) will be helpful in this regard.

The most interesting result of the comparative statics analysis of MBIs in chapter 4 is that product certification might have an overall negative effect. As the negative impact of the certified product on other products declines, production of these other goods becomes more appealing, which in turn might have negative impacts on the ecosystem's integrity. Therefore, the effectiveness and efficiency of product certification hinges on the indirect effects through other production in that ecosystem. This does not mean that certification can be dismissed, but rather that it ranks as an applicable second-best option next to mitigation trading and wetland certification. These other two analyzed policy options do not suffer from drawbacks such as the indirect effects of product certification. If parameters were set right, mitigation trading or wetland certification would lead to a socially optimal outcome by providing the right incentives to wetland holders. However, setting these parameters right is a considerable practical problem. In practice, for example, it will be hard to agree on how to measure certain types of damage to ESS such as biodiversity (de Groot, Alkemade, Braat, Hein, & Willemen, 2010), as would be necessary for mitigation trading to be all-encompassing over the different ESS. Similarly, agreeing on goals for wetland management and measuring them might be a practical drawback to wetland certification. However, as the results show, going as far with these instruments as possible realizes efficiency potential. Thus, the theoretical analysis shows that offset mechanisms akin to the ones created following the Kyoto Protocol would indeed be applicable to the protection of ecosystems. Further, the theoretical analysis of an offset mechanism for ecosystem protection shows that an offset mechanism is similarly efficient as a wetland certification mechanism and superior to a solution based on subsidies (which is analogous to product certification as far as the theoretical model is concerned).

Chapter 5 contains an overview of existing international MBI schemes. The overview is geared towards the situation in sub-Saharan countries, its political, institutional and social environment. These factors make the choice, implementation and financing of MBIs particularly difficult. The overview takes this into account by focusing on concepts from the strand of 'Integrated Natural Resource Management', which have been applied more recently (Ash et al., 2010; Carew-Reid, 2003; Reid, Berkes, Wilbanks, & Capistrano, 2006), and are financed or at least able to be financed, by international partners.

Chapter 5 also contains three broader categories of instruments: Carbon markets (CDM, REDD and related schemes), sustainability certification and product certification. Though many of these schemes are applicable to the African situation in principle, they demand a high effort from local partners and often demand a project scale which is unrealistic in a sub-Saharan context. Implementation certainly suffers from the local social, financial and institutional situation, but environmental protection schemes can be improved by keeping these things in mind. The overview demonstrates that protected areas (PAs) do not have to stay what is known as 'paper parks'; PAs which exist only on paper but do not fulfill any of a PA's function. A properly working international MBI could link all actors in the necessary value chain, from local stakeholders to international financiers and their customers. However, even with international MBIs which are less dependent on national governments, transaction costs for application, verification and enforcement will be problematically high.

Chapter 6 finishes this dissertation with an analysis of local stakeholder group decision making when confronted with a common-pool resource dilemma. The bare results on the effectiveness of governance treatments of experimental groups have shown that all kinds of introduced governing rules (cheap talk, unlikely punishment for unsocial behavior and likely punishment for unsocial behavior) make a difference to the behavior of participants and improve the situation. However, rules differed in progress and sustainability of effect.

The results of the regression analysis based, among other things, on the introduction of governance treatments shows that conforming to the behavior of the rest of the group plays a role as long as the consequences of unsocial behavior are less certain. However, if more certain consequences (i.e. likely fines) are introduced, conformity becomes insignificant. Context consistently swayed participants to behave a certain way, especially if they identified as gaining their livelihood from within context (e.g. fisherman participating in a fishing based common-pool resource experiment), and other factors like leadership and group cohesion had the expected effect on behavior as well. These results hold one important behavioral and one important methodological implication. Behaviorally, it matters what a participant thinks the others do, as long as the rules are not strong enough to render a good prediction of other's behavior. Methodologically, the experiment shows that the degree of abstraction and sort of behavioral pattern the experiment invokes need to be considered in experimental design. Generalized experiments might grant representative insights, but they might not be applicable to the situation even at the site of the experiment. If these insights are meant to lead to changes at the site of the experiment, the experiment should be tailored to it. Otherwise it runs the risk of not being specific enough and implying inefficient or even wrong policies.

All in all the results of my dissertation show the potential but also the many complexities of MBIs. Establishing them cannot possibly be done in a one-size-fits-all manner. Even if we could abstract from the surrounding macro-economic and political circumstances, the differences in ESS and in stakeholder perceptions and preferences make a case-to-case consideration inevitable. Finding a system or frame that can include and manage this kind of economic, ecologic and social diversity without losing the efficiency of markets will be a future challenge of environmental economists.

1.5 Thesis Structure

Chapter	Authors	Title	Published/ Presented
2	D. Röttgers A. Faße U. Grote (2012)/(2010)	The Canola Oil Industry and EU Trade Integration: A Gravity Model Approach	Published in: Operations Research Proceedings 2012 - GOR (Gesellschaft für Operations Research e.V.); ISSN: 0721-5924.
			Earlier version published in: Proceedings of the German Development Economics Conference, Hannover 2010 No. 32, Verein für Socialpolitik, Annual International Conference of the German Economic Association 2010 http://www.econstor.eu/bitstream/10419/40018/1/306_roettgers.pdf.
			Faße, A., Grote, U. and D. Röttgers (2009): Analysing the EU Canola Oil Trade with Developing Countries: A Gravity Model Approach. Paper presented at Tropentag 2009, Oct 6 - 9, 2009, Hamburg, Germany.
			Faße, A. and D. Röttgers (2009): An Analysis of EU Canola Oil Trade for Biodiesel: A Gravity Model Approach. Paper presented at the International Conference on Applied Business Research (ICABR) 2009, Sept 21 - Sept 25, 2009, Ravello,Italy.
3	D. Röttgers U. Grote	Africa and the Clean Development Mechanism: What Determines Project Investments?	Submitted to the journal *World Development*.
			Röttgers, D., Grote U. (2010). Bilateral CDM-flows: Stand-alone or substitute for FDI and aid. Paper presented at the 117th EAAE Seminar 2010, Nov 25 - 27, Hohenheim, Germany.
			Röttgers, D. (2010): Bilateral CDM-flows: Stand-alone or substitute for FDI and aid. Paper presented at Tropentag 2010, Sept 14 – 16, Zürich, Switzerland.
4	D. Röttgers A. Segerstedt	The Economics of Ecosystems: Market-Based Instruments and Effective Protection Strategies	Röttgers, D. and A. Segerstedt (2011): Efficiency of Market Based Instruments for Protecting Ecosystems: The Example of Wetland. Paper presented at 18th Ulvön Conference on Environmental Economics 2010, June 21 – 23, Ulvön, Sweden.
			Röttgers D., Segerstedt A. (2011). The Economics of Ecosystems – An Integrated Institutional Approach. Paper presented at the International Conference on Climate Change, Agri-Food, Fisheries, and Ecosystems 2010 (ICCAFFE), May 20 – 22, Agadir, Morocco.
5	T. Stellmacher D. Röttgers U. Grote E. Winter	Financing Protected Areas in sub-Saharan Africa through International MBIs	Submitted to the journal *Development Policy Review*.
6	D. Röttgers	Conformity, Leadership and Why Strong Rules Work – A Namibian Common-Pool Resource Experiment	Röttgers, D. (2013). The Strategy of the Commons – What determines cooperative behavior in common-pool resource experiments? Paper presented at the 7th Annual Meeting of the US Society for Environmental Economics 2013, June 9-12, Burlington, USA.

Note: Authors contributed to the chapters of this thesis as follows. Anja Faße and Dirk Röttgers equally shared work on secondary data collection, model estimation and writing of chapter 2, while Ulrike Grote took on a supervisory role and provided suggestions on results and general contents. Dirk Röttgers provided the idea, data collection, modeling, calculation and writing of chapter 3, while Ulrike Grote had a supervisory role and provided suggestions on results and general content. Anna Segerstedt and Dirk Röttgers equally shared writing and modeling in chapter 4. The concept and major parts of research in chapter 5 were contributed by Till Stellmacher; Dirk Röttgers mainly contributed chapter 5.3, editing and paper design, while Etti Winter and Ulrike Grote added and revised sub-chapters, took on a supervisory role and provided suggestions on results and general contents.

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2 The Canola Oil Industry and EU Trade Integration: A Gravity Model Approach

Abstract

In the last years, biodiesel used for blending of fossil fuels has become prominent in European Union (EU) countries. The rapidly increasing domestic production and consumption of biodiesel is accompanied by increasing trade flows of inputs such as crude vegetable oil from canola seeds into the EU. It is questionable which factors significantly determine the trade of canola oil used for biodiesel production in the EU. Two factors are emphasised: (1) Bioenergy policies and (2) Potential trade barriers for non-EU countries. A sector-specific analysis taking industry patterns into consideration is necessary to evaluate the impact different policy instruments on trade flows. A common way to analyse trade flows is the so-called gravity model, which is applied here. Because of zero-inflated trade data, the model is expanded using the Heckman approach and augmented by spatial weights and Anderson and Van Wincoop's controls for multilateral resistance. The obtained results suggest that while the mandatory biofuel blending quota has a significant positive impact, investment subsidies cannot be shown to have any effect. Trade integration even has a trade inhibiting effect among EU members. The latter result can be explained by an exhausted domestic European market for raw and intermediate materials for biodiesel and proves stable even when controlling for sector specific variables.

2.1 The Production and Trade Situation in the Biodiesel Sector

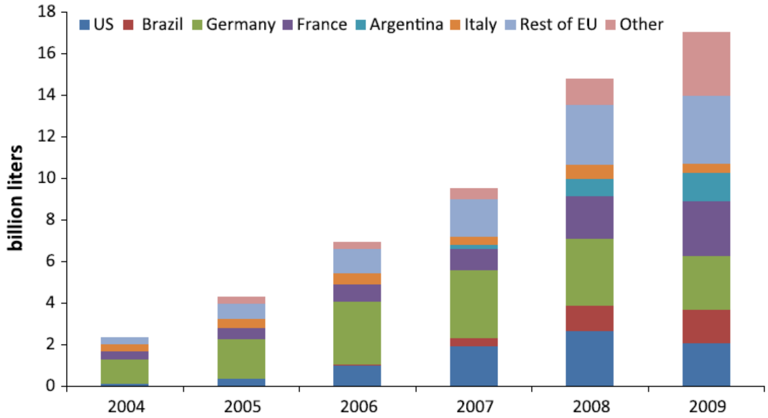
In recent years, many developed countries emphasized the support for the production of biofuels in their political agenda (Butterbach-Bahl and Kiese, 2013). This new interest in biofuels arose mainly from the quest for increasing national energy sovereignty. Specifically, governments aimed at becoming more independent from fossil fuels - due to strong fluctuations of crude oil prices - and reducing emission of greenhouse gases (Florin and Bunting, 2009). Hence, the European Union (EU) set mandatory quotas introduced by the Biofuel Directive 2003/30/EC to encourage the use of biofuel within the European transport sector: 2 per cent by the end of 2005, 5.75 by 2010 and 10 per cent by 2020 (Schnepf, 2006; Lamers et al. 2011).

Further national and supranational measures followed, such as raising excise taxes or providing capital subsidies for green investments (Kutas et al., 2007). These political requirements set by the Commission at the supranational level are passed down to and enforced by the individual states at the national level. In the case of the mandatory biofuel quota, this resulted in different pathways of EU member states for the fulfilment of these requirements. For other measures the picture is even more diverse: Capital subsidies and excise tax raises, for example, are fully implemented in some countries while non-existent in others (Wiesenthal et al., 2009). Transfers associated with these EU policies in support of biofuels amounted to around 3.7 billion Euros in 2006 alone (Kutas et al., 2007). However, many European member states have not succeeded in reaching their targeted blending quota yet (Charles et al. 2013).

With these market stimulating policies, Europe has quickly become the world's most important producer of biodiesel (Timilsina and Shrestha, 2011) (Figure 2.1).

The main biodiesel feedstock in the European Union is canola oil (Lamers et al. 2011; Firrisa et al. 2013). However, Landeweerd et al. (2012) stated that it is not very likely that the EU is not able to produce the biomass needed for biodiesel domestically at its own. Therefore, additional canola oil is imported into the EU. Indeed, the import volume of canola oil is smaller compared to other vegetab le oils such as palm and soybean oil, though its relevance for the European biodiesel sector is significant (Lamers et al. 2011). Figure 2.2 shows the increase of canola oil imports in the past. As can be seen, the import increase can be partly attributed to the European Union, especially in the period from 2003 to 2006 when the biodiesel production in Europe soared. The political setting lead to a biodiesel market in the European Union which is mainly demand driven through the mandatory biodiesel quotas set in the transport sector. Banse et al. (2008) confirmed based on a CGE model that, without policy intervention stimulating the use of biofuel crops, the mandatory blending quota will not be met.

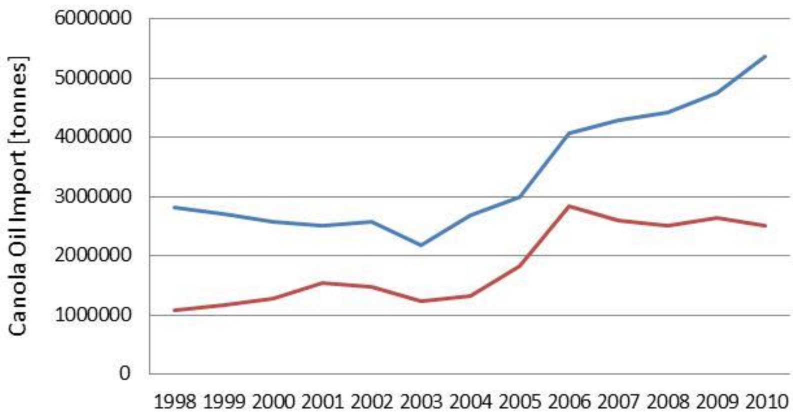
Figure 2.1



Source: Timilsina and Shrestha (2011)

Figure 2.1: World biodiesel production 2004-2009

Figure 2.2



Source: FAOStat (2013)

Figure 2.2: Canola oil import of the European Union (lower curve) in tonnes, (upper curve: World Import)

Due to available land, labour, and favourable climate developing countries are regarded as a suitable producer and exporter of biomass (Landeweerd et al., 2012). These countries' governments, especially net importers of crude oil, value biofuels as a means for stimulating their economy and reducing the dependency on fossil fuels (Arndt et al. 2011). Although most developing countries are still lagging behind in biofuel implementation on a larger scale, they aim at participating in the production of biomass utilized for the biofuel production.

Lamers et al. (2011) hypothesised that the promotion of domestic biofuel in the EU affects the pattern of international biofuel trade. The authors assumed that import duties significantly influence trade volumes often resulting in trade barriers for less developing countries. It is obvious that being a member of the EU makes a difference for trade patterns of a country. Thus it creates a difference among members and, more importantly, between members and non-members.

The aim of this paper is to analyse the determinants of canola oil trade based on a gravity model. We assess the impact of the two important factors derived from the literature from the perspective of the European Union: Trade regulations and bioenergy policies. To correctly analyse this question, biodiesel production and consumption patterns have to be taken into consideration as well. Therefore the employed gravity model is expanded with sector specific variables.

The paper is organized as follows: Section 2.2 provides an overview of the gravity model and its specification and the data set used here. Section 2.3 shows the results of the model estimations and interpretation. Based on these results, section 2.4 concludes.

2.2 Methodological Framework and Data Collection

To analyse trade relationships for canola oil, we apply the gravity model based on the Newtonian formulation of the gravitational concept. The gravity model describes the amount of trade between two countries as directly related to the size of the two countries involved and inversely related to the geographical distance between them (Bergstrand, 1985). The basic theoretical model of the gravity model on trade between two countries takes the following form:

$$X_{ij} = A \frac{M_i M_j}{D_{ij}} \tag{1}$$

Here X_{ij} represents the trade flows in values from origin i to destination j. A is a constant of proportionality. M_i and M_j are indicators for the economic sizes of origin i and destination j, respectively, reflecting the ability to produce and consume. D_{ij} represents the distance between the trading countries. It functions as a proxy for transaction costs including transport costs which generally decrease trade.

Since the first application of the gravity model by Tinbergen (1962) and Pöyhönen (1963), its use has been justified on theoretical grounds by Anderson (1979), Deardorff (1998) and Bergstrand (1985, 1989). The model has been used for the analysis of bilateral flows as diverse as tourism (Lerch and Schulze, 2007) and migration (Afifi and Warner, 2008), but mainly for trade flows (e.g. Anders and Caswell, 2007; Martínez-Zarzoso et al., 2008; Rose, 1999). A gravity model applied to estimate the determinants of bioenergy trade has not been found in the literature yet.

The model can be expanded by other possible influential factors. However, when including other variables in equation (1), a choice has to be made between including it in a multiplicative or other form. After taking logs on both sides of the equation, a variable added multiplicatively. A variable added to equation (1), which is the power of the Euler’s number, would however enter the regression as just one more summand. Compared to economic sizes of countries, it has to be determined if the new variable would automatically lead to zero trade if itself is zero. If that is the case, it would enter the gravity equation in multiplicative form. Otherwise it can be made the power of Euler's number for convenience, so it is just one more straightforward summand in the regression equation.

The flow analysed here is the import of canola oil for non-food use (TARIC: 15141110) into EU countries (EU Export Helpdesk, 2009). The data set is based on the trade data from 2006. It spans trade of 39 different countries, 23 EU members and 16 non-EU countries, leading to 1300 potential pairs of trade partners. However, by far not all of those 1300 actually trade; only 107 do. This leads to what is known as a zero-inflated dependent variable. Unfortunately, simply eliminating the irrelevant cases of non-trading pairs is not possible because there is no easy way to distinguish between relevant and irrelevant cases.

However, since this zero-inflation can be treated as a selection bias problem, it can be resolved using the method of Heckman (1979) as advised by Linders and de Groot (2006). Among the possible specifications, Martin and Pham (2008) prompt to use the two-step-Heckman approach for this specific case. With this specification, the Heckman method calculates a selection equation in its first step. This equation tries to determine the impact of certain factors on the probability to trade canola oil at all rather than their impact on the amount traded. Consequentially, the dependent variable for this equation is a dummy which is equal to 1 if trade actually occurs between the pair and 0 otherwise. The selection equation used here contains the classic gravity variables 'economic sizes' and 'distance', and is augmented by canola seed production and block fixed effects, which are explained further below.

The results of the selection equation allow the calculation of the so-called inverse Mill's ratio (IMR). To counter the bias caused by the zero-inflation, the IMR can be introduced into the outcome equation, which includes the variables of interest. If it is significant, it is interpreted as an account for an assumed selection bias.

Even with this correction the outcome equation might still suffer from two more flaws. These two other possible problems are omitted multilateral resistance and spatial autocorrelation. Omitted multilateral resistance is caused by the lack of inclusion or observability of countries' alternatives to trade with a particular partner. While the amount of actual trade between two partners can be measured, the amount of potential trade occurring if certain factors of trade were different is impossible to know. This is not a new concept to the gravity model: The distance term already tries to control for the resistance to trade. However, as Anderson and Van Wincoop (2003) argue, this is not enough. There are other factors about possible trade partners which are not included in a standard gravity analysis. Therefore, they advise to use a term controlling for prices in potential other trade partner countries and transaction costs.

This would require vast amounts of data on prices, not only of goods, but also of transport and information services. Since these data are not available for the canola oil case, the proposed model here reverts to a method described in Behrens et al. (2007). Instead of calculating the omitted multilateral resistance term from a plethora of data for all countries, a fixed effects dummy is introduced for every country. This dummy is assumed to hold constant for all immeasurable factors concerning trade this country faces, thereby controlling for omitted factors causing resistance to trade.

By the assumption, these dummies rather serve as indicators for having trade at all than having more or less trade. Therefore, they are introduced in the selection equation rather than the main regression. Instead of using these country fixed effects as proposed by Behrens et al. (2007), the selection equation contains effects for country blocks. This is done to save degrees of freedom and essentially does not yield results very different from the use of country fixed effects due to the composition of countries in our data set.

Unlike multilateral resistance, which deals with the availability of trade alternatives, a further possible problem, spatial autocorrelation, deals with trade similarities. This kind of autocorrelation stems from being part of a cluster of traders or, conversely, being remote from clusters. As suggested by Porojan (2001), to correct for the part of trade that is explained by being part of a cluster, spatial weights are included in the gravity model. These weights summarize the relationship of the importer to all its trade partners relative to all other trade partners. They are used to weigh the dependent variable, which is then introduced as another right hand-side variable. Thus the part of trade caused by the importer being part of a cluster is controlled for. The most relevant kind of cluster is a geographical one. Therefore, the model here includes distance weights. Distance weights are $w_{ij} = (1/d_{ij})/(\sum 1/d_{ij})$. Here d_{ij} is the distance between the importer i and the exporter j and therefore the sum is the sum of distances between the importer i and the exporters j.

Additionally to distance, measured in kilometres according to a geographical approach developed in Mayer and Zignago (2006), the previously described IMR, country fixed effects and weighted trade values, the two regressions contain the following variables.

The total GDPs in current dollars taken from the IMF (2009) are used to account for the economic sizes of the trade partners in the selection equation. In the outcome equation total GDP of the exporter is replaced by the total GDP produced by agriculture, taken from Earthtrends (2007). The size of the agricultural industry reflects the ability to produce and therefore export canola better than the less related total GDP. If both countries of the pair are members of the EU in 2006, the 'EU Both Dummy' is equal to 1 and 0 otherwise. There are two variables indicating political intervention. The first, biofuel quota, is compiled using mainly the REN21 (2009) database and Kutas et al. (2007), complemented by individual country data, for a mandatory quota for the amount of biodiesel that has to be blended with conventional diesel. The second is a dummy indicating if a capital subsidy for green energy projects exists taken again from the REN21 database. Furthermore, the model includes three variables describing the biofuel industry. Production cost ratio is an indicator for the disparity between the costs of production in the respective countries in a given pair. The data stem from Johnston and Holloway (2007). Canola seed production and biofuel consumption in the transport sector are indicators for the size of the respective parts of the value chain. Numbers for canola seed production were taken from FAOSTAT (2009) and biofuel consumption data stem from IEA (2009). Adding the error term leaves the outcome regression as follows, with the index i denoting importer and j denoting exporter of the observed pair:

$$
\begin{aligned}
\text{Canola Import}_{ij} = \; & a \\
& + \beta_1 \log \text{GDP}_i \\
& + \beta_2 \log \text{Agricultural GDP}_j \\
& + \beta_3 \log \text{Distance}_{ij} \\
& + \beta_4 \text{ EU Both Dummy}_{ij} \\
& + \beta_5 \text{ Biofuel Quota}_i \\
& + \beta_6 \text{ Subsidy Dummy}_i \\
& + \beta_7 \log \text{Production Costs Ratio}_{ij} \\
& + \beta_8 \text{ Canola Seed Production}_i \\
& + \beta_9 \text{ Canola Seed Production}_j \\
& + \beta_{10} \text{ Biofuel Consumption Transport}_i \\
& + \beta_{11} \text{ Biofuel Consumption Transport}_j \\
& + \beta_{12}\, w_{ij} * \log \text{Canola Import}_{ij} \\
& + \beta_{13} \text{ Inverse Mill's Ratio}_{ij} \\
& + e_{ij}
\end{aligned}
\qquad (2)
$$

To prevent skewing of results through outlying observations, the most likely candidates identified by both a QQ-plot and Cook's distance are removed. Moreover, the models are tested for heteroscedasticity with a Breusch-Pagan test and for multicollinearity using the variance inflation factor. The goodness of fit is verified by the Akaike’s information criterion.

2.3 Results

The results of the selection equation are shown in table 2.1 in order to identify the variables explaining the (non)-participation in canola oil trade. The coefficient for the exporter's as well as the importer's GDP are positive and significant. From the point of view of the importer, this suggests that the size of the economy has a pull effect on the probability of canola oil import. Similarly the GDP of the exporter countries is according to the expectation acting as a proxy of national economic output expressed in monetary units. As expected, distance has a significant negative effect on the probability of canola oil trade. This is consistent with the usual interpretation of the distance variable as a proxy for transaction costs: A longer route between two places will cause larger travel costs and is often also associated with other transaction costs such as costs of communication and information to bridge geographical, cultural and linguistic divides.

All regional 'block'-variables controlling for fixed-effects have a positive significant effect on the probability of canola oil trade except for an insignificant non-EU-European Block representing European countries not being a member of the European Union. This might be surprising since being closer to the EU should lead to a higher probability for trade relationships between non-EU Europeans and EU countries. However, large parts of this effect are taken up by the distance variable already. Exporters' production of canola seeds for canola oil has no significant effect on the probability to export canola oil, whereas the importers' production of seeds decreases the probability of importing canola oil.

Table 2.1: Selection equation of the Heckman model

Dependent Variables	Independent Variable: Existence of Intern. Canola Trade (1=yes)	
	Coefficient	**t-value**
Intercept	3.09 ***	3.72
Log GDP_i	0.40 ***	8.13
Log GDP_j	0.31 ***	6.03
Log $Distance_{ij}$	-1.18 ***	-10.18
Block North $America_j$	1.35 ***	3.83
Block South $America_j$	1.44 **	2.52
Block $Non\text{-}EU\text{-}Europeans_j$	0.27	1.33
Block $Asia_j$	1.43 ***	2.99
Block $Africa_j$	1.76 ***	4.85
Log Canola Seed $Production_i$	-0.04 *	-1.72
Log Canola Seed $Production_j$	0.02	0.79
Adjusted R^2	0.34	
AIC	492.60	
N	1295	

Denotation: i = importer, j = exporter; *Significant at 10%, **Significant at 5%, ***Significant at 1%; Source: Own calculation.

The results of the second step - the outcome equation - of the gravity model are shown in table 2.2. The outcome equation is used to estimate the determinants affecting the amount of the actual trade volume. The sample size for the sample of trading pairs is 107. Nine outliers needed to be dropped due to an unduly high influence on the outcome of the estimation process according to QQ-Plots and Cook's Distance. The dependent variable is the log-transformed import volume in Euro.

The Global Moran's I statistic as a measure for spatial autocorrelation in the data set suggests negative spatial correlation. To correct for the spatial autocorrelation, the variable 'value weighted distance' has been included in all four models. It uses a distance related weight on the trade value. The results show that 'value weighted distance' is robust and significant. Therefore we can conclude that cluster effects exist and are controlled for.

As indicated in all four estimations by a significant coefficient for the IMR, zero-inflation caused omitted variable bias and was countered by introducing the IMR. It also carries the country fixed effects from the first stage into the second stage of the regression.

The first estimation shown in table 2.2 represents the basic gravity model including only total GDP of the importer and the agricultural GDP of the exporter and the distance between them. Here, only the distance as a measure for transaction costs has a significant impact on trade and interestingly exhibits a positive coefficient. As opposed to the selection model result, distance does not seem to act as a barrier in terms of additional costs due to transportation and other distance-related transaction cost. An economic explanation could be economics of scale in terms of production and transportation costs.

Table 2.2: Outcome equation: Determinants of canola oil import to the European Union

Variables	**Basic Gravity Model**		**+ Trade Integration Effect**		**+ Biofuel Policy Effect**		**+ Value Chain Effect**	
Dependent Variable	Log (Import Value Canola Oil)							
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Intercept	4.89***	2.51	9.40***	3.92	9.14***	4.02	11.15***	4.99
Log GDP$_i$	0.23	1.20	0.39**	2.04	0.23	1.20	0.19	0.75
Log Agricultural GDP$_j$	-0.01	-0.09	0.06	0.34	0.01	0.06	-0.22	-1.19
Log Distance$_{ij}$	1.04***	3.61	0.40	1.15	0.26	0.83	-0.04	-0.12
EU Both$_{ij}$ Dummy			-1.83***	-3.00	-1.98***	-3.51	-1.67***	-3.05
Biofuel Quota$_i$					0.90***	2.87	0.85***	2.79
Subsidy Dummy$_i$					0.98	1.22	1.18	1.45
Log Product. Costs Ratio$_{ij}$							0.89	0.86
Canola Seed Production$_i$							$-4.59\cdot10^{-07}$*	-1.88
Canola Seed Production$_j$							$1.72\cdot10^{-07}$**	2.04
Biofuel Cons. Transport$_i$							$8.65\cdot10^{-04}$***	2.64
Biofuel Cons. Transport$_j$							$1.30\cdot10^{-04}$**	2.10
Value Weighted Distance$_{ij}$	$4.16\cdot10^{-06}$***	6.39	$4.09\cdot10^{-06}$***	6.54	$3.79\cdot10^{-06}$***	6.72	$3.21\cdot10^{-06}$***	5.68
Inverse Mill's Ratio$_{ij}$	-0.64**	-2.37	-0.59**	-2.27	-0.58**	-2.46	-0.50**	-2.20
Adjusted R²	0.13		0.15		0.20		0.24	
AIC	429.59		429.22		408.94		402.12	
Breusch-Pagan Test	insignificant		insignificant		insignificant		insignificant	
Global Moran's I Test	-0.28							
N	98		98		98		98	

Denotation: i = importer, j = exporter; *Significant at 10%, **Significant at 5%, ***Significant at 1%; Source: Own calculation.

The GDP of the importer and the agricultural GDP of the exporter country are insignificant. In the case of the importer's GDP this is not surprising since GDP is a very broad indicator for the economic size included in an analysis for a very specific sector. However, the GDP generated only from the agricultural sector in the exporter country has no significant effect on the trade volume either. In conclusion, the basic gravity model, even with further specifications, does not seem to explain trade well. That is also reflected in the relatively low adjusted R^2 of 13 per cent.

In the second model, the dummy variable for EU trade integration, 'EU Both Dummy' is added. A negatively significant coefficient indicates that the trade volume is higher if one of the partners is a non-EU country. This is a sign that the border effect of the European Union seem not to be a trade inhibitor for trade partnership of two EU countries but rather for a non-EU/EU-partnership. That is consistent with the interpretation of the distance coefficient of the first outcome equation: It indicates that higher transaction costs due to distances and tariffs play a minor role in the trade volume. After all, if both countries are in the EU it also means that they are close neighbours, which was captured by distance before the introduction of the new dummy. Therefore, once this effect is taken up by the newly introduced ‘EU Both’ Dummy, distance becomes insignificant. This is the opposite compared to the findings of Salamon et al. (2006) who found for the European ethanol market trade diverting effects. In particularly, regional agreements reduce the linkage to international markets and increase the intra-European trade. In the case of biodiesel, the production input canola oil seems to be scarce, wherefore a trade protection would threaten the European biodiesel industry.

In the third model, biofuel quotas and a dummy for the existence of subsidizing the green industry are introduced to gauge the effect of political measures. Biofuel quotas have a positive and significant coefficient whereas the dummy for a subsidization of the green industry in the importer country is not significant. The result concerning the quota is expected since the quotas are clearly defined and their ultimate goal demands an increase in production and consumption of biodiesel. Naturally that would lead to increased imports of intermediate products, too. The insignificance of the subsidy dummy could be due to the summary of very diverse subsidization schemes that are not even necessarily targeted at bioenergy in just one dummy variable. A variable that is more differentiated might have yielded a clearer result.

Lastly, the fourth and best specified model controls for up- and down-streamed value chain stages of the biodiesel chain. To avoid multicollinearity between the possible value chain variables and endogeneity with the dependent variable, we introduced only the two extreme ends of the biodiesel chain instead of variables for the whole chain: The production of raw material, for which canola seed production is a proxy, on the one hand and the consumption of the product, for which liquid biofuel consumption for transport is a proxy, on the other hand. Both parts of the value chain are assumed to affect the trade of canola oil: Raw material because of its role for sector specific supply and liquid biofuel consumption for its role for sector specific demand. For the value chain stages, all coefficients for the importer and exporter countries are significant and have the expected sign, except for the biodiesel consumption of exporter countries exhibiting a positive coefficient. This indicates that the demand in biodiesel for transport of exporter countries might have an effect on a high level of canola oil production which is not only being consumed but also exported. However, the coefficient of the importer's biodiesel transportation sector is much higher, indicating that the pull is stronger on the importer side due to a higher biodiesel consumption level.

2.4 Summary and Conclusions

The main objective of this analysis is to identify the effect of different EU policies on the canola oil import of the European Union and the trade integration of non-EU member countries. The estimation results show a negative coefficient for the EU trade integration dummy. This indicates that even though EU trade integration has been set up to foster trade among members, in the case of canola oil, EU members do rather import from outside. This negative relationship could possibly be explained by the import pull caused by exhausted input production of canola oil in the biodiesel value chain. The magnitude of a mandatory biofuel quota showed a significantly positive influence on the import of canola oil. Though not surprising, it reinforces the interpretation that demand of biodiesel is policy driven and the demand for raw or intermediate inputs for biodiesel production cannot be satisfied within the EU. Therefore these intermediates have to be imported from non-EU countries. Accordingly the answer to our research question is that 1) political measures seem to have a positive influence on trade whereas 2) the EU trade integration cannot be found to have an inhibiting effect on canola oil trade.

Apart from these results, we have to withhold judgement on the effect of further political measures since the coefficient for a green investments subsidy dummy was insignificant. This warrants a closer look at the specific kinds of different political measures and their effectiveness.

In contrast to the interpretation of distance based on the outcome equation, the decision whether to import canola oil at all is significantly negatively affected by distance, as can be seen in the selection equation. Here, a closer look at economies of scale and resource scarcity in the importer country needs to be taken. The value chain structure, which also affects the trade volume of canola oil, has to be taken into account as well.

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This chapter is a version of:

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3 Africa and the Clean Development Mechanism: What Determines Project Investments?

Abstract

The Clean Development Mechanism (CDM) under the Kyoto Protocol allows companies in developed countries to meet their carbon emission commitments by financing projects for certified emission reductions (CERs) in developing countries. These can benefit by turning their environmental problems into investment opportunities. However, African countries so far have hardly used this opportunity to implement CDM projects. This paper finds out why by identifying factors which promote CDM projects in African countries. A gravity model is used to analyze flows of CERs between host and financier countries. The special roles of foreign direct investments (FDI), official development assistance (ODA) and trade are scrutinized closely in this context. Findings show that FDI, ODA and trade have a positive influence on project attraction, even when holding determinants of these factors constant. A distinction between mere CER flow existence and CER flow size yields two additional results: FDI and trade switch places in importance as determinants for project attraction and the specific failure of African countries consist of a failure in initial attraction of investors. This points to an inadequacy in the initial process of project generation as reason for Africa's lack of projects in comparison to other developing regions.

3.1 Introduction

Only in 2005, eight years after it was drafted to mitigate global climate change, the Kyoto Protocol entered into force. It sets maximum amounts of greenhouse gas emission rights allowed per year by individual developed countries. One of the most important instruments created as a consequence is an emission rights trading scheme to manage these emission ceilings. Each country allocates the amount of rights under its ceiling to domestic companies. The main market for this is the EU Emission Trading Scheme (EU ETS) which calls these tradable rights Emission Reduction Units (ERU). The companies under such a scheme can further increase their emission rights by financing emission reduction projects in developing countries. Generally a partner finances a Clean Development Mechanism (CDM) project in return for the resulting emission rights (Certified Emission Reductions; CERs). The possibility to invest in projects abroad is an opportunity for companies and state organizations in developed countries to produce emission rights cheaper than buying them on carbon markets (Tian & Whalley, 2008). This is a targeted outcome of the Kyoto Protocol (Michaelowa & Dutschke, 1998), partly for the promotion of technology transfer to developing countries.

Though in recent years demand and therefore the price of certificates is low, the price difference between certificates like the ERU and CERs was notable in the first period after the Kyoto Protocol was enacted in 2005. But even then the opportunity for emission reduction in most developing countries was largely untapped (UN, 2010). Of the circa 3800 projects started up to spring 2010, about 80 per cent have been started by companies in developing countries with financing from partners in developed countries in return for emission rights (UNFCCC, 2010). The remaining 20 per cent of the CDM projects are financed by companies in developing countries themselves and are therefore not the cases of interest here. Of the 80 per cent, only about two per cent are located in Africa (UNFCCC, 2010). As the next section will show, the lack of overall development in Africa, when compared to other regions in the world, does not explain this small share of CDM projects. The question is: What does? Answering this first of two research question of this paper may help identifying constraints for CDM project investments in Africa. Overcoming these constraints could help African countries create payment benefits and spill-over effects attributed to CDM projects, such as technology transfer.

In this respect it is important to know which channels project realization takes. The process of starting CDM projects is long-wound and complicated. Decision-making in this process might be influenced differently by certain factors like foreign direct investment (FDI) (Dinar et al., 2008; Winkelman & Moore, 2011), trade (Dolsak & Dunn, 2006) and aid flows (Dolšak & Bowerman Crandall, 2007) at different stages. Though some of these factors might influence project creation in general, they might not be crucial for the stage at which African countries are at a disadvantage to attract projects. Other factors might be crucial at just that one stage but not at others. Identifying these factors and their more particular influence will help targeted re-structuring of either facilitating agencies at the country level or re-alignment of the CDM process. Evaluating channels and their influence on project initiation and expansion is therefore a second research question of this paper.

To set the stage for an answer to the two posed research questions, the next section will review relevant literature and describe the links between FDI, ODA and CDM projects further. After that, section 3.3 discusses the employed gravity model and data for the analysis, before the actual results of the research are presented and discussed in section 3.4. Section 3.5 will close with summarizing remarks on climate change policy and further research needs.

3.2 Background and Literature

The establishment of CDM projects, although facilitated by the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environmental Program (UNEP) and others (Hinostroza, 2008), seems to be particularly hard for African countries. Accordingly African countries lack projects compared to other CDM eligible countries. Basic economic intuition fails to explain this lack of projects in Africa, as indicated in Namanya (2008): The number of projects is small even when set in relation to factors associated with low opportunity for greenhouse gas abatement, like GDP and GDP per capita, as the following figures show.[1]

Figure 3.1

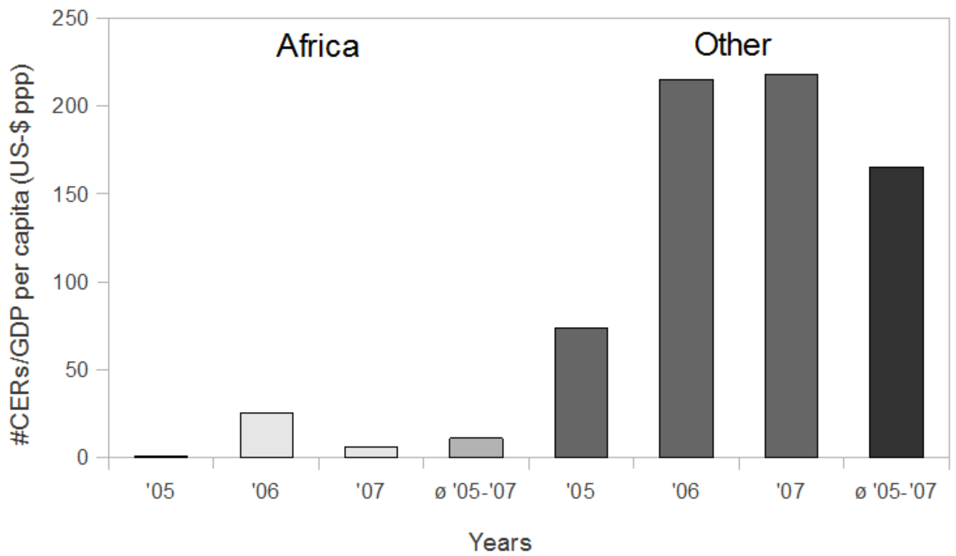

Figure 3.1. Comparison certificates relative to GDP, per capita Africa versus other eligible countries (2005-2007; source: UNFCCC (2010), World Bank (2010))

[1] The conclusions drawn from this descriptive analysis are only valid, if the assumed relationship is linear.

Figure 3.1 shows the average number of CERs per total GDP PPP per capita, a proxy for economic welfare, separately for African countries and all other eligible countries from 2005 to 2007. Figure 3.2 shows the average number of CERs per total GDP PPP, a measure for the size of the economy.

Figure 3.2

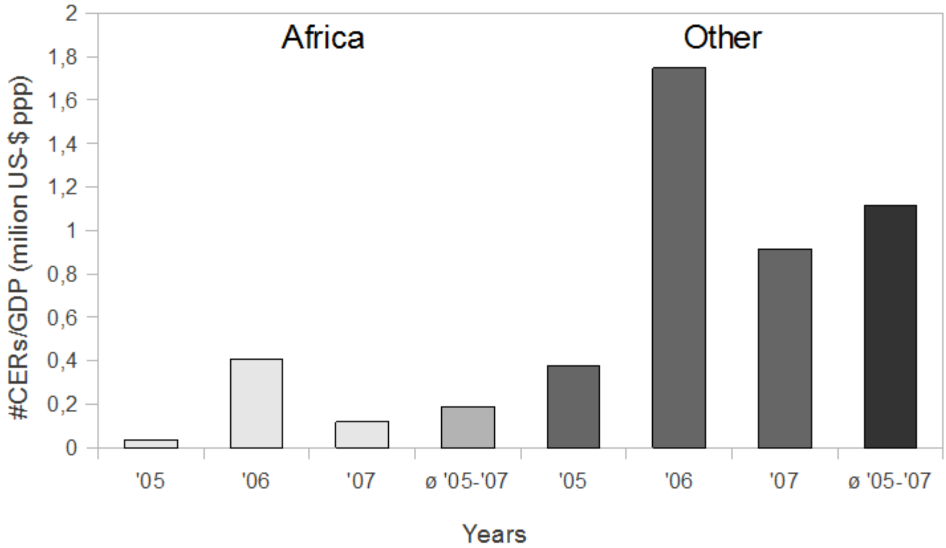

Figure 3.2. Comparison certificates relative to GDP, Africa versus other eligible countries (2005-2007; source: UNFCCC (2010), World Bank (2010))

Both, total GDP and GDP per capita have been identified as determinants of CDM partnerships (Dinar et al., 2008; Wang & Firestone, 2010): A richer or a larger economy generally point to more abatable greenhouse gas emissions and a better economic capability for abatement. But the welfare or size of an economy alone does not explain the number of CERs. As can be seen from figures 3.1 and 3.2, the conditional CER output in Africa is on average ten times lower than in other regions. Similarly, comparing numbers of CERs issued per total emissions and per capita emissions respectively, show a large gap between African and other CDM-eligible countries as figures 3.3 and 3.4 show.

Figure 3.3

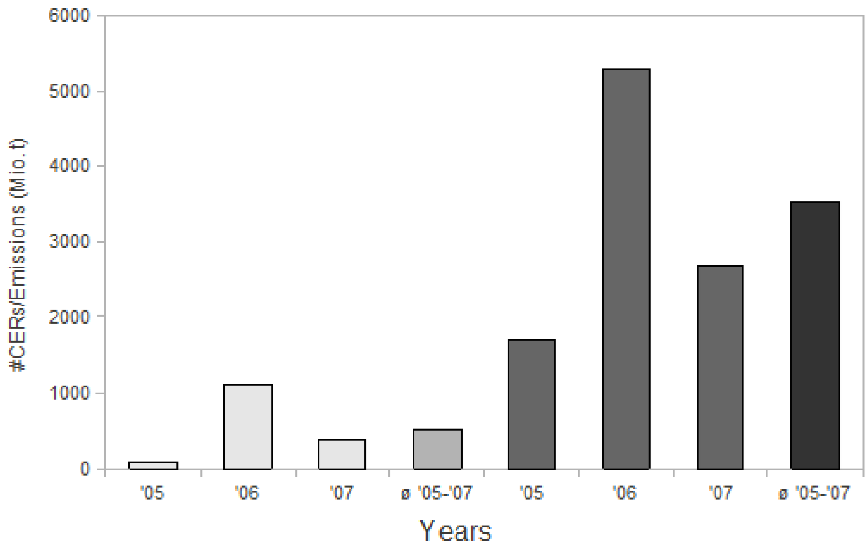

Figure 3.3. Comparison certificates relative to total emissions, Africa versus other eligible countries (2005-2007; source: UNFCCC (2010), World Resource Institute (2010))

Figure 3.4

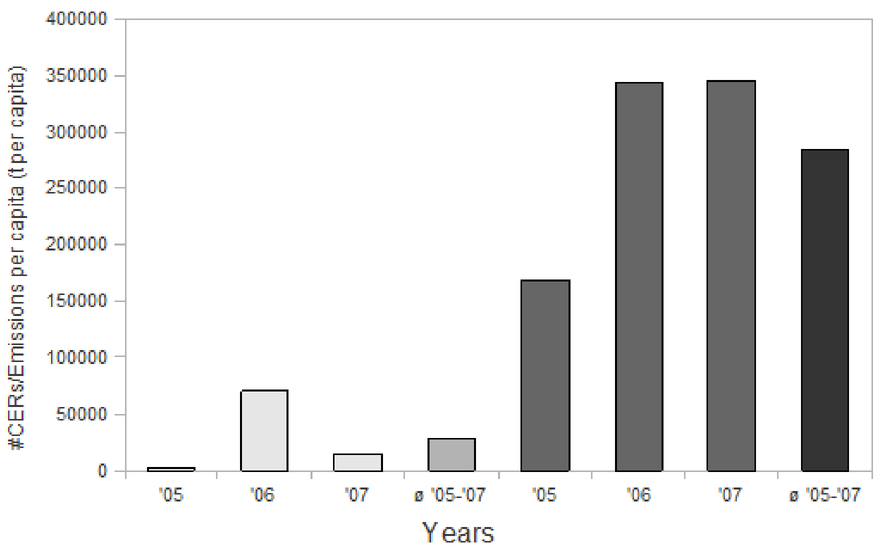

Figure 3.4. Comparison certificates relative to emissions per capita, Africa versus other eligible countries (2005-2007; source: UNFCCC (2010), World Resource Institute (2010))

If no other particular factor influences African project numbers, the relation of those indicators to CERs should be similar to that in other regions. Figures 3.5 and 3.6 clearly show, however, that even when the relation between the above discussed and previously identified determinants for CERs, FDI (Dinar et al., 2008; Winkelman & Moore, 2011) and aid (Dolsak & Dunn, 2006), are set in relation to CERs, we do not see a different picture. The figures show that Africa's smaller involvement in the CDM cannot be explained by just the simple relation between CERs and the two explaining factors FDI and ODA (as proxy for aid). If that were so, setting CERs in relation to FDI and ODA would not lead to such a high discrepancy between Africa and other continents.

Figure 3.5

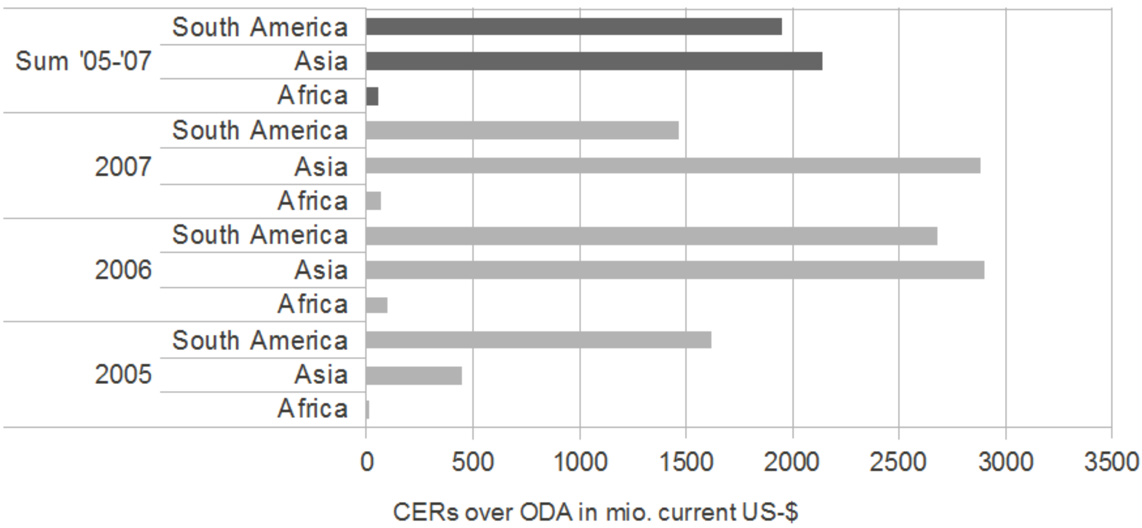

Figure 3.5. CERs in Relation to ODA in Regions of CDM Eligible Countries (2005-2007; source: UNFCCC (2010), OECD.QWIDS (2010))

Figure 3.6

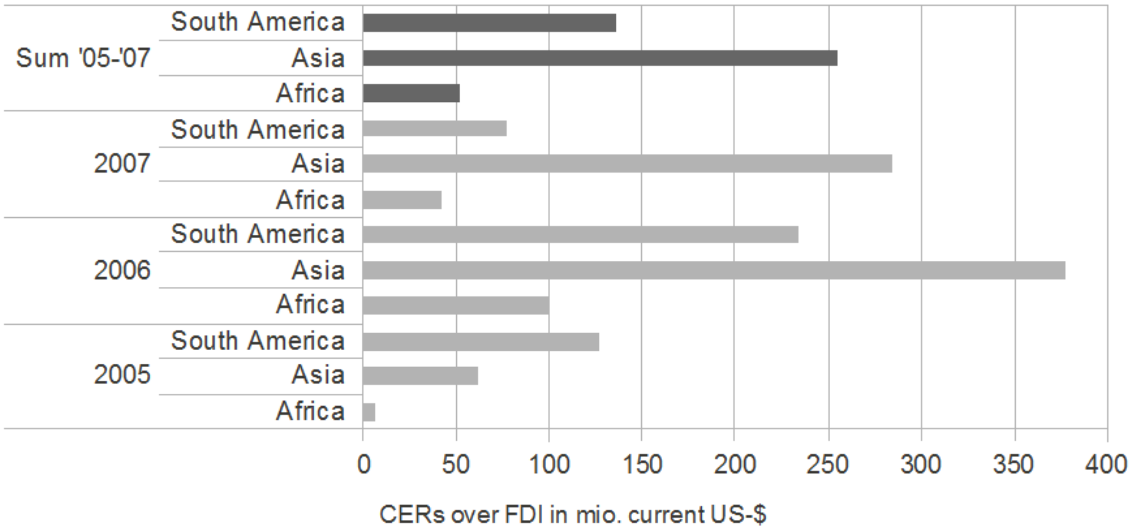

Figure 3.6. Foreign Direct Investments in Regions of CDM Eligible Countries (2005-2007; source: UNFCCC (2010), OECD.QWIDS (2010))

These figures show that explaining the small number and/or size of CDM projects in Africa is not straightforward. Attracting CDMs is neither simply a matter of general economic development or emissions reduction potential, nor just of development aid or foreign industrial involvement.

This does not necessarily indicate that foreign non-CDM involvement is irrelevant for the existence and expansion of CDM projects. In fact, facilitation is not only hoped to help combating climate change but also combating poverty by furthering development (Rübbelke, 2009). Therefore CDM projects themselves could be perceived as a form of development aid and in fact as aid projects. Even if CDM projects are not financed as aid, it is possible that existing or finished ODA-based projects make the establishment of CDM projects simpler by using existing contacts, one of many possible soft or immeasurable factors. In other words, if aid relationships are well established, they might present a favorable environment for other activities such as CDM projects. Such a relationship can be interpreted as a spillover effect caused by soft or immeasurable factors.

In contrast to aid, CDM projects could also be planned and perceived as foreign direct investments by international partners. Therefore it is worthwhile analyzing the relationship between the amount of bilateral FDI flows and the number of CERs transferred back to financier countries. Many factors generally determining investments in foreign countries possibly also determine investments in CDM projects. Factors commonly named as FDI determinants are political rights and civil liberties (Suliman & Mollick, 2009), the social development in a country (Kolstad & Villanger, 2004) as well as human capital (Noorbakhsh, Paloni, & Youssef, 2001), infrastructure (Kumar, 2001) and the geographical and cultural distance between the two countries involved (Ito & Rose, 2002). Accounting for these other factors will help isolating the effects that stem from a coinciding or previous engagement in FDI.

In addition, comparable to ODA, certain spillover effects of FDI might exert an influence on CDM projects (for an overview of literature on FDI spillovers see Blomström, Globerman, & Kokko (1999)). Due to previous investment activities, CDM investors already might have contacts to a host country and knowledge about legal and institutional structure. Investors could then reuse their contacts and knowledge to finance CDM projects. If CDM projects indeed benefit from such thinking, FDI would seem to have an effect through these soft and immeasurable factors even in presence of other generally beneficial factors already explaining FDI inflows.

3.3 Gravity Model and Data

3.3.1 Theoretical Model and its Specification

The model best suited to analyze the bilateral transfers of CERs from one country to another is an augmented gravity model. Gravity models account for bilateral determinants of two countries between which the transfer takes place as well as for determinants attributed to each country individually. In a gravity model these factors are all multiplicands, signifying that their effects on transfers are not separable from each other. A generic gravity model considers the geographical distance between two countries *i* and *j* ($Dist_{ij}$) as bilateral and transfer-inhibiting factor, GDPs of each country (GDP_{ij}) as individual and transfer-enhancing factors, and a constant *A*. It takes the following form:

$$Flow_{ij} = A \cdot GDP_i \cdot GDP_j \cdot Dist_{ij} \qquad (1)$$

To be able to estimate such a model in a regression, the multiplicands have to be turned into summands by taking the natural logarithm on both sides of the equation and adding coefficients as well as an error term. Thus equation (1) would turn into the following regression equation[2]:

[2] Note that the change in the sign of the factor Dist will be reflected in an opposite sign in the coefficient. To wit,

$$lnFlow_{ij} = \alpha + \beta_1 lnGDP_i + \beta_2 lnGDP_j + \beta_3 lnDist_{ij} + \mu_{ij} \quad (2)$$

Out of the many pairs of potential host and financier countries, only a fraction actually generates projects. Therefore the data set has a large number of observations with no project partnerships and hence zero transfers of CERs between countries. The inclusion of these pairs leads to a so-called zero-inflation. Simply discarding these zero-observations possibly means losing information on why some pairs do not interact. Treatment of zero-inflation is similar to a selection bias problem. Analogically to Helpman, Melitz, & Rubinstein (2008) and following Linders & de Groot (2006) as well as the specification of Martin & Pham (2008), regression calculations here use a 2-stage Heckman solution (Heckman, 1979). In the 2-stage approach, a first regression called selection equation determines the likelihood of having at least one project started by a pair of partners. So at the same time as countering the bias of the zero-inflation the selection regression enables us to make a statement about first project initiation.

It is a common strategy for the selection equation of a Heckman correction to include the same variables as in the outcome equation and at least one more. This helps avoiding high multicollinearity between the inverse Mill's ratio (IMR) and other variables in the outcome equation. As for zeros (or even negative values) in variables on the independent side, the solution is more straightforward. Strictly following the gravity model would mean that further independent variables would enter multiplicatively as well, like $VarY_{ij}$ in equation (3). This would mean that rearranging the equation to an additive term leads to logarithms of variables which possibly contain negative values or values equal to zero (see equation 4). Since taking logarithms of these numbers is impossible, the variables can be added to the original model as an exponent of Euler's number, like $VarZ_{ij}$ in equation (3). Taking the logarithm of this term would simply lead to the actual variable being one of the summands (see equation 4), instead of its logged form. This would change the interpretation of variables such that if the value was indeed zero, the transfer of CERs would not necessarily become zero as well.

$$Flow_{ij} = A \cdot GDP_i \cdot GDP_j \cdot Dist_{ij} \cdot VarY_{ij} \cdot e^{VarZ_{ij}} \quad (3)$$

$$lnFlow_{ij} = \alpha + \beta_1 lnGDP_i + \beta_2 lnGDP_j + \beta_3 lnDist_{ij} + \beta_4 lnVarY_{ij} + \beta_5 VarZ_{ij} + \mu_{ij} \quad (4)$$

Seven models test for determinants of a first project partnership, i.e. what influences a project initiation between a pair of countries. Comparing these will show the differences between a

the negativity of the term is transferred to the coefficient. So judgment on the inhibiting or enhancing nature of the factor can be reserved until the regressions yields a coefficient.

general analysis of determinants, the effect of being an African host, including other big players in the CDM business (namely China and Brazil) and redefining the set of 'African hosts' excluding South Africa.

These seven models are used as the selection equations to seven corresponding outcome regressions which analyze the determinants of flow size, i.e. number of produced CERs between countries. Again, comparing the seven models with each other shows particular country as well as region effects and demonstrates the robustness of the results. A further comparison between the selection equations and the outcome equations shows the difference in determinants between the two stages of CER production.

The time-fixed effects regressions employed here use period dummies in a pooled data set. This dummy variable least squares (DVLS) approach offers two advantages over standard fixed-effects methods. First, not only does it allow controlling for period-specific effects but also retains information on the influence of periods to be interpreted. This includes effects like global crises, the global business cycle and changes in how CDM business was perceived or conducted. Second, standard fixed-effects models would hold effects of countries constant over time rather than periods' effects. However, this method would omit information on countries which could have an influence on CDM attraction. DVLS allows for interpreting the effects of countries separately. The drawback of losing some degrees of freedom compared to a standard fixed-effects method is negligible.

3.3.2 Data

In order to estimate the gravity model, a panel has been set up for the years from 2005 to 2007. The panel contains pairs of all possible developed financier countries and all eligible developing project host countries. Summary statistics for the variables are listed in table 1. Data were taken from the following sources.

Number of CERs and CDM project data stems from the UNFCCC (2010) database, which provides numbers of CERs granted to a project and information on which host and financier partners take part in the project. To make this data fit the other data and the bilateral observations needed for a gravity model regression, conversion from project data to country data is necessary. For this, all CERs from projects financed, say, by Germany in Tanzania in 2007, are added up to one number. This number then reflects how many CERs result from CDM projects originating from the partnership between companies of those two countries in 2007. However, a project in Tanzania could as well be jointly financed by a financier from Germany and one from France. Since the UNFCCC data does not contain information on how many certificates are allocated to the German and French financier, respectively, every country is given equal weight for each project. Projects solely financed by a developing country are discarded from the dataset (less than 20 per cent of the cases).

Table 3.1

Summary statistics for the full sample (23 financier countries, 121 hosts)

Variable	**Mean Host** *(Financiers)*	**Std. Dev.** *(Financiers)*	**Min** *(Financiers)*	**Max** *(Financiers)*	**Source**
CERs	19761	319274	0	15641024	UNFCCC (2010)
GDP PPP pc	4939	4535	185	21643	World Bank (2010)
Log GDP PPP pc	3.50	0.44	2.27	4.34	World Bank (2010)
CO_2e Emiss pc	2.10 (10.79)	2.63 (4.78)	0.02 (5.50)	14.90 (24.90)	World Resource Institute (2010)
Log CO_2e Emiss pc	-0.04 (1.00)	0.64 (0.17)	-1.61 (0.74)	1.17 (1.40)	World Resource Institute (2010)
FDI flows[a]	0.05	0.40	-2642	11	OECD.Stat (2010)
ODA flows[b]	0.02	0.08	-0.48	3.19	OECD QWIDS (2010)
Import/GDP[c]	0.0021	0.0135	0	0.5643	Comtrade (2010)
Common Language	0.14	0.35	0	1	Mayer & Zignago (2006)
Colonial Relationship	0.04	0.19	0	1	Mayer & Zignago (2006)
Log Distance	7873.16	3734.49	420.25	19333.78	Mayer & Zignago (2006)
Governance	1.56	0.61	0.20	3.22	World Bank (2010)
Infrastructure	0.17	0.16	0.01	1	CIA Factbook (2010), SeBa World (2010)
Literacy	76.73	21.53	5.74	104.14	Nation Master (2010), World Bank (2010)
Africa-Dummy	0.42	0.49	0	1	
China-Dummy	0.01	0.09	0	1	
Brazil-Dummy	0.01	0.09	0	1	
Africa-w/o-SA-Dummy	0.41	0.49	0	1	

a: data in bio.; b: data in mio.; c: both in bio.

FDI values as bilateral flows in billion US-$ are taken from the database OECD.Stat (2010). To reflect the relationship between business partners in countries, not only the unilateral FDI flows are considered but rather the sum of FDI flows in both directions.

Bilateral official development assistance (ODA) in million US-$ is taken from (OECD QWIDS, 2010) as a proxy for development aid. This data only has positive flows from developed countries to developing countries and none in the other direction.

Import data of host countries in US-$ stem from Comtrade (2010) and to further shed light on business relationships of partner countries. In the following regression these data were set in relation to the economic size of the country to avoid mistaking the country's trade's impact for the impact of its size. In the set the variable is called trade. Data for the total GDP were taken from the IMF (2010).

GDP PPP per capita from the World Bank (2010) database is also included in the model's data, to test for welfare and development levels of countries. GDP data covering the overall size of the economy is not taken up like in equation (2) since other variables already carry the size of the country.

Per capita CO_2-equivalent emissions (CO_2e) data gauges the need for abatement certificates, in the case of developed countries, and the potential to abate, in the case of developing countries. Wang & Firestone (2010) showed that emissions are a factor in CDM emergence and Winkelman & Moore (2011) even base their main argument on project developers' rationale to start CDM projects in emission heavy industries. To include this influence on CER transfers, emissions are taken up in the regression. The emission data originate from the CAIT data set and are augmented by forecasts from the POLES data set, both from the World Resource Institute (2010).

A number of additional variables control for the determinants of FDI (and therefore probably also ODA and trade): A ***common colonial past*** dummy, a ***common language*** dummy to control for cultural proximity, a governance index as a measure for institutional quality, the literacy rate as a control for human capital, and an index for infrastructure. The cultural data, a common official language dummy and a former colonial relationship dummy, as well as distance data are taken from the CEPII set of Mayer & Zignago (2006). Those three are excluded from the outcome regression due to the Heckman exclusion restriction. In their seminal gravity model paper Helpman et al. (2008) argue that religious similarities (i.e. cultural closeness) can be used as exclusion restriction in Heckman models. Likewise the Heckman procedure here includes the measures for culture closeness of common official languages and former colonial relationships as well as a distance as a measure for the actual physical closeness. Helpman, Melitz and Rubinstein's original cannot assume a pair relationship which is not on par. In the case of CDM, however, relationships are not on par by design. Therefore we chose to replace their cultural closeness indicator with a variable which captures more relevant kind of similarity or, in this case more likely, dissimilarity. Using distance as well is warranted by the same reasoning and the fact that, other than Helpman, Melitz and Rubinstein's trade example, CDM project costs do not systematically increase in costs with distance.

Governance data stem from the Kaufmann, Kraay, & Mastruzzi (2009) set for governance indicators.

The literacy rate is taken from the Education Statistics of the World Bank (2010) for which missing literacy rate values had to be replaced with data from the Nation Master (2010) website.

The infrastructure index used here is specifically constructed. Since no comprehensive infrastructure index exists, Martınez-Zarzosoa, Perez-Garcıab, & Suarez-Burguetc (2008) as well as Wang & Firestone (2010) use aggregates of certain infrastructure proxies to complete their gravity models. The following ad-hoc aggregate included in the model is constructed with the same rationale in mind:

$$Infrastructure_i = {}^1/_3 \cdot \frac{EnProd_i}{maxEnProd} + {}^1/_3 \cdot \left({}^1/_3 \cdot \frac{Mob_i}{maxMob} + {}^1/_3 \cdot \frac{Landl_i}{maxLandl} + {}^1/_3 \cdot \frac{Inet_i}{maxInet} \right) + {}^1/_3 \cdot ({}^1/_2 \cdot \frac{Roads_i}{maxRoads} + {}^1/_2 \cdot \frac{Airports_i}{maxAirports}) \quad (5)$$

Here $EnProd_i$ is the production of kwh per person in country i, Mob_i is the number of mobiles per person, $Landl_i$ the number of landlines per person, $Inet_i$ the number of internet connections per person, $Roads_i$ the kilometers of paved and unpaved road per square kilometers and $Airports_i$ the number of airports per square kilometer. Data for energy production, telecommunication, roads, area and population were taken from the CIA Factbook (2010); data for airports were retrieved from SeBa World (2010).

After discarding countries with missing data, the set contains 23 industrialized countries and 121 developing countries (see the appendix for a full list).

3.4 Results

As table 3.2 shows, GDP per capita, emissions of both partners, FDI flows, the ODA flow, governance[3], infrastructure and literacy as well as the three cultural factors have a significant impact on project initiation in most selection models. When some of these variables do not have a significant impact, it is due to the inclusion of particular region or country dummies,

[3] Note that to avoid taking logarithms of negative numbers, the governance index was shifted upwards.

which will be discussed below. The only of the analyzed variables which stays consistently insignificant in the selection models is the trade flow.

Of the significant variables, the significantly positive GDP per capita shows that investors would rather invest in the economically more developed countries among developing countries. The higher per capita emissions the host country has, the more opportunity to abate and start CDM projects, therefore the likelier a financier will invest (compare Jung (2006); see Marc, Alphonse, & Vincent (2005) for a discussion of the so-called low-hanging fruit discussion). All selection models show a negative effect of financier country emissions. This is an indicator for the general inclination of financier countries to avoid emissions: Countries which avoid emissions at home also do so more likely through CDM projects abroad. FDI is positively significant in the selection models, which means that when first project partnerships of countries are concerned, a relationship like FDI requiring transfers of technology and finances as well as an established institutional framework, formal or informal, facilitates a first project partnership. Partners in countries (or country governments themselves) that previously established enough trust or a similar partnership leading to the necessary prerequisites for FDI partnerships can probably do so again for the sake of CDM projects. This replicates the finding of Jung (2006) who finds that a good general investment climate, next to mitigation potential (see above) and institutional capacity, is one of three indicators of CDM project activity. A similar explanation can be applied to the significantly positive impact of ODA: Previous relationships through this channel and required prerequisites of ODA make project initiation easier as well. Moreover, alleviating poverty or gaining political favors (Dreher, Nunnenkamp, & Thiele, 2008; Dreher, Sturm, & Vreeland, 2009) are two reasons for providing ODA, which could also be reasons for CDM projects and thus explain the significance of this factor. Governance, infrastructure and literacy cover their respective reasons for investing in a country. The better governance and literacy, the likelier an initial project partnership between actors exists because institutional strength and human capital are helpful to setting up projects. Conversely, the better the infrastructure, the less likely it is to have a first project partnership. This effect is a second indicator for project financiers getting into countries because of the low-hanging fruits rationale: Countries with bad infrastructure likely also have easily refurbished high-emission sites. Therefore financing a first project there comes easy to financiers. Including these three factors, infrastructure, governance and literacy, shows that the effect of ODA and FDI goes beyond simply being a proxy for good investment conditions. The three controls for cultural factors, common

Table 3.2: Determinants of CER project initiation

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Dependent:	Dummy '*any CER'*	Dummy '*any CER'*	Dummy '*any CER'*	Dummy '*any CER'*	Dummy '*any CER'*	Dummy '*any CER'*
Intercept	-4.79 (0.72) ***	-2.81 (0.78) ***	-5.54 (0.75) ***	-4.13 (0.73) ***	-2.88 (0.82) ***	-2,51 (0,79) ***
Log GDP PPP pc_i	0.11 (0.07) *	0.09 (0.07)	0.25 (0.07) ***	0.04 (0.07)	0.16 (0.08) **	0.13 (0.07) *
Log CO_2eEmiss pc_i	0.13 (0.05) ***	0.12 (0.05) **	0.02 (0.05)	0.17 (0.05) ***	0.05 (0.05)	0.09 (0.05) *
Log CO_2eEmiss pc_j	-0.28 (0.08) ***	-0.30 (0.08) ***	-0.27 (0.08) ***	-0.28 (0.08) ***	-0.28 (0.08) ***	-0.30 (0.08) ***
FDI $flow_{ij}$+FDI $flow_{ji}$	0.35 (0.05) ***	0.34 (0.05) ***	0.29 (0.05) ***	0.32 (0.05) ***	0.24 (0.05) ***	0.33 (0.05) ***
ODA $flow_{ji}$	0.53 (0.22) **	0.67 (0.23) ***	0.43 (0.23) *	0.55 (0.22) **	0.57 (0.24) **	0.72 (0.23) ***
Tradeji	-3.79 (3.81)	-5.39 (3.93)	-3.23 (3.65)	-3.51 (3.78)	-4.52 (3.75)	-5.22 (3.85)
$Governance_i$	0.16 (0.06) ***	0.23 (0.06) ***	0.17 (0.06) ***	0.17 (0.06) ***	0.27 (0.06) ***	0.24 (0.06) ***
$Infrastructure_i$	-1.97 (0.33) ***	-2.12 (0.34) ***	-2.08 (0.34) ***	-1.94 (0.33) ***	-2.21 (0.37) ***	-2.49 (0.36) ***
$Literacy_i$	0.01 (0.00) ***	0.00 (0.00)	0.01 (0.00) ***	0.01 (0.00) ***	-0.00 (0.00)	-0.00 (0.00)
Common $Language_{ij}$	-0.43 (0.11) ***	-0.30 (0.12) **	-0.40 (0.11) ***	-0.41 (0.11) ***	-0.26 (0.12) **	-0.28 (0.12) **
Colonial $Relationship_{ij}$	0.57 (0.14) ***	0.55 (0.14) ***	0.61 (0.14) ***	0.57 (0.14) ***	0.59 (0.14) ***	0.51 (0.14) ***
Log Distance	0.27 (0.06) ***	0.18 (0.06) ***	0.23 (0.06) ***	0.26 (0.06) ***	0.12 (0.06) **	0.13 (0.06) **
Africa-$Dummy_i$		-0.85 (0.09) ***			-0.83 (0.09) ***	
China-$Dummy_i$			1.5 (0.17) ***		1.48 (0.17) ***	
Brazil-$Dummy_i$				1.02 (0.17) ***	0.96 (0.17) ***	
Africa-w/o-SA-$Dummy_j$						-1.13 (0.11) ***
Pseudo R^2	0.12	0.16	0.18	0.13	0.19	0.17
BP-test (p-value)	$<2.2^{-16}$	$<2.2^{-16}$	$<2.2^{-16}$	$<2.2^{-16}$	$<2.2^{-16}$	$<2.2^{-16}$
Observations	8326	8326	8326	8326	8326	8326

Levels of significance: *=10%. **=5%. ***=1%. Standard errors in parentheses. Subscripts denote host countries (i) and partner countries (j). Source: Own calculations.

Table 3.3: Determinants of CER transfers

Table 3.3	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Dependent:	Log of CERs	Log of CERs	Log of CERs	Log of CERs	Log of CERs	Log of CERs
Intercept	*24.46 (3.36) ****	*21.02 (2.9) ****	*21.06 (4.01) ****	*25.18 (3.12) ****	*19.66 (3.16) ****	*20.89 (2.96) ****
Log GDP PPP pc_i	*-0.76 (0.37) ***	*-0.59 (0.36) **	*-0.34 (0.44)*	*-0.85 (0.35) ***	*-0.35 (0.39)*	*-0.70 (0.38) **
Log CO_2eEmiss pc_i	*1.27 (0.24) ****	*1.25 (0.24) ****	*1.03 (0.25) ****	*1.29 (0.25) ****	*1,07 (0.26) ****	*1.35 (0.24) ****
Log CO_2eEmiss pc_j	*-0.31 (0.43)*	*-0.40 (0.46)*	*-0.59 (0.42)*	*-0.31 (0.42)*	*-0.64 (0.43)*	*-0.16 (0.50)*
FDI $flow_{ij}$+FDI $flow_{ji}$	*-0.34 (0.22)*	*-0.29 (0.24)*	*-0.11 (0.20)*	*-0.33 (0.18) **	*-0.13 (0.18)*	*-0.36 (0.27)*
ODA $flow_{ji}$	*2.59 (1.37) **	*2.59 (1.50) **	*3.03 (1.31) ***	*2.47 (1.38) **	*2.95 (1.41) ***	*1.53 (1.62)*
Tradeji	31.85 (17.45) *	32.98 (18.1) *	25.47 (16.94)	31.87 (16.89) *	26.76 (16.84)	26.49 (18.21)
$Governance_i$	*-0.74 (0.38) **	*-0.92 (0.41) ***	*-0.23 (0.40)*	*-0.73 (0.38) **	*-0.36 (0.43)*	*-0.98 (0.43) ***
$Infrastructure_i$	*1.43 (2.55)*	*2.81 (2.87)*	*-0.06 (2.59)*	*1.31 (2.46)*	*0.93 (2.84)*	*2.96 (3.08)*
$Literacy_i$	*-0.06 (0.01) ****	*-0.04 (0.01) ****	*-0.06 (0.01) ****	*-0.06 (0.01) ****	*-0.05 (0.01) ****	*-0.03 (0.01) ***
Africa-$Dummy_i$		*1.35 (0.93)*			*1.03 (0.85)*	
China-$Dummy_i$			*-0.42 (1.15)*		*-0.29 (1,16)*	
Brazil-$Dummy_i$				*-0.94 (0.78)*	*-0.95 (0.83)*	
Africa-w/o-SA-$Dummy_j$						*0.38 (1.40) ****
Inverse Mill's $Ratio_{ij}$	*3.01 (0.87) ****	*2.78 (1.03) ****	*2.12 (0.89) ***	*3.07 (0.82) ****	*2.05 (0.96) ***	*3.35 (1.20) ****
Adjusted R^2	0.29	0.28	0.31	0.31	0.32	0.28
BP-test (p-value)	$5.5 \cdot 10^{-4}$	$3.3 \cdot 10^{-3}$	$3.1 \cdot 10^{-4}$	$2.1 \cdot 10^{-4}$	$3.5 \cdot 10^{-4}$	$1.3 \cdot 10^{-4}$
Observations	351	351	351	351	351	351

Levels of significance: *=10%. **=5%. ***=1%. Standard errors in parentheses. Subscripts denote host countries (i) and partner countries (j). Source: Own calculations.

language, colonial relationship and distance, are significant as well and show that culture matters for project partnership initiation.

Models 2 through 6 introduce different country and region dummies to see the Africa effect and separate country effects. Model 2 shows that being an African country decreases the chance of finding a partner for a first project. This Africa effect lets the significantly positive effect of literature, which is a proxy for human capital, and GDP per capita become insignificant. This shows that whatever is holding Africa back explains it better than these two variables, and is connected to them. As for human capital, it stands to reason that financiers more likely invest in countries with better educated personal. That the Africa dummy takes up that effect here, in the probit regression, shows two things. First, Africa's problem is more specific than not being able to provide qualified personal for projects (otherwise literacy would stay significant). Second, Africa's problem occurs at the critical point of first project initiation. To show the robustness of the Africa effect, models 3, 4 and 5 look at 2 of the 3 most successful CDM attracting countries, China and Brazil[4]. Naturally both dummies have a significant coefficient. Though both countries cause their own individual effects when models 3 and 4 are compared to the baseline model 1, major results do not change (though China notably takes up the effect of host emissions). It is only the inclusion of the Africa dummy which leads to the insignificance of literacy.

Just as models 3, 4 and 5 tested the effect of big players outside of Africa, model 6 makes a distinction between South Africa and the rest of African countries. In the data from 2005 to 2007 South Africa produced a third of all African CERs. As model 6 shows, however, even excluding South Africa, the only bigger African player, does not make a big difference to the robustness of models 2's results: The Africa effect is still negative, even increases and when introduced takes up the literacy effect.

Table 3.3 shows the results of the corresponding outcome regressions[5]: The determinants of overall CER production between pairs (as opposed to the probit selection regression looking at project initiation). As the baseline model 7 shows, GDP per capita, host emissions, ODA, trade, governance and literacy have a significant impact on the size of CER productions. The less developed a country, the more partners will invest in CDM projects in it (though as following models show, this result is not quite stable). The more emissions it has, the more

[4] The third country, India, was omitted due to high multicollinearity of different variables in the set, including the inverse Mill's ratio.

[5] Model 7 is the corresponding outcome regression to the selection equation of model 1; model 8 corresponds to model 2 and so forth.

can be abated and opportunity for new CER production exists, similarly to the explanation for selection models. For ODA flows and trade, the reasoning from the selection models applies as well: Having more relations through other partnerships facilitates CDM projects, no matter if they are first or following projects. Furthermore, higher governance and literacy lead to less CER production. One possible explanation for the negative effect of literacy is the altruistic attitude that goes with giving aid (Berthélemy, 2006). If giving aid is motivated by altruistic principles, results suggest that CDM projects might originate from the desire to improve the situation wherever the project takes place. Moreover, the literacy rate might not only be a proxy for human capital but also labor costs in general, analogous to the hypothesis of (Noorbakhsh et al., 2001) that labor costs might be a proxy for skills. Higher labor costs deter investments in a country, explaining the negative relationship. Controlling for sub-indices of governance, which are more diversified, leads to the same results and the corresponding regressions are omitted here. For an explanation of the governance effect, see the comparison between the selection and outcome equation below.

Based on model 7, the following models test for the same country and region effects as models 2 through 6. Introducing the Africa dummy to the outcome regression in model 8 has no effect. This leads to the conclusions that whatever effect African countries carry that causes them to take such a small share of CER production, it does not have an impact beyond the first project. This result is stable, even when the China and Brazil dummies are introduced in models 9 through 11. However, it becomes clear that the governance effect of model 7 is explained by the China dummy: The fact that much CER production takes part in China and causes much variation in the governance variable leads the China dummy to take up the governance effect. Similarly, the China dummy takes up the GDP per capita and trade effect. This does not mean that the above explanations do not hold. It just means that China with its many and large projects dominates this effect.

The Africa effect becomes interesting once more when Africa excluding South Africa is analyzed in model 13. In this case, the dummy turns positive and ODA even turns insignificant. This shows that the few African (but non-South African) CERs that are produced are mainly the result of ODA channels. So even when countries in the narrowed down set of non-industrialized Africa do get projects, their number and size is partly dependent on aid channels. Once this effect is taken up by this narrow Africa dummy, it is clear that ODA is not a determinant of CER production for other countries.

One more interesting point about the regressions of table 3.2 and 3.3 is their direct comparison. While the selection equations show a negative Africa effect, the outcome regressions either do not show an Africa effect at all or that an Africa effect depends on ODA, if South Africa is excluded. This is akin to the statement that African countries have a problem at first project initiation except for those projects which are a result of development aid (and therefore either aid projects or facilitated through aid project channels). There is a hurdle at project initiation that African countries need to overcome to take part in the CDM business. Though we cannot point directly at the hurdle, the regressions narrow it to a small set of possibilities. From the selection equations we know that this hurdle has to do with literacy or whatever literacy is a proxy for. That the Africa dummy takes up the literacy effect in the selection equation shows that the African problem can be identified as a junction in the process of CDM project initiation. This effect disappears after a first project partnership between two countries and is connected to human capital. Candidates for what causes this are singled out in literature as missing DNAs (Michaelowa, 2003) due to high costs for setting up dedicated institutions (Ellis et al., 2007), lack of human capacity for technology transfer (Karani, 2002) as well as human capacity for climate research and development (Michaelowa, 2007) and last of a non-exhaustive list, even if DNAs exists, a lack of institutional capacity of these DNAs (Desanker, 2005; Jung, 2006).

To conclude the comparison, a few comments on other differences between selection and outcome regression are required: A few coefficients change their signs in the outcome regressions compared to the selection regressions. Of the two stable sign-changing effects literacy has been discussed. The other, governance, is negated by including the China dummy.

Another remarkable change from the regressions on project initiation to the ones on CER numbers is the swap in the significance of FDI and trade. Trade can replace FDI as a significant factor here because of its substitutive nature. Generally speaking, while FDI is an indicator of intra-firm trade, foreign trade values measure the inter-firm trade (Yarbrough & Yarbrough, 2006). This inter-firm trade (here: Trade) takes place if ties between partners are not and need not be close. For a first project it makes sense that FDI shows a significant impact and trade does not: After all, whatever makes a big investment like FDI possible and less risky, like strong political or personal ties as well as previous business in a country, is also helpful in facilitating a first CDM project. Once a first project is setup and project expansion and repetition becomes possible, the relationship resembles a trade relationship much more. Qualitative factors such as trust, experience and knowledge are not as necessary anymore since the process has become more repetitive.

All models were subjected to robustness checks, such as replacing governance, literacy and infrastructure with their logged counterparts to do justice to the gravity model. None of these changes caused a noteworthy difference to the core results of the regression. No presented results suffer from heteroskedasticity (see Breusch-Pagan p-values for all models). Outcome models including China and Brazil dummies exhibit a variance inflation factor for the IMR slightly above the critical value of 10. Otherwise models do exhibit multicollinearity at all. Moreover, all outcome regressions have a significant IMR coefficient, showing that a bias was present and is countered by the two-stage approach employed here.

3.5 Conclusion

Using a two-step gravity regression model, this study analyzed channels for CDM project partnership promotion and Africa's lack of success in this area. Results show that the set of factors for a first initiation of projects in a given year is different from the set for expanding existing efforts. In general CER creation is mostly driven by emissions, FDI, ODA and trade. When only the size of production is concerned, literacy as a proxy for labor costs has a robust effect.

While first project initiation hinges more on FDI relation, overall CER volume is determined by trade relations instead. FDI requires a stronger relationship between investor and host country since considerable investments have to be made. A similar rationale might drive decision making for first project partnerships between countries. However, beyond this point, such strong relationships are not necessary anymore. The rationale of CDM investors changes from that of FDI investors to a business-as-usual attitude of commodity traders that can be surer about the continuity of processes since paths have been broken already.

These paths are broken through soft and immeasurable factors associated with FDI, ODA and trade, like formal and informal collaboration or other institutional effects. That this has an influence on CDM project initiation and volume is a strong affirmation of current policy measures. The UNFCCC and UNEP Risoe Center established programs which are a framework for carrying out and facilitating partnerships and projects under the Kyoto Protocol umbrella. Our results show that political and industrial efforts that lead to informal institutions, business connection or exchange of inside knowledge as well as facilitating partnership on a broader scale are crucial factors. This is especially true if these linkages cannot be established in other ways, as is the case if FDI and ODA do not take place.

The same econometric investigation shows that as far as CER volumes are concerned, an African effect only appears if the biggest African producer is disregarded. In that case, and only then, African projects are revealed to be ODA driven. Otherwise there is no difference to being an African country or not. It is the project initiation step, however, which shows a strong Africa effect. African countries fail to attract initial investments. This interpretation of our results is supported by anecdotal evidence (e.g. Minang, McCall, & Bressers (2007); Nhamo (2006)) and consistent with reports of lack in technical, procedural and institutional capabilities concerned with the CDM process in Africa (Desanker, 2005; Ellis et al., 2007; Karani, 2002; Michaelowa, 2003, 2007). Capacity building in these areas will help Africa succeed in attracting investors for CDM projects and, with these projects, the capacity to find their way on a path to green growth.

Appendix

Table 3.A1: List of countries	
Industrialized countries (23)	Australia, Austria, Belgium, Canada, Denmark , Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, United States of America **Note:** Even though countries might not have signed or ratified the Kyoto Protocol or might not have a nationwide emission trading scheme, single organizations in these countries might have partaken in CDM projects.
Developing countries (121)	Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Cape , Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Democratic Republic of the Congo, Republic of the Congo, Costa Rica, Côte d'Ivoire, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libya, The Former Yugoslav Republic of Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Republic of Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Tonga, Tunisia, Turkmenistan, Uganda, Uruguay, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe

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4 The Economics of Wetlands: Market-Based Instruments and Effective Protection Strategies

Abstract

Among the instruments proposed for the sustainable management of wetlands, product certification for wetland-based goods, wetland mitigation trading and ecosystem certification are some of the most recent. Based on a general model of wetland management, this paper analyzes the applicability of these three market-based instruments using a static optimization model. Taking the example of agriculture and aquaculture, findings suggest a potential to increase welfare for all three instruments. However, product certification suffers from drawbacks owing to strong interdependencies between the ecosystem services. Wetland mitigation trading and ecosystem certification are first-best choices within this model as long as ecosystem services can be quantified properly and transaction costs are not prohibitive.

4.1 The State of Wetlands

Over the past years, awareness of wetlands and their importance for the biological cycle has been raised. Though cover of wetlands on earth as share of total land surface is relatively small (5-8 percent depending on the definition used (McCartney, Rebelo, Senaratna Sellamuttu, & de Silva, 2010b; Mitsch & Gosselink, 2007)), wetlands' impact in terms of ecosystem services (ESS) is far-reaching (Barbier, 2010; Costanza et al., 1997; Rebelo, McCartney, & Finlayson, 2009). On local and regional level, crucial functions include supplying and maintaining the quality of fresh-water, regulating disasters like floods, droughts, and disease, preserving the fertility of soils as well as providing intangible values such as leisure, space for religious activities and tourism (Falkenmark, 2007; Millennium Ecosystem Assessment, 2005). On a global level, wetlands play a decisive role in carbon sequestration (Badiou, McDougal, Pennock, & Clark, 2011; Bernal & Mitsch, 2012; Duan, Wang, Lu, & Ouyang, 2008; Hansen, 2009; Xiaonan, Xiaoke, Lu, & Zhiyun, 2008) and are home to some of the world's most precious biodiversity hotspots (Gopal & Junk, 2000; Keddy et al., 2009; Liu & Lü, 2011; Sukhdev & Kumar, 2008).

While some human activities may interact in a positive way with each other, many activities are competing for the same resources and are mutually exclusive. As a result, wetlands are continuously degraded and depleted. For example, the extensive use of fertilizers in crop production belongs to one of the primary threats for biodiversity of inland water and coastal areas (Malmqvist & Rundle, 2002; Skourtos, Kontogianni, & Harrison, 2010; Wood & van Halsema, 2008). Land use change (such as deforestation and drainage for agriculture), urban development, water extraction, overexploitation and the dissemination of invasive species are further drivers of degradation (Millennium Ecosystem Assessment, 2005). These interactions and their negative consequences are increasingly becoming a dilemma. Especially the rural poor in developing countries frequently find themselves in vicious circles; on the one hand, the ecosystem often provides the largest share of locals' means of subsistence, which means the rural poor are highly vulnerable to ecosystem deprivation and the direct effects of climate change (droughts, floods etc.). On the other hand, limited funds in combination with lacking property rights and other market failures render sustainable management of wetlands very difficult. To sustain themselves, locals slowly degrade the ecosystem which delivers their livelihood (Lee & Neves, 2010; Ratner, 2011).

4.2 Market-Based Instruments

Various policy options are available for dealing with the usual type of externality and many of them are efficient, market-based instruments. However, the particular interconnectedness of ESS with each other and their surrounding ecosystem demands consideration when implementing policies.

Classical MBIs for instance include taxes and subsidies, which optimally internalize the social costs and benefits by increasing or decreasing the market price. Typical examples are output or input taxes (e.g. on timber or fertilizers, see Bach & Gram (1996) as well as Claassen & Horan (2001)) and conservation subsidies (financial and technical assistance programs (Hoekman, Maskus, & Saggi, 2005), cost-sharing programs for habitat expansion (Bastos & Lichtenberg, 2001; Hardie & Parks, 1996), targeted product subsidies, etc.). A number of articles have highlighted the possibilities and limitations of these instruments also within the context of ESS, which are rival in their use (see e.g. Lankoski & Ollikainen (2003) and Havlík, Veysset, Boisson, Lherm, & Jacquet (2005)).

Apart from these measures there are various more recent market-based instruments (MBIs) driving the commodification of natural resources (Gómez-Baggethun, de Groot, Lomas, & Montes, 2010). In our analysis we will focus on three such instruments; (1) product certification, (2) capped mitigation trading, and (3) wetland certification. As opposed to taxes and subsidies, these instruments are often governed across borders and may - but must not necessarily - be administered by a public authority. As a result, they may be appealing especially for developing countries as they provide the possibility to find finance abroad (Freireich & Fulton, 2009; Gunatilake & De Guzman, 2008; Mandel et al., 2009; Nahman et al., 2008, 2009).

The general approach of the first of those three, product certification, is to certify a specific ESS, e.g. an agricultural product. Many certification programs pursuing sustainable food products (coffee, sugar, fish and others) but also commodities and services like timber, flowers and tourism already exist (for an elaborate survey see Golden et al. (2010)). Other approaches focus only on one part of the production process such as greenhouse gas emissions (e.g. the EU Biofuel Renewables Directive (European Parliament, Council, 2009)).

The second of the three MBIs considered here, capped mitigation trading, uses the market to provide incentives to control the quantities of the externalities rather than the prices. It allows offsetting damage to a particular ecosystem by saving or rebuilding an ecosystem elsewhere, as practiced with emission certificates gained through Flexible Mechanism projects (ETS, 2003; UNFCCC, 1997) and in mitigation banking (Stein, Tabatabai, & Ambrose, 2000). Mitigation trading is criticized widely for unwanted side effects causing inefficiencies. This critique reaches from perverse incentives (Schneider, 2011; Winkler, 2004) over institutional misalignment and unintended financing side-effects (Castro, 2007; Axel Michaelowa & Michaelowa, 2007) to counterproductive outcomes (Kallbekken, 2007). However, least of this criticism is aimed at the core principle: Offset trading. This makes it worthwhile to discuss if it would be appropriate as alleviation mechanism for wetland externalities.

Third, a relatively new approach for ecosystem protection and management is the idea of a certificate for the whole ecosystem (Dargusch, 2010; Jie, 2008). Within such schemes the management or area of an ecosystem is evaluated according to fixed standards and the ecosystem certificates can be sold to finance the sustainable management of the ecosystem. Buyers are companies participating in offset schemes or generally interested in fulfilling their corporate social responsibility as well as NGOs and private persons interested in nature conservation (Cohen, 2011; Hedden-Dunkhorst et al., 2011).

Careful re-evaluation of political instruments is necessary in a context as interconnected as an ecosystem. In doing so, we will consider existing measures as well as potential initiatives aimed to target ecosystems directly (such as Reducing Emissions from Deforestation and Degradation (REDD) and the Green Development Initiative (GDI)), which center on a more holistic approach and to our best knowledge have not been included in similar analyses. Chapter 4.3.1 presents an ecosystem with only one stakeholder. Advancing from there, chapter 4.3.2 adds stakeholders who do not have an influence on ecosystem use and production decisions, but profit from its ESS, in order to demonstrate the welfare loss through externalities. These two models serve as baseline for the private and, respectively, public optimal maximization to compare the three selected instruments to. Chapter 4.4 presents three possible political instruments to set incentives for all stakeholders to achieve socially optimal production demonstrated in 4.3.2. To show the advantages and disadvantages as clearly as possible, the three existing and proposed environmental protection systems are stripped to their essential features to create a model of stylized environmental protection measures. This helps to sharpen the view on the workings of different mechanisms and allows for a more in depth theoretical analysis of them.

4.3 Basic Model

4.3.1 Production Optimum of a Private Wetland Holder

A wetland L provides a number of ecosystem services (ESS) with positive utilities, some of which are treated as commodities exchanged at the market (q_i) (agricultural products, fish, hydro-power etc.) and some for which no market exists (x_i) (e.g. biodiversity or carbon storage capacity). To simplify analysis, we consider only one landholder, although we could also imagine the more realistic case of numerous landholders with a commons law and commons decision makers (e.g. a common village head). That landholder produces two goods: One from agriculture (q_1) and one from aquaculture (q_2). Both goods compete for the same land resources L, but agricultural activities also impose additional costs on aquaculture through runoff and pesticide pollution (v_2)[6] (Carvalho et al., 2002; Sarrazin, Tocqueville, Guerin, & Vallod, 2011; Thiere & Schulz, 2004). The producer may choose to reduce the impact of the negative externality by introducing abatement measures (a). Hence, we define the functional relationship of q_1 and q_2 as

[6] Negative or positive impacts of aquaculture on agriculture may exist as well, but for now we will ignore such externalities, i.e. $v_1 = 0$. This assumption can be discarded in models with a higher number of ESS, but facilitates the presentation and is more realistic in context of the example ecosystem with agriculture and aquaculture.

$$q_1 = f_1(l_1) \tag{1}$$

and

$$q_2 = f_2(l_2)[1 - v_2(f_1(l_1), a)] \tag{2}$$

with l_1 and l_2 representing the amount of land used for the production respectively, v_2 the negative externality of agriculture on aquaculture and a the abatement technology used in the production of q_1. To make both production processes as distinct as possible, we do not model a converse negative effect of aquaculture on agriculture. Production of both goods increases in land but with diminishing returns so that $\frac{\partial f_i}{\partial l_i} > 0$, and $\frac{\partial^2 f_i}{\partial l_i^2} < 0$ for $i = 1,2$. We further assume that the value loss in aquaculture is a positive concave function of agriculture, where $\frac{\partial v_2}{\partial q_1} > 0, \frac{\partial^2 v_2}{\partial q_1^2} < 0$ and $0 \leq v_2 \leq 1$. The underlying assumption is that the first unit of damage inflicted on an otherwise unharmed ecosystem will cause a greater value loss than further units. While the point of marginal increase or decrease is debatable[7] and certainly depends on the interaction between specific ESS and production types, we assume diminishing marginal damage. If production inflicts damage to a pristine part of the ecosystem, it has still more environmental integrity to lose than an already damaged part of the ecosystem. We are aware that this very abstract line of reasoning does not hold for all ecosystem interactions we cover with our model, but due to its level of abstraction it can be applied in general to our model. Further, v_2 is a convex decreasing function of abatement with $\frac{\partial v_2}{\partial a} < 0, \frac{\partial^2 v_2}{\partial a^2} > 0$ and $\frac{\partial^2 v_2}{\partial q_1 \partial a} > 0$. The last term implies that the negative impact of agriculture on aquaculture products weakens when abatement is applied. For simplicity's sake we consider linear cost functions both for production (c_1 and c_2) and for abatement (c_a). Using this information we obtain the decision problem:

$$\max_{l_1, l_2, a_1} \pi = f_1(l_1) \cdot p_1 + f_2(l_2)[1 - v_2(f_1(l_1), a)] \cdot p_2 - c_1 \cdot l_1 - c_a \cdot a - c_2 \cdot l_2 \tag{3}$$

subject to

$$l_1 + l_2 \leq L \tag{4}$$

$$l_1, l_2 \geq 0 \tag{5}$$

$$a \geq 0 \tag{6}$$

[7] For example, (Roughgarden & Schneider, 1999) assume decreasing marginal damage while (Kahn & Kemp, 1985) find empirical evidence for an increasing marginal damage function.

To simplify the analysis, we assume that production of both agriculture and aquaculture takes place and that all available land is used productively. Accordingly, strict equality in (4) applies and (5) cancels out, therefore the Lagrangian is

$$\mathcal{L} = f_1(l_1) \cdot p_1 + f_2(l_2) \cdot [1 - v_2(f_1(l_1), a)] \cdot p_2 - c_1 \cdot l_1 - c_a \cdot a - c_2 \cdot l_2 - \mu \cdot (l_1 + l_2 - L) - \lambda_1 \cdot a \quad (7)$$

Deriving (7) with respect to l_1 as well as l_2 , results in the following optimal prices p_1 and p_2:

$$p_1 = \frac{f_2(l_2) \frac{\partial v_2}{\partial f_1} \frac{\partial f_1}{\partial l_1} \cdot p_2 + c_1 + \mu}{\frac{\partial f_1}{\partial l_1}} \quad (8)$$

$$p_2 = \frac{c_2 + \mu}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \quad (9)$$

As would be expected, the price of agriculture p_1 increases in marginal costs of land c_1 as well as the shadow price of land μ and decreases in land productivity $\frac{\partial f_1}{\partial l_1}$. However, the producer also internalizes the marginal value loss caused by agriculture on aquaculture $f_2(l_2) \frac{\partial v_2}{\partial f_1} \frac{\partial f_1}{\partial l_1} \cdot p_2$ by demanding a higher price p_1 than he would in the case of $\frac{\partial v_2}{\partial f_1} \frac{\partial f_1}{\partial l_1} = 0$. Further, as can be seen in (9), the negative externality of agriculture also leads to a higher price of the aquaculture product, as the value loss lowers the land productivity term in the denominator. Finally, by deriving (7) with respect to a, we find that in the optimum

$$c_a = -f_2(l_2) \frac{\partial v_2}{\partial a} \cdot p_2 \quad (10)$$

The producer will abate to the point where the marginal value increase from abatement on aquaculture equals the marginal cost of abatemen[t.]

4.3.2 Production Optimum under Welfare Considerations

The previous profit function models the production rationale of an ecosystem holder. Hence maximizing it exclusively focuses on what is best from a producer's perspective. By contrast, members of society maximize their utility by consuming agriculture and aquaculture products but also through consumption of non-market ESS such as biodiversity, carbon sequestration and scenic beauty. We summarize the potential utility of these ESS in x. Land allocation to and production of q_1 and q_2 may have a positive impact on x when it implies a higher degree of conservation (for example, this could be the case of eco-tourism). Nevertheless, sticking to the example of conventional agriculture and aquaculture, at this point we assume that production of both goods will have a negative impact d on x, but to different extents (for further discussion of wetland interaction compare Wood & van Halsema (2008)). This damage may be mitigated by introducing abatement a_1 and a_2 so that

$$x = x_0 - d(\underbrace{q_1}_{(+)}, \underbrace{q_2}_{(+)}, \underbrace{a_1}_{(-)}, \underbrace{a_2}_{(-)}) \geq 0 \tag{11}$$

with d representing the damage on x, and x_0 the initial stock of x. Damage d behaves similar to the value loss in aquaculture, accordingly $\frac{\partial d}{\partial l_i} > 0$, $\frac{\partial d}{\partial l_i} < 0$ and $\frac{\partial d}{\partial a_i} < 0$, $\frac{\partial^2 d}{\partial a_i^2} > 0$. Accumulating the utility gained from production and utility from other ESS, the welfare function therefore takes the following shape

$$WF = \pi + x_0 - d(\cdot) \tag{12}$$

Deriving the welfare equation with respect to l_1 and l_2 under consideration of the constraints in (4)-(6), (13) and (14) yield the socially optimal prices:

$$p_1 = \frac{\left[p_2 + \frac{\partial d}{\partial v_2}\right] \frac{\partial v_2}{\partial f_1} \frac{\partial f_1}{\partial l_1} f_2(l_2) + c_1 + \mu + \frac{\partial d}{\partial f_1} \frac{\partial f_1}{\partial l_1}}{\frac{\partial f_1}{\partial l_1}} \tag{13}$$

$$p_2 = \frac{c_2 + \mu + \frac{\partial d}{\partial f_2} \frac{\partial f_2}{\partial l_2}}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{14}$$

In both (13) and (14), prices increase with the marginal damage caused by the production of both ESS, $\frac{\partial d}{\partial f_1} \frac{\partial f_1}{\partial l_1}$ and $\frac{\partial d}{\partial f_2} \frac{\partial f_2}{\partial l_2}$, as compared to a model that only considers the producer. This is in line with the general theory that social prices should be higher than private prices in presence of negative externalities (compare e.g. Tietenberg (2000)). We find the welfare-maximizing abatement costs by deriving with respect to a_1 and a_2:

$$c_1^a = -f_2(l_2) \frac{\partial v_2}{\partial a_1} \cdot p_2 - \frac{\partial d}{\partial a_1} \tag{15}$$

$$c_2^a = -\frac{\partial d}{\partial a_2} \tag{16}$$

Comparing to (10), the social optimum would therefore require the producer to abate above the private level until marginal abatement costs equal the marginal damage reduction *in addition* to any marginal value loss reduction on other goods produced by the landholder.

To conclude, both, optimal prices and abatement, are higher in a model that considers overall welfare beyond producer profit are higher. The first-best solution to this problem would be to introduce a pigouvian tax equal to the marginal damage caused by production on the non-market ESS (compare Pigou (1952)). Yet, as has been discussed extensively in the literature (e.g. Baumol (1972) and Pearce & Turner (1990)), lack of information and information asymmetries restrict possible applications. Instead, policy makers often have to revert to alternatives which limit damage of production and stimulate more sustainable production methods. In the following section we will consider three such options that aim at increasing abatement of a single commodity (product certification), increase the cost of damaging production/benefit of conservation (mitigation trading) as well as compensating for provision of non-market ESS (wetland certificates).

4.4 Models for Market-Based Instruments

4.4.1 Resource Certification

Targeted subsidies and sustainability certification may be useful instruments to increase abatement efforts of producers in the broader sense (including all kind of actions aiming at more sustainable production methods).

Given the significance of agriculture for livelihoods of people living in wetlands and its impact on the deterioration of wetlands, targeted subsidies and certification programs may be a possibility to improve sustainability. Abatement measures could for example include a more sustainable nutrient management, better waste-water treatment and integrated pest management. In functional terms, we include this by distinguishing between conventional agriculture $f_1^{co}(l_1^{co})$ with conventional abatement a_1^{co} and certified agriculture $f_1^{cer}(l_1^{cer})$ with production methods according to the environmental certificate standards. (This case encompasses the targeted subsidy case.) To make it attractive for producers to increase the level of abatement above the private optimum, we consider a case where the producer receives a price premium per unit. Subtracting additional expenses of compliance and direct certification costs yields the net premium p_{cer}^{net}. We assume that this abatement level would neutralize all negative externalities of production (i.e. both the impact of q_1 on q_2 and on x). Moreover, we employ the assumption that the abatement level of certified production reflects an abatement ceiling of the producer, i.e. the producer may choose to produce in a conventional way or certify (part of the) production but will not abate *above* the fixed level corresponding to certification.

A possible impact of certified land area on the efficiency of abatement is ignored ($\frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} = 0$), as are potential productivity losses in q_1 due to the sustainability standards. Finally, we suppose that the allocation of land to certified agriculture reduces the value loss in aquaculture $\frac{\partial v_2}{\partial l_1^{cer}} < 0$ with $\frac{\partial^2 v_2}{\partial l_1^{cer2}} > 0$ and a negative cross-elasticity $\frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} < 0$. This assumption may apply for some farming systems (e.g. when buffer zones are required, which might increase the carrying capacity of the wetland) but may not always be the case, as we will discuss later. The new decision problem is given by:

$$\max_{l_1^{co}, l_1^{cer}, l_2, a_1^{co}} \pi = f_1^{co}(l_1^{co}) \cdot p_1 + f_1^{cer}(l_1^{cer}) \cdot (p_1 + p_{cer}^{net}) + f_2(l_2)\left[1 - v_2\left(f_1^{co}(l_1^{co}), a_1^{co}, l_1^{cer}\right)\right] \cdot p_2 \qquad (17)$$
$$- l_1^{co} \cdot c_1 - c_a \cdot a_1^{co} - l_1^{cer} \cdot c_1 - c_2 \cdot l_2$$

with the extended land constraint $l_1^{co} + l_1^{cer} + l_2 \leq L$. To analyze how resource certification affects the total damage level, it is necessary to analyze how it affects land allocation. In order to do so, we first hold land allocated to aquaculture l_2 fixed. This makes sense for two reasons. First, many new certification schemes considering agriculture in wetlands (such as the Roundtable on Sustainable Palm Oil (RSPO, 2007) and the EU Biofuel Renewables Directive (European Parliament, Council, 2009)) rule out land with high carbon stock, such as peat, or high biodiversity (in which category many natural fishing grounds would fall). Second and perhaps most obvious, draining the fish ponds for agricultural land is related to costs and would generally not apply for the short term. Employing comparative statics, we find that an increase in p_{cer}^{net} in most circumstances would imply an expansions of land used for certified production at the cost of conventional farming (for further mathematical derivation see appendix). We also find that the total amount of abatement outside of the certification program decreases, which is reasonable, since the area of conventional farming declines. The impact of these changes on damage depends on the aquaculture production on the one hand, and the damage function on the other hand. Looking first at aquaculture, v_2 decreases as $f_1^{co}(l_1^{co})$ decreases and l_1^{cer} increases.

$$f_2(l_2)[1 - v_2(f_1^{co}(l_1^{co}), a_1^{co}, l_1^{cer})] \qquad (18)$$

If this value loss is not completely compensated by the decrease in a_1^{co}, productivity of aquaculture increases and as a result q_2 turns out to be larger. As for the effect on non-market ESS x, we therefore obtain an ambiguous impact; the negative impact of farming falls whereas the negative impact of aquaculture increases

$$x = x_0 - d(q_1^{co}, q_2, a_1^{co}, a_2) \qquad (19)$$

We may also consider the other case where the producer withdraws land from aquaculture for certified production or to replace the reduction in conventional farming (i.e. l_2 as variable). However, to be able to derive clear results from the analysis we would have to specify prices and the functional relationships more explicitly (for more details, also see appendix). In general terms, the reduced damage in q_2 would have to be weighed against negative effects from land use change.

In conclusion, the use of certification to reduce negative externalities on non-market ESS x by means of increased abatement measures is likely to have impacts on the production of other (marketable) goods as well. With respect to our example, the aim of agricultural certification could be to improve biodiversity, soil and water quality et cetera. Nevertheless, as pesticide pollution and siltation decline, the certification standards may lead to a positive impact on aquaculture as well. If aquaculture has a positive impact on x, for example through higher food security and health, the beneficial effect of certification may be fortified. On the other hand, if - as assumed in 4.2.1 - the negative impact of aquaculture on x dominates (e.g. through feed pollution or other unsustainable methods; see FAO (2011)), the positive impact of abatement on agriculture is countervailed by increased pollution from q_2. As a result, certification as stand-alone measure to reduce damage of one good may have unwanted side-effects.

4.4.2 Mitigation Trading

In most cases, resource certification as discussed above is voluntary (Golden et al., 2010). More sustainable production methods (captured by the abatement function) are awarded, depending on the willingness of consumers to shoulder the additional cost or price premium p_{cer}^{net}. By contrast, so called mitigation trading systems focus on the maximum damage $\bar{d}$ that society is willing to accept. In mitigation trading systems the cost to keep damage below $\bar{d}$ (by producing less or increasing abatement) is shifted to producers (even though this generally affects prices paid by end-consumers). Prime examples for this method are some schemes under the Wetland Mitigation Banking framework in the US (Morgan & Roberts, 1999; Sip, Leitch, & Meyer, 1998; Wilkinson & Thompson, 2006) and, on a global scale, the cap and trade system under the Kyoto protocol (UNFCCC, 1997), most prominently implemented in the EU emission trading scheme (ETS, 2003). These kinds of systems, within their particular frameworks, allow for only a certain overall amount of environmental degradation or pollution which can be offset elsewhere. The optimal amount of $\bar{d}$, the cap, could be taken from the results of the model in 4.3.2, but is of no further concern here. It matters only that such an amount is specified (e.g. by setting maximum levels of phosphorous runoff (Stephenson, Norris, & Shabman, 1998) or CO2 emissions (Gayer & Horowitz, 2006)) and that it is smaller than x_0. To pollute and destroy parts of the ecosystem, a polluter has to hold a proportional amount of permits to do so. An authority gives out these permits, producers buy these permits and can attain more (and in turn sell) by creating and maintaining buffer areas or protected zones $f_{pt}(l_{pt})$ and so save a proportional amount of the ecosystem. Hence the total amount of pollution permits is described by

$$Allowed\ Emissions = \bar{d} + f_{pt}(l_{pt}) \tag{20}$$

In this equation $\bar{d}$ represents the previously determined optimal amount that society is willing to accept as pollution and $f_{pt}(l_{pt})$ is a function for the activity of converting land into protected areas or buffer zones. This protected area function is essentially a production function for permits. Externalities of the permit production are captured by including the production function as a factor of value loss v_2. Under an offset scheme the outcome of $f_{pt}(l_{pt})$ can be converted into offset certificates. It incurs costs caused by maintenance of the protected area c_{pt} . Including input costs for abatement in f_{pt}like for f_1 and f_2 is unnecessary, since permit creation by definition does not pollute or destroy the environment and therefore does not need to be abated. For simplicity we assume that each additional unit of land gives the same amount of additional permits. Damage caused by the production of products other than offset permits has to be accounted for through permits bought at price p_{pt}. We cannot assume that each type of production causes the same amount of damage and therefore needs the same amount of permits to cover this damage. Hence a conversion factor $w_i(a_i)$ is necessary, which describes the negative environmental impact of production depending on abatement efforts. This factor for production-to-pollution conversion will be smaller the larger a_1 gets, but decreasingly so. That is, $\frac{\partial w_i}{\partial a_i} < 0$ and $\frac{\partial^2 w_i}{\partial a_i^2} < 0$ for both $i = 1,2$.

Hence the additional cost paid by the producer for damage caused by agriculture and aquaculture, the allowance cost, equals:

$$Allowance\ cost_1 = f_1(l_1) \cdot w_1(a_1) \cdot p_{pt} \tag{21}$$

$$Allowance\ cost_2 = f_2(l_2) \cdot w_2(a_2) \cdot p_{pt} \tag{22}$$

Similar to resource certification, apart from the reduction in d to $\bar{d}$, also the value loss of aquaculture might decrease due to positive external effects of the production of permits.

Incorporating this interaction to accommodate a mitigation trading system thus changes the decision problem.

Since a third type of land use is introduced, the land constraint changes to $l_1 + l_2 + l_{pt} \leq L$. In addition, the Lagrangian contains a cap which constrains production $\bar{d}+f_{pt}(l_{pt}) = f_1(l_1) \cdot w_1(a_1) + f_2(l_2) \cdot w_2(a_2)$ with $l_{pt} \geq 0$. Accordingly the new Lagrangian is defined as:

$$\begin{aligned}\mathcal{L}_{pt} = {} & f_1(l_1) \cdot p_1 + f_2(l_2) \cdot \Big(1 - v_2\big(f_1(l_1), f_{pt}(l_{pt}), a_1\big)\Big) \cdot p_2 + f_{pt}(l_{pt}) \cdot p_{pt} \\ & - l_1 \cdot c_1 - c_a^1 \cdot a_1 - c_2 \cdot l_2 - c_a^2 \cdot a_2 - c_{pt} \cdot l_{pt} - f_1(l_1) \cdot w_1(a_1) \cdot p_{pt} \\ & - f_2(l_2) \cdot w_2(a_2) \cdot p_{pt} + \mu \cdot (l_1 + l_2 + l_{ct} - L) + \psi \\ & \cdot \big(\bar{d} + f_{pt} - w_1(a_1) \cdot f_1 - w_2(a_2) \cdot f_2 \big) + \lambda_2 \\ & \cdot \Big(1 - v_2\big(f_1(l_1), f_{pt}(l_{pt}), a_1\big)\Big) + \lambda_3 \cdot l_1 + \lambda_4 \cdot l_2 + \lambda_5 \cdot a_1 + \lambda_6 \cdot a_2 \\ & + \lambda_7 \cdot l_{pt}\end{aligned} \tag{23}$$

Derivation yields (24) and (25) which show that the mitigation trading scheme accounts for damage caused by production independently of the product.

$$p_1 = \frac{f_2(l_2) \frac{\partial v_2}{\partial f_1} \frac{\partial f_1}{\partial l_1} \cdot p_2 + c_1 + \mu + \frac{\partial f_1}{\partial l_1} \cdot w_1(a_1)(p_{pt} + \psi)}{\frac{\partial f_1}{\partial l_1}} \tag{24}$$

$$p_2 = \frac{c_2 + \mu + \frac{\partial f_2}{\partial l_2} \cdot w_2(a_2)(p_{pt} + \psi)}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{25}$$

Accordingly, changing land allocation between the products is of minor importance. Comparing (24) and (25) to (13) and (14), respectively, shows that the marginal damage of production, $\frac{\partial d}{\partial f_1} \frac{\partial f_1}{\partial l_1}$, in the optimality calculation for welfare has been replaced. Instead the terms show the marginal cost of land-use in terms of permit prices, $\frac{\partial f_i}{\partial l_i} w_i(a_i) \cdot p_{pt}$, and $\psi \frac{\partial f_i}{\partial l_i} \cdot w_i(a_i)$, the shadow costs of permits, using the shadow price ψ and weighing it with the marginal damage. Both these terms are price drivers since they make production more costly and therefore decrease production and consequently pollution.

The third price in the model, p_{pt}, behaves differently than the prices of agriculture and aquaculture products,

$$p_{ct} = \frac{f_2(l_2)\dfrac{\partial v_2}{\partial f_1}\dfrac{\partial f_1}{\partial l_1}\cdot p_2 + c_{pt} + \mu - \psi\dfrac{\partial f_{pt}}{\partial l_{pt}}}{\dfrac{\partial f_{pt}}{\partial l_{pt}}} \tag{26}$$

Though it also increases in marginal productivity of input use and marginal production costs, it decreases in $\psi\frac{\partial f_{pt}}{\partial l_{pt}}$. This term simply is a measure of efficiency for permit production. As (26) shows, such changes in efficiency are passed on to the price, providing correct signaling on the mitigation trading market.

Turning to the optimal abatement, equations (27) and (28) emerge.

$$c_a^1 = -f_2(l_2)\frac{\partial v_2}{\partial a_1}\cdot p_2 - f_1(l_1)\cdot\frac{\partial w_1}{\partial a_1}\cdot p_{pt} - \psi\frac{\partial w_1}{\partial a_1}\cdot f_1(l_1) \tag{27}$$

$$c_a^2 = -f_2(l_2)\frac{\partial w_2}{\partial a_2}\cdot p_{pt} - \overbrace{\psi\frac{\partial w_2}{\partial a_2}}^{<0}\cdot f_2(l_2) \tag{28}$$

In comparison to (10) (and the analog case for c_a^2), the cost functions in the mitigation trading model are extended with two terms. Producers will abate up to the point where marginal costs of abatement equal the marginal value increase in the other ESS plus the nominal and shadow decrease in production-to-pollution conversion. That means essentially two factors have been added to the cost rationale, gauging the potential of damage and potential of abatement of this damage. Thus mitigation trading gives an incentive to accept abatement costs not only due to gains through another ESS, but also due to cost savings in the production to the two considered goods. Higher acceptable costs for pollution and environmental destruction will lead to higher prices, which in turn will lead to less demand and therefore less production.

Comparing the private optimum of chapter 4.3.1 to the results of (27) and (28) shows that any cap on environmental degradation or pollution will increase welfare as long as that cap is based on the value for d suggested by a calculation similar to the one from 4.3.2. This, however, only applies if homogenous units of environmental degradation are considered. With respect to emissions this might be realistic. When turning to biodiversity or scenic beauty, however, homogeneity or mathematical conversion is hard to achieve.

4.4.3 Wetland Certificates

So-called wetland certificates are a third marked-based instrument worth considering. Similar to mitigation trading, the idea is to create a market for global payments for environmental services. However, while the mitigation trading approach is based on a cap of the negative externalities in the tradable commodities, wetland certificates put the focus on the positive externalities of a well-maintained wetland. The idea is relatively new and can be connected with initiatives like the Green Development Initiative (GDI)[8]. Here we assume that a wetland certificate x_z can be sold to ESS users at a price p_z depending on how well a set of non-market ESS are maintained.

$$x_z(\underbrace{f_1(l_1)}_{(-)}, \underbrace{f_2(l_2)}_{(-)}, \underbrace{l_{ct}}_{(+)}\ \underbrace{a_1}_{(+)}, \underbrace{a_2}_{(+)}) \tag{29}$$

As can be seen in (29), x_z decreases when conventional production of agriculture and aquaculture increase, and grows with conservation. However, note also that the producer can achieve certificates by introducing more a_1 and a_2. Hence - as opposed to mitigation trading where abatement could reduce the *need* for permits but not create new ones - the producer does not have to stop production of q_1 and q_2 in order to obtain a certificate. The extended objective function translates into:

$$\begin{aligned}\max_{l_1,l_2,l_{ct},a_1,a_2} \pi = {} & f_1(l_1)\cdot p_1 + f_2(l_2)[1 - v_2(f_1(l_1), a_1, l_{ct})]\cdot p_2 \\ & + x_z(f_1(l_1), f_2(l_2), l_{ct}, a_1, a_2)\cdot p_z - c_1\cdot l_1 - c_a^1\cdot a_1 - c_2\cdot l_2 - c_a^2\cdot l_2 \\ & - c_{ct}\cdot l_{ct}\end{aligned} \tag{30}$$

Deriving with respect to l_1 and l_2 under consideration of the necessary conditions now yields:

$$p_1 = \frac{f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1}\cdot p_2 + c_1 + \mu - \frac{\partial x_z}{\partial f_1}\frac{\partial f_1}{\partial l_1}\cdot p_z}{\frac{\partial f_1}{\partial l_1}} \tag{31}$$

$$p_2 = \frac{c_2 + \mu - \frac{\partial x_z}{\partial f_2}\frac{\partial f_2}{\partial l_2}\cdot p_z}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{32}$$

As can be seen in the last terms containing $\frac{\partial x_z}{\partial f_i}\frac{\partial f_i}{\partial l_i}\cdot p_z$, wetland certificates increase the prices of agriculture and aquaculture products as we assume that l_i affects the vector of ESS in x_z negatively. The certificate price in turn can be established at a lower level if the impact of conservation on the value loss in $f_2(l_2)$ is large:

[8] For more information on this initiative, see (GDI, 2011).

$$p_z = \frac{f_2(l_2)\frac{\partial v_2}{\partial l_{ct}} \cdot p_2 + c_{ct} + \mu}{\frac{\partial x_z}{\partial l_{ct}}} \tag{33}$$

Similarly, the more conservation affects the amount of certificates obtainable (i.e. the higher $\frac{\partial x_z}{\partial l_{ct}}$), the smaller can be the certificate price without losing its appeal to producers. By contrast, the additional costs connected with conservation would boost the price. In the break-even point where the reduced marginal value loss in aquaculture and the opportunity cost of land (as reflected in the land constraint parameter μ) are equal to the marginal costs of conservation, the producer would conserve without any certificate.

Marginal abatement costs are given by

$$c_a^1 = \frac{\partial x_z}{\partial a_1} \cdot p_z(l_2)\frac{\partial v_2}{\partial a_1} \cdot p_2 \tag{34}$$

$$c_a^2 = \frac{\partial x_z}{\partial a_2} \cdot p_z \tag{35}$$

As would be expected, c_a^1 increases in the reduced marginal value loss in aquaculture (as before) and both marginal costs increase in the impact on x_z.

4.5 Conclusion

Modeling the interdependencies between ecosystem services in a wetland, we showed how applicable economic instruments fit into this model and whether they are effective and efficient. As flexible instruments with long tradition, product certification may be attractive given the (relatively) low requirements in terms of system infrastructure, monitoring and information costs. However, similarly to (Heberling, García, & Thurston, 2010), we conclude that instruments targeting abatement of one product only may also lead to counterproductive effects; as the negative impact on other goods declines, production of these other goods becomes more appealing. In which way this will affect the overall welfare depends on the positive or negative impact of these goods on non-market ESS. Setting incentives right and applying this method to wetlands in an efficient manner demands close monitoring. Therefore, depending on the transaction costs and the complexity of the system, this kind of instrument may be rated as second-best when compared to mitigation trading and wetland certificates. The former would punish all polluting and destructive production and hence internalize the externalities where they occur. Accordingly, as the equations in 4.3.2 show, prices would increase without giving cause to an unintended reallocation. One possible drawback might be the measurement of externalities. While it may be easier to do for single pollutants as carbon dioxide or water contaminants (as is already practiced within the EU ETS (ETS, 2003) and various water trading programs (Colby, 2000; Schary & Fisher-Vanden, 2004; Speed, 2009; Thompson, Supalla, Martin, & McMullen, 2009)), it is challenging with respect to biodiversity and other ESS, which tend to be very heterogeneous.

By contrast, the wetland certificates as described here may be less demanding in terms of emission calculation, given that it is based on inventories of available ESS rather than ongoing emissions of production activities. They further allow the producer great latitude as conservation, production and abatement measures can be combined in the, for the producer, most efficient way. On the other hand, this advantage may also be a shortcoming of the system, as it demands a high degree of knowledge of the landholder how production and conservation affect biodiversity, carbon sequestration capacities, etc. Hence, depending on the circumstances, it will probably be easier - and less costly - to provide certificates for straight conservation or to compensate directly for the abatement measures taken.

A second concern relates to the payment vehicle. In the case of resource certification, end-consumers generally pay price premiums directly, while for mitigation trading the polluters pay the cost (although ultimately consumers may do, too, through higher prices). An advantage of these systems in terms of efficiency is thus the possibility to make use of the market mechanism for price signaling. Wetland certificates as bundles of ESS cannot as easily be connected with specific products. Because of this, non-governmental organizations, governments or companies with an interest in increasing their social responsibility could be potential funders.

Having provided a framework to capture the interactions in a wetland ecosystem, there are still many open questions that need to be addressed. For example, the multiple producer structure present in many wetlands and how traditional institutional settings (e.g. with respect to property rights) may affect the outcome of policy measures are two of many issues that remain to be tackled successfully. Finally, empirical research to follow up new initiatives is crucial, especially for developing countries where the market potential is high, but little infrastructure is available.

Appendix: Comparative Statics

To evaluate the impact of certified production for a fixed land area l_2, we take the first order conditions of (17) with respect to the optimization variables and derive again with respect to the net price premium p_{cer}^{net}.

$$\frac{\partial^2 \mathcal{L}}{\partial l_1^{cer} \partial p_{cer}^{net}} = \frac{\partial^2 f_1^{cer}}{\partial l_1^{cer^2}} \cdot (p_1 + p_{cer}^{net}) \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 v_2}{\partial l_1^{cer^2}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} + \frac{\partial f_1^{cer}}{\partial l_1^{cer}}$$

$$\frac{\partial^2 \mathcal{L}}{\partial l_1^{co} \partial p_{cer}^{net}} = -f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co^2}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} + p_1 \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \frac{\partial v_2}{\partial f_1^{co}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}}$$

$$\frac{\partial^2 \mathcal{L}}{\partial a_1^{co} \partial p_{cer}^{net}} = -f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co^2}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}}$$

$$\frac{\partial^2 L^*}{\partial \mu \partial p_{cer}^{net}} = -\frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}}$$

From the assumptions in 4.3.1 and 4.3.2, we know that:

Symbol	Function	Sign
a	$\frac{\partial^2 f_1^{cer}}{\partial l_1^{cer^2}}$	< 0
b	$\frac{\partial^2 v_2}{\partial l_1^{cer^2}}$	> 0
c	$\frac{\partial f_1^{co}}{\partial l_1^{co}}$	> 0
d	$\frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}}$	< 0
e	$\frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}}$	$= 0$
f	$\frac{\partial^2 v_2}{\partial f_1^{co^2}}$	< 0
g	$\frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \frac{\partial v_2}{\partial f_1^{co}}$	< 0
h	$\frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}}$	> 0
i	$\frac{\partial^2 v_2}{\partial a_1^{co^2}}$	> 0

We may use this information to calculate the determinant Δ:

$$\Delta = \begin{vmatrix} 0 & -1 & -1 & 0 \\ -1 & a\cdot(p_1+p_{ab}) - f_2(l_2)b\cdot p_2 & -f_2(l_2)cd\cdot p_2 & -f_2(l_2)e\cdot p_2 \\ -1 & -f_2(l_2)cd\cdot p_2 & -f_2(l_2)cf\cdot p_2 + p_1 g - f_2(l_2)g\cdot p_2 & -f_2(l_2)ch\cdot p_2 \\ 0 & -f_2(l_2)e\cdot p_2 & -f_2(l_2)ch\cdot p_2 & -f_2(l_2)i\cdot p_2 \end{vmatrix} < 0$$

Then by Cramer's Rule

$$\frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & 0 & -1 & 0 \\ -1 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} & -f_2(l_2)cd\cdot p_2 & -f_2(l_2)e\cdot p_2 \\ -1 & 0 & -f_2(l_2)cf\cdot p_2 + p_1 g - f_2(l_2)g\cdot p_2 & -f_2(l_2)ch\cdot p_2 \\ 0 & 0 & -f_2(l_2)ch\cdot p_2 & -f_2(l_2)i\cdot p_2 \end{vmatrix}}{\Delta} < 0$$

$$\frac{\partial l_1^{co}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & -1 & 0 & 0 \\ -1 & a\cdot(p_1+p_{ab}) - f_2(l_2)b\cdot p_2 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} & -f_2(l_2)e\cdot p_2 \\ -1 & -f_2(l_2)cd\cdot p_2 & 0 & -f_2(l_2)ch\cdot p_2 \\ 0 & -f_2(l_2)e\cdot p_2 & 0 & -f_2(l_2)i\cdot p_2 \end{vmatrix}}{\Delta} > 0$$

$$\frac{\partial a_1^{co}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & -1 & -1 & 0 \\ -1 & a\cdot(p_1+p_{ab}) - f_2(l_2)b\cdot p_2 & -f_2(l_2)cd\cdot p_2 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} \\ -1 & -f_2(l_2)cd\cdot p_2 & -f_2(l_2)cf\cdot p_2 + p_1 g - f_2(l_2)g\cdot p_2 & 0 \\ 0 & -f_2(l_2)e\cdot p_2 & -f_2(l_2)ch\cdot p_2 & 0 \end{vmatrix}}{\Delta} = ?$$

A price premium increase would clearly have a positive impact on land allocation to certified production l_1^{cer} and a negative impact on land for conventional production l_1^{co}. By contrast, the system does not provide an unambiguous answer for the impact on a_1^{co}. In general, a small impact of agricultural production on the value loss in aquaculture increases the probability of a reduction in abatement for conventional farming (reflected in the diagonal element in the third row).

If we assume that land for aquaculture is variable as well, we would do the same exercise but include the first and second order conditions with respect to l_2 and p_{cer}^{net}. However, the complexity of such a system does not allow a straight reply but would have to be checked in a numerical context.

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5 Financing Protected Areas in sub-Saharan Africa through International Market-based Instruments

Abstract

Many Protected Areas (PAs) in sub-Saharan Africa (SSA) are severely underfinanced 'paper parks' that offer only scant protection for the resources they contain. This calls for new PA financing approaches. This paper reviews opportunities for and obstacles against the use of international market-based instruments (MBIs) to provide supplemental financing of PAs in SSA. Causal loops of low effectiveness, high transaction costs and limited efficiency have resulted in relatively few international MBI projects in SSA compared to Asia or Latin America. The current shift from state-based 'fines and fences' PA management towards integrated sustainable use concepts will allow for a better integration of international MBIs into PA concepts, as exemplified by Climate, Community and Biodiversity Alliance (CCBA) certified PAs.

5.1 Introduction

The impact of human activities on natural ecosystems is significant, and is escalating worldwide (CBD, 2010; Chapin & Matson, 2011; UNEP, 2010). Over the last decades, many convincing arguments have been made that support the need for more sustainable use of our world's ecosystems (Biermann et al., 2012; Rockström et al., 2009). There are a number of multilateral agreements which indicate international concern in this regard. These include the Rio Conventions, which were drawn up in 1992, the outcomes of the Kyoto climate conference in 1997, the Millennium Development Declaration from 2000, and the Nagoya Biodiversity Summit in 2010. Focus has increasingly shifted from the impacts of economic growth on the world's ecosystems to the impacts of ecosystem degradation and destruction on economic productivity and human well-being (Dalby, 2009). Incentives are needed to minimize both of these impacts. This requires institutional structures capable of guiding human society away from critical tipping points and irreversible change to ensure sustainable livelihoods (Kanie, Betsill, Zondervan, Biermann, & Young, 2012).

Sub-Saharan Africa (SSA) boasts some of the world's richest and most diverse natural landscapes and biological resources, including several global biodiversity hotspots and areas of particularly high endemism (Biervliet, Wiśniewski, Daniels, & Vonesh, 2009; Davies et al., 2011). However, in the last half century, population growth coupled with agricultural expansion, rural poverty and technological progress have massively increased pressure on SSA's ecosystems, often leading to their irrevocable destruction (Kideghesho, Røskaft, & Kaltenborn, 2007; McCartney et al., 2010a; Schuyt, 2005; Turpie, Barnes, Lange, & Martin, 2010; Wood & van Halsema, 2008). In response, most SSA countries have established extensive national systems of environmentally Protected Areas (PAs) (Chape, Blyth, Fish, Fox, & Spalding, 2003; C. N. Jenkins & Joppa, 2009). In 2003, about 9 per cent of Western and Central Africa was formally protected according to the standards of the International Union for Nature Conservation (IUCN), of which 35 per cent belonged to IUCN's protection categories I-III (Chape et al., 2003). Similarly, 17 per cent of Eastern and Southern Africa was formally protected of which 26 per cent was under protection categories I-III (Chape et al., 2003). On a national scale, some figures are even higher. Tanzania, for example, designated a total of 792 PAs, which account for more than 38 per cent of the country's total area (Consortium, 2003). The main responsibility for managing and financing these extensive systems of PAs lies with governmental agencies.

In practice, however, most PAs in SSA are ‘paper parks’ (Duffy, 2006; Wilkie et al., 2001). They offer little de facto protection for the natural and biological resources they contain and are under considerable threat from anthropogenic modification and habitat destruction. Many PAs no longer harbour the biological resources and ecosystems for which they were established. Reasons are institutional weaknesses alongside population growth, technological progress, rural poverty, armed conflict, forced relocation, and most importantly, the massive and chronic lack of funding (Frazee, Cowling, Pressey, Turpie, & Lindenberg, 2003; King, 2009). PA budgets, both from own revenues or financiers such as the state, international donors or Non-Governmental Organisations (NGOs), rarely allow for an effective long-term management of PAs in SSA. In this context, scholars and practitioners are working towards the development of international market-based financing mechanisms that promote private investments for the more effective management of PAs (Parker, Mitchell, Trivedi, Mardas, & Sosis, 2009).

Scholar and practitioners pay increasing attention to Payments for Ecosystem Services (PES) on the one hand and PAs in SSA on the other. The class of PES that is commonly called market-based instruments (MBIs) are often mentioned in this debate as applicable for financing PAs in SSA. This paper aims to provide a critical review and assessment of the major opportunities for and obstacles to use of international MBIs in SSA. Based on theoretical and empirical literature from various disciplines and the authors’ own empirical field research in Tanzania, Namibia and Ethiopia, this paper critically reflects on MBIs and their actual and potential effective implementation in SSA, and attempts to reconcile some contrasting views.

Section two briefly reviews the recent PA discourse and current trends in PA financing, with a particular focus on SSA. Part three deals with the performance and potential of currently applied or developed international market-based instruments for financing PAs in SSA. Part four provides the concluding summary, outlook and policy recommendations.

5.2 Protected areas as spaces for nature conservation and sustainable livelihoods

The importance of PAs is growing. In most areas of the world, their numbers and size have increased considerably in the last two decades. Since 1990, the increase in developing countries has been higher than in developed ones (WDPA, 2011). This trend is likely to continue in the near future. In 2010 the CBD COP10 in Nagoya set the ambitious goal that "by 2020, at least 17 per cent of terrestrial […] areas […] should be conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas" (CBD, 2010).

5.2.1 Definition and categorization of protected areas

PAs are established to promote the conservation and sustainable use of terrestrial or aquatic ecosystems. The overall aim of a PA is to locally plan and manage human-nature interactions in order to create synergy between the conservation of natural and biological resources and the maximization of societal or individual human welfare, or at least the avoidance of inferior welfare outcomes (CBD, 2010).

The International Union for Conservation of Nature (IUCN) defines a PA as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008). This definition is widely accepted and adopted by policy-makers and scholars worldwide. The IUCN classifies Therefore, PAs into six categories, based on primary management objectives, doing justice to the multitude of functions that PAs have today (Dudley & Phillips, 2006). As multi-functional landscapes, PAs provide a variety of services ranging from carbon storage, biodiversity conservation and water purification to tourism and recreation as well as direct contribution to local livelihoods e.g. through the provision of food and firewood. PAs can hence function as catalysts that may help local, regional and national economies move towards integrated concepts of sustainability.

5.2.2 The need for (co-)funding

PAs are expensive. There are real and significant running costs associated with ensuring that PAs are effectively protected, that the ecosystem services they provide are maintained and that local communities benefit from them. Someone has to pay for these costs. But acquiring these funds is particularly challenging in developing countries where most PAs depend on funding from international bilateral and multilateral donors. In Uganda, for example, more than three quarters of the country's PA budget in 1995 was contributed by foreign donors (Emerton, Bishop, & Thomas, 2006). Since its establishment in 1991, the Global Environment Facility (GEF) allocated US$10 billion worldwide, supplemented by more than US$47 billion in co-financing for more than 2,800 projects, many of which are related to PA financing (GEF, 2010). Today, GEF is the largest multilateral fund for environmentally related projects in developing countries. Consistent with the CBD, the GEF has defined strategic priorities for catalyzing the financial sustainability of PAs.

The extent of both required and available funds for PAs worldwide is difficult to assess due to a lack of consistent reporting and the absence of an international clearing-house of information about PA funding (Emerton et al., 2006). Nevertheless, three separate studies have estimated the costs for the effective management of all existing PAs in developing countries as falling somewhere in the range of US$1.1 billion to US$2.5 billion per year; The funding gap is estimated between US $1 billion and $1.7 billion per year (Bruner, Gullison, & Balmford, 2004; A. James, Gaston, & Balmford, 2001; A. N. James, Gaston, & Balmford, 1999; Vreugdenhil, 2003). These studies are relatively old, however. As number and size of PAs rises, along with costs related to increased governance complexities, the discrepancy between required and available funds is likely to increase in the future. State and donor funding opportunities do not keep pace with this trend (M. Jenkins, Scherr, & Inbar, 2004; Scherr, Milder, & Shames, 2010). Much emphasis is now placed on developing ‘Proactive Investment in Natural Capital’ (Trivedi et al., 2009). This holistic view of natural capital offers the potential for global biodiversity finance. A recent study on biodiversity finance, published by the Global Canopy Programme, reviews 17 mechanisms which together could raise up to US$ 160 billion per year (Parker et al., 2009). In 2010 the global scale of funding for biodiversity and ecosystem services is estimated at US$ 52 billion - of which Africa receives as little as 6.24 per cent (Parker et al., 2009).

5.2.3 Towards integrated concepts

Most PAs in SSA have been established in geographically ‘remote’ rural areas with relatively low population densities. In the last few decades, population in and around PAs has grown, and agriculture as well as technical infrastructure has spatially expanded and developed. This has increased land use pressure, leading to conflicts between PAs and groups of individuals living in or adjacent to the PAs, often referred to as local communities (Balmford et al., 2001).

Most local communities depend on agriculture or pastoralism for their livelihoods, often using subsistence-based and land-intensive production systems. They are predominantly members of the rural poor. The nexus between rural poverty and PAs in SSA has hence gained increasing attention (Ferraro, 2002; Teklenburg, ten Brink, & Witmer, 2009). Local effects of a PA establishment can aggravate poverty, e.g. when local communities lose their user rights to their farmland or when they are forcibly resettled due to the establishment of a new PA. In recent times, therefore, more emphasis is placed on the role of PAs as instruments for mitigating rural poverty, as in “Integrated Natural Resource Management” (INRM) (Ash et al., 2010; Carew-Reid, 2003; Reid et al., 2006).

Assessing local opportunity costs for restricting the use of resources from PAs is an important factor in designing cost-effective conservation schemes that minimize adverse effects on local communities. The failure to measure the local opportunity costs of PAs often leads to ineffective and inefficient conservation strategies, and not only in developing countries (Fuller et al., 2010; Kramer & Sharma, 1997; Wiersma & Nudds, 2009). In depth ex-ante assessments of the local impacts of PA establishment are therefore increasingly becoming a more and more critical component in the PA debate.

5.3 International MBIs as a source of finance for Pas in SSA?

The past decade has seen a growing international discourse on how to make conservation and sustainable utilization of ecosystems financially rewarding. The PES approach is one idea aimed in this direction. It has gained momentum since the 1990s as a way to generate revenues for the conservation and sustainable utilization of ecosystems (Engel, Pagiola, & Wunder, 2008; Farley & Costanza, 2010; Polasky & Segerson, 2009; Redford & Adams, 2009). PES includes a variety of concepts aimed at promoting the sustainable use of the environment by evaluating the economic value of its services and then getting private or public buyers to pay for it (Wunder, Engel, & Pagiola, 2008). In the last years, PES was also targeted by criticism, largely referring to problems related to the commoditization of public goods (Kosoy & Corbera, 2010) or the hidden political ambiguities of PES (Van Hecken & Bastiaensen, 2010).

Many PES-labeled approaches are designed as MBIs which are "regulations that encourage behaviour through market signals rather than through explicit directives" (Stavins, 2001). Marketability can ensure appropriate valuation of ecosystem services, proper functioning of market signals and consequently the provision of ecosystem services according to market demand (Beder, 1994). But how is the use of ecosystem services carried over into market signals?

Ecosystem services have varying degrees of excludability and use-rivalry (Deke, 2008):

- In the case of lumber-provision from a PA, for example, certain user groups can be physically excluded, and lumber can only be used once. Both, the properties of excludability and use-rivalry, make this ecosystem service a purely private good. A service like carbon sequestration, on the other hand, can benefit anyone, and nobody can be excluded. There is no incentive to sequester carbon at an optimal level like a private good.
- Cap-and-trade schemes attribute property rights similarly. Without such schemes, the amount of carbon that could be emitted to the atmosphere would be unallocated, and whatever carbon there is would be freely usable. Within the scheme, property rights make exclusion and rivalry in consumption possible, and bring use of the atmosphere to the realm of private goods.
- Another group of MBIs concerns markets for ecosystem services that are non-rivals in use but for which excludability can be established, so that service users can be forced to pay user charges. MBIs for these so-called 'club goods' can be separated into payments for direct use values, e.g. National Park entrance fees, and indirect ones, e.g. payments for the provision of water from protected watersheds (Deke, 2008).

Figure 5.1

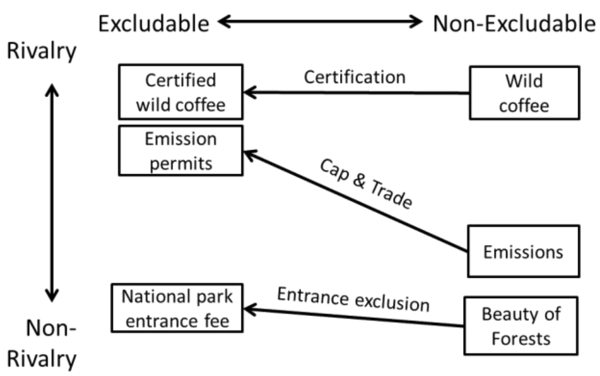

Figure 5.1: Conceptualization of MBIs (source: Own)

International MBIs are characterized by having supplier an ecosystem service and its a a buyer in different countries. The discussion about the potential of international MBIs to generate revenues for the conservation and sustainable use of ecosystem services has heralded a lot of international recognition, reputation and expectation. Parallel to this, new communication channels have developed. The webpage ecosystemmarketplace.com, for example, has become a leading PES trading floor. The CBD COPs regularly call for the development and implementation of international MBIs to support the achievements of the CBD in general and those of the CBD Program of Work on Protected Areas (PoWPA) in particular. Large international donors such as GEF or the World Bank's BioCarbon Fund promote international MBIs in order to help them achieve their objectives. Governmental and non-governmental agencies field-test MBIs together with stakeholders on the ground (Milder, Scherr, & Bracer, 2010). While national MBIs are mainly located in developed countries, many international MBIs focus on ecosystem services provided in developing and transition countries (Richards, 2004).

The focus, structure and extent of international MBIs in developing countries, however, varies considerably (Gutman & Davidson, 2007). Most MBIs value ecosystem services that also play central roles in PAs, such as prevention of deforestation (carbon sequestration), biodiversity conservation or watershed protection (Meijaard et al., 2011). However, despite the important role that PAs in developing countries play for the provision of ecosystem services of local, national and global importance, little academic attention has been given so far to the question of how international MBIs can contribute as a catalyst to PA (co-)financing.

In the following, we will review the three groups of international MBIs which are currently referred to as having the greatest potential for contributing to the improved financing of PAs in SSA. These are carbon markets/CDM; REDD+; and sustainability certification approaches.

Their respective foci are arranged along a gradient, from covering a single ecosystem service (carbon) to three such services (carbon, local people benefits, biodiversity conservation) towards concepts that value bundles of ecosystem services and local community development.

5.3.1. Carbon markets/CDM

Carbon markets aim to combat climate change as cost efficiently as possible. The idea behind it is that pollution rights can be traded. Ideally, those who can get the highest marginal value out of a unit of pollution will pay the highest price to actually pollute.

The most prominent carbon trading mechanism was set up under the Kyoto Protocol, underpinned by the UNFCCC signed in 1992, with the Clean Development Mechanism (CDM) being the most relevant part for developing countries. The CDM allows developed countries to meet their carbon emission commitments by financing carbon saving or sequestration projects in exchange for certified emission reductions (CERs) in developing countries. Alternatively, organisations and companies in developing countries can themselves invest in CDM projects and then sell their CERs to companies in industrialized countries. These CERs can be used to cover the carbon emissions allowed under the emission cap of industrialized countries. As such, the CDM has been heavily critiqued internationally as a "green wash" business opportunity for companies in developing countries.

However, according to the World Bank, "to date [2010], Africa hosts less than 2 percent of all registered CDM projects" (WBI, 2010). One major reason for the lack of projects in African countries is the large transaction costs involved in starting a CDM project (Chadwick, 2006). These costs are often prohibitively high for small projects and cannot be justified by the gains from selling CERs (Michaelowa, Stronzik, Eckermann, & Hunt, 2003). A large part of these costs is attributable to the extensive bureaucracy and checking mechanisms involved in approving a project. Namibian accounts state that these costs are the foremost reason as to why they do not start afforestation/reforestation projects under the CDM umbrella (own interview with Namibian Nature Foundation, 21/03/2012, Windhoek).

General criticism of the CDM points at the relatively low price of the certificates as well as its poor sustainability and environmental scope (Boyd et al., 2009; Lovell, 2010; Sutter & Parreño, 2007). As a consequence, the Verified Carbon Standard (VCS, formerly Voluntary Carbon Standard) emerged in 2005 (Bryan, Akpalu, Yesuf, & Ringler, 2010). In principle, the voluntary carbon offsets of the VCS work like the CDM. Some major points differ, however. The larger bureaucratic overhead of the CDM allows it to include an intensive review and approval process for projects and methodologies. The VCS in contrast has a more simplified set of institutions and stakeholders at the decision-making level. As a response to the CDM's tight focus on carbon, VCS offsets also certify ancillary benefits with respect to environmental sustainability and poverty eradication (Lovell, 2010). VCS could offer opportunities for African countries to access carbon offset funds: Africa recently held a larger portion (almost 7 per cent) of the transaction volume in the voluntary offsets market than in the CDM market (2 per cent) (Peters-Stanley, Hamilton, Marcello, & Sjardin, 2011; UNFCCC, 2010). This does not make up for the fact that SSA is still the region least engaged in offset projects, but it does show that the voluntary offset market has some advantages in this region. The VCS might be a stepping stone for SSA countries to more fully participate in the carbon offset market.

5.3.2 REDD

In 2007, the parties of the UNFCCC COP 13 in Bali adopted a decision to reduce emissions from deforestation in developing countries (REDD). REDD initiatives aim to provide financial incentives to reduce or stop deforestation (Emerson et al., 2010). REDD+ additionally aims to yield co-benefits for community development and biodiversity conservation to generate synergies for the achievement of both UNFCCC and CBD objectives. However, REDD+ is not yet internationally binding. In SSA, REDD activities are sponsored by bilateral donors or multilaterals such as the World Bank Forest Carbon Partnership Facility (WBFCPF), the African Development Bank or the Congo Basin Forest Fund (Cerbu, Swallow, & Thompson, 2011).

REDD readiness aims to help countries preparing REDD payment mechanisms by developing REDD national strategies, building capacities and analyzing emission sources and forest carbon stocks. REDD readiness activities are relatively evenly distributed across Asia, Latin America and Africa. As of 2009, Africa plays host to 22 REDD readiness activities, 11 in East Africa, 8 in Central Africa, and 3 in West Africa (Cerbu et al., 2011). However, Africa lags behind in terms of on-the-ground REDD field testing and pilot project implementation, with a total of 18 local REDD demonstration and pilot projects throughout the whole continent. With its 31 projects, Africa hosts far less projects than e.g. the Amazon region (Cerbu et al., 2011). The relatively small number of REDD demonstration and pilot projects in Africa mirrors the limited number of CDM projects in Africa.

Tanzania is at the forefront of REDD demonstration and piloting in SSA. As part of the Norwegian Climate and Forest Initiative, launched at the Bali Summit to initiate early action on REDD in developing countries, Norway invested large amounts (some speak of US$100 million) to establish REDD pilots in Tanzania between 2008 and 2013. This helped Tanzania to prepare for a future global REDD regime, and to launch 10 REDD local pilot projects (own interview with REDD Secretariat Tanzania, 13/08/2011, Dar-es-Salaam). However, the practical outcomes on the ground give little reason for optimism. The pilots struggle with questions of how to develop equitable and corruption-free benefit-sharing, and how to monitor and certify the systems.

Deforestation and forest degradation generate almost one fifth of global anthropogenic greenhouse gas emissions (Pelletier, Ramankutty, & Potvin, 2011). It is undeniable that the potential for REDD in SSA is enormous. As of 2005, about 21.4 per cent of Africa’s total land area comprised a total of 635 million hectares of forest – about 16 percent of the world's total (FAO, 2006). At the same time, SSA experiences some of the highest deforestation and degradation rates in the world. The loss in forest area mainly reflects the conversion of forest land to agriculture (FAO, 2007). Estimates suggest that Nigeria, Tanzania and Zambia are potentially the most important SSA suppliers of REDD carbon credits during the first commitment period 2013-2020 (Emerson et al., 2010).

Many forests threatened by deforestation and degradation are located within PAs. As REDD increasingly shifts its attention towards the integration of CO_2 emission reduction, conservation of biodiversity, sustaining ecosystem functioning and supporting local livelihoods (Elliott, 2010), REDD could be used to monetize the protection of these forests by building upon existing PA structures. However, the complexities involved in implementing REDD are even greater than with CDM. This makes it particularly difficult to use it as an instrument for financing PAs in SSA. The direct commercial benefit to a private company investing in REDD in SSA is questionable (own interview with Carbon Tanzania, 19/08/2011, Arusha). In this regard, the manager of a private forest investment company in Tanzania stated that:

> "*Everybody talks about REDD. However, for a commercial company the avoidance of deforestation is difficult to be commercially viable. You would need very large areas to get sizable amounts of carbon. Afforestation makes commercially more sense. With REDD you have to work intensively with the local communities, which takes even more time and money* [than CDM], *and gains should go to the local communities. Therefore there is hardly any private company in the REDD sector, but mostly NGOs and GOs*" (own interview with Green Resources, 12/08/2011, Dar-es-Salaam).

The consequence is a limited number of pilot projects which entirely depend on external donors for funding. To make matters more uncertain, the structure of REDD is vague and constantly changing (Agrawal, Nepstad, & Chhatre, 2011; Elliott, 2010). It is still not clear to what extent funding of REDD will be based on MBIs, carbon credits, public funds, or a mixture of these. Coupling carbon markets with pro-poor development under REDD further complicates the design of the mechanism, and payments to communities from REDD may not be sufficient to cover the opportunity costs of conservation. Accordingly, the aim of global carbon markets to deliver low-cost mitigation is not necessarily conducive to supporting the priorities and needs of local communities (Mustalahti, Bolin, Boyd, & Paavola, 2012).

5.3.3 Sustainability certification

"Certification is a process of controlling particular aspects of a system to provide some guarantee to outsiders that the system complies to an agreed set of rules" (Meijaard et al., 2011). With regard to PAs in SSA, three clusters of certification are particularly relevant, namely product certification, forest management certification and certification of ecosystem services.

5.3.3.1 Product certification

Agriculture is the largest land use category in the world and one of the main reasons for the loss of ecosystem services. Even though, the area and intensity of agricultural activity are still on the rise (Tejeda-Cruz, Silva-Rivera, Barton, & Sutherland, 2010). According to (UNEP, 2011), environmental sustainability could be largely driven by positive agrarian change towards increased use efficiency, productivity and profitability. In order to promote socio-economic and ecological transformation of agricultural sectors worldwide, a broad range of product- and process-related certification schemes were developed in the last decade.

Most international certification standards for agricultural products place a strong emphasis on environmental sustainability. Many studies have been conducted on the impact of certification on natural ecosystems in developing countries. For example, Poncelet, Defourny, & De Pelsmacker (2005) evaluated Fair Trade projects with bananas in Costa Rica and Ghana, and with coffee in Tanzania and Nicaragua, and concluded that the impact of Fair Trade is easily identifiable with respect to human and social capital, but that it has an ambiguous effect on environmental sustainability. Philpott, Bichier, Rice, & Greenberg (2007) found that Fair Trade coffee brought economic benefits to farmers, but did not necessarily protect biodiversity.

However, using certification of agricultural products to generate revenue for the financing of PAs is a relatively new phenomenon, especially in SSA. A particular challenge of certification schemes is the complex interaction between conservation of ecosystem services and smallholder agricultural practices within or adjacent to a PA. As shown by Stellmacher & Grote (2009) using the example of the certification of forest coffee in Ethiopia, the benefit paid to local farmers due to certification can provide strong incentives for them to increase their agricultural activities and management intensities within PAs, with negative environmental consequences. As chapter 4 of this dissertation shows, this can also be shown on theoretical grounds. Hence the use of product certification for PA financing needs to focus on the development areas and buffer zones of PAs. One alternative approach to generating funding for PAs by means of product certification is exemplified by the Darara Bunna coffee project in Ethiopia. It uses revenues generated from organic certified coffee produced in unprotected areas of Ethiopia to co-finance a UNESCO Coffee Forest Biosphere Reserve in Ethiopia, which harbours some of the last wild coffee (*coffea Arabica*) populations in the world (own interview with Environment and Coffee Forest Forum, 04/11/2011, Addis Ababa).

5.3.3.2 Forest management certification

Forest management certification was introduced as an international market-based instrument in 1993 to mitigate unsustainable forest management practices, with a focus on developing countries. Since then, the instrument has addressed growing public concerns about deforestation worldwide, a phenomenon which is increasingly linked to debates on climate change, loss of biodiversity and local participation (Rametsteiner & Simula, 2003). Today there are more than 60 forest management certification systems around the world, which certify a total of about 10 per cent of the worldwide forest area (Preece, 2011).

In Africa, the total area of certified forests increased by about 18 per cent between 2002 and 2007 and in 2007 an additional 0.6 per cent of Africa's forests were certified (ITTO, 2008). When compared to the worldwide figure of 10 per cent this shows the remarkably small contribution that Africa makes to the global forest management certification system.

The main forest management certification scheme currently used in SSA is that of the Forest Stewardship Council (FSC). National forest certification systems are largely absent, and "FSC does not play a role on the domestic timber markets in Africa" (own interview with Green Resources, 12/08/2011, Dar-es-Salaam). FSC certified products hence mainly aim at markets in Europe and North America.

As of 2007, the total FSC certified area in Africa was 7.3 million ha. This accounts for only about 5 per cent of the total FSC certified areas worldwide (ITTO, 2008). With 1.7 million ha, South Africa accounts for the largest portion of this percentage (ITTO, 2008). The dominant share of FSC certified forests in Africa are forest plantations rather than primary forests (FAO, 2007) and they are managed by the private sector (ITTO, 2008). The Norwegian private company Green Resources (GR), Africa's leading forestation company, for example, afforested 22,000 ha in Eastern Africa with Pine and Eucalyptus, and holds another 300,000 ha of land for future planting. It has begun pursuing FSC certification for its forests in Tanzania and Mozambique, and aims to certify all of its forests in Africa according to FSC in the near future. Beyond that, GR has started to register its activities as CDM projects and to certify them according to the Climate, Community & Biodiversity Alliance (CCBA) Standard. In 2010, the 2,000 ha GR Kachung forest project in Uganda was registered as a

CDM project and validated to the CCBA standard (own interview with Green Resources, 12/08/2011, Dar-es-Salaam).

5.3.3.3 Certifying bundles of ecosystem services and community development

Certification of ecosystem services and community development can be used as an instrument to verify PAs or other spatial areas according to certain international standards. Depending on the projects' characteristics and the specific preferences of buyers, they may well be incorporated into CDM, REDD or other carbon markets, and guarantee their co-benefits beyond carbon sequestration. Companies or other organisations wishing to offset greenhouse gas emissions can then purchase offset certificates. The most widely implemented certification standards in this regard in SSA are those of the Climate, Community & Biodiversity Alliance **(**CCBA) and Plan Vivo. In addition, new certification initiatives like the Green Development Initiative (GDI) are currently under development.

The CCBA is a global partnership of private companies (e.g. BP, GFA Envest, Intel, SC Johnson) and NGOs (e.g. Conservation International, CARE, Rainforest Alliance) created in 2003. It aims to leverage policies and markets to promote the development of forest protection, restoration and agroforestry projects through high quality multiple-benefit land-based carbon projects. CCBA does not issue quantified CERs itself but encourages the use of a carbon accounting standards such as VCS or CDM in combination with CCB Standards. Its standard design comprises of 14 required criteria and 3 optional 'Gold Level' criteria. As of February 2012, CCBA had registered 47 projects worldwide, 12 out of which are located in SSA (5 in Kenya, 2 in Tanzania, 2 in Uganda, 1 in Ethiopia, 1 in Mozambique, and 1 in Zimbabwe). As of early 2012, 22 projects are currently undergoing validation, 8 of which are located in SSA (CCBA, 2012).

Plan Vivo is a certification standard for sustainable land use projects aimed at improving the livelihoods of local communities in developing countries by connecting them to international carbon markets. Plan Vivo does not issue CERs, but issues Plan Vivo Certificates (PVCs) instead. PVCs are environmental service certificates, each representing the reduction or avoidance of one metric ton of CO_2, plus livelihood and ecosystem benefits. Until December 2010, Plan Vivo issued PVCs for a total of 1 $MtCO_2e$ (Peters-Stanley et al., 2011).

In 2012, Plan Vivo has 5 registered projects worldwide, 3 out of which are located in SSA (1 in Mozambique, 1 Tanzania, 1 in Uganda). 8 more projects are in the pipeline, of which 5 are located in SSA (Plan Vivo, 2012a). Of the 3 current Plan Vivo projects in SSA, 2 are designed to generate revenues for financing PAs. The project in Mozambique is located in the buffer zone of a National Park; that in Uganda is part of a Ugandan REDD pilot project (Plan Vivo, 2012b).

Although the total number of CCBA and Plan Vivo certified projects in SSA is still rather small, their relative engagement in SSA (CCBA: 12 out of 27 projects; Plan Vivo: 3 out of 5 projects) is higher than that of CDM or REDD, as well as that of the certification of sustainable agricultural production or forest management. Additionally, CCBA and Plan Vivo both have a relatively large number of projects in SSA in the pipeline. In bringing together local community-based PA approaches and international frameworks and conventions, CCBA and Plan Vivo can be seen as pioneers for integrated international MBI approaches in SSA.

Certification of ecosystem services and community development can also be used as a justification for the high prices of carbon credits from SSA. With 9.1 US$/ tCO_2e, the price of carbon credits from SSA on the international voluntary market is substantially higher than, for example, that of carbon credits from Asia (5.4 US$/$tCO_2e$) or Latin America (5.3 US$/$tCO_2e$) (Peters-Stanley et al., 2011). This can be attributed to the limited supply of credits from African locations. In this context, certification according to CCBA and Plan Vivo can act as a ‘shopping guide’ that helps buyers to ‘cherry-pick’ carbon credits from PA projects with benefits going far beyond carbon sequestration (Peters-Stanley et al., 2011).

Most projects on the international voluntary market are large-scale. 93 per cent of all projects have a transaction volume larger than 20,000 t CO2/year. Carbon emission reductions from PA projects are relatively small. However, some buyers preferentially buy credits from small projects with high publicity potential for reasons related to their public image (Peters-Stanley et al. 2011).

In the context of the CBD PoWPA and the CBD Strategic Plan for Biodiversity 2011-2020, a number of new global biodiversity initiatives have been established in recent years that try to promote biodiversity conservation by establishing international MBIs. The most prominent of these is the Green Development Initiative (GDI). It was established to support the CBD in its work on innovative MBIs by developing an international certification system for land management and biodiversity conservation that particularly promotes business engagement. Comparable to the CDM and carbon credits, the GDI is supposed to mobilize additional private sector finance. GDI does so by establishing a standard and an accreditation process for certifying the management of geographically-defined areas in accordance with objectives in the areas of conservation, sustainability, equity, and development. Among other things, GDI aims at certifying the supply of biodiversity-protected areas in developing countries, which can then be sold in the form of GDI credits to buyers in developed countries (OECD, 2010). In its scheme, GDI envisages a major role for the private sector in financing projects. Contributions are especially likely to originate from companies whose production processes depend on genetic diversity (e.g., pharmaceutical companies, seed producers, or bioengineering companies). This broader GDI concept could be appropriate for regions that cannot apply for REDD+ projects because of little forest cover, but have a low ecological footprint and a high biocapacity. GDI could also be combined with other schemes like

REDD+ or CDM, if there is biodiversity or any other ecosystem service apart from carbon sequestration involved (OECD, 2010). It is envisaged that a future GDI scheme will enable PA managers that use and manage the biological resources sustainably to be legally recognized and financially rewarded for their efforts.

In response to a call for pilot projects in 2011, GDI received 20 Project Information Notes (PINs). 10 of these PINs were received from SSA (2 from Namibia, 2 from South Africa 1 from Central Africa, 1 from Ghana, 1 from Kenya, 1 from Mozambique, and 1 from Tanzania) (GDI, 2012). These PINs provide a pipeline for a GDI pilot phase and are expected to become the first GDI-registered areas. However, GDI is in its early stages and many questions related to financing, enforcement and monitoring are still unsolved.

Biodiversity conservation is also the focus of a number of other certification standards which are currently under development. The Standard on Biodiversity Offsets (SBO), developed by the Business and Biodiversity Offsets Program (BBOP), aims at promoting best practices for biodiversity offsets in developing countries. The Global Conservation Standard (GCS) and the Biodiversity Area Management Standard (BAMS) both focus on commercial land use and the management of protected areas. The main difference between GCS and BAMS is that GCS aims to release above-ground carbon stocks, whereas BAMS works on the concept of issuing credits for areas managed rather than for units of ecosystem service generated. All of these standards, however, are works in progress.

5.4 Summary and conclusion

Most PAs in SSA have been established in a top-down manner using a ‘fines and fences’ approach that provides little incentive for local communities to engage in PA maintenance. Today, funds for PAs are highly dependent on international donors. However, PAs are still often managed as ‘costless places’ and are therefore chronically underfinanced, which negatively affects their effectiveness.

The establishment of effective PAs alone is not enough to guarantee the conservation and sustainable use of SSA's ecosystem services. PAs are only one instrument among others. However, given the large and increasing size of PAs in SSA and the value of ecosystem services they contain, they should be more qualified and able to contribute more effectively to 'green development' solutions than they do today. The effectiveness of PAs, both within and beyond SSA, is, however, greatly determined by the question of who shares in their monetary costs and benefits.

On these grounds, voluntary international MBIs contribute to establishing value chains that link ecosystem service providers to beneficiaries and make the beneficiaries pay for them (Farley & Costanza, 2010). In recent years a number of theoretical approaches have been put into practice, driven by international conventions and donors. Although PAs are large-scale providers of ecosystem services, it is not clear to what extent revenues can be generated for them from international MBIs. This paper aims to contribute to this discussion.

Few voluntary international MBI projects have been implemented in SSA, and domestic instruments and markets rarely exist. SSA countries are lagging behind in the implementation of CDM projects and REDD demonstration and pilot activities when compared to countries in Asia and Latin America, which often provide similar ecosystem services in international markets. The major problem of certification in SSA is related to the costs of accreditation and evaluation, which are prohibitively high for smaller projects and local communities (Frost, Mayers, & Roberts, 2003; Molnar & Trends, 2003; Richards, 2004). "*Certification needs certain economies of scale. This limits local initiatives in Africa.*"[9] Costs arise, for example, from complex application, evaluation and auditing processes, or from complying with audit-related recommended actions (Molnar & Trends, 2003). Beyond the question of costs, the successful combination of certification tools, in terms of effectiveness and equity, depends on

[9] Interview Green Resources, 12/08/2011, Dar-es-Salaam

a set of beneficial policy and governance pre-conditions. These relate to the existence of 1) clearly defined and secure land tenure rights, 2) land management units with the necessary administrative and technical capacities to access certification markets, 3) social and environmental pressure groups with the capacity to participate in certification standard-setting processes, 4) effective and regular audits, and 5) transparent information flows (Richards, 2004).

One obstacle to the initiation of new MBI projects is related to high upfront costs. Entering new markets, particularly international ones, is complex and expensive. In comparison with providers of ecosystem services from Asia and Latin America, most of those in SSA are relatively small, as are the range of services they provide. Economies of scale are limited. The upfront costs for entering international markets for ecosystem services are therefore mostly prohibitive in SSA, particularly for NGOs and local community-based organisations. For the most part, international start-up capital and human expertise remain decisive factors in kick-starting projects. This external factor limits the potential for growth and sustainability.

In addition, buyers will only pay if they are confident that the ecosystem service they are paying for is actually effectively delivered by the PA (Scherr et al., 2010). This calls for operationalization and constant monitoring. Measuring and valuing ecosystem services, which are complex, dynamic and participatory, can be extremely difficult and costly. The definition of baselines for ecosystem services, for example, necessitates in-depth empirical research, which is often done by international research consortia or consultants. There is hence a need to continue working towards better methods to operationalize, map, model and value ecosystem services at multiple levels.

There is often little information on the real costs of PAs and the ecosystem services they provide. Available data mostly refers to management expenditures, whereas opportunity costs and transaction costs often remain unknown. Information on the local opportunity costs of restricting resource use from PAs is critical in generating a product and its price when traded in international MBIs. Many PAs in SSA face rising opportunity costs due to population increase, expansion of smallholder agriculture and large-scale agricultural investments. These costs have to be valued and incorporated in MBIs. In order to minimize costs, PAs with relatively low actual and projected opportunity costs should be prioritized. Similar considerations apply to transaction costs, which burden small projects over-proportionally. This particularly concerns SSA providers of ecosystem services from PAs.

PAs need reliable and foreseeable budgets. International MBIs are mostly established without a time limit; however, they are prone to market fluctuations, price volatilities and market failures. Although this happens in all markets, it particularly holds true for new and voluntary ones. This mostly affects smaller projects. One should hence try to avoid using budgets generated through international MBIs to finance fixed costs of PAs.

Another challenge concerns local participation. Most international MBIs that may be used to contribute to PA financing are aimed at involving local people and communities in decision-making processes and to make them direct beneficiaries. In many SSA contexts, this is a challenging task. Ecosystem services that qualify for international trading often provide the livelihood basis of poor smallholders living in or adjacent to PAs. In the last 20 years, a mixture of democratization, liberalization and decentralization efforts have been made in SSA countries. PA governance has increasingly shifted towards joint, participatory and community-based approaches. The relation between poverty, natural resource use and PAs is, however, still both strong and contested. In this context, international MBIs may help by providing incentives for local people and communities living in or around the PA to work towards its conservation, but can also add new complexities and conflict lines to the situation.

Our assessment of the effectiveness of international MBIs in contributing to financing PAs in SSA provides mixed results. A lot of good and innovative ideas for increasing funding for

PAs in developing countries by international MBIs have been suggested in the last decade (Gutman & Davidson, 2007). Many important stakeholders, such as GEF, the World Bank and other donors, massively support the implementation of these ideas. However, little has happened so far and bringing potential into practice will be a long road. International MBIs are far from reaching the breakthrough point or scale at which they attain global significance. In most SSA countries, the necessary underlying human, technical and institutional capacities for using international MBIs to internalize PA benefits that are currently externalized are not yet developed. This results in limited efficiency, high transaction costs and a small number of projects. Paradoxically, if the underlying capacities necessary to implement international MBIs were stable and effective, these MBIs might not be needed.

However, things are changing for the better. Many PAs in SSA ultimately left the 'fines and fences’ road to reduce their dependency on state structures and funding. This provides greater space in which to choose and develop individual paths. The use of international MBIs to support these PAs can create synergies, e.g. with regard to organisational structures or property rights. Simultaneously, the global demand for ecosystem services is rapidly increasing. Although markets are still mainly concerned with carbon credits, particularly from BRIICS countries, the interest in ecosystem services and (co-) benefits from SSA is growing. This is evidenced, for example, by the high demand for CCBA certified projects from SSA. PAs mostly harbour complex ecosystems and a multitude of functions. Ecosystem services could therefore be bundled into certificates, as was intended by the Green Development Initiative. In a manner similar to that seen in product certification in the 1990s, a ‘survival of the fittest’ of international MBIs will likely take place in the next few years. However, voluntary international MBIs will remain only one of the many options for generating budgets for PA in SSA. If well designed and properly implemented, synergies between MBIs, innovative PA approaches and a combination of other financing sources can significantly contribute to achieving the goals of the UNFCCC and CBD environmental conventions.

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6 Conformity, Leadership and Why Strong Rules Work – A Namibian Common-Pool Resource Experiment

Abstract

In the vast literature on communities facing common-pool resource dilemmas, the interplay between the effects of social dynamics group cohesion, governance and the framing of an experiment has not been fully explored. As factors of these categories influence the experimental results and their interpretation, this paper analyzes how participants in common-pool resource experiments cooperate depending on these factors. The results show that the strength of rules in an experiment can determine the relevance of group conformity for an extraction decision: The most important indicator for conformity in the experiment loses relevance in the presence of strong rules. Other guiding factors like personal relationships and leadership retain relevance, even in strong rule settings. Furthermore, the experiments show that framing plays a decisive role. This implies the possibility to tailor experiments to their specific use: If they are meant to give concrete information on the situation on the ground or even help with capacity building, they can be adapted to the relevant local situation.

6.1 Introduction and literature

Environmental Economics is inherently anthropocentric. Therefore it ultimately has to grapple not only with the ecological side of environmental problems, but also with behavioral aspects. Stakeholders of an ecosystem will not only react to their surrounding environment and the natural resources it contains, but also to each other and the rules, implicit or explicit, with which they govern themselves. Since Gardner et al. (1990) conducted their seminal field work on community behavior in the presence of common pool resources (CPR), it is clear that a certain cooperative behavior is ingrained in stakeholders that constrains them from exploiting resources as much as they could. Numerous field experiments in different parts of the world have since painted a similar picture with respect to overuse, even though outcomes show diverse behavioral patterns (e.g. Cardenas et al. (2000), Gardner et al. (2000), Hackett, Schlager and Walker (1994); for an early overview see Agrawal (2003)). What is clear in all of them, is that resource extraction in the real world is not as exploitative as previously thought (Hardin, 1968) or as predicted by applying policy or game theory to the common pool resources (Ostrom, Walker, and Gardner 1992).

Much research has been done in communities in developing countries into how different forms of governance can solve the prevalent problem of resource overuse, like overfishing, deforestation and overgrazing (Agrawal, 1999; Cardenas, Ahn, & Ostrom, 2004; Cavalcanti, Schläpfer, & Schmid, 2010; Janssen, Bousquet, Cardenas, Castillo, & Worrapimphong, 2013; Nordi, 2006; Ostrom, 2006; Travers, Clements, Keane, & Milner-Gulland, 2011). Many field experimental papers dealing with common-pool resources focus on testing different rule mechanisms, but not factors of decisions and how they change under new rules. Only a few researchers look into the process of decision-making which leads to the results obtained in the field. Velez, Stranlund, and Murphy (2009) find that decisions in CPR experiments hinge on expectation and are a result of the human tendency to conform10 to the group, i.e. behave as they see others behave and therefore make similar decisions. Furthermore, Hayo and Vollan (2011) attribute decisions to group cohesion, among other things, of which conformity is one form. These results go some of the way towards explaining decision-making in common-pool resource situations. Still they do not fully meet the call of Anderies et al. (2011) and Ostrom, Dietz, and Dolsak (2002) to do more research on what they label “micro-situational variables and broader context” or more fully examine what Agrawal (2003) calls “more variables than possibly analyzable”. Among others, Anderies et al. (2011) and Castillo and Saysel (2005) reinforce the point that economic and game theory cannot fully explain behavior in field experiments, much less its determinants. Most importantly though, existent research does not pave the way for finding why certain rules change decision making and why others do not. Following the implicit challenge behind these findings, this paper helps filling the knowledge gap for what determines decisions in cooperative experiments. More specifically, it contributes to research on CPR behavior by answering two research questions in CPR experiment analysis.

[10] There are, of course, variations of other-regarding tendencies that could in principle lead to the same effect as that which this paper calls conformity. The most prominent of those similar other-regarding tendencies is reciprocity (which can be further split into direct reciprocity, indirect reciprocity, and network reciprocity according to Nowak (2006); for an experiment and discussion on conformity versus reciprocity, see Bardsley and Sausgruber (2005)) In this paper other-regarding effects will solely be referred to as conformity since neither a useful distinction can be made based on the present data nor is it necessary to answer the posed research questions.

The first research question is on the interplay between rules on the one hand and conformity as well as leadership on the other. Though the cited work on governance and rules for common pool resources showed their different - or not so different - impact in CPR experiments, they do not explain why certain measures work better than others (if any such claim can be generalized at all). Two factors - conformity and leadership - have been treated before, but not necessarily in CPR field experiments and in connection with rules. While it is common knowledge that greater cohesion leads to more cooperation (Dayton-Johnson, 2003; Evans & Dion, 1991; Vos & van der Zee, 2011) there seems to be a driver beyond cohesion that lets participants in field experiments conform to others' decisions to cooperate (Hayo & Vollan, 2011; Tavoni, Schlüter, & Levin, 2012; Velez et al., 2009) . What is missing with respect to cohesion is the interplay between conformity within a group and newly introduced rules: Is conformity independent, supportive or obstructive to new rules? Similar to cohesion, leadership has proven to be an important factor in CPR (Ostrom, 2006; Vedeld, 2000) and other cooperation scenarios (Moxnes & Heijden, 2003; van Dijk, Wilke, & Wit, 2003). Therefore, similarly to conformity, the interplay between leadership and the introduction of new rules is possible and worthwhile analyzing. This paper contributes to a fuller understanding of the rationale behind a participant's decision to change behavior (or not) based on rule changes, especially with respect to conformity and leadership.

The second research question the analysis answers is on framing, or more specifically the 'context', as Anderies et al. (2011) call it. In general, framing distorts experiments and therefore, experimenters try to test theories under abstraction from these distorting outside factors so as to make the result as generalizable as possible (Davis, 1993). However, if experimental results are used to justify political measures pertaining to very specific situations, the experiments should approximate these specific situations as much as possible. After all, presumably this specific context has an influence on real-life results just as it would on experimental results. Therefore the experiments described in this paper were framed to analyze the reaction of participants to different contexts. Framing with contexts introduces more realism to the experiment and therefore results and their interpretation relate more strongly to the real world situation.

The field study site offers the opportunity to test the framing effects of contexts. Data was collected in the October of 2012 in the community-managed conservancy Sikunga, an area in the Namibian Caprivi strip. In the conservancy subsistence fishing and farming as well as a fledgling tourism business are main income sources. Fishing and the interplay of tourism with subsistence farming present fitting CPRs as a background for CPR experiments. Fishery resources are endangered through overfishing and a fledgling ecosystem-based tourism and hunting industry is endangered by destruction of wildlife habitat through slash and burn farming. While fishing has been analyzed many times in CPR experiments (Bwalya, 2007; Cavalcanti et al., 2010; Fehr & Leibbrandt, 2008; Velez, Murphy, & Stranlund, 2006), framing wildlife habitat maintenance as a CPR problem is seldom done. Nevertheless, framing more complex and realistic context experiments can bridge the gap between experimental research of a qualitative nature (e.g. Lankford (2004)) and the purely quantitative but abstract experimental sphere. Therefore the experiments in Sikunga were presented in the fishery and in the wildlife context, as will be explained further in the next section along with other aspects of the experimental design. In the section following that, we will remark on the direct evaluation of decisions made under different rule settings. The sections after that deal with the regression analysis of determining factors of decisions, starting with a section describing the econometric method in detail, followed by a section describing the variables at hand, which leads into the section of the interpretation of econometric results. The last section concludes.

6.2 Experimental design

The following common-pool resource experiment reuses the basic design of Cardenas (2004). In this design the five individuals in each experiment group individually decide on an effort level of resource extraction (referred to from here on as effort or extraction) from 1 to 8, which they note on their participant sheet (see appendix). A “1” would represent the lowest effort level of extraction of the CPR, an “8” the highest effort level of extraction. Depending on a participant’s decision and the decision of the four others, participants achieve a payoff for each played round. A higher payoff is achieved with higher individual efforts, given the decision of the other participants, and vice versa. Contrary to that, the individual payoff is lower with higher cumulative efforts of the rest of the group, given an individual level of effort, and vice versa. Every experimental group conducts 20 rounds. After all 20 rounds are finished the payoff for only one randomly chosen round is paid out in Namibian Dollars. For payoff function (1) the Nash equilibrium (NE) is at 8 and the social optimum (SO) lies at 1, which is a corner solution. For a full table of payoffs given a participant’s decision and the cumulative decisions of the four other participants rounded to the next dollar, see the appendix. Note that the payoff equation of Cardenas (2004) was adjusted with a factor for currency conversion to Namibian dollars of 5/64:

$$\pi_i = \frac{5}{64} \cdot (60x_i - 0.5 \cdot 5 \cdot x_i^2 + 20 \cdot 5 \cdot 8 - 20 \sum x_i) \qquad (1)$$

Similar to Cardenas (2004), participants are not allowed to communicate and have to decide on effort levels in secret and on their own. For the last 10 of the 20 rounds the experiment introduces one of three different rules. As summarized in table 6.1, the three treatments introduce additional rules to 30 of the 40 groups; ten groups conducted all 20 rounds under the same conditions to form a baseline. Of the 40 groups, 9 were allowed to talk to each other and coordinate their decisions after round 10. Before their 11th round, they were allowed to talk for ten minutes, for rounds 12-20 the allowed time was five minutes. In these 9 groups, an individual however, would still make their decision in secret and none of the group discussions and agreements were binding (hence the name 'cheap talk' (CT)). 21 further groups were told what the socially optimal amount was and that they would suffer a penalty of four Namibian dollars towards their payoff for every unit above the socially optimal effort level. After the rule had been established after round 10, they were not allowed to talk with each other for the remainder of the game and made decisions in secret. In these groups participants' decisions were checked and participants were penalized with a certain likelihood if they cheated. In 10 of those 21 groups the likelihood of being checked upon ('being caught') was 20 per cent ('Weak Enforcement' (WE)), for the other 11 groups it was 70 per cent ('Strong Enforcement' (SE)). This difference in likelihood of being caught tests the difference in strength of enforcement. We deviate from Cardenas (2004) in this respect to simulate realistic circumstances of the conservancy. Locals reported in previous stakeholder workshops that the likelihood to be checked upon and punished for certain abuses of the ecosystem has a strong influence on the decision to actually transgress. Therefore the difference between weak and strong enforcement is the change in likelihood of being caught cheating rather than the size of the penalty. Equations (6) and (7) in Cardenas (2004) provide the underlying math. Instead of changing the fine f, paid for every unit above the SO, the experiments in Sikunga changed P, the likelihood of being caught, between weak enforcement and strong enforcement. Therefore f stays at four Namibian dollars for every additional level of effort, but the likelihood to get caught cheating P changes from 1/5 to 175/50 · 1/5=0.7. These numbers are still comparable to Cardenas (2004), except for the 4 Namibian dollars fine, which is an approximation to Cardenas' fine of 50, rounded up from 50 · 5/64=3.91. Nevertheless, the best response in a symmetric NE for weak enforcement is an effort level of 6, while it is 1 for strong enforcement. The practical simulation of being checked was done by letting all participants draw one marble randomly from a bag of ten at the end of each round.

If the marble was black, the participant's sheet was marked for cheating in this round and the participant was penalized accordingly. For the treatment with 20 per cent likelihood, which simulates weak enforcement, the bag held two black and eight white marbles. Accordingly, for the treatment with 70 per cent likelihood, simulating strong enforcement, the bag held seven black and three white marbles.

As additional difference between groups and another deviation from Cardenas (2004), the experiment was conducted in three different contexts to test framing effects. In the baseline context participants were told that the experiment was about an abstract natural resource without adding any further details. This kept the experiments as neutral as possible and was conducted that way for 14 of the 40 groups. In the two other contexts the experiment was orientated towards two prevalent cases of resource overuse in the area. One of these overuse cases was overfishing; a classical CPR problem. Though only a small part of the Sikunga population identifies as fishers, the nearby fish stocks of the Zambezi are noticeably being depleted (Heider, 2012). To reflect that in the CPR experiment 14 groups of the remaining 26 were told that the experiment was about fishing resources. Participants had to decide on an effort in the form of sending 1 to 8 of their hypothetical household members either fishing or do subsistence farming on marginal land. The second resource overuse case is the use of slash and burn practices in the area. Though in itself not a CPR, it has an indirect but strong effect on wildlife in the area. The areas which are slashed and burned as well as the surrounding areas are habitat for wildlife. While there are many ways to profit from wildlife, the one reflected in the experiment is a regularly issued and tradable hunting quota. Depending on the amount of wildlife the conservancy regularly receives a permit to shoot certain numbers of animals, which can be resold to a professional hunter or hunting tourists for a substantial amount of money. This money has in the past been distributed among the members of the conservancy. In this context the money from the hunting quota is the CPR. The extent of slash and burn farming takes on the role of the extractive action, because while it diminishes wildlife habitat and therefore the equally distributed hunting quota, it increases the productivity of the land and therefore the yield and farming income. Again, farming on marginal land is the alternative to the exploitative choice. The trade-off decision in this CPR context becomes: Slash and burn farming for the farmers own good versus more sustainable but marginal farming and thereby protecting valuable wildlife habitat. The remaining 12 groups conducted the experiment in this context. The decision participants had to make is the number of fields from 1 to 8 that participants could farm using the slash and burn practice. Table 6.1 shows the distribution of rule change and context treatments.

Table 6.1: Distribution of contexts over experimental groups (source: Own data)

Rule/Context	Wildlife	Fishery	No Context	
None	3	4	3	10
Cheap Talk	1	4	4	9
Weak Enforcement	4	2	4	10
Strong Enforcement	4	4	3	11
	12	14	14	40

For both contexts the experiment host used visual aids for the explanation to make the respective context tangible (see Figure 6.A1 and Figure 6.A2 in the appendix). The main visual aid was a wooden board with a map of the conservancy and the bordering Zambezi river on it. Depending on the context applied, the experiment host used either animal figures on the conservancy map or ellipsoid marbles representing fish on the Zambezi part of the board. They aided the host in explaining the ecological situation and the difference between one participant making a large or small effort and the other participants making a large or small effort. The game host was trained to keep value judgments on different strategies out of his explanation. For a word by word transcript see appendix.

The experiment host explained the setup in the local language, then answered participants' questions on the experiment, trained participants to read the payoff table correctly, explained how to fill in the decisions on the provided player sheet, and conducted 3 test rounds after which he would answer participants' questions again (see appendix for an experiment host transcript, the payoff table and a player sheet). After conducting the full experiment, the game host tested participants on their understanding of the experiment mechanics with a small comprehension test and conducted a short questionnaire collecting data further described below (see appendix for the comprehension test and the participant questionnaire).

6.3 Descriptive results

Figure 6.3 shows the average decision on effort the participants chose from the range between 1 and 8 for every round, by rules treatments. The drop in efforts for all treatments after round 10 indicates an effect of the treatments on participants' behavior. The *baseline* (BL) centers closely around its mean value of 3.69. With that value the baseline is not only far below its own NE (8), but also even below the NE for the weak enforcement case (6). Further, the baseline does not deviate from this value too far, neither before nor after round 11. This is consistent with the assumptions that there is no progression dependent effect (e.g. a learning effect) or natural tendency to switch strategies after a few rounds involved.

The *cheap talk* treatment leads to a slow drop over the last 10 rounds. While initially, after the first round of talking, participants only slightly deviate from their strategy from rounds 1-10, they increase their deviation in the next rounds. Although values fluctuate too much to make a clear statement, there seems to be a continuous downwards trend leading to values at a relatively low level between 2 and 3. This downward trend might be a sign for a high sustainability of this rule change. Concerning the limit on discussion time for the cheap talk rule treatment, it should be noted that participants never had to be told to stop because their time was up in one of the 10 minute discussion and rarely even used the five minutes slots after round 11 to reiterate their group discussion.

Figure 6.1

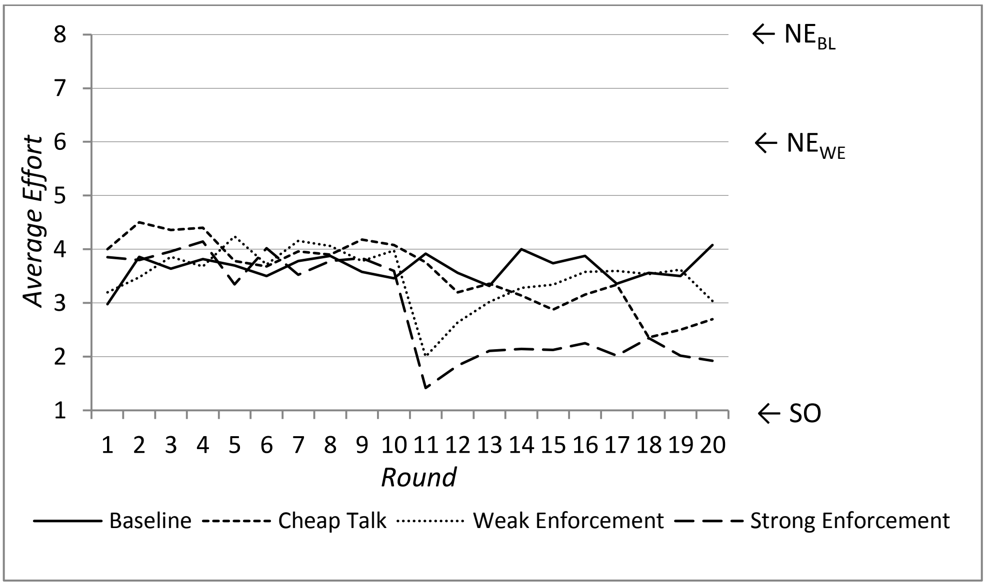

Figure 6.2: Average effort in the experiment by rules (source: Own depiction)

The punitive treatments weak enforcement and strong enforcement led to an initial drop to almost the SO and then rises slowly but steadily for the rest of the rounds. However, under this treatment average efforts never reach the baseline values again. Instead the lines for both punishment treatments seem to approach their own asymptote, which would roughly be 3.5 in the case of weak enforcement and just above 2 in the case of strong enforcement. Participants likely were intimidated by the prospect of punishment at first and then started experiencing the new rule and how costly it really was to break. This is not an unusual effect in behavioral experiments (Smith, 2010) and that participants become more competitive, i.e. test if they could not gain a greater share after all, has also been observed in repetitive CPR experiments before (Gillet, Schram, & Sonnemans, 2009). The respective Nash equilibria for weak and strong enforcement are 6 and 1. This has implications for the interpretation under both punitive rules. Under the weak enforcement regime, on the one hand, although disobeying the new rules, participants still behave more social than the NE predicts. On the other hand, even under strong enforcement participants orientate towards a value above the SO and even above the NE. Over time, participants even move further away from the SO.

Factors explaining this bounded rational behavior are captured in the regression of the following section. What we can see here already, though, is that *weak enforcement* is indeed weaker in reaching the SO as *strong enforcement*. The same applies to *cheap talk*. In that sense weak enforcement and cheap talk are not only the weaker rules in that enforcement is by design less likely to lead to punishment, but also that they indeed reach a higher average effort in equilibrium. Therefore the following discussion adopts the term *weak rules* for weak enforcement and cheap talk and *strong rule* for strong enforcement.

6.4 Econometric model

For further analysis of participant's decision-making, the influence of socio-economic factors as well as environmental awareness, context, personal relationships, leadership and conformity are regressed on the effort levels participants decided on. The basic regression looks as follows:

$$Decision = \alpha + \beta SEcon + \gamma EA + \delta CX + \epsilon Personal\ Relationships + \zeta Opinion\ Leadership + \eta Others' Extraction_{t-1} + e \qquad (2)$$

In this regression equation SEcon is a vector of socio-economic variables, CX a vector of simple context variables and EA a vector of environmental awareness variables. *Others' extraction*$_{t-1}$ captures the most likely indicator for what to conform to and *Opinion Leadership* captures the presence of a leadership figure in the experiment group. Both variables are explained further in the next section. Further iterations of the regression include dummies for the introduction of rules and more specific context variables.

The estimator is a right- and left-censored Tobit model with cluster-robust standard errors. Using a censoring model is necessary because the number 0 and numbers higher than 8 are plausible for the dependent variable - the decision about the effort level in the experiment - but the experiment restricts them to between 1 and 8. Further, the regression uses cluster-robust effects because participants make their decisions over 20 consecutive rounds. The regression has to account for a possible relationship between the decisions of a participant.

Since it is plausible that an underlying decision making process of participants does not correlate with that of other participants, apart from the variables controlled for, the data demands using cluster-robust standard errors. Comparing results of the following regression to a random effects specification (see table 6.A2 in the appendix) show that results of this paper cannot solely be caused by misspecification: They are practically identical.

The above results of the impact of rule changes might be real outcomes of rational (or at least bounded rational) individuals, and therefore are represented in figure 6.3 using the full sample. They are what an investigator wants to look at when the impact of rules is concerned that are actually implemented. Rules apply to everyone, not only those who understand them, so gauging their impact using the full data set as basis is the correct procedure. But interpreting the statistical effect of particular factors on behavior only makes sense if we can be sure that the interpretation based on the experimental setup is valid. That is, behavior should be a result of deliberate and informed decisions as opposed to choosing a number between 1 and 8 just because the game host tells participants to do so. If rules are implemented in the real world, compliance would be expected from everyone, not only those that understand them. This makes it reasonable to use the full sample for figure 6.3. But why should a regression analysis which is supposed to find causal factors in making a decision include observations for which we have to assume that the dependent variable decision is a random choice due to failing to understand the experiment? The participants included as observations should be able to understand these ramifications under which the observations are made. If they would not, making conclusions based on their introduction or omission would be misleading. List and Shogren (1998) and Galarza et al. (2009), for example, found a distortion of results by participants misunderstanding the experimental setup or not understanding it at all. Smith (2002) criticizes the experimental method on a fundamental level for the same reason. To make the regression meaningful, it includes only observations of participants who have understood the experiment fairly well. The employed subsample is based on the results of a post-experiment multiple choice comprehension test. The test checks how well participants actually understood the central element - the payoff table - used in the experiment (see comprehension test in the appendix). If a participant answered 50 per cent or more correctly, their data is considered in the subsample. This leaves 64 of 200 participants for the subsample. The sample is stripped further by one observed round per participant, since the model contains a lagged variable, as well as by discarding observations for missing values, resulting in an overall subsample size of 1216 observations.

6.5 Variable description

This chapter characterizes the variables used in the regression and explains the rationale for including them. Table 2 shows an overview of basic statistics.

The first set of variables included in the regression, SEcon, is a set of relevant basic socio-economic variables. *Age* is a common control indicating differences in experience and between age cohorts. To include an indicator for wealth, we asked participants to rate the extent of land possession and welfare in comparison to the rest of the group. The respective variables are *comparison land participants* and *comparison welfare participants*. Two further variables describe the occupation of participants as either *farmer* or *fisher*, *other* being the third and in the regression model omitted alternative.

Table 6.2: Variable descriptives (source: Own data)

Variable	Obs.	Mean	SD	Min.	Max.
Decision	1254	3.39	2.20	1	8
Age	1254	36.18	14.81	16	77
Comp. Land Participants	1254	3.61	1.11	1	5
Comp. Welfare Participants	1254	2.74	0.99	1	5
Farmer	1254	0.83	0.37	0	1
Fisher	1254	0.06	0.24	0	1
Awareness Fishery	1254	3.97	3.93	1	16
Awareness Wildlife	1254	2.50	2.40	1	10
Awareness Conservancy	1235	0.91	0.29	0	1
Wildlife Context	1254	0.21	0.41	0	1
Fishery Context	1254	0.41	0.49	0	1
Personal Relationship	1254	3.26	1.21	0	4
Opinion Leadership	1254	0.33	0.47	0	1
Others' Extraction$_{t-1}$	1254	13.90	5.74	4	30
Slash & Burn Farmers * Wildlife C.	1235	0.17	0.38	0	1
Fishers * Fishery Context	1254	0.09	0.29	0	1

The second set of variables used in the regression, EA, describes the environmental disposition relevant to the contexts. Participants were asked for their degree of *awareness of fishery* problems, degree of *awareness of wildlife* problems, and if they are *aware of conservancy* management. The awareness for wildlife and fishery were each gauged on two scales between 1 and 5. On the first scale, participants answered to the question how strong they think the amount of big game and fish, respectively, has changed recently. On the second scale participants answered to a question asking if the change had a negative impact on locals within the conservancy. These results were multiplied to get to the awareness variables used in the regressions. Awareness of the conservancy is captured by a binary response in a dummy variable.

The third set of variables, CX, is that of variables controlling for the experiment's framing. The set is a simple set of dummies for the three possible contexts: Changes attributable to framing are caught by *wildlife context* and *fishery context*, and *no context*. The regression omits *no context* as the precaution against a dummy trap.

The influence of the number of *personal relationships* with others in the group is measured and also taken into account. Further, identifying opinion leadership gives clues on how strong the influence of a hierarchy is or at least how strongly participants orientate toward the behavior of a perceived leader. For that the opinion of every participant who of the others has the most influence in general was reported. For every group in which the same individual was named by three or four other participants as having influence on decisions, the dummy for *opinion leadership* is 1, indicating that a perceived opinion leader was present. Further, a dummy for each group is included to hold group effects constant.

Last, as far as the basic regression of equation 2 is concerned, the lag variable *others' extraction*$_{t-1}$ captures the effect of the respective last round's extraction by the rest of the experimental group; it is the sum of the other four players' decisions. This variable reveals the influence of using other participants' behavior as a guide for decision-making. This is the indicator for conformity in the model, because it shows how much participants are oriented towards what other group members do.

To test the effect of the introduced rules, models 2-5 include rules treatments using dummy variables for *cheap talk, weak enforcement* or *strong enforcement*. The variable for the *baseline* groups with no rule changes is excluded.

To test context-specific behavior, model 6, based on equation 2, adds two interaction variables. They interact self-reported real-life behavior with the experiment contexts. Self-reported slash and burn practice, though condemned in many parts of the world, is not likely to be underreported due to the social acceptance of the practice in the area. The regression includes this variable in one of the two interaction terms between occupational behavior and context. The interactions pair the occupation *slash & burn farmers* and *fishers* with the *wildlife* or *fishery* context, respectively. These two interaction terms show the specific impact of the context if paired with people that have a larger practical understanding of and possibly a deeply rooted behavioral pattern in that context. Model 7 brings all variables together to check for any possible interaction.

6.6 Econometric results

Table 6.3 shows the results of seven regressions: The *basic regression* tests for the effects of context, opinion leadership and conformity while controlling for other possible determinants. The *rules regressions* add rule changes of the experiment as factors to test for the changes in other variables, specifically a change in the effect of conformity. A first regression for *all rules* includes cheap talk, weak enforcement as well as strong enforcement. Further regressions test changes for each rule separately. The *context-specificity regression* adds interactions to the basic regression testing for context-specific behavior and what difference that makes for the explanatory power of other variables. Finally there is the *combined regression* to see if the combination of rule changes and framing effects yield discernible differences. For all regression results negative coefficients represent a smaller extraction of natural resources due to the coefficient's variable. This can either be interpreted as more environmentally friendly, because a smaller extraction effort per se leads to a higher sustainability of the environment, or it can be interpreted as more social, because a smaller extraction effort leaves more resources for others to extract. Since recorded data does not give any indication which of those two rationales spurs a participant's decision-making, the interpretation of each variable's influence is based on what seems most appropriate for that particular variable.

Table 6.3: Determinants of common-pool resource game decision (1-8)

	(1) Basic	(2) All Rules	(3) Cheap Talk	(4) Weak Enforcement	(5) Strong Enforcement	(6) Context Specificity	(7) Combined
Constant	3.574***	6.097***	4.535***	3.750***	4.690***	4.054***	6.539***
	(1.067)	(1.114)	(1.132)	(1.081)	(1.047)	(0.969)	(1.042)
Age	0.031**	0.030***	0.030**	0.030**	0.031***	0.036***	0.034***
	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
Comp. Land Participants	-0.004	0.009	-0.007	-0.009	0.018	0.198	0.203
	(0.140)	(0.132)	(0.139)	(0.140)	(0.135)	(0.188)	(0.178)
Comp. Welfare Participants	-0.500***	-0.485***	-0.492***	-0.496***	-0.500***	-0.644***	-0.626***
	(0.165)	(0.156)	(0.163)	(0.164)	(0.160)	(0.179)	(0.170)
Farmer	1.798***	1.645***	1.782***	1.788***	1.683***	1.005	0.881
	(0.540)	(0.515)	(0.531)	(0.534)	(0.534)	(0.584)	(0.560)
Fisher	2.414***	2.320***	2.381***	2.394***	2.386***	1.201	1.180
	(0.718)	(0.676)	(0.706)	(0.713)	(0.697)	(0.671)	(0.649)
Awareness Fishery	-0.046	-0.043	-0.047	-0.046	-0.042	-0.020	-0.018
	(0.063)	(0.058)	(0.062)	(0.063)	(0.060)	(0.066)	(0.061)
Awareness Wildlife	0.062	0.061	0.062	0.061	0.062	-0.009	-0.008
	(0.065)	(0.060)	(0.064)	(0.064)	(0.062)	(0.084)	(0.078)
Awareness Conservancy	-1.721***	-1.686***	-1.717***	-1.711***	-1.705***	-1.808***	-1.757***
	(0.440)	(0.396)	(0.438)	(0.439)	(0.403)	(0.421)	(0.388)
Wildlife Context	0.020	-0.614	-0.085	-0.043	-0.389	-1.592*	-2.130**
	(0.546)	(0.509)	(0.541)	(0.542)	(0.529)	(0.806)	(0.774)
Fishery Context	2.134***	1.362*	1.999***	2.057***	1.645**	2.504*	1.783
	(0.632)	(0.585)	(0.628)	(0.625)	(0.611)	(1.122)	(1.027)
Personal Relationships	-0.326**	-0.309**	-0.323**	-0.326**	-0.315**	-0.388***	-0.370***
	(0.120)	(0.110)	(0.119)	(0.119)	(0.115)	(0.125)	(0.115)
Opinion Leadership	-3.034***	-2.266**	-3.678***	-3.014***	-1.620*	-3.166***	-2.456*
	(0.799)	(0.810)	(0.796)	(0.797)	(0.817)	(1.073)	(1.011)
Others' Extraction$_{t-1}$	0.079***	-0.010	0.064*	0.071**	0.021	0.082***	-0.005
	(0.026)	(0.020)	(0.027)	(0.026)	(0.021)	(0.026)	(0.020)
Cheap Talk		-1.482***	-1.253***				-1.463***
		(0.362)	(0.343)				(0.358)
Weak Enforcement		-1.563**		-1.444*			-1.564**
		(0.561)		(0.571)			(0.563)
Strong Enforcement		-2.902***			-2.729***		-2.859***
		(0.576)			(0.572)		(0.572)
Slash & Burn Farmers * Wildlife						1.894***	1.798***
						(0.617)	(0.592)
Fishers * Fishery						-0.029	-0.089
						(0.921)	(0.870)
Pseudo-R²	7.7%	10.1%	8.1%	8.1%	9.1%	7.6%	10.1%
AIC	4714	4596	4698	4695	4646	4664	4547
BIC	4889	4786	4877	4875	4825	4843	4741
N	1235	1235	1235	1235	1235	1216	1216

* p<0.05, ** p<0.01, *** p<0.005

Notes: Model is a Tobit I regression with cluster-robust standard errors and dummies for experimental groups.

The results for the basic regression show that age leads to a higher extraction, which is founded in the cultural background of Namibian locals. Though not uniformly true, age is generally equated with power and influence in sub-Saharan Africa (Sokolovsky, 2002). Older people are generally more respected to the extent that they are used to claiming a larger share of common resources. Therefore they also claim more in the experiment and thus make decisions that leave less for others. Further, the regression shows that feeling comparatively well-off makes participants take less. The converse interpretation is that participants who feel poorer are less social or environmentally friendly. This is likely due to prioritization for generation of income through immediate use of natural resources over environmental friendliness (Duraiappah, 1998). Among the group of experiment setup variables, others' extraction$_{t-1}$ shows a positive impact, revealing that participants have a tendency to follow what the group does. Similar to Velez et al. (2009), the basic regression also finds this pattern of conformity based on an expectation formed by the cumulative extraction decision of the rest of the group in the previous round. Other than that, conducting the experiment in the fishery context made participants extract more compared to the other contexts. This is an expression for the disregard for fishery problems, even though the awareness for overfishing is relatively high (see table 6.2). Among the attitude variables, the occupation variables farmer and fisher indicate that someone whose livelihood depends on the ecosystem in real life extracts more. These participants are used to exploiting the ecosystem and therefore do it in a hypothetical setting as well. Though the awareness for the particular ecological problems is not significant, the awareness for the conservancy organization, through which restrictions on fishing and hunting wildlife are enforced, leads to lower extraction. Participants who are aware of the conservancy certainly know also what it stands for and are also generally aware of what not to do. Therefore they take less, as they would in real life. The number of personal relationships to other candidates also leads to lower extraction. In a group with more acquaintances participants simply are more social. Lastly, the regression shows that opinion leadership matters. The mere presence of a leader decreases the extraction decision due to obedience to an implicit or, in the case of cheap talk rounds, possibly explicit behavioral guideline of a respected voice in the group.

The rules regression (2) shows that including dummies for rounds played under different rule settings changes the interpretation of only one variable: Others' extraction$_{t-1}$. Introducing clear rules (or letting the group find their own rules, in the case of cheap talk) replaces the extraction of others as orientation for own behavior. In other words, rules explain the forming of expectations better than previous action by those the expectations are formed about. So as long as a rule exists, participants will assume that others behave accordingly. Looking closer at the separate effects of introducing single rule changes, shows more specific effects on others' $extraction_{t-1}$. In the regressions which control only for cheap talk and weak enforcement, i.e. the weaker rules, the rule change itself has a negative impact on extraction, but the extraction of others still is positively significant. So, apart from the expectation effect caused by the new rule, participants still look at their peers and leader for clues on what to conform to. Under the rule setting with strong enforcement these conformity effects are gone. Since the rule more strongly dictates behavior, there is no reason to look for any other indication of behavior to conform to.

The context specificity (6) regression shows that the effect of having an occupation fitting the context, and therefore the effect of daily direct use of the ecosystem, has an even more direct impact on experiment results than just testing for the occupation. The slash and burn interaction takes up the effect of being a farmer. That shows that the interaction is the more specific of the two variables. At the same time the wildlife context dummy has a negative coefficient. The interaction variable is more specific and helps distinguishing between those farmers who keep to their pattern of ecosystem use and those who react to the danger of losing yet more wildlife. Introducing the fishery interaction cannot quite achieve a similarly clear picture, but also subtracts from the significance of the fishery context dummy. The fishery interaction also renders the occupation dummy insignificant, even though the interaction itself stays insignificant as well.

The all-encompassing combined regression shows that having all relevant variables in one model does not change results much. The only remarkable difference is that the fishery context's significance level is reduced to the point of insignificance and the wildlife context is significant at an even higher level here.

Thorough robustness checks show that results of all regressions are stable. The low Pseudo-R^2 values are due to the inherent randomness in human behavior, which, after all, is the subject of economic experiments. Our CPR experiments are no exception (Hayo & Vollan, 2011). Models with additional variables yield better values for the AIC and the BIC, showing that specifications were indeed useful and not simply a case of overfitting. The variance inflation factor test consistently yields values below 10 for all variables used in the 7 different models.

Running the same regressions without omitting observations of participants who answered less than half of the comprehension test right justifies the decision to include only the subsample (see table 6.A1 in the appendix). Results for this regression show smaller R^2-values and less diverse results. What is most striking is the apparent stronger dependency of participants on orientation with respect to what the others do and what the participants themselves know about the context. The variables accounting for these two strands of explanation (others' extraction, the rules and the contexts) are the only significant determinants left in this set. This shows what is an understandable result, but can endanger many experimental field research projects: Including data from participants who did not fully understand the experiment will heavily bias the regression towards points of orientation variables. This is a result of not knowing what to do when confronted with an experiment that participants did not understand. These participants will rely on the few points of reference which remain; in this case, what the others do or what they think the others do, i.e. conforming to the rules. Conforming to the perceived will of a leader, considering the effects of decisions on others or carrying own real-life behavior to an imagined situation loses its significance in this situation. While the R^2 alone is already indicative, these biased results show why it is important to consider the participants comprehension of the experimental method.

6.7 Conclusion

The results of this paper allow us to comment on the modus operandi of implicit versus explicit rules in CPR experiments. While effects of rules in CPR experiments have been tested before (Cardenas et al., 2004; Cardenas, 2004; Cavalcanti et al., 2010) and literature on the effect of conformity on CPR experiments also exists (Velez et al., 2009), analyzing the interplay between explicit rules and implicit guidelines leads to new insights in decision making. Not only does the analysis show that rules can break or replace the effect of conformity, but also that it depends on the rules and their possible enforcement which kind of orientation participants choose. Although figure 6.3 shows that not only strong rules can have an impact, the regression results revealed that the factors influencing decisions change depending on the introduced rule. What clearly emerges is that rules which are harder to undermine give stronger guidance. Therefore either there is no perceived possibility to deviate too far from the SO or reassurance of conformity is strong enough under better enforced rules that conforming is the perceived best option. In summary, conformity has either a supportive effect on behavior independent of rules, as long as those rules are relatively weak, or is replaced by rules, as long as these rules are strong.

Either way, the implications for a real world setting in a traditionally governed community such as the case study area of Sikunga are clear. In Sikunga, like in many other areas under community-based natural resource management, strong enforcement is costly, sometimes prohibitively so, and often underlies other constraints outside of the sphere of control of community leaders. For that reason, strengthening conformity by using leadership characters like the traditional authorities, i.e. tribal leaders, themselves or promoting exemplary villagers as role models might be a low cost practical approach, as long as strong enforcement remains infeasible or cost-inefficient.

To meet the call of Anderies et al. (2011) to analyze framing effects, we can also comment on CPR experiments as a method and the relevance of context. The regression shows that results are dependent on framing, partly because established behavioral patterns in that particular context matter. On the one hand, this result shows that bringing lab experiments to the field adds to the distortions in the results of the experiments. On the other, it makes clear that modeling an experiment to more specific situations can give an even better insight into the behavior of the people actually affected in that setting as opposed to impartial outside lab subjects. Using well-specified CPR experiments to tailor policy measures based on the results of a specific area would therefore possibly be a new approach to design and test new governance measures.

Moreover we can say that field experiments truly deserve a place beside lab experiments precisely because lab experiments do not allow for simulating the social environment of the field. This is especially true for the implicit interaction like the opinion leadership which comes from outside the experiment and cannot be separated from the participants' decisions making within the experiment. Additional to that, while a more realistic context might be possible to simulate in the lab, a deeply ingrained pattern of behavior in such a context cannot possibly be fabricated. This behavioral pattern resulting from daily use of a CPR cannot be simulated in a lab, but might make a difference for experimental results and policy recommendations based on those results. The same might be true for social interaction like opinion leadership and conformity to a group of peers, which is hard to carry into the lab.

Appendix

Payoff Table

You	1	2	3	4	5	6	7	8	
Others									**Others**
4	47	49	51	53	54	54	55	55	**4**
5	46	48	50	51	52	53	54	54	**5**
6	45	47	49	50	51	52	52	53	**6**
7	44	46	47	49	50	51	51	51	**7**
8	42	44	46	48	49	49	50	50	**8**
9	41	43	45	46	47	48	49	49	**9**
10	40	42	44	45	46	47	47	48	**10**
11	39	41	42	44	45	46	46	46	**11**
12	37	39	41	43	44	44	45	45	**12**
13	36	38	40	41	42	43	44	44	**13**
14	35	37	39	40	41	42	42	43	**14**
15	34	36	37	39	40	41	41	41	**15**
16	32	34	36	38	39	39	40	40	**16**
17	31	33	35	36	37	38	39	39	**17**
18	30	32	34	35	36	37	37	38	**18**
19	29	31	32	34	35	36	36	36	**19**
20	27	29	31	33	34	34	35	35	**20**
21	26	28	30	31	32	33	34	34	**21**
22	25	27	29	30	31	32	32	33	**22**
23	24	26	27	29	30	31	31	31	**23**
24	22	24	26	28	29	29	30	30	**24**
25	21	23	25	26	27	28	29	29	**25**
26	20	22	24	25	26	27	27	28	**26**
27	19	21	22	24	25	26	26	26	**27**
28	17	19	21	23	24	24	25	25	**28**
29	16	18	20	21	22	23	24	24	**29**
30	15	17	19	20	21	22	22	23	**30**
31	14	16	17	19	20	21	21	21	**31**
32	12	14	16	18	19	19	20	20	**32**

Participant Sheet

Participant #:	*Group #:*	*Name:*

Test Run		You (Choose 1-8)	Total (Announced)	Others (*Total* minus *You*)	Points (See Payoff-table)
Turn	1				
	2				
	3				
Game 1		You (Choose 1-8)	Total (Announced)	Others (*Total* minus *You*)	Points (See Payoff-table)
Turn	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
Game 2		You (Choose 1-8)	Total (Announced)	Others (*Totall* minus *You*)	Points (See Payoff-table)
Turn	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				

Comprehension Test

Recall the first 10 turns of the **natural resource** game you just played with the other 4 players. Please answer the following questions:

1. Imagine you know that **everyone else extracts 4** (*Others: 16*). What extraction level would you have to write down, to earn more than everyone else?

☐ More than 4 ☐ Less than 4 ☐ Exactly 4

2. Imagine **everyone else extracts 5**, but **you extract 3**. Do you earn more than anyone else?

☐ I would earn more ☐ I would earn less

☐ I would earn as much as other players

3. Imagine everyone including you chose an **extraction level** of 5 in the first turn *(Your effort: 5; Others' effort 20)*. In the second turn, everyone including you increases their **extraction level** to 6 *(You: 6; Others: 24)*. How does the income of everyone change compared to the first turn?

☐ Every player earns more ☐ Every player earns less

☐ Every player earns the same as in the first turn

4. *Imagine everyone choses the* ***same extraction level*** *as in the turn before. How do the incomes of the players change compared to the turn before?*

☐ Only you earn more ☐ Everyone earns the same as last turn

☐ Everyone but you earns more ☐ Everyone including you earns more

(Note: This is the game mechanics comprehension test for the unframed groups. For the fishery and wildlife contexts, more specific vocabulary according to the context was used. Otherwise questions remained the same and therefore imply the same understanding of the experiment.)

Visual Aid
Figure 6.A1

Figure 6.A1: Game host explains fishery context using visual aids (source: Own)

Figure 6.A2

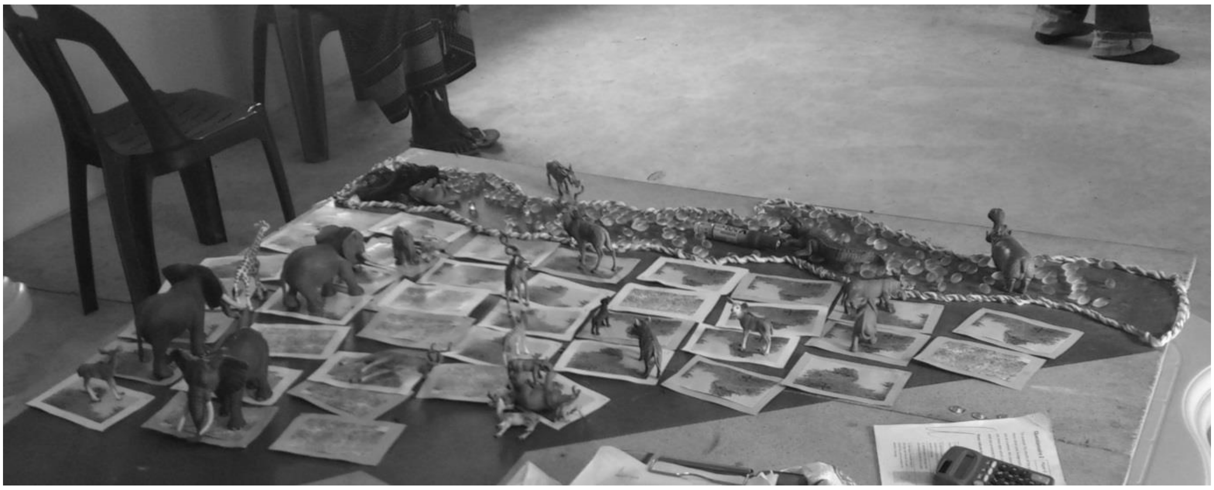

Figure 6.A2: Complete visual aids for wildlife and fishery context (source: Own)

Additional Tables

Table 6.A1: Determinants of common-pool resource game decision (1-8) in a random effects model

	(1) Basic	(2) All Rules	(3) Cheap Talk	(4) Weak Enforcement	(5) Strong Enforcement	(6) Context Specificity	(7) Combined
Constant	4.436***	6.097***	4.539***	4.397***	4.930***	4.942***	6.534***
	(1.020)	(1.023)	(1.034)	(1.019)	(1.017)	(1.021)	(1.026)
Age	0.030***	0.030***	0.030***	0.030***	0.030***	0.034***	0.034***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Comp. Land Participants	-0.006	0.009	-0.007	-0.008	0.012	0.191	0.203
	(0.124)	(0.123)	(0.124)	(0.124)	(0.124)	(0.145)	(0.144)
Comp. Welfare Participants	-0.482***	-0.485***	-0.482***	-0.482***	-0.489***	-0.627***	-0.626***
	(0.142)	(0.141)	(0.142)	(0.142)	(0.142)	(0.151)	(0.150)
Farmer	1.759***	1.645***	1.759***	1.762***	1.690***	0.977*	0.882
	(0.511)	(0.505)	(0.511)	(0.511)	(0.511)	(0.567)	(0.563)
Fisher	2.377***	2.320***	2.375***	2.376***	2.377***	1.175	1.181
	(0.734)	(0.726)	(0.733)	(0.734)	(0.733)	(0.948)	(0.943)
Awareness Fishery	-0.046	-0.043	-0.047	-0.046	-0.044	-0.021	-0.018
	(0.044)	(0.043)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
Awareness Wildlife	0.062	0.061	0.062	0.062	0.062	-0.008	-0.008
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.051)	(0.050)
Awareness Conservancy	-1.707***	-1.686***	-1.707***	-1.706***	-1.704***	-1.792***	-1.757***
	(0.496)	(0.490)	(0.496)	(0.496)	(0.494)	(0.510)	(0.504)
Wildlife Context	-0.298	-0.614	-0.296	-0.283	-0.478	-1.890**	-2.129**
	(0.763)	(0.752)	(0.763)	(0.763)	(0.759)	(0.927)	(0.916)
Fishery Context	1.740**	1.362*	1.742**	1.759**	1.531**	2.090*	1.784
	(0.774)	(0.763)	(0.774)	(0.774)	(0.770)	(1.260)	(1.250)
Personal Relationships	-0.317***	-0.309***	-0.317***	-0.318***	-0.312***	-0.378***	-0.370***
	(0.092)	(0.091)	(0.092)	(0.092)	(0.092)	(0.097)	(0.096)
Opinion Leadership	-3.010***	-2.266***	-3.113***	-3.007***	-1.926**	-3.131**	-2.456*
	(0.853)	(0.866)	(0.871)	(0.854)	(0.868)	(1.250)	(1.255)
Others' Extraction t-1	0.035*	-0.010	0.035*	0.037**	0.008	0.037**	-0.005
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Cheap Talk		-1.482***	-0.198				-1.460***
		(0.277)	(0.337)				(0.277)
Weak Enforcement		-1.563***		-0.401			-1.561***
		(0.302)		(0.360)			(0.302)
Strong Enforcement		-2.902***			-2.119***		-2.856***
		(0.321)			(0.364)		(0.320)
Slash & Burn Farmers * Wildlife C.						1.866***	1.798***
						(0.614)	(0.607)
Fishers * Fishery Context						-0.022	-0.088
						(1.000)	(0.995)
Pseudo-R²	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable
AIC	4690	4622	4692	4691	4658	4635	4575
BIC	4931	4878	4938	4937	4904	4885	4840
N	1235	1235	1235	1235	1235	1216	1216

* p<0.1, ** p<0.05, *** p<0.01; Notes: Model is a Tobit I regression with random effects and dummies for experimental groups.

Table 6.A2: Determinants of common-pool resource game decision (1-8) with full sample

	(1) Basic	(2) All Rules	(3) Cheap Talk	(4) Weak Enforcement	(5) Strong Enforcement	(6) Context Specificity	(7) Combined
Constant	4.110***	6.469***	4.925***	4.240***	5.273***	4.321***	6.686***
	(0.723)	(0.684)	(0.740)	(0.726)	(0.676)	(0.724)	(0.688)
Age	0.002	0.002	0.002	0.002	0.003	-0.000	0.000
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Comp. Land Participants	-0.067	-0.057	-0.067	-0.068	-0.058	-0.034	-0.026
	(0.102)	(0.097)	(0.102)	(0.102)	(0.099)	(0.103)	(0.097)
Comp. Welfare Participants	-0.094	-0.093	-0.093	-0.094	-0.093	-0.140	-0.136
	(0.121)	(0.114)	(0.120)	(0.120)	(0.116)	(0.127)	(0.120)
Farmer	-0.267	-0.249	-0.264	-0.266	-0.255	-0.292	-0.274
	(0.378)	(0.358)	(0.375)	(0.377)	(0.365)	(0.394)	(0.372)
Fisher	-0.607	-0.547	-0.604	-0.602	-0.559	-0.636	-0.580
	(0.464)	(0.439)	(0.459)	(0.463)	(0.446)	(0.495)	(0.468)
Awareness Fishery	0.027	0.026	0.027	0.027	0.026	0.020	0.019
	(0.020)	(0.019)	(0.020)	(0.020)	(0.019)	(0.020)	(0.019)
Awareness Wildlife	-0.056	-0.052	-0.056	-0.056	-0.053	-0.063	-0.058
	(0.033)	(0.030)	(0.032)	(0.032)	(0.031)	(0.034)	(0.031)
Awareness Conservancy	0.843	0.804	0.836	0.845	0.811	0.863	0.821
	(0.497)	(0.477)	(0.493)	(0.496)	(0.483)	(0.500)	(0.480)
Wildlife Context	-1.838**	-2.385***	-1.919***	-1.878**	-2.222***	-2.556***	-3.079***
	(0.675)	(0.628)	(0.677)	(0.672)	(0.633)	(0.620)	(0.572)
Fishery Context	-1.767*	-2.333***	-1.860**	-1.807**	-2.156***	-1.753*	-2.342***
	(0.699)	(0.653)	(0.704)	(0.695)	(0.657)	(0.696)	(0.648)
Personal Relationships	-0.124	-0.120	-0.123	-0.125	-0.121	-0.154	-0.148
	(0.081)	(0.077)	(0.080)	(0.081)	(0.078)	(0.083)	(0.079)
Opinion Leadership	-0.870	-0.057	-1.458	-0.872	0.594	-0.858	-0.027
	(0.794)	(0.789)	(0.791)	(0.788)	(0.797)	(0.804)	(0.798)
Others' Extraction t-1	0.051***	-0.037***	0.040*	0.044**	-0.013	0.053***	-0.035**
	(0.017)	(0.013)	(0.017)	(0.017)	(0.013)	(0.017)	(0.013)
Cheap Talk		-1.392***	-1.149***				-1.391***
		(0.239)	(0.224)				(0.240)
Weak Enforcement		-1.205***		-1.052***			-1.206***
		(0.298)		(0.306)			(0.299)
Strong Enforcement		-3.331***			-3.197***		-3.331***
		(0.380)			(0.379)		(0.382)
Slash & Burn Farmers * Wildlife C.						1.062*	1.026*
						(0.435)	(0.411)
Fishers * Fishery Context						0.067	0.092
						(0.347)	(0.331)
Pseudo-R^2	4.4%	6.6%	4.6%	4.6%	6.0%	4.5%	6.7%
AIC	14924	14590	14894	14897	14675	14557	14225
BIC	15242	14927	15218	15221	14999	14886	14573
N	3781	3781	3781	3781	3781	3686	3686

* p<0.05, ** p<0.01, *** p<0.005; Notes: Model is a tobit I regression with cluster-robust standard errors.

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Dissertation Appendix

Experiment Host Script

(English transliteration from the Silozi original)

Welcome and thank you for coming to our game today. My name is [name] and I am here as a representative of the research team from the Leibniz University of Hanover. Although we are not affiliated with them, I'd like to thank the Namibia Nature Foundation for their support in organizing the games in your conservancy. Let me make clear at this point, that the money you will take away from today's game does not come from the NNF and that in future projects in your conservancy you cannot expect to be paid money just because you get some today. [handout clipboards with questionnaires, participant sheet, payoff sheet, comprehension test]

Today, in the next 3 to 4 hours, we will conduct a game, which will take up the largest part of the time, and then I will ask you a few questions. Afterwards you will be paid according to your performance in the game. Let me start all this with explaining the game. [Distinguish between the three cases here; explain only one of them].

1.) The game you will conduct now will be about a natural resource in the conservancy. Imagine you 5 are the only people in Sikunga that can use this natural resource.

You can decide to adjust your level of extraction of this resource between 1 and 8. Whatever effort you do not put into extracting this resource, we will assume you put it into farming. Provided there is enough of the resource left, you will be left with a relatively good income from extracting the resource compared to farming.

If, however, everyone decides to put much effort into extraction, the resource will be more exhausted because it cannot regenerate quickly enough, and extraction will be less profitable.

What each of you gets is therefore dependent on what you do and what the others do. What you get in total you can see in this Payoff Table *[point to table]*. If you extract a total of 4 *[point at You-row]* and the others together extract 27 *[point at Others-column]*, you end up with 30 R for this turn *[let pointing finger wander to the payoff]*. If you decide to farm at a level of 2, which means you extract with an effort level of 6 *[point at You-row]*, and the others combined extract at a level 15 of their total 32 *[point to 15 on the Other-column]*, you earn 51 R. A third example: Imagine you decide to do the same as the others. Everyone extract at a level of 3 plots. So you extract at 3 [point to You-row] and the others extract at level 3 each, too, so 3 plus 3 plus 3 plus 3 equals 12 [point to Others-row]. Your earning would be 51 R.

Are there any questions? *[Count to 10 if no question arises immediately. If anyone even slightly looks like he might be asking a question, politely ask him to ask it.]*

These earnings will be real money. This game will be played 10 times and then 10 times more with a slight change in the rules of the game. At the end of the 20th turn, a random turn of the 20 will be chosen. Whatever you earned in this turn will be paid out to you.

So, to test if I have not made a mistake in my explanation, I will ask you some test questions now. [From here on in start asking some combinations of You- and Others-numbers, like 5 and 17, 7 and 19 and so on. Ask a particular player and if they don't know, explain it again. Then ask the next player. Do this until everyone has confidently called out the right Payoff to your question at least once.]

Every turn will be a reset, so it has nothing to do with what you decided before. So every turn, you get a fresh start.

Now, to how we conduct the game and record what we do. On your clipboard you all have a sheet which says 'Participant Sheet' [show them a Participant Sheet]. First things first: Please enter your name in the top right. As you can see, we have 3 rows for test turns we will play first, then 10 rows for the real game, then 10 rows for the real game with changed rules [point to each while talking about it]. In each row, you will find 4 columns:

1.: A column where to enter your decision [point]

2..: A column where the total the group decided on will be entered [point]. I will announce this number once I took a look at every Participant Sheet and added them up.

3.: A column where you enter the number from column 2 minus your own decision in column 1 [point to each]. You calculate that in your head, if you are comfortable with that, or use the calculator we provide.

4.: A column in which you enter the payoff resulting from the numbers in column 1 and 3.

Every turn we will do the following:

1.: I will ask you to make a decision. You put that number in the first column.

2.: Once everyone has done that, I will go around and look at the numbers and add them up.

3.: I will announce the total number, which you will enter in your 2nd column then [point].

4.: You subtract your decision from the number in column 2 and enter it in column 3. If you are not sure if you subtracted correctly, use the calculator we provided.

5.: You look up your payoff in the Payoff-Table like we discussed before.

6.: Then we'll start the next turn, where I'll ask you to decide again.

We'll do that for 10 turns, during which you are not allowed to communicate and also are not allowed to look on the sheets of other players.

2.) The Fishery Game

"The game you will play now will be about the fishery in the conservancy.

Imagine you 5 are the heads of the only fishing families in Sikunga and each of you has a household of 8 people, including yourself. I don't know if your household really has 8 people, but for the sake of this game, let's pretend this is so. Imagine your brothers or sisters moved in with you, for example.

You can decide for your household if only 1 or 2 or up to all 8 people should go fishing. Provided enough fish are still in the Zambezi, fishing will leave your family with a relatively good income. The rest will work on your family plot as farmers, leaving you with little income per family member working.

If however all other families [point to group of players] are fishing a lot as well, fishing grounds are so exhausted that they cannot regenerate quickly. Accordingly fishing will be less profitable for everyone who is fishing.

What each one of you gets, therefore, is dependent on your own amount of family members who go fishing on the one hand, and the total number of people fishing on the other hand.

What you get in total you can see in this Payoff Table [point to table]. If 4 of your family members go fishing [point at You-row] and from the other families together 27 family members go fishing [point at Others-column], you end up with 30 R for this turn [let pointing finger wander to the payoff]. If 2 of your family members farm on the family plot, which means the rest, so 6 family members, go fishing, [point at You-row], and the others combined send 15 of their total 32 family members fishing [point to 15 on the Other-column], you earn 51 R. A third example: Imagine you decide to do the same as the others. Everyone sends 3 family members fishing. So you send 3 [point to You-row] and the others send 3 each, so 3 plus 3 plus 3 plus 3 equals 12 [point to Others-row]. Your earning would be 51 R.

Are there any questions about this table? [Count to 10 if no question arises immediately. If anyone even slightly looks like he might be asking a question, politely ask him to ask it.]

These earnings will be real money. This game will be played 10 times and then 10 times more with a slight change in the rules of the game. At the end of the 20th turn, a random turn of the 20 will be chosen. Whatever you earned in this turn will be paid out to every player.

So, to test if I have not made a mistake in my explanations, I will ask you some test questions now. [From here on in start asking some combinations of You- and Others-numbers, like 5 and 17, 7 and 19 and so on. Ask a particular player and if they don't know, explain it again. Then ask the next player. Do this until everyone has confidently called out the right Payoff to your question at least once.]

Every turn will be a reset, so it has nothing to do with what you decided before. So every turn, you get a fresh start.

Now, to how we play and record what we do. On your clipboard you all have a sheet which says player sheet [show them a Player Sheet]. First things first: Please enter your name in the top right. As you can see, we have 3 rows for test turns we will play first, then 10 rows for the real game, then 10 rows for the real game with changed rules [point to each while talking about it]. In each row, you will find 4 columns:

1.: A column where to enter your fishing decision [point]

2..: A column where the total of all fishers the group decided on will be entered [point]. I will announce this number once I took a look at every Player Sheet and added them up.

3.: A column where you enter the number from column 2 minus your own decision in column 1 [point to each]. You calculate that in your head, if you are comfortable with that, or use the calculator we provide.

4.: A column in which you enter the payoff resulting from the numbers in column 1 and 3.

Every turn we will do the following:

1.: I will ask you to make a decision on how many of your household members you send fishing. You put that number in the first column.

2.: Once everyone is finished, I will go around and look at the numbers and add them up.

3.: I will announce the total number which you enter in your 2nd column then [point].

4.: You subtract your decision from the number in column 2 and enter it in column 3. If you are not sure if you subtracted correctly, use the calculator we provided.

5.: You look up your payoff in the Payoff-Table like we discussed before.

6.: Then we'll start the next turn, where I'll ask you to decide again to send between 1 and 8 family members fishing.

We'll do that for 10 turns, during which you are not allowed to communicate and also are not allowed to look on the sheets of other players.

[Do exactly as you said you would. Always leave enough time for players to fill in their columns and do their calculations. While checking on the decisions of participants, check if they maybe calculated or entered unreasonable numbers like 0 or 105.]

3.) The Wildlife Game

The game you will conduct now will be about the effect of slash and burn farming on the wildlife in your conservancy. Imagine you 5 are the only people in Sikunga who work their plots.

You can decide to slash and burn between 1 and 8 of your plots. If you do not slash and burn a plot, we will assume you farmed it without the slash and burn practice. Working your plots is one of two sources of income for you. If you slash and burn them, you will have a higher yield and therefore income, but you will also destroy habitat for wildlife in the conservancy. [Note by the author: It is a widespread belief in the conservancy that the slash and burn practice is beneficial in that way.] This wildlife is your second source of income. The conservancy can sell hunting permits based on how much wildlife lives in Sikunga due to the habitat left after farming. The money from these permits is distributed equally among you, independent of how much habitat was destroyed through slashing and burning.

Provided there is enough habitat for wildlife left, you will be left with a relatively good income: Your share plus the slash and burn farming. If, however, everyone decides to slash and burn a lot, habitat and therefore wildlife will be rarer, and the everyone's share of money will be smaller.

What each of you gets is therefore dependent on what you do and what the others do. What you get in total you can see in this Payoff Table *[point to table]*. If you slash and burn a total of 4 plots *[point at You-row]* and the others together slash and burn 27 plots *[point at Others-column]*, you end up with 30 R for this turn *[let pointing finger wander to the payoff]*. If you decide to slash and burn on 6 plots *[point at You-row]*, and the others combined slash and burn on 15 plots of their total 32 *[point to 15 on the Other-column]*, you earn 51 R. A third example: Imagine you decide to do the same as the others. Everyone uses slash and burn on 3 plots. So you take 3 [point to You-row] and the others slash and burn on 3 plots each, too, so 3 plus 3 plus 3 plus 3 equals 12 [point to Others-row]. Your earning would be 51 R.

Are there any questions? *[Count to 10 if no question arises immediately. If anyone even slightly looks like he might be asking a question, politely ask him to ask it.]*

These earnings will be real money. This game will be played 10 times and then 10 times more with a slight change in the rules of the game. At the end of the 20th turn, a random turn of the 20 will be chosen. Whatever you earned in this turn will be paid out to you.

Now my colleague outside will ask you a few questions which you can answer using the short questionnaire on your clipboards. Afterwards your winnings will be handed out separately to each one of you.

So, to test if I have not made a mistake in my explanation, I will ask you some test questions now. [From here on start asking some combinations of You- and Others-numbers, like 5 and 17, 7 and 19 and so on. Ask a particular player and if they don't know, explain it again. Then ask the next player. Do this until everyone has confidently called out the right Payoff to your question at least once.]

Every turn will be a reset, so it has nothing to do with what you decided before. So every turn, you get a fresh start.

Now, to how we conduct the game and record what we do. On your clipboard you all have a sheet which says ‘Participant Sheet’ [show them a Participant Sheet]. First things first: Please enter your name in the top right. As you can see, we have 3 rows for test turns we will play first, then 10 rows for the real game, then 10 rows for the real game with changed rules [point to each while talking about it]. In each row, you will find 4 columns:

1.: A column where to enter your decision [point]

2..: A column where the total the group decided on will be entered [point]. I will announce this number once I took a look at every Participant Sheet and added them up.

3.: A column where you enter the number from column 2 minus your own decision in column 1 [point to each]. You calculate that in your head, if you are comfortable with that, or use the calculator we provide.

4.: A column in which you enter the payoff resulting from the numbers in column 1 and 3.

Every turn we will do the following:

1.: I will ask you to make a decision. You put that number in the first column.

2.: Once everyone has done that, I will go around and look at the numbers and add them up.

3.: I will announce the total number, which you will enter in your 2nd column then [point].

4.: You subtract your decision from the number in column 2 and enter it in column 3. If you are not sure if you subtracted correctly, use the calculator we provided.

5.: You look up your payoff in the Payoff-Table like we discussed before.

6.: Then we’ll start the next turn, where I’ll ask you to decide again.

We’ll do that for 10 turns, during which you are not allowed to communicate and also are not allowed to look on the sheets of other players.

[Do exactly as you said you would. Always leave enough time for players to fill in their columns and do their calculations. While checking on the decisions of participants, check if they maybe calculated or entered unreasonable numbers like 0 or 105.]

Participant Questionnaire

Questionnaire 2

Player #:	*Group #:*	*Name:*	*Gender:*

To evaluate the results of the experiment we are here for, it is helpful for us to know a little more about your background. On this sheet we kindly ask you to answer questions concerning you as a person. We assure you that we will use this data for research purposes only and will not share data which could make you identifiable in any way. The other players will not see what you answered here.

Please indicate how you relate to the following statements:

	I strongly agree	I agree	I am neutral	I disagree	I strongly disagree
1. The Zambezi near Sikunga is overfished.	☐	☐	☐	☐	☐
2. Overfishing of the Zambezi would be a serious problem for people in Sikunga.	☐	☐	☐	☐	☐
3. Wildlife visits in Sikunga have decreased over the last 10 years.	☐	☐	☐	☐	☐
4. Decrease of wildlife visits in Sikunga over the last 10 years would be a serious problem for people in Sikunga.	☐	☐	☐	☐	☐

	Much better off	Better off	Same	Worse off	Much worse off
5. How well off do you consider yourself in comparison to the other 4 players?	☐	☐	☐	☐	☐
6. How well off do you consider yourself in comparison to others in your village?	☐	☐	☐	☐	☐

	Much more	More	Same	Less	Much less
7. In comparison to the other 4 players here, how much more or less farmland do you think you have?	☐	☐	☐	☐	☐
8. In comparison to the others in your village, how much more or less farmland do you think you have?	☐	☐	☐	☐	☐

	Only fishing	Mostly fishing	50/50	Mostly farming	Only farming
9. **Outside of the flooding season**, do you spend your working hours rather fishing or rather farming?	☐	☐	☐	☐	☐

	Only fishing	Mostly fishing	50/50	Mostly farming	Only farming
10. **During the flooding season**, do you spend your working hours rather fishing or rather farming?	☐	☐	☐	☐	☐

	All	Most	50/50	A few	None
11. How much of your working hours do you spend at a job other than fishing or farming?	☐	☐	☐	☐	☐

Please answer the following questions:

12. Have you taken part in the survey by the University of Hanover, which is conducted in the conservancy from 23rd of September until 14th of October?

☐ Yes ☐ No ☐ Don't know

13. What is the name of the village you live in?

☐ Kalimbeza ☐ Kalundu ☐ Mabula

☐ Malindi ☐ Nasisangami ☐ Old Isize

☐ Sifuha ☐ Other (please specify):…………………………………………

14. How many years did you successfully complete in school?

15. How many children do you have?

16. How many people other than you live in the same household as you?

17. How old are you?

18. What do you consider your occupation? Please mark **only one** appropriate answer.

☐ Farmer ☐ Fisher

☐ Other (please specify):………………………………………………………………………………….

19. Which position do you have in the Sikunga Conservancy? Please tick the appropriate answer.

☐ Member, but not in the committee ☐ Part of the committee

☐ None

20. Which tribe/ethnical group do you belong to, if any?

☐ Mayeyi ☐ Masubia ☐ Caucasian

☐ Other (please specify): ………………………………………………………………………………..

21. Are you the decision-maker in your household (*household head*)?

☐ Yes, and I decide on my own ☐ No

☐ Yes, but I consult with other household members first

22. Which religious group do you belong to?

☐ 7th Day Adventist ☐ Roman Catholic

☐ New Apostolic Church ☐ None

☐ Other (please specify): …………………………………..

23. Before today, have you discussed this game with anyone before?

☐ Yes ☐ No

The following questions aim at finding out more about the relationship between you and the other players. Please indicate to the best of your abilities, but without asking the other players, what you think describes your relationship best. Ignore the lines for your own player number.

24. **How much more or less well off do you consider yourself in comparison to…**	A lot wealthier	A little wealthier	About the same	A little less wealthy	A lot less wealthy
…player 1	☐	☐	☐	☐	☐
…player 2	☐	☐	☐	☐	☐
…player 3	☐	☐	☐	☐	☐
…player 4	☐	☐	☐	☐	☐
…player 5	☐	☐	☐	☐	☐

25. **You are in the same tribe as…**	Yes	No	I don't know
…player 1	☐	☐	☐
…player 2	☐	☐	☐
…player 3	☐	☐	☐
…player 4	☐	☐	☐
…player 5	☐	☐	☐

26. **Do you share a religion with…**	Yes	No	I don't know
…player 1	☐	☐	☐
…player 2	☐	☐	☐
…player 3	☐	☐	☐
…player 4	☐	☐	☐
…player 5	☐	☐	☐

27. **Please describe your relationship to…** *(mark only one answer)*	Private relationship (family, friend, neighbour, etc.)	Business relationship (doctor, teacher, employer, etc.)	Business and private	No relationship	Don't know her/him
…player 1	☐	☐	☐	☐	☐
…player 2	☐	☐	☐	☐	☐
…player 3	☐	☐	☐	☐	☐
…player 4	☐	☐	☐	☐	☐
…player 5	☐	☐	☐	☐	☐

28. **How long do you know…**	(…best estimate in years)
…player 1	☐
…player 2	☐
…player 3	☐
…player 4	☐
…player 5	☐

29. Among the other 4 players, who influenced your game decisions most (mark only one)?	
…player 1	☐
…player 2	☐
…player 3	☐
…player 4	☐
…player 5	☐

29. Among the other 4 players, who has the most influence on community decisions in Sikunga (mark only one)?	
…player 1	☐
…player 2	☐
…player 3	☐
…player 4	☐
…player 5	☐

31. **This is how important [player] is in my life.** *(mark only one answer)*	Very important	Important	Neutral	Unimpor-tant	Very unimpor-tant
…player 1	☐	☐	☐	☐	☐
…player 2	☐	☐	☐	☐	☐
…player 3	☐	☐	☐	☐	☐
…player 4	☐	☐	☐	☐	☐
…player 5	☐	☐	☐	☐	☐

The next question is to be filled out by an enumerator or the game leader. Please wait until he gets to you for filling out this question.

32. **Is there a family relation between you and…**	None	Child	Parent	Spouse	Sibling	Son / daughter in law	Sister / brother in law	Mother / father in law	Uncle / Aunt	Niece / Nephew	Cousin
…player 1	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…player 2	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…player 3	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…player 4	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…player 5	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Thank you for your participation.