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Why and how much are firms willing to invest in ecosystem services from tropical forests? A comparison of international and Costa Rican firms

Thomas Koellner [a,b,*], Joachim Sell [a], Guillermo Navarro [c]

[a] Natural and Social Science Interface NSSI, Institute for Environmental Decisions IED, Department of Environmental Sciences, ETH Zurich, Switzerland
[b] Professorship of Ecological Services (PES), Faculty of Biology, Chemistry and Geosciences, University of Bayreuth, Germany
[c] CATIE, Turrialba, Costa Rica

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ABSTRACT

In recent years, schemes for payment for ecosystem services PES have emerged in tropical countries. Besides public demand, the private demand offers the opportunity to develop PES. The goal of this paper is to investigate the potential demand by firms for four ecosystem services from tropical forests: biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection. Those are the four granted in the forest legislation and rewarded for in the PES scheme in Costa Rica. To explain stated willingness to invest WTI, we assess influential factors: expectations with respect to financial and non-financial benefits of investing in ecosystem services; experience with forest ecosystem services; firm attributes, like origin, sector membership, and size; and finally, perceived behavioral control. We sent a questionnaire to over 900 international and Costa Rican firms from different sectors. The low response rate of the survey of overall 6% can be explained by – in a business context – rather new topic of ecosystem services from tropical forests. The analysis showed that a firm's willingness to invest (WTI) depends on the origin of the firm. International firms are interested in buying certificates mainly for carbon sequestration; Costa Rican firms, for all four ecosystem services in the following order: watershed protection, biodiversity conservation, carbon sequestration, and scenic beauty. Indirect and non-financial benefits are surprisingly important and can impede the development of ecosystem service markets. At the same time, the activities of intrinsically motivated green entrepreneurs in a financially oriented firm setting might be a prerequisite within a firm context for bringing such innovative topics as ecosystem services from tropical forests to the table.

1. Introduction

Tropical forests are not only valuable for the intrinsic value of the species inhabiting them; they also provide society with functional ecosystem services, such as carbon sequestration, water cycling, and scenic beauty (Daily, 1997). The scarcity and importance of such ecosystem services has been stressed, because effective substitutes are missing (Batabyal et al., 2003). In the past the contingent valuation method (CVM) was applied to value such ecosystem services, e.g., it has been applied in northern countries (Loomis et al., 2000) and the tropics (Carson, 1998; Adams et al., 2008; Wattage and Mardle, 2008). To investigate their economic value, meta-analyses of such surveys have been used to calculate global values for ecosystem services from all ecosystem types (Costanza et al., 1997) and for those only from wetlands (Brander et al., 2006). Normally, CVM is used for valuing non-marketable environmental goods and services based on surveys of citizen, but not for investigating the demand by firms for such goods and services (Bateman and Willis, 1999). However, besides the government and the civil society, companies are an important demand side actor in Payments for Ecosystem Services (PES) Schemes. This is because ecosystem services are an input into their production function (e.g. watershed protection for hydropower companies or drinking water providers, scenic beauty for tourism industry, or biodiversity for pharmaceutical companies). For that reason Sell et al. (2006, 2007) did investigate the decision making criteria of market actors with respect to the supply and demand for ecosystem services from tropical forests.

Those studies did include all types of organizations including governmental ones, non-governmental ones and companies. What is until now missing is an analysis of the demand specifically by firms. Also missing is an analysis of their expectations about financial and non-financial benefit of their potential investments into ecosystem services from tropical forests.

In order to fill this gap we apply a CVM style analysis to firms. We labeled the output willingness to invest (WTI) to signal that those are different from conventional CVM studies, which focus on the willingness to pay (WTP) of consumers. Of course, if firms are the

* Corresponding author. Professorship of Ecological Services (PES), Faculty of Biology, Chemistry and Geosciences, University of Bayreuth, Germany. Tel.: +49 921 55 2373.
E-mail address: thomas.koellner@uni-bayreuth.de (T. Koellner).

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beneficiaries of positive environmental changes it is best, as Arrow (1999) suggests, "to measure the benefits [of environmental improvement] by objective technological analysis of increased output or decreased cost". This is correct, unless – as in the case of ecosystem services from tropical forests – financial engagement of firms is novel and rare, but ecosystem service suppliers still want to know more about potential demand of firms. Currently, there are insufficient observable investments of firms for accurate analysis of their demand for ecosystem services and the assessment of objective economic benefit of an investment in ecosystem services. Only for hydrological ecosystem services such calculations of the objective financial cost and benefits have been done (Pagiola, 2002; Bruijnzeel, 2004).

The goal of this paper is firstly to quantify firms' willingness to invest in ecosystem services from tropical forests and secondly to investigate factors potentially influencing stated demand: General benefit expectations of paying for ES, experience with and knowledge about forests and their ecosystem services, firm attributes (e.g., origin, sector membership, or size), and finally, the behavioral control perceived by decision-makers in firms, which hinder that they implement stated investments into true investments.

The knowledge provided in this study should foster the understanding of ecosystem services as an input into the production function of firms and is important to develop marketing strategies for ecosystem services targeting the private sector (Gähwiler et al., 2009). This is relevant because schemes for Payments for Ecosystem Services are either user or government financed, or a combination of both (Wunder et al., 2008). One of the most prominent examples for a nationwide PES scheme is the Costa Rican one developed in 1997 (Pagiola, 2008). Although mainly publicly financed via a fuel tax the Costa Rican PES scheme also seeks financing from users of ecosystem services, such as water utilities, hydropower companies, or the tourism sector.

2. The model

Through this decision-making model, we want to clarify factors influencing a firm's investments in ecosystem services, its stated investments, and its observed investments behavior (see Fig. 1 and Table 1 for constructs and variable explanation). The model is adapted from Ajzen's (1991) theory of planned behavior. He makes a distinction between intention (= stated investment) and behavior (= observed investment). Regardless of how solid one's intention is, a corresponding behavior may not be executed because of perceived behavioral control (e.g., a decision-maker in a firm may perceive difficulties budgeting for ecosystem services). In economics, this distinction of decision-making between intention and the observable

Table 1
Constructs and corresponding variables in the general model (see Fig. 1). For types of ecosystem services *ES* were analysed: Biodiversity conservation (BIO), Carbon sequestration (CA), Scenic beauty (SC) and Watershed protection (WA).

Construct	Variables	Explanation
(Cost–)benefit expectations *A*[a]		(Cost–)benefit expectations for engaging in ecosystem services
	DIRFIN_ES	Expected direct financial benefit from ES
	INDFIN_ES	Expected indirect (non-) financial benefit from ES
Experience *E*		Experience and knowledge about ES
	FOREST	Past engagement in primary or secondary forestry
	PLANTATION	Past engagement in plantations
	ENGAGE_ES	Past engagement in ES
	KNOWLEDGE	Personal knowledge of general ES
Firm *C*		Characteristics of the firm
	SECTOR	Membership in sector group
	•SECTOR(1)	Sector group level (1)
	•SECTOR(2)	Sector group level (2)
	•INDUSTRIES	Firms active in sectors *energy, materials, industrial,* and *utilities*
	•CONSUMERS	Firms active in sectors *consumer staples, consumer discretionary* and *health care*
	•FINANCIALS	Firms active in financial sector
	ORIGIN	Origin of firm
	•COSTA RICAN	Firms originating in Costa Rica
	•INTERNATIONAL	International firms
	EMPLOYEES	Number of employees
	ENVMAN	Implemented environmental management system
Behavioral control *B*		Factors affecting purchase behavior
	PUBLIC_ES	Position that public should pay for ES
	INTERMED	Existence of an intermediary
	VERIFIER	Existence of a verifier
	LOCATION	Location of forest providing ES
	CERTIFICATES	Tradable certificates
	PROJECT	Forest projects
Stated investment *S*		Stated investment in ecosystem services ES
	WTI	Willingness to invest per unit ES-certificate
	N_CERT	Stated demand in number of certificates per year
Purchase behavior *P*[a]		Observed purchase of ES certificates

[a] Purchase behavior and cost expectations were not further operationalized in this study, but remain in the general model for the sake of completeness.

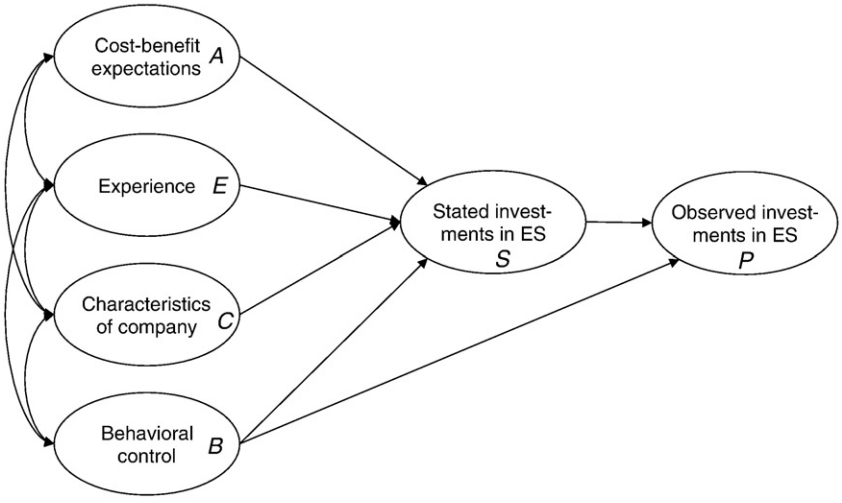

Fig. 1. General model of institutional decision-making with respect to stated investments and observed investments in ecosystem services ES.

behavior has lead to discussion about the validity of stated preferences techniques in contrast to revealed preferences for environmental valuation (Bateman et al., 2002).

In this paper, we are investigating firms' stated investments in four ecosystem services: biodiversity conservation, carbon sequestration, scenic beauty and watershed protection. These services have been selected because they are often addressed in existing payment schemes for ecosystem services from tropical forests (especially in the PES scheme in Costa Rica). Demand for ecosystem services is operationalized by willingness to invest (WTI) for one certificate representing one hectare of forest providing a flow of a specific ecosystem service for one year, by the number of certificates they intend to issue per year for a given stated WTI and by the firm's total demand for ecosystem services in US$ in a specific time period.

In order to explain stated investments S for each of the four ecosystem services, we have designed four constructs. These are cost-benefit expectations of investing in ecosystem service certificates A; experience with and knowledge about forests and their ecosystem services E; firm characteristics C (e.g., origin, sector membership, or size); and finally, perceived behavioral control B. It is

$$S = f(A, E, C, B) \quad (1)$$

The observable investment behavior P is according to the model a function of the stated investments S for ecosystem services and perceived behavioral control B. This is important to distinguish, because the stated intention to pay for ecosystem services might not be realized due to perceived difficulties in realizing the behavior. A reason for this could be that there is no supply of ecosystem service certificates in the region where the firm is economically active. It is

$$P = f(S, B) \quad (2)$$

Since we did not observe investment behavior in this study this was not further implemented.

- Cost-benefit expectations A of an intended behavior determine the *attitude towards behavior* in Ajzen's theory of planned behavior (1991). Here cost-benefit expectations are operationalized only as potential benefit expectations in qualitative terms as a driver for demanding ES. Cost expectations were not further investigated in order to keep the questionnaire simple. Benefit expectations fall conceptually into three categories (Table 2). The motivation can arise from direct financial benefits (e.g., tropical forests reducing sediment yield in rivers and decreasing the costs of water filtration), indirect financial benefits (e.g., engagement in tropical forests can improve a firm's public image), and non-financial benefits (e.g., personal satisfaction from acting ecologically responsibly). The direct and indirect financial benefits appeal to a firm's profit goals, whereas the construct of non-financial benefits assumes that the firm, or at least a decision-maker in the firm, has non-profit goals as well. Our assumption is that decision-makers in a firm setting can act in the role of a manager as well as a good citizen. Of course it will depend on the situation and individual, which impact the manager preferences versus citizen preferences have on decision-making. This distinction is motivated by Sagoff (1998), who made the argument that personal decision-making is done either in the role of a consumer or in the role of a citizen, which can result even in conflicting preferences given the same decision problem.
- Next we assume that a decision-maker's experience E with ecosystem services and a firm's prior engagement in forestry, plantations, or ecosystem services influence stated demand. In this sense past experience is assumed to be a strong predictor of intended behavior. Also a decision-maker's personal knowledge about ecosystem services can have a strong influence on investment intention.
- In addition, general characteristics C of the firm – such as sector membership, origin, and size – can influence both the demand for ES and the management style of the firm with respect to sustainability and the environment. In this study we investigated three sector groups, because of expected differences of firms active in the sectors "energy, materials, industrial, and utilities"; firms active in the sectors "consumer staples, discretionary staples and health care", and firms active in the "financial sector".
- Lastly, perceived behavioral control B has to do with factors, which support or hinder the transformation of stated demand into observable investment behavior. The following factors we included in the model: the opinion that not the firm but the public should ultimately pay for the ecosystem services it uses; the existence of an intermediary to bridge supply and demand; the existence of an independent verifier augmenting trust that the service invested in will be provided; the incongruence of the location of the firm's operational activity and the location of the service provided; the availability of tradable certificates, which can be transferred; and the non-technical nature of forest projects.

Table 2
Classification of firms' benefit expectations *AE* for engaging in ecosystem services.

Type	Factors influencing WTI for each ES
Direct financial benefit	a. The service creates *direct financial income* for my firm.
	b. The service *reduces costs* for my firm.
	c. This ecosystem service secures my firm's *natural resources.*
	d. We are active in this field out of our *clients'* demand.
Indirect financial benefit	e. It is a requirement of our *shareholders*.
	f. We do mandatory compensation for *legal compliance.*
	g. We compensate our impacts on a *voluntary* basis.
	h. We expect *image benefits* in the public.
	i. We perceive high pressure by *NGOs*.
Non-financial benefits	j. We want to contribute to *human welfare.*
	k. We want to act *ecologically responsibly*.

Based on the model as developed above we explicitly test the following hypothesis:

- H_1: willingness to invest in biodiversity conservation and carbon sequestration is global and demand for scenic beauty and watershed protection is regional. This plausible hypothesis was for example published in Castro et al. (Castro et al., 2000).
- H_2: willingness to invest in the four investigated ecosystem services differs between three sector groups (INDUSTRIES, CONSUMERS, and FINANCIALS). We suspected that WTI for biodiversity is highest for CONSUMERS, because food industry and pharmaceutical industry utilize biodiversity as a factor of production. With respect to carbon sequestration we assumed that INDUSTRIES show the highest WTI, because of their huge environmental carbon emissions and the voluntary or mandatory commitments for carbon reduction. For SCENIC BEAUTY we did not assume a strong difference between sector groups, because the tourism industry directly depending on scenic beauty as an input was not sampled. Finally, for watershed protection we assumed high WTI values for the CONSUMERS and INDUSTRIES, because of their dependence on water resources. Finally, we expect lowest WTI for FINANCIALS because of their very indirect relations to ecosystem services.
- H_3: we assumed that the direct and indirect financial benefits are more important compared to non-financial benefits, because the survey was done in a financially driven business environment and participants were asked to answer the questionnaire as representatives of their firm. Non-financial benefits were introduced in order to test in which role the participant is answering the questionnaire — either in the role of a manager representing the firm or as a concerned citizen.

3. Method

3.1. Variable measurements

We developed and pretested a questionnaire in order to quantify the variables in the model. The questionnaire was arranged according to Bateman et al. (2002). It contained the following sections: general introduction to the questionnaire and survey, explanation of forest types and ecosystem services, sample framework for payments for ecosystem services, a central question portion, and background information about the firm and the respondent. The central question portion covered the firm's (i) maximum willingness to invest in each ecosystem service per ha and yr in US dollars, (ii) willingness to invest in ecosystem service certificates in *N* per year, (iii) and expected benefits of investing in ecosystem service certificates, as well as (iv) external factors influencing the decision to buy ecosystem service certificates.

The section *explanation of forest types and ecosystem services* contained brief descriptions of the terms related to forestry and ecosystem services used in the questionnaire. We asked the firms to rate the relevancy of various types of forestry and ecosystem services. We inquired about their degree of engagement (independently of its form, e.g., purchase, investments, credits, trade of products, services or certificates) in the tropics in different types of forestry. Those were primary forest (forests of native species in which there are no clearly visible indications of human activity), secondary forest (forests of naturally regenerated native species where there are clearly visible indications of human activities), exotic species plantations (forests of intensively managed mono-specific, introduced, and fast-growing species — e.g., teak, eucalyptus), native species plantations (forests of intensively managed mono-specific, native species — e.g., mahogany, pochote), and mixed plantations (forests of introduced and native species managed in an environmentally friendly manner). The answers were given on a seven-point Likert scale ranging from 1 (no engagement) to 7 (main field of engagement).

In the succeeding parts of the questionnaire, no distinction among forestry types was made on the basis of the ecosystem services they provide. We simply used the umbrella term "sustainable forest management." This was done in order to reduce the complexity of the questionnaire.

We focused in the questionnaire on the four ecosystem services from tropical forestry, mentioned in the Costa Rican forest law, and gave the following explanations.

1. Biodiversity conservation: tropical forests provide and conserve diversity with regard to genes, species, habitats, and ecosystems. Important in eco-tourism and the pharmaceutical industry (bio-prospecting), biodiversity conservation is often linked with certification of sustainable forest management.
2. Carbon sequestration: tropical forests remove carbon dioxide from the atmosphere through the sequestration and storage of carbon. Carbon sequestration can be traded by means of "certified emission reductions" (CERs) under the Clean Development Mechanism of the Kyoto-Protocol or "verified emission reductions" (VERs) outside of the Kyoto regime.
3. Scenic beauty: tropical forests fulfill visual aesthetic values. This is important for recreation, tourism, and a host of other cultural services, such as cultural identity. Entrance fees (e.g., for national parks) offer one possible mechanism for financing scenic beauty.
4. Watershed protection: tropical forests filter water, regulate its flow, and prevent erosion. This ecosystem service plays an important role in water quality for rural, urban, industrial, and agricultural use. Upstream forest owners receive payments from downstream water consumers (e.g., hydroelectric power plants) for protecting their forests.

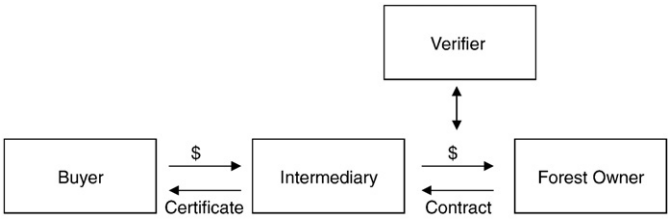

Fig. 2. This chart depicts the framework for payments for ecosystem services – including the relationships between a forest owner, buyer, intermediary, and verifier – as it was shown in the questionnaire.

Accordingly for each item, we asked how engaged the firm is in the ecosystem services mentioned on a seven-point Likert scale (1 = no engagement at all, 7 = main field of engagement).

In the next section of the questionnaire, we briefly described a *sample framework for payments for ecosystem services*. This allowed firms to contextualize their willingness to invest while addressing many of their questions. The scheme focuses on several involved actors and briefly describes their roles. It assumes that the legal and institutional framework for the transactions of ecosystem services has already been given. The description was kept general and did not contain all of the information necessary for a good investment decision. Its aim was for all the participants to refer to a common type of payment mechanism, thus establishing references for the valuation questions.

Based on Fig. 2, the payment scheme was described in the questionnaire as follows:

> In the scheme, ecosystem services are provided through sustainable management of forests by local forest owners. A verifier controls and monitors the sustainable management of forests and the provision of four ecosystem services: biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection. The verifier controls the transparency of the transactions and insures their credibility. An intermediary issues certificates for the ecosystem services. Please imagine your firm representing the buyer of certificates from the intermediary. The intermediary is in charge of the transaction of certificates to your firm and payments to the local forest owners. Accordingly, local owners of natural forests and forest plantations receive payments from your firm. The certificates provide access to the ecosystem services for 5 years. During this period, your firm is informed about the state of the forest each year. One unit of sustainably managed area always consists of one hectare of forest land.

In the central question portion, we posed several questions concerning willingness to invest in ecosystem services. We urged the respondents to answer the questions, to their best ability, as representatives of their firm. Even if they didn't know exactly, we asked them to estimate willingness to invest, introducing the topic with the following explanation:

> Imagine your firm as the buyer of certificates for the four ecosystem services (biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection). One certificate represents a unit of one hectare of sustainably managed forest. The degree to which the different types of forest mentioned in section B provide ecosystem services varies. Please imagine that each ecosystem service is provided by the most appropriate forest type.

The answer to the question about willingness to invest was further framed by the statement that in the Costa Rican Program of Environmental Service Certificates, buyers pay US$ 60 per year for

Table 3
Distribution of the surveyed International and Costa Rican firms that completed questionnaires, across sectors and sector groups (industries, consumers and financials).

	International					Costa Rica sample				
	Surveyed		Completed		Response rate	Surveyed		Completed		Response rate
	N	%	*N*	%	%	*N*	%	*N*	%	%
Energy (1)	37	6.0	3	9.7	8.1	16	4.3	2	6.9	12.5
Materials (2)	62	10.1	7	22.6	11.3	39	10.4	1	3.4	2.6
Industrials (3)	177	28.9	4	12.9	2.3	69	18.4	0	0.0	0.0
Consumer discr. (4)	37	6.0	2	6.5	5.4	57	15.2	5	17.2	8.8
Consumer staples (5)	47	7.7	3	9.7	6.4	80	21.3	5	17.2	6.3
Health care (6)	59	9.6	4	12.9	6.8	26	6.9	3	10.3	11.5
Financials (7)	142	23.2	5	16.1	3.5	73	19.5	6	20.7	8.2
Utilities (8)	52	8.5	3	9.7	5.8	15	4.0	7	24.1	46.7
Total	613	100.0	31	100.0	5.1	375	100.0	29	100.0	7.7
Industries (1 + 2 + 3 + 8)	328	53.5	17	54.8	5.2	139	37.1	10	34.5	7.2
Consumers (4 + 5 + 6)	143	23.3	9	29.0	6.3	163	43.5	13	44.8	8.0
Financials (7)	142	23.2	5	16.1	3.5	73	19.5	6	20.7	8.2
Total	613	100.0	31	100.0	5.1	375	100.0	29	100.0	7.7

one hectare of sustainably managed forest. We asked every firm about its willingness to invest annually for each ecosystem service in the following order: biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection. The questions were stated in the following open format.

- How much are you willing to pay per year on average for one certificate of biodiversity conservation? The payment ensures that one hectare of forest is managed in a way that its highly valued biodiversity is protected. _ US$ per certificate
- How much are you willing to pay per year on average for one certificate of carbon sequestration? The payment ensures that one hectare of forest is managed in a way that carbon is sequestered. The potential for carbon sequestration varies widely (4–60 t CO2/ha year[1]) among the above mentioned forest types. To reduce the questionnaire's complexity, assume that one hectare of tropical forest sequesters 32 t CO2. _ US$ per certificate
- How much are you willing to pay per year on average for one certificate of scenic beauty? The payment ensures that one hectare of forest is managed in a way that maintains its scenic beauty. Assume that your firm can choose the location of the unit of forest land you are paying for. _ US$ per certificate
- How much are you willing to pay per year on average for one certificate of watershed protection? The payment ensures that one hectare of forest continuously provides watershed protection. Assume that the forest land you are paying for is located in the watershed area you are interested in. _ US$ per certificate

In addition, we asked the respondents about their certainty on each answer they gave about their willingness to invest in a unit of ecosystem service. Then, based on the figures the respondents had given, we asked them how many certificates their firm would be willing to buy on average annually between 2005 and 2010. This was done as an open question for each ecosystem service where a certificate represented one hectare of sustainably managed forest.

The next section of the questionnaire contained questions about the expected benefits influencing their answers on willingness to invest and numbers of certificates for ecosystem services. For each expected benefit item mentioned in Table 2, a seven-point Likert scale was used ranging from 1 (not true at all) to 7 (very true). Each of the four ecosystem services was treated separately.

In the following section, we asked about the *importance of some external factors* that might influence the firm's decision to invest in certificates of ecosystem services from tropical forestry. On a scale from −5 (negative influence) to 0 (no influence) to +5 (positive influence), the respondents could indicate the influence the following aspects might have on their decision: the existence of an intermediary, the existence of a verifier, the location of the project in Latin America, the tradability of the certificates, and the fact that the certificates are for forestry projects. In two open questions, we asked what other factors would support or hinder a firm's decision to engage in ecosystem services from tropical forests.

The last section of the questionnaire was dedicated to additional information about the firm and the respondent. To characterize the firms, we asked for its number of employees, whether it has an environmental management system, the total US dollars spent in 2004 for tropical forestry projects investments and/or donations, and we requested a copy of its most current sustainability and/or environmental report, To characterize the respondent, we asked about his/her position in the firm, the name of the department, and his/her duration in this position. In addition, we asked him/her to rate on a seven point Likert scale his/her expert knowledge on the four ecosystem services in general as well as specifically economic, environmental, political, and social aspects of them.

3.2. Sample of firms and data collection

In order to test our hypotheses about the demand for ecosystem services and the expected benefits influencing them, we selected firms located in Costa Rica and international firms from various sectors. The source for sampling international firms was the MSCI World, which is maintained by Morgan Stanley Capital International and is composed of 1549 large, international capitalized firms in developed countries (Anonymus, 2004). The source for Costa Rican firms was the online Costa Rica Yellow Pages (Anonymus, 2006b) and two other internet sites — one for industrial firms (Anonymus, 2006a), the other for financial firms (Anonymus, 2006c).

Based on the Global Industry Classification System (GICS) (Anonymus, 2005), we selected firms from three sector groups: INDUSTRIES, CONSUMERS, and FINANCIALS. The reason was that we expected the sector groups' expected benefits from buying certificates for ecosystem services to vary (see hypothesis 2). The first sector group was labeled INDUSTRIES and included the GICS sectors *energy*, *materials*, *industrials* and *utilities*. The second group was labeled CONSUMERS and included the GICS sectors *consumer discretionary*, *consumer staples,* and *health care*. The third group was labeled FINANCIALS and contained banks and investment firms. The MSCI sectors *information technology* and *telecommunication services* were

[1] These carbon values are based on undisturbed primary forest, a slightly logged primary forest, a secondary forest and four 11-year old plantations of Tectona grandis (teak), Bombacopsis quinata, Terminalia amazonia and Swietenia macrophylla (mahogany) in Costa Rica (Ziltener, 2005). The high value of 60 tons CO_2 ha^{-1} and $year^{-1}$ for fast growing plantations correspond to 55 tons CO_2 ha^{-1} and $year^{-1}$ as reported by Lugo and Brown (1992).

excluded from the analysis, because they were expected to be the least interested in ecosystem services.

We used stratified, random sampling for selecting the firms from our general sources. The strata we were testing as independent variables were, first, the origin of the firm (International or Costa Rican) and, second, the sector group (industries, consumers, or financials). Between September and November 2005 we sampled the international and Costa Rican firms in two waves. In total, 988 firms (613 international firms and 375 Costa Rican firms without overlap) were contacted. The questionnaires were sent to contact persons for the international sample in English language and for the Costa Rican in Spanish; both by email as Word files in the *forms* mode. From these, we received 60 valid questionnaires, which means an overall response rate of 6%. Table 3 shows the breakdown in geographical origin and membership in groups of sectors of the firms surveyed and their response rates. Because the topic of ecosystem services is well established in Costa Rica we expected that the final response rate of international firms would be lower than that of Costa Rican firms. With the disproportional sampling we finally achieved an almost even distribution in the geographical origins of the firms completing questionnaires. It was not possible, however, to achieve an even distribution across sector groups as well. Among the sector groups, the group *financials* had the lowest response rate. The Pearson Chi-Square test (value = 2.57, $df = 2$, $p = 0.28$) shows that observed and expected counts in the crosstabulation of origin × sector group do not differ significantly.

3.3. Data analysis

We used multivariate ANOVA with SPSS 11 to analyze differences in the firms' willingness to invest WTI in ecosystem services with respect to their sector group membership s and geographical origin o. The overall model design is

$$WTI = f(o, s, o \times s) \tag{3}$$

To test the difference in the expected benefits A between sectors as well as origin of the firms we performed multivariate ANOVA with following model structure:

$$A = f(o, s, o \times s) \tag{4}$$

However, we did not use the 11 benefit items individually for the ANOVA, but used first factor analysis to further aggregate them. The extraction method we used was the Principal Component Analysis with an Eigenvalue of 1 (Kaiser–Gutmann retention criterion) as the cut-off criteria, and the rotation method was Varimax with Kaiser normalization. For each firm, the score S for k aggregated motivation factors was calculated using the loading factors l to weight the factor score z for each item j. It is

$$S_k = \sum_{j=1} l_j{}^* z_j \tag{5}$$

To test the robustness of the results obtained with the ANOVA, we also used the Mann–Whitney U-test for the comparison of origins, and the Kruskall–Wallis Test for that of sector groups.

In order to explain the demand for ecosystem services, binary logistic regression with stepwise exclusion of variables (backward Wald method) was used for all four ecosystem services in order to extract independent variables (see Table 1) which have a significant influence on willingness to invest on a binary scale (WTI = 0 or WTO > 0) as a dependent variable. The binary scale was chosen in order to allow for a more robust analysis.

4. Results

4.1. Business context and personal attributes of respondents

As expected, the number of employees was very different for the 31 international firms (mean 39846, max 230000, min 1200 employees) than it was for the 29 Costa Rican firms (mean 343, max 3100, min 11 employees). Together, the 60 firms have 1.12 million employees. Whereas 24 of the international firms publish a sustainability report, only nine of the Costa Rican firms do. Similarly, 29 of the international firms have an environmental management system installed, while 17 of the Costa Rican firms do.

Table 4
Firms' stated demand for the flow of ecosystem services from one hectare of forests for one year (represents one certificate). Part (a) of the table shows the max willingness to invest in US$ per certificate, (b) shows the number of certificates, and (c) shows the total demand. Ecosystem services (ES) are: biodiversity conservation (BIO), carbon sequestration (CA), scenic beauty (SC), watershed protection (WA).

	International				Costa Rican		
Sector	Ecosystem service	Mean	Std Dev	Valid *N*	Mean	Std Dev	Valid *N*
Willingness to invest in US$ per certificate (a)							
Industry	BIO	6	18	11	28	70	8
	CA	84	187	12	11	17	8
	SC	1	4	13	15	35	8
	WA	8	28	13	30	22	9
Consumer	BIO	19	40	6	51	53	12
	CA	44	46	6	113	155	12
	SC	19	40	6	50	60	12
	WA	20	39	6	94	137	12
Financials	BIO	33	58	3	165	227	4
	CA	33	58	3	165	227	4
	SC	33	58	3	290	475	4
	WA	0	0	2	165	227	4
All sectors	BIO	14	32	20	63	109	24
	CA	65	143	21	88	148	24
	SC	10	29	22	78	203	24
	WA	11	30	21	82	132	25
Number of certificates (b)							
Industry	BIO	0	0	12	6	7	8
	CA	5885	14933	13	20	25	8
	SC	0	0	13	4	5	8
	WA	0	0	13	525	752	9
Consumer	BIO	5	11	5	34	46	12
	CA	1005	2233	5	19	38	12
	SC	5	11	5	16	30	12
	WA	5	11	5	40	62	12
Financials	BIO	0	0	2	2	1	4
	CA	0	0	2	2	1	4
	SC	0	0	2	2	1	4
	WA	0	0	2	2	1	4
All sectors	BIO	1	6	19	19	35	24
	CA	4076	12181	20	17	30	24
	SC	1	6	20	10	22	24
	WA	1	6	20	208	499	25
*Total demand in US$1000 (c = a*b)*							
Industry	BIO	0.0	0.0	12	0.5	1.4	8
	CA	189.0	458.1	13	0.3	0.3	8
	SC	0.0	0.0	13	0.1	0.3	8
	WA	0.0	0.0	13	18.2	29.3	9
Consumer	BIO	0.5	1.1	5	1.8	2.4	12
	CA	100.2	223.5	5	0.9	1.7	12
	SC	0.5	1.1	5	0.8	1.7	12
	WA	0.5	1.1	5	2.4	3.6	12
Financials	BIO	0.0	0.0	2	0.3	0.4	4
	CA	0.0	0.0	2	0.3	0.5	4
	SC	0.0	0.0	2	0.6	1.0	4
	WA	0.0	0.0	2	0.3	0.5	4
All sectors	BIO	0.1	0.6	19	1.2	2.0	24
	CA	147.9	383.5	20	0.6	1.2	24
	SC	0.1	0.5	20	0.6	1.3	24
	WA	0.1	0.5	20	7.8	18.9	25

Table 5
Multivariate ANOVA analyzing differences in firms' willingness to invest WTI in ecosystem services with respect to their membership in sector groups *s* and geographical origin *o*. What is reported are the results of inter-subject effects for each ecosystem service individually[a]. The full model design is $WTP = f(o, s, o \times s)$. The results show that for BIO, SC and WA the Costa Rican and international companies differ significantly.

Source	Dependent variable	Type III sum of squares	*df*	Mean Square	*F*	Sig.	Partial eta squared	Noncent. parameter	Observed power[b]
Corrected model	BIO[c]	84059	5	16812	2.70	0.04*	0.27	13.48	0.75
	CA[d]	110703	5	22141	1.56	0.20	0.17	7.81	0.48
	SC[e]	276455	5	55291	2.79	0.03*	0.27	13.96	0.77
	WA[f]	107328	5	21466	2.07	0.09	0.22	10.36	0.62
Intercept	BIO	59431	1	59431	9.53	0.00**	0.21	9.53	0.85
	CA	112610	1	112610	7.94	0.01**	0.18	7.94	0.78
	SC	115785	1	115785	5.84	0.02*	0.14	5.84	0.65
	WA	83519	1	83519	8.06	0.01**	0.18	8.06	0.79
Sector *s*	BIO	17947	2	8974	1.44	0.25	0.07	2.88	0.29
	CA	30641	2	15320	1.08	0.35	0.06	2.16	0.23
	SC	77611	2	38805	1.96	0.16	0.10	3.92	0.38
	WA	21540	2	10770	1.04	0.36	0.05	2.08	0.22
Origin *o*	BIO	39882	1	39882	6.40	0.02*	0.15	6.40	0.69
	CA	35780	1	35780	2.52	0.12	0.06	2.52	0.34
	SC	92180	1	92180	4.65	0.04*	0.11	4.65	0.56
	WA	55210	1	55210	5.33	0.03*	0.13	5.33	0.61
Sector * origin $o \times s$	BIO	22146	2	11073	1.78	0.18	0.09	3.55	
	CA	44025	2	22013	1.55	0.23	0.08	3.11	0.31
	SC	83799	2	41899	2.12	0.14	0.10	4.23	0.41
	WA	22631	2	11316	1.09	0.35	0.06	2.19	0.23
Error	BIO	230759	37	6237					
	CA	524572	37	14178					
	SC	733006	37	19811					
	WA	383205	37	10357					
Total	BIO	380117	43						
	CA	814316	43						
	SC	1103323	43						
	WA	608538	43						
Corrected total	BIO	314818	42						
	CA	635275	42						
	SC	1009461	42						
	WA	490534	42						

* significant at $p<0.05$; ** significant at $p<0.01$.
[a] Biodiversity conservation (BIO), carbon sequestration (CA), scenic beauty (SC), watershed protection (WA).
[b] Computed using alpha = .05.
[c] *R* squared = .267 (adjusted *R* squared = .168).
[d] *R* squared = .174 (adjusted *R* squared = .063).
[e] *R* squared = .274 (adjusted *R* squared = .176).
[f] *R* squared = .219 (adjusted *R* squared = .113).

The respondents of the *international firms* estimated their expert knowledge as following: ecosystem services (median 5 on a 7-point scale) in general and specifically environmental aspects (median 6), political aspects (median 5), social aspects (median 5), and economic aspects (median 4). A high number (21) of the respondents from the international firms are located in the sustainability or environmental department, four in marketing and communications, and four in operations. In addition, nine of the respondents had positions of authority (director, vice president, and head of their department); the others had managerial or advisory positions.

The respondents of the *Costa Rican firms* estimated their expert knowledge about ecosystem services (median 5) and specifically about economic aspects (median 6), environmental aspects (median 6), social aspects (median 5), and political aspects (median 4). Only four respondents are members from the environmental department, two are from operations, two from the sales department, and 15 are from the general management. In addition, 19 of the respondents had high positions (president, CEO, and CFO); the others had managerial or advisory positions.

4.2. Firms' demand for ecosystem services (H_1 and H_2)

The firms stated their willingness to invest in one certificate of each ecosystem service. One certificate represents one hectare of forest's delivery of the respective ecosystem service for one year. Part (a) of Table 4 shows a breakdown by sector and origin of willingness to invest per certificate in US dollars and part (b) shows the average number of certificates for each ecosystem service the firms would be willing to invest in annually from 2005 to 2010. Finally, part (c) gives the calculated total demand in US dollars of the 60 firms that answered the questionnaire.

The Costa Rican firms participating in the survey generally exhibit a greater willingness to invest in ecosystem services than the international firms. This is especially the case for biodiversity conservation (BIO), scenic beauty (SC), and watershed protection (WA), in which the WTI is 4.5 to 7.5 times higher for Costa Rican firms. For carbon sequestration certificates, the difference in WTI is far less pronounced.

The first two hypotheses were tested statistically, which relate to the differences in stated WTI across origin (H_1) and sector (H_2). Levene's test and the Kolmogorow Smirnov tests showed that the WTI data are heteroscedastic and non-normal. However, we still use multivariate ANOVA-based tests, because they are much more robust in distributional form than other normal theory procedures (O'Brien, 1979). Table 5 shows that firms from Costa Rica are statistically significantly different from international firms in their WTI for three ecosystem services — Biodiversity Conservation, Scenic Beauty, Watershed Protection. The Costa Rican WTI for the three ecosystem services is much higher compared to international firms. The hypothesis 1 cannot be confirmed for carbon sequestration. WTI for this service does not depend on the origin of the firms.

Sector groups *s* are statistically not significantly different in their WTI for any ecosystem service and hypothesis two cannot be confirmed by this study. Surprisingly, the mean WTI is highest for

the FINANCIAL sector group, but this result is driven by a few Costa Rican banks. When we only compare CONSUMERS and INDUSTRIES we can see in Table 4a that the WTI for all ecosystem services is much higher in the CONSUMERS sector group. However, one must state that the number of samples for each sector is low and standard deviation is high.

Generally, the full model shows moderate partial Eta-square values for the total variability explained. The values of the observed power is much higher for the independent variable origin *o* than it is for the variable sector groups *s*, which means that the chance of detecting an existing effect was much lower for the variable sector groups than it was for the variable origin (i.e., type II error is larger).

Nonparametric tests – for comparison of Costa Rican and international firms' WTI, the Mann–Whitney *U*-test, and for comparison of sector groups, the Kruskall–Wallis Test – had the same significant results (the only difference was that the WTIs for scenic beauty varied significantly among sectors, $p = 0.04$) and confirmed the robustness of ANOVA.

Part (b) of Table 4 shows that the average number of certificates firms state they want to invest in annually between 2005 and 2010 varies widely among sectors and origin of firms. Of the 60 total firms that answered the questionnaire, 45 indicated they would invest in certificates for ecosystem services. Since one certificate represents one ha of forest delivering the desired ecosystem service for one year, the values can be interpreted as the annual number of hectares of forest under management for ecosystem services. In total, the 45 firms would purchase certificates equivalent to 819 km^2 of forest for carbon sequestration, 52 km^2 for watershed protection, 4.8 km^2 for biodiversity conservation, and 2.5 km^2 for scenic beauty. International firms basically intend to only purchase certificates for carbon sequestration, while Costa Rican firms are also interested in buying certificates for the other ecosystem services. Their interest in carbon sequestration and watershed protection is much higher than it is for biodiversity conservation and scenic beauty. The sectors also differ remarkably. Although firms in the financial sector claim to have the highest WTI per ha and yr, their intent to purchase certificates is rather symbolic. Statistical analysis of those figures would require adjusting the number of certificates intended for purchase to the scale of operations. However, multivariate ANOVA with sector group, origin and number of employees (as course proxy for the size of the firm, because financial data especially for the non-listed Costa Rican companies were not available) did not produce any statistically significant results.

Part (c) of Table 4 gives the resulting total demand in US dollars of the 45 firms, representing 764,000 employees, which gave information about their WTI and annual demand in hectares. It shows that the total annual demand for certificates for carbon sequestration would be 2.97 million dollars and for watershed protection, US$196,300, while for biodiversity conservation and scenic beauty it would only be US$30,100 and US$15,800, respectively.

4.3. Expected benefits of firms to pay for ecosystem services (H_3)

The main contribution of this study to the theory and practice of developing markets for ecosystem services was our investigations into the expected benefits underlying demand. Fig. 3 shows the

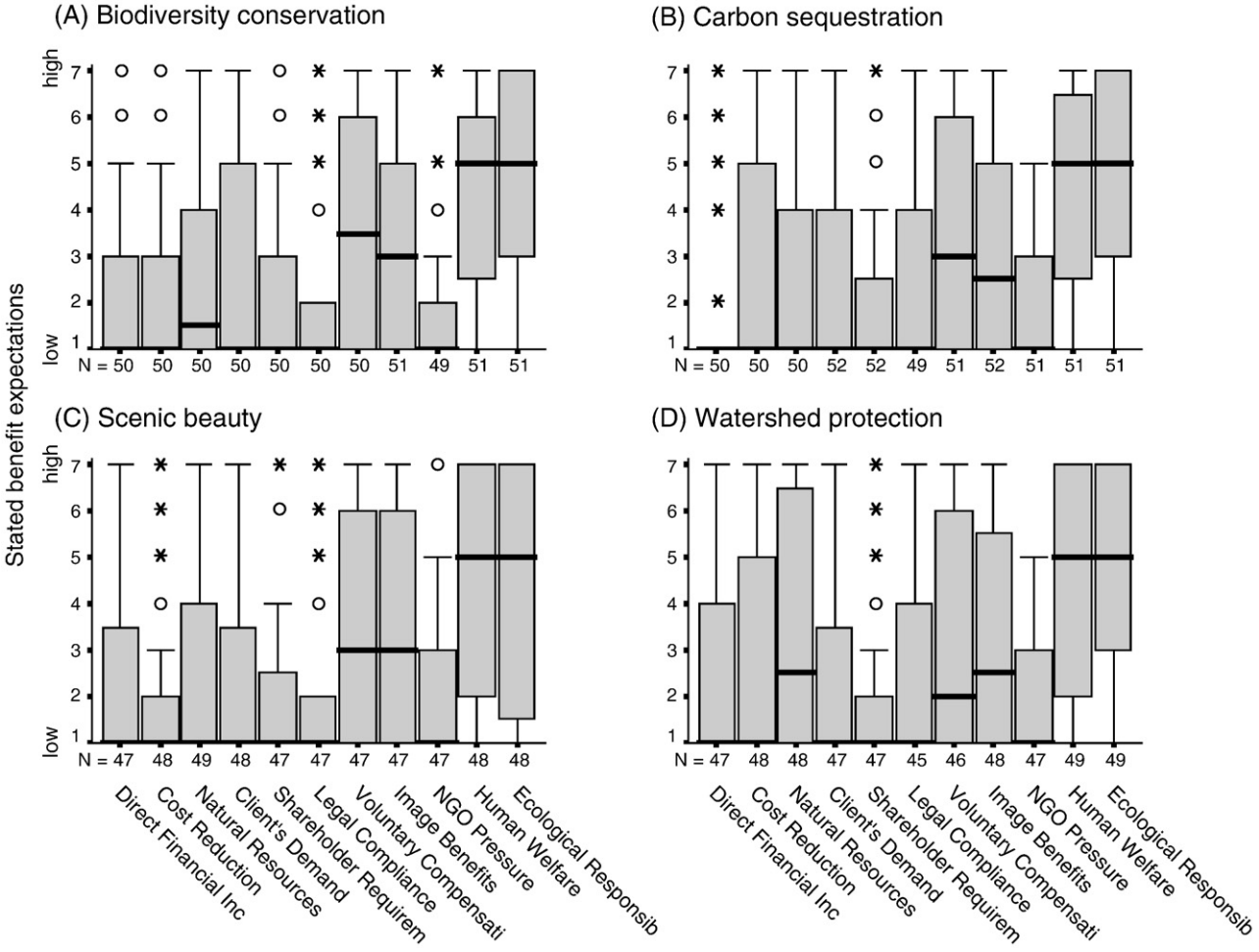

Fig. 3. Boxplots with median and percentiles of stated benefit items for (A) biodiversity conservation, (B) carbon sequestration, (C) scenic beauty, and (D) watershed protection.

Table 6
Aggregation of the 11 benefit items with factor analysis using principal component analysis as the extraction method. The table shows the loadings for the two extracted components for each ecosystem service. (Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. Rotation converged in 2 iterations.)

Components[a]	Biodiversity conservation		Carbon sequestration		Scenic beauty		Watershed protection	
Benefit expectation	1	2	1	2	1	2	1	2
a. Direct financial income	.804	.238	.814	.029	.862	.130	.888	.093
b. Cost reduction	.839	−.033	.861	−.034	.885	.070	.783	.163
c. Natural resources	.789	.145	.653	.481	.835	.263	.681	.351
d. Client's demand	.764	.462	.786	.337	.830	.356	.805	.315
e. Shareholder requirement	.737	.410	.824	.227	.910	.227	.719	.344
f. Legal compliance	.105	.627	.569	.268	.068	.583	.337	.574
g. Voluntary compensation	.016	.853	.163	.783	.089	.852	.203	.783
h. Image benefits	.310	.776	.248	.790	.222	.826	.159	.784
i. NGO pressure	.549	−.044	.557	.048	.594	−.038	.586	.146
j. Human welfare	.118	.881	.050	.869	.214	.835	.214	.862
k. Ecological responsibility	.123	.901	.103	.906	.092	.918	.231	.850

[a] Component one is labeled direct financial benefit (DIRFIN) and component 2, indirect (non-) financial benefit expected from ES (INFIN).

boxplots of respondents' stated benefit expectations, which they say have influenced their statements on WTI per certificate and number of certificates per year for the four ecosystem services. For all ecosystem services, the median of the stated motivation was highest for the intrinsic motivations operationalized with the items *human welfare* and *ecological responsibility* (see Table 1 for explanation of the items). This result does not confirm the third hypothesis and was not expected at all by us. In a business environment by definition financial motivations should score higher compared to intrinsic motivations. The second highest median was held by *image benefits* for the firm and *voluntary compensation* of firms' impacts. The item *NGO pressure* had a median of 1 for all four ecosystem services. The item *legal compliance* had some interesting variations; it had a rather high 75% percentile for carbon sequestration and watershed protection and a low 75% percentile for biodiversity conservation and scenic beauty. The items related to direct financial benefits had the lowest possible median of 1. The item *natural resource* had a higher median for biodiversity conservation and watershed protection. Correlations of items across ecosystem services are generally high (Pearson correlation between 0.4 and 0.8); that is, respondents tend to attribute the same level of benefit expectations to all four ecosystem services. Items with high correlation were *human welfare* and *ecological responsibility*. Items with low correlation were *legal compliance* and *direct financial income*.

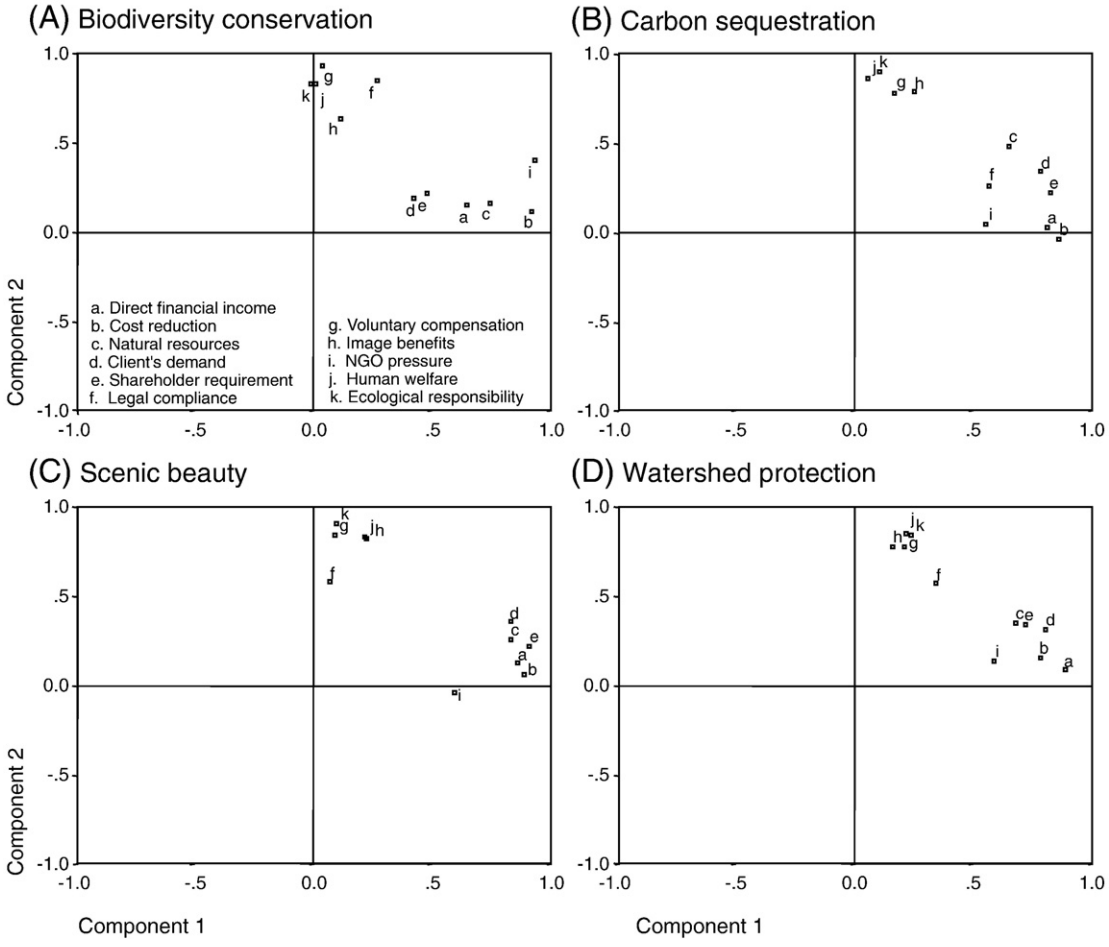

Fig. 4. Component plot of factor analysis showing the 11 benefit items for the four ecosystem services in rotated space. For each ecosystem service they clearly fall into two clusters.

Table 7
Differences in benefit expectations for investing in ecosystem services between sector membership of firms and between their origins. Results for multivariate ANOVA based on Wilks' Lambda to test design. Interaction is not reported, because it was never significant.

Ecosystem service	Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.	Partial eta squared	Noncent. parameter	Observed power [a]
Biodiversity conservation BIO	Intercept	0.13	17.65	11	30	0.00**	0.87	194.10	1.00
	Origin	0.53	2.47	11	30	0.03*	0.48	27.12	0.88
	Sector	0.58	0.85	22	60	0.65	0.24	18.71	0.57
Carbon sequestration CA	Intercept	0.14	17.49	11	30	0.00**	0.87	192.33	1.00
	Origin	0.44	1.38	22	60	0.16	0.34	30.29	0.84
	Sector	0.43	3.57	11	30	0.00**	0.57	39.24	0.98
Scenic beauty SC	Intercept	0.15	15.58	11	29	0.00**	0.86	171.36	1.00
	Origin	0.52	1.03	22	58	0.45	0.28	22.65	0.68
	Sector	0.43	3.57	11	29	0.00**	0.58	39.31	0.97
Watershed protection WA	Intercept	0.17	11.67	11	27	0.00**	0.83	128.36	1.00
	Origin	0.55	0.87	22	54	0.63	0.26	19.14	0.57
	Sector	0.49	2.61	11	27	0.02*	0.52	28.65	0.89

* significant at $p<0.05$; ** significant at $p<0.01$.
[a] Computed using alpha = .05.

Factor analysis was used to aggregate the 11 benefit variables, resulting in two clear components for all ecosystem services. Table 6 shows the factor loadings for the individual items. For all four ecosystem services, component 1 had the highest loadings with respect to the benefit items related to direct financial benefits (*direct financial gain*, *cost reduction*, *natural resources*, *client's demand*, and *shareholder requirement*). In contrast, component 2 had the highest loadings for the benefit items related to indirect financial benefits (mainly *voluntary compensation* and *image benefits*) and non-financial benefits (*human welfare* and *ecological responsibility*). For biodiversity conservation, the Eigenvalue for component 1 was 5.21, and for component 2, it was 2.21; and the explained variance after rotation for component 1 was 34%, and for component 2, it was 32%. For carbon sequestration, the values were 5.00, 2.15, 35%, 30%; for scenic beauty, they were 5.36, 2.41, 38%, 32%; and for watershed protection, they were 5.43, 1.64, 33%, 31%, respectively. For each ecosystem service only factors over Eigenvalue 1 were extracted. In three cases the next factor was below Eigenvalue 1. Only for the ecosystem service watershed protection the Eigenvalue of the third factor was 1.1, but still not extracted. The component plot in rotated space shows the same pattern with two clusters of items representing the two components (Fig. 4).

The next question was whether stated benefit expectations (aggregated in two factors: direct financial benefit from ES; and indirect (non-) financial benefit) varied across firm origin and membership in a sector group. For three ecosystem services, multivariate ANOVA resulted in significant differences between sectors (Table 7). The origin of the firm only had a significant influence on the stated benefit expectations for biodiversity conservation.

4.4. Requirements of firms

The results for the factors potentially fostering or hindering demand for ecosystem services are shown in Fig. 5. The existence of an intermediary was more important for international firms than for Costa Rican ones. A verifying organization was important for all firms. The location of forestry projects was controversial for some international firms, but positive for Costa Rican ones. The ability to sell certificates was more important for international firms. The fact that certificates are issued based on forestry projects is neutral to positive for firms.

The statement that the public, not the firm, should pay for ecosystem services from tropical forests was strongly confirmed by respondents of international firms (Fig. 6). Carbon sequestration was the only item where there was less agreement on this. Interestingly, many respondents from Costa Rican firms did not hold the opinion that the public should pay for ecosystem services.

4.5. Explaining demand for ecosystem services

In order to explain the binary willingness to invest, we used logistic regression for all four ecosystem services. Influencing constructs (cost-benefit expectations, experience, firm characteristics, and behavioral control) and their corresponding independent variables are given in Table 3. The results of stepwise regression for the four ecosystem

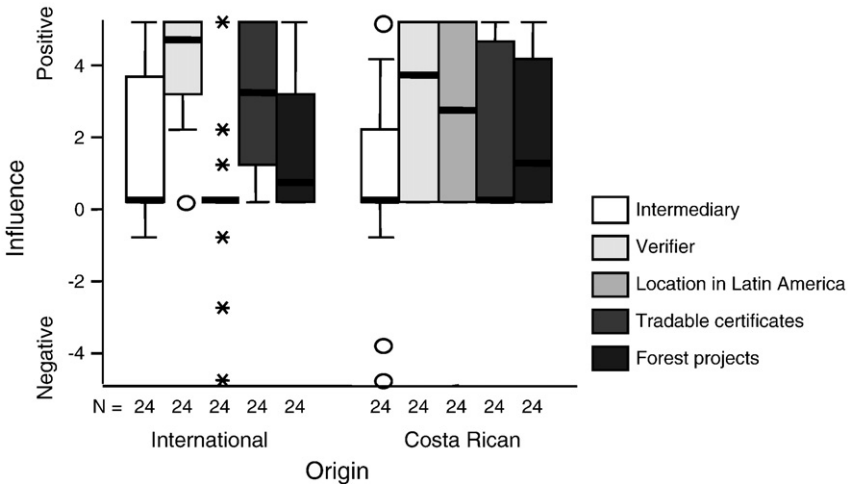

Fig. 5. External factors influencing respondents' decision to purchase ecosystem services from tropical forests (Boxplot with median and percentiles).

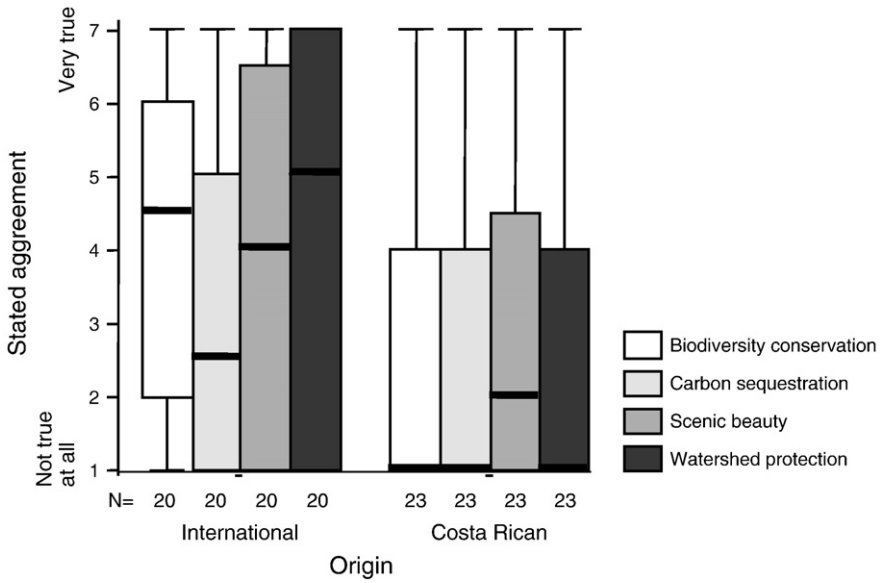

Fig. 6. The question of whether or not the public should pay for ecosystem services (Boxplot with median and percentiles).

services investigated are show in Tables 8–11 (see the Tables 8–11 in the electronic appendix, http://www.pes.uni-bayreuth.de/en/download/2010_Koellner_WTI_appendix.pdf).

In step seven of the model for biodiversity conservation, two independent variables have a significant negative influence and two a positive influence on binary WTI: the opinion that the public should pay and past engagement in biodiversity conservation have a negative influence; their previous experience with forest projects and direct financial benefits have a positive influence on stated WTI. For carbon sequestration in step 9 of the regression model, previous experience with forest projects elicits a significant, positive influence on binary WTI. For scenic beauty, expected indirect (non-) financial benefits have a positive influence on binary WTI. The opinion that the public should pay for scenic beauty appears to negatively influence WTI, but the results are not significant at a 5% level. For watershed protection, there is clearly a link between the origin of a firm and its WTI, as expected. Compared to international firms, the Costa Rican firms show significantly greater interest in paying for this locally restricted service.

5. Discussion

In this study, we have investigated the firms' demand for ecosystem services from tropical countries. The main goal was to compare Costa Rican and international firms in their willingness to invest (WTI) in biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection as well as factors influencing WTI.

5.1. Demand for ecosystem services

The WTI per certificate and number of certificates demanded certainly differ between Costa Rican and international firms. The international firms who responded are clearly interested in carbon sequestration, which is a global ecosystem service. In contrast, Costa Rican firms express a strong demand for all ecosystem services. Mean willingness to invest per ha and yr stated by Costa Rican firms is significantly higher for biodiversity protection, watershed protection and scenic beauty compared to international ones. This shows that all three are of regional concern from a business perspective. However, carbon sequestration seems to be of regional and international concern given the equally high mean WTI stated by international and Costa Rican firms.

It is difficult to compare the absolute demand in ha or US$, because this should depend on the size of the firms, which is very different between the international participants and the Costa Rican ones. The mean size in terms of number of employees of international firms is about 100 times higher than that of the Costa Rican firms. However, only the mean demand for carbon sequestration is much higher for international firms. Relevant demand in ha for the other three regional ecosystem services is only shown by Costa Rican firms in this study, which might reflect the marketing activities of FONAFIFO with respect to ecosystem services in Costa Rica (see Table 4b). This pattern might change if one asked not explicitly for ecosystem services provided by tropical forests, but by forests in the region where the firms operate their businesses. It also might change if one would have asked about bundled services.

The total demand expressed by the 45 international firms (in hectares and US dollars) is relatively rather low. All surveyed firms together would potentially demand 819 km^2 tropical forest area for carbon sequestration, 52 km^2 for watershed protection, 4.8 km^2 for biodiversity conservation and 2.5 km^2 for scenic beauty. In Costa Rica alone FONAFIFO managed 2700 km^2 at the end of 2005 under its Payment for Environmental Services scheme, which covers exactly the four services analyzed in this study (Pagiola, 2008).

In theory a firm should be willing to invest into ecosystem services if discounted financial benefits are higher than (investment) costs. However, this depends on the context under which the firm operates. In this survey we could not sufficiently take into account that a specific firm's demand for ecosystem services measured as WTI depends very much on the natural context, but also on the legal and socio-economic context (as is the case for organizations supplying ecosystem services, see Koellner et al., 2008).

On the one hand the natural context in terms of climate, geology, hydrology, ecology etc. will influence the benefit a company has from investing money into a specific ecosystem services. The natural context also defines to which extent the use of an ecosystem service is rival (i.e., one user's consumption of an ecosystem service leaves less for others to use).

On the other hand the legal and socio-economic context does influence a firm's expected financial benefit as well. In particular, property rights are required for the market mechanism to work. Private property rights over specific ecosystem services allow firms to

invest in service provision and reduces investment risk (Engel and Palmer, 2008). If it is not possible or acceptable to exclude others from using an ecosystem service, then the service is not marketable, and the public should pay for its provision.

Markets mechanisms may function best for ecosystem services, which have in the sense of Samuelson (1954) private good characteristics, i.e. rivalness (i.e., one user's consumption of an ecosystem service leaves less for others to use) and excludability (i.e., private property rights are possible) is given (Farley, 2009). Those two factors might also explain the highest WTI by international firms for carbon sequestration compared to watershed protection, biodiversity conservation and scenic beauty. They might perceive that carbon sequestration is rival (if one firm uses this capacity of an ecosystem, there is less available for others to use) and excludable due to the legal context provided by the Kyoto protocol signed by developed countries. In contrast Costa Rican firms state equally high WTI for all four ecosystem services. This might reflect the fact that the legal framework in the Costa Rican forestry law creates via the certificates for ecosystem services the semblance of private property rights. In addition the campaigns about the value of ecosystem services as well as the scarcity of forests they provide might have fostered the interviewees' perception of rivalness with respect to ecosystem services in their country.

5.2. Benefit expectations related to purchase of certificates for ecosystem services

Surprisingly, the non-financial benefit rated the highest as a motivation for paying for the provision of all four ecosystem services. An explanation is that due to the somehow atypical topic of our study (ecosystem services from tropical forests) we had a low response rate and therefore a selection of highly motivated persons participating. It is likely that the participants are engaged in the political discourse about voluntary compensation of ecological impacts in order to contribute to human welfare and ecosystem quality. Such “green” entrepreneurs with intrinsic motivations might be a prerequisite for bringing the issue of ecosystem services from tropical forests to the table. The power to do so is of course dependent on the authority of the respondents, which was in the Costa Rican firms higher compared to the international ones (i.e. difference in high positions like president, CEO, CFO). However, such non-financial benefits in a firm context are certainly insufficient for supporting serious ecosystem services business. It is still necessary to construct a business case to convince purely financially motivated decision-makers in firms.

NGO pressure had very low importance as a motivating factor. This can be explained by the fact that NGOs often focus on negative externalities of business activities with their campaigns, whereas ecosystem services are a positive externality, which is less covered by NGOs. Similarly, the factor analysis showed that legal compliance does group together with non-financial benefits. Only for carbon sequestration legal compliance switches into the group of financial benefit expectations (see Fig. 4B benefit f), which clearly reflects the mechanism of mandatory carbon reductions through market mechanisms (e.g. the European trading scheme) and the financial consequences involved.

5.3. Factors stimulating firms' demand

Beside the benefit expectations an important factor influencing stated demand for ecosystem services is the past experience of firms in this field. The logistic regression showed that past experience with primary or secondary forests is an important factor explaining the binary WTI for two ecosystem services. Those were biodiversity and carbon sequestration. Expected direct financial benefits were only stated for biodiversity conservation — a variable positively explaining WTI. In contrast, past engagement in biodiversity was a variable, which negatively influenced the binary WTI. This might reflect bad experience with biodiversity projects in the past.

Also the respondents' opinion that the public should pay for biodiversity conservation or for scenic beauty had a significantly negative effect. In other words, participants who think that paying for such ecosystem services is of public concern, and not a duty for firms, are not willing to pay for ecosystem services. A differentiated analysis of this factor controlling the purchase behavior, shows that international firms agree more strongly with the statement that the public should pay than Costa Rican firms do (see Fig. 6). This might reflect the long ongoing debate about payments for ecosystem services in Costa Rica and the marketing activities of FONAFIFO – the governmental agency managing the PES scheme – aiming at the private sector.

For international firms the existence of an independent verifying organization and the option of tradable certificates had a stated positive influence on the decision to purchase certificates for ecosystem services. Both aspects can reduce the risk of losing invested money and should be reflected in the design of such schemes. Although intermediaries have an important role of bundling supply of individual landholders and standardizing the offer, this aspect was less important. Naturally, the location of Latin America was positively perceived by Costa Rican firms, whereas some international firms had strong negative associations with this location, perhaps because they are not economically active in this region or might associate higher risk with it.

5.4. Methodological aspects

Because CVM studies are optimized to survey citizens, we did not follow established standards in two important aspects of the questionnaire's design. First, we did not provide an alternative scenario in the questionnaire. We assume that this is the normal decision situation. The decision-maker in a firm does not know what would happen if he weren't to pay for the ecosystem service. He/she can only assume that payment reduces the risk of losing the ecosystem service. Second, demand for four ecosystem services were addressed in one questionnaire simultaneously. The reason for this was that we assumed that professional decision-makers are able to reliably assess the benefit to their firm and demand for multiple ecosystem goods and services. The wide range in the responses from both Costa Rican and international firms about their estimated demand for the four ecosystem services firms suggests that this assumption is correct.

The question about the stated willingness to invest was framed by giving the example of the Costa Rican scheme on payments for ecosystem services. We especially mentioned that in this scheme the buyers pay US$ 60 per ha and yr for sustainable managed forests providing ecosystem services. The stated WTIs for the four ecosystem services range between US$ 40 and US$ 77 per ha and yr. Especially international firms show much lower WTIs for three out of four ecosystem services (US$ 10 to US$ 14). Only for carbon sequestration the mean stated WTI was very close to the given value (US$ 65). Differences between economic sectors with respect to stated WTI are pronounced in terms of its mean, however due to large standard deviations difficult to interpret.

For the Costa Rican scheme prices for private buyers of ecosystem services certificates are available, which were US$ 57 per ha and yr in 2003. US$ 45 is normally paid to the land user and US$ 12 used for overhead costs, i.e., administration, product placement and certification (FONAFIFO, 2003). Prices for ecosystem services are normally reported as payments to land users and vary considerably according to opportunity costs. In the Costa Rican PES scheme land users are paid US$ 12–67[2] per ha and yr for watershed services, for all four

[2] The high payment only for water related eocosystem services was to o overcome high local opportunity costs (Pagiola, 2008).

services mentioned in this study land users in Costa Rica receive the standard payment of US$ 40–43 (Pagiola, 2008). In the Mexican scheme land users are paid for providing hydrological ecosystem services US$ 27.3 per ha and yr for all forests except US$ 36.4 for cloud forests (Muñoz-Piña et al. 2008). In Bolivia land users are paid US $1.5–3 and in Ecuador US$ 6–12 (by Pimampiro) and US$ 100–200 per ha of forest (by PROFAFOR) providing ecosystem services for one year (Wunder et al., 2008).

Clearly a flaw of the study is the low response rate of only 5.1% for the international firms and 7.7% for the Costa Rican ones. However, given that the topic of ecosystem services from tropical forest is unusual in a firm context this is not surprising. The overall low response rate also implies that, in all likelihood, we have captured the most motivated individuals in firms, who might also have a personal interest in ecosystem services from tropical forests. Therefore, the results certainly are not representative of most firms in the underlying sample framework. But still relative comparisons of sectors and origins of participating firms allowed interesting insights.

The stratified sampling design with origin and sectors caused problems in reaching sufficient numbers of valid questionnaires for statistical analysis. Since we expected a lower response rate for international companies relatively to Costa Rican companies we included more international firms in the study in order to reach a fairly even distribution of the replies among origin.

6. Conclusion

The goal of this study was to explore the private market for ecosystem services provided by tropical forests. In contrast to other studies aiming at citizens we were not interested in finding a total economic value of ecosystem services for the society, but in gathering more knowledge about the demand of private firms and in extracting factors, which can explain their intention to invest in certificates for ecosystem services. Ecosystem service providers can use the results of this study in order to improve their marketing activities, which aim at the private sector. Given the high importance of non-financial benefit expectations stated by the participants it seems advisable to improve the scientific and practical knowledge about the financial value of ecosystem services as an input into the production function of firms. Only if this can be proven individually for the distinct ecosystem service in the specific context of business operations, a considerable demand for ecosystem services by the private sector will develop, which goes beyond donating money for doing something generally good for the environment.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ecolecon.2010.05.010.

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