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ARTICLE, ANALYSIS: ECOLOGICAL ECONOMICS

Title: Why Do Farmers Join Payments for Ecosystem Services (PES) Schemes? An Assessment of PES Water Scheme Participation in Brazil

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1. Introduction

As discussed in the growing body of literature on Payments for Ecosystem Services (PES), in the last two decades such schemes have become a popular and attractive policy instrument for many rural developers, environmental managers, and other practitioners, as well as a fashionable concept for academics (Engel et al., 2008; Ferraro, 2011; Ferraro and Kiss, 2002; Ottaviani and Scialabba, 2011; Pagiola et al., 2002; Pirard, 2012; Wunder, 2005). Part of the attraction of this instrument is the apparently simple rationale behind it: In certain situations, providing economic incentives can prove more effective and efficient than taking regulatory measures in supporting the provision of ecosystem services (ES) for land users.

However, even though at first sight the logic of PES schemes may appear uncomplicated, in practice, paying land users in exchange for a service is by no means a simple and straightforward task. ES result from a number of ecological interactions, many of which are only moderately understood by science. Any guarantee that a payment will secure or provide such a service is subject not only to underlying ecological uncertainties but also to those entailed by the kinds of social interaction that are inherent to policy implementation.

Different frameworks have been advanced to conceptualize PES schemes at the theoretical level. The previously predominant view of PES as a market-based Coasean solution (Wunder, 2005) has been increasingly challenged by institutional economists (Vatn, 2010) who suggest alternative conceptual frameworks that pay more attention to, for example, aspects of conditionality and positive incentive theory (Sommerville et al.,

2009) or issues related to governance and institutions (Muradian et al., 2010). Furthermore, recent studies have been debating the limits of what can be considered to be PES schemes (Pirard and Broughton, 2011) and how they should be governed (Muradian and Rival, 2012).

This lively debate on and critique of PES schemes has prompted a cautious attitude among those discussing them from both theoretical and practical perspectives (Muradian et al., 2013). Current concerns are related to a lack of evidence regarding the effectiveness of PES schemes (Calvo-Alvarado et al., 2009) and their limited additionality, with the latter focused on whether an ES would indeed not be secured or provided in the absence of a PES scheme. These concerns are found even in those projects that have been considered to be successful and inspiring examples (Arriagada et al., 2012; Robalino et al., 2008). Equity implications and asymmetric power distributions between actor groups and their consequences for the legitimacy of PES projects are other areas of attention. Some authors even claim that existing power imbalances and the resulting inequalities and vulnerabilities might even be reinforced by the design and implementation of PES projects (Corbera et al., 2007a; Corbera et al., 2007b).

In Brazil, there is a growing trend of proposing PES schemes to address environmental issues. Even though PES schemes are a rather new policy tool in Brazil – the concept was relatively unknown in the country until the early 2000s – since then, the country has been experiencing a “PES boom”. A recent report has revealed the existence of more than 70 independent projects using PES schemes as the main instrument of intervention. Most of these schemes are related to the field of water resources protection and carbon-related

payments and have been introduced in the rather well-off center-south area of the country (Guedes and Seehusen, 2012).

Given this increasing importance of PES schemes in Brazil´s environmental policy agenda, the absence of studies that touch upon the issue of participation in them is somewhat surprising. The present article tries to fill this gap by presenting and discussing evidence regarding farmer's reasons for participating in three PES water projects: two municipal projects in Extrema, Minas Gerais State (*Extrema*) and Apucarana, Paraná State (*Oásis*) and one state-level program in the State of Espírito Santo (*ProdutorES*) (see Figure 1).

HERE FIGURE 1

2. Importance of Participation in PES schemes: A literature review

Notwithstanding the differing views on the conceptualization of PES schemes, voluntary participation – or at least the claim that participation in a scheme is voluntary – forms a distinctive characteristic of this policy instrument. This feature of PES schemes has profound implications for both their effectiveness in securing or restoring ES and for their intended social outcomes. Particularly in the case of watershed protection, PES objectives will only be attained if there is sufficient participation of land users within a given watershed. This is, for instance, due to the close interdependencies between different land uses, land users, and the potential effects of upstream water management on downstream water users.

92 There are also equity issues related to participation. It is important to consider whether
93 poor households are actually able to join a scheme as easily and frequently as better-off
94 land users. Even though hitting two targets – environmental effectiveness and
95 distributional equity – with a single arrow might prove difficult from a practical
96 perspective (Pattanayak et al., 2010), to neglect the distributional effects of PES may
97 delegitimize the tool itself (Corbera and Pascual, 2012). Concerns about equitable
98 participation in PES schemes have been voiced in the literature from very early on
99 (Grieg-Gran et al., 2005; Pagiola et al., 2005; Pagiola et al., 2002). However, only a few
100 studies have analyzed the issue as a primary research objective (Corbera et al., 2007b;
101 Kosoy et al., 2008; Pagiola et al., 2008, 2010). The results generated by this body of
102 literature are mixed: In some cases, poor households were indeed discriminated against
103 because they lacked formal land titles necessary for contract arrangements, whereas in
104 others poor communities benefited more than richer ones, because they were the
105 preferential target of a PES scheme (e.g.,Grieg-Gran et al., 2005). The main structural
106 limitations that potentially inhibit participation of poor households include lack of
107 effective property rights (either formal or informal) and high transaction costs, such as
108 time and resources that need to be dedicated to negotiating and agreeing on contract
109 details (Wunder, 2005). Pagiola et al. (2005) suggest categorizing the factors that might
110 affect participation into three groups: i) eligibility factors (who is selected to participate,
111 i.e., belongs to the target group or target area), ii) desirability factors (who wants to
112 participate), and iii) ability factors (who can participate). Econometric analyses have been
113 conducted to identify these factors and their relative importance (Pagiola et al., 2010;
114 Zbinden and Lee, 2005), suggesting that observable characteristics, such as farm size,

household assets, and other economic factors, are relevant to participation as well as transactions costs and procedural aspects. Other studies, favoring more holistic approaches embedded in institutional theories (Kosoy et al., 2008), have stressed the importance of procedures and stakeholder interaction. Few studies, however, have proposed a combination of quantitative and qualitative empirical techniques (Arriagada et al., 2009; Kosoy et al., 2007). Such an approach is thus employed in this article, aimed at understanding farmers' decisions by taking into consideration farmer characteristics, assets, and values as well as procedural issues related to how schemes are designed and governed.

3. Methods

The emergence of an institutional economics critique and corresponding alternative frameworks to conceptualize PES has widened the range of issues that might be covered when analyzing these schemes. In particular, it has raised more attention towards aspects related to governance; institutions, in particular property rights; and power relations among actors (Muradian and Rival, 2012). It is thus apparent that a comprehensive analysis of farmer participation in PES schemes has to go beyond the identification of characteristics that explain the propensity of farmers to participate. It also needs to focus on the process of designing PES schemes and on contract negotiations between land users and scheme providers.

In order to address these issues, two complementary empirical approaches were combined in doing the research for this article: (i) a qualitative institutional analysis

guided by the Institutions of Sustainability (IoS) Framework (Hagedorn et al., 2002) and (ii) a quantitative analysis consisting of a logistic regression model. While the first approach pays more attention to governance and institutions, the second analysis estimates factors that, in a statistically significant way, may increase or decrease the probability of farmer participation in PES schemes.

In order to integrate these different approaches, qualitative data collection and pre-analysis was performed prior to the conducting of field surveys, which then formed the data source for the regression estimates. This preparatory step was important not only for completing and refining the questionnaires but also for clarifying, for example, the different roles of actors in the design process of the PES schemes. At the same time, we regard the qualitative inputs as valid sources for understanding the relevance of and interdependence between factors that were later tested in the regression analysis. Meanwhile, besides assisting in framing the data collection and pre-analysis, the IoS framework proved to be a relevant tool for contextualizing and interpreting the statistical results.

3.1 Cases: selection and main characteristics

To select the three study sites, eight potential sites with water-related PES schemes "under implementation" were identified from previous studies (Gavaldão and Veiga Neto, 2011). Water-related PES schemes were preferred to other kinds for a number of reasons, such as their prominence in the conservation-policy landscape of Brazil, the existence of previous documentation efforts that could set the stage for analysis of a more

161 scientific character to be undertaken and the importance of sufficient participation in
162 water-related schemes for the ecological effectiveness of the instrument. The three
163 selected study sites represent schemes where contracted farmers were already receiving
164 payments, conservation or restoration activities were being implemented, and land use
165 changes were being monitored.

166 The selection procedure was guided by five criteria. The three cases – *Extrema*,
167 *ProdutorES*, and *Oásis* – were selected because, at the time of data collection, they were
168 already *active projects* with *active participation* (criteria 1 and 2), meaning that a
169 substantial number of farmers – more than 60 – were already contracted and had been
170 receiving payments for at least one year. The three cases also shared *similar ecological*
171 *objectives* (criterion 3): watershed protection, restoration of riparian vegetation, and
172 increase in forest cover. Finally, they also represented *different farming regions* (criterion
173 4) but, more importantly, *different governance structures* (criterion 5) in terms of
174 coordinating organizations, sources of funding, and monitoring systems.

175 Although the three selected cases shared similar ecological objectives, they present
176 striking differences in terms of their overall rationales. While *ProdutorES* was created
177 with the specific objective of establishing a financial incentive scheme for reducing forest
178 conversion[2], *Oásis* and, to a lesser extent, *Extrema*, aim at strengthening enforcement of
179 Brazilian environmental legislation applied to private land properties. The Forestry Code
180 of 1965, which was recently reformed in 2012, has established a set of restrictions on

[2] It is important to mention that *ProdutorES* was a pilot project supported by the National Water Agency and other organizations, and it was concluded in late 2012. Since 2011, the State of Espírito Santo has been working on the broader and more comprehensive program *Reflorestar*, which incorporated lessons and aspects of *ProdutorES*, besides at least five other environmental programs running in the State. In addition to other interventions types, such as incentives for forest recover and agroforestry systems, *Reflorestar* is keeping the PES mechanism for already existing forest cover, although implementation is still in an early stage.

land use, the two most important ones being Permanent Protection Areas (APPs) and Legal Reserves (RLs). APPs are environmentally sensitive areas – such as margins of rivers and hilltops – on private lands that have to be safeguarded by their owners. An RL is a quota for each parcel of private property which must be protected for the sustainable use of natural resources, conservation, and rehabilitation of ecological processes as well as biodiversity conservation – in the three cases, it was equivalent to 20% of the total farm land (Brazilian National Congress, 1965). Due to weak or absent law enforcement, however, these two legal provisions are repeatedly ignored, particularly the RLs. Thus, an important difference between our cases is that, in practice, *ProdutorES* pays for already existing forest tracts that might be either endangered or are not facing real pressure for conversion, while *Oásis* and *Extrema* seek to restore forest cover. Thus, in the case of *ProdutorES*, additionality is harder to demonstrate than for the other two. Moreover, particularly in the case of *Extrema*, the Municipal Environmental Agency has been assuming a strong role and bearing the costs of implementing restoration activities, from tree seedling to the fencing of APPs to block the entrance of cattle. Table 1 shows other dissimilarities in terms of funding sources, organizations involved, and primary contract features between the cases.

HERE TABLE 1

3.2 Qualitative analysis: Institutions of Sustainability analytical framework

The Institutions of Sustainability (IoS) framework is an analytical tool designed for policy and institutional analysis of complex social-ecological systems (Hagedorn, 2008; Hagedorn et al., 2002). It locates its theoretical origin in the New Institutional Economics (North, 1994; Williamson, 1985, 1998) and in other institutional approaches which are increasingly being applied to agriculture and natural resource management, in particular the work of Elinor Ostrom (2005, 2009) and Daniel Bromley (1989; 1991). The IoS framework identifies four interconnected key factors shaping the contexts in which social and ecological interactions are undertaken, influencing outcomes: *properties of transactions, characteristics of actors*, *institutions*, and *governance structures* (see Figure 2).

HERE FIGURE 2

Two important concepts in the IoS literature are *transactions* and *institutions*. The former are understood in terms of their physical dimensions, according to transaction cost economics, which defines the term as follows: "A transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates and another begins" (Williamson, 1985, p.1). The IoS framework considers environmental problems derived from production or consumption activities as transactions between resource users and the public. Moreover, these nature-related transactions present notable kinds of complexity, for instance, heterogeneity, nonlinearity, and high variability.

225 In New Institutional Economics, *institutions* are usually understood according to Douglas
226 North's definition: "institutions are the rules of the game in a society or, more formally,
227 are the humanly devised constraints that shape human interaction" (1990, 3 ff). They can
228 be formal, such as laws, other written rules, and codes of conduct, as well as informal,
229 such as cultural conventions, verbal agreements, and moral norms.
230 The emergence of *governance structures*, understood as coordination mechanisms that
231 make institutions effective, are dependent on "the properties of the transactions and the
232 characteristics of the actors involved in such transactions" (Hagedorn, 2008, p. 369). The
233 IoS framework conceives the emergence and performance of these institutions and
234 governance structures to be taking place in *action arenas,* which are the spaces where
235 different groups of actors interact.
236 For the purpose of this study, we follow Prager (2010) and employ an adaptation of the
237 IoS framework (Figure 2) to analyze decisions in three sub-arenas: at the farm, policy
238 implementation, and policy design levels. In each sub-arena, stakeholders were identified
239 and interviewed according to a semi-structured guide developed with reference to the
240 four analytical categories of the IoS Framework. For example, when exploring
241 characteristics of actors at the farm level, questions were designed to illuminate
242 motivations and voluntariness, while at the policy design and implementation levels, the
243 concern was whether different types of farmers were involved and had an influential
244 voice during policy discussions.[3]
245
246 3.3 *Quantitative analysis: logistic regression*

[3] The general guide, constructed on the basis of the IoS Framework, is provided as supplementary material 1.

247

248 For farmers, whether or not to participate in a given PES scheme is a binomial decision.
249 The payment amount can differ, depending on the characteristics of the farm holding –
250 for instance, the size and slope of land plots or the presence of water springs – and
251 farmers can be pressured or coerced to participate. But, ultimately, the decisions of
252 farmers remain limited to joining or not joining the PES scheme. Dichotomous decisions
253 can be analyzed using logistic regression models, which enable estimating how a series of
254 independent variables affects the probability of one dependent binominal variable. These
255 models are popular in many natural sciences and health studies, but their application to
256 social science and economics is also widespread, for instance in studies analyzing the
257 adoption of conservation techniques or organic farming (Garbach et al., 2012; Mzoughi,
258 2011).
259 For selection and operationalization of the study's independent variables, first, the
260 literature on farmer participation in PES schemes and other agri-environmental schemes
261 (Defrancesco et al., 2007; Edwards-Jones, 2007; Falconer, 2000; Kauneckis and York,
262 2009; Knowler and Bradshaw, 2007; Mzoughi, 2011; Pattanayak et al., 2003; Toma and
263 Mathijs, 2007) was reviewed to identify those variables that have been found to be
264 important for explaining participation, either using regression models or other empirical
265 methods. Since these studies were conducted in different contexts, in-depth interviews
266 were used to validate, correct, and complement the set of independent variables to be
267 used in the questionnaire. The final questionnaire and selection of variables were refined
268 after a preliminary test with project managers and a pre-test with five farmers.[4]
269 The independent variables were classified into three groups:

[4] The complete list of variables and measurement can be found in the second column of Table 5.

i) *Farmer and household characteristics*: age, gender, time living in the area, education level, household size, family labor composition, income, share of off-farm income, residence at the farm, and membership in a farmers' association;

ii) *Farm structure/practices*: farm size, diversity of agricultural activities, main agricultural activity, slope, and forested area on farm; and

iii) *PES scheme factors*: payment, perception of its value, share of PES payment relative to total household income, use of PES payments, satisfaction level, interest in renewing the contract after expiration, ownership of the decision to participate, opportunity costs, and difficulties related to negotiation and application of PES contracts.

For those items representing perceptions and opinions, categorical variables were used. Some of these categories were constructed by coding answers to an open question (e.g., use of payment [x27] and ownership of decision [x30]). Some of these variables only have values assigned to those respondents that actually participated in a PES scheme (e.g., satisfaction level). These, together with those variables which were ex-post, were not used in the modeling exercise but only considered in the descriptive statistics and analysis.

Four attitude variables belonging to the group of farmer and household characteristics – namely, access to information [x12], general environmental concern [x13], knowledge about environmental legislation [x14] and access to credit [x15] – were not directly observable and, therefore, were estimated through the use of latent variables. Following Toma and Mathijs (2007, p. 149), constructed variables were validated following a two-step procedure. First, a factor analysis using Principal Component Analysis and varimax

293 rotation was applied to a set of 12 indicators to assess the appropriateness of defining the
294 four latent variables. Second, a separate factor analysis for each of these factors was
295 performed to assess the indicators' total variance, explained by each of the generated
296 factors. All indicators present factor loadings higher than .65, and the total variance
297 explained by each factor varied between 59% and 82%, confirming the appropriateness
298 of reducing the indicators to the selected factors.[5] The complete list of latent variables
299 and their constituent indicators is reproduced in Table 2.
300
301 **HERE TABLE 2**
302
303 On-site opportunity cost estimates were processed for each farmer, combining available
304 information on potential revenues of typical agricultural activities in the region with
305 specific farm characteristics. Given the temporary nature of these PES contracts (three to
306 four years), estimates of Net Present Value (NPV) would have been the preferred
307 method. However, for simplification and since the contracts are only short term, all
308 opportunity cost estimates make reference to a given year, in this case 2011. Given the
309 specificities of the three PES projects analyzed in this article, different means and sources
310 of reference values were employed. It is necessary to note that, particularly for those
311 farmers not participating in the PES schemes, important data for estimating opportunity
312 costs were unavailable – for instance, the marginal payment amount for which farmers
313 would have participated. For estimating these missing values, several assumptions were
314 made. (Details on sources and assumptions are described in Table 3.) All in all, the

[5] Full results of the validation process are provided as supplementary material 2.

315 conclusions drawn from these opportunity cost estimates should be considered as being
316 preliminary and interpreted with caution.
317
318 **HERE TABLE 3**
319
320 The field work was undertaken from February to May 2011. Semi-structured in-depth
321 interviews were executed with 24 project managers, environmental and agricultural
322 experts, government officials, farmers, and local leaders. Meanwhile, questionnaires were
323 conducted with 163 farmers, balanced between the three PES cases: 54 from *Extrema*, 57
324 from *ProdutorES*, and 52 from *Oásis*.
325 A stratified randomly selected sample of farmers participating and not participating was
326 interviewed. Of the 163 farmers contacted, 91 (55.8%) declared themselves to be
327 participating in the PES scheme, while 72 (44.2%) said that they were not participating.
328 Yet this proportion clearly does not reflect the general participation rate of eligible
329 farmers, which is estimated to be much lower, as indicated in Table 4.
330
331 **HERE TABLE 4**
332
333 A complete list of variables, units of measurement and their results is presented in Table
334 5. Statistical tests were performed comparing means of participant and non-participant
335 groups. Variables that presented significant differences and which were not ex-post
336 (mostly PES scheme factors) were considered to be factors potentially influencing
337 farmers' decisions and formed the first basis for the logistic regression estimates.

HERE TABLE 5

A three-step procedure was applied to determine the final version of the model: i) an initial selection of variables based on literature and summary statistics results; ii) a second run of the model, with the elimination of seven observations where farmers declared their decision was not completely voluntary and that they were either coerced or threatened to participate; iii) a third model specification only with significant variables, in order to generate more reliable odds ratios (e^{β}). Following Garson (2011b), who claims that logistic regression models are very sensitive to outliers, seven outliers were excluded from the analysis. After the elimination of involuntary participation and outliers, 149 observations were retained in the model.

4. Results

This section seeks to identify the determinants of participation in the PES schemes being implemented in the case study areas. First, we explore the results revealed by qualitative analysis of three aspects covered by the IoS framework: properties of transactions, actor characteristics, and governance structures. Then we describe the results of the logistic regression.

4.1 *Properties of transactions*

361 At least two main *transactions* can be identified in all PES schemes: 1) a monetary
362 transaction typical of PES policies and 2) a transaction related to how the service itself is
363 being produced and delivered, meaning, the transaction (or the set of potential
364 transactions) induced by changes in land-use practice which, in general, effectively
365 support water quantity and quality provision, erosion control or other ecosystem services
366 provision. While the monetary transaction is simple and generally easily understood by
367 project managers and farmers, the second transaction – how land-use secures ecosystem
368 services provision – is subject to a complex set of ecological interactions, marked by high
369 uncertainty as well as other factors. Indeed, in one case presented here (*Extrema*), a
370 substantial number of farmers from both participant *and* non-participant groups doubted
371 that improving forest cover was a meaningful approach to increasing water quality. While
372 some farmers argued that there are more efficient ways of dealing with the problem of
373 water quantity and quality, others totally rejected the idea of increasing forest cover for
374 better water infiltration and stabilization of water flow during dry and wet seasons.
375 This perception appeared to be indirectly influencing the decisions of some farmers not to
376 participate in the program, as they argued that they were not willing to cooperate in
377 implementing an intervention with which they did not agree and did not believe would
378 generate results. It also affected the satisfaction levels of some farmers already engaged
379 in the PES scheme, who argued for other types of interventions rather than reforesting.
380
381 4.2 *Actor characteristics*
382

How representative farmer bodies are organized and whether these organizations influence the design of PES schemes were identified as factors highly affecting participation rates. In all cases, farmers were asked if they were active members of farmer-related associations, cooperatives, or unions and if they felt themselves to be properly represented by one of those organizations. In *Extrema*, only a minority of farmers (29.1%) were members in any of these representative bodies, distributed between the local farmers' union branch and the association of rural residents. Although the local rural farmers' union and the association of rural residents expressed their support of the PES scheme, the vast majority of the interviewed farmers declared that they did not consider these organizations to be important means of impacting local public policymaking. In a nutshell, the association was portrayed as limited in terms of resources and the union as being distant from its constituency.

Meanwhile, in *ProdutorES*, membership in farmer-related representative bodies was considerably higher (72.1%), distributed between the local farmer's unions, rural residents' associations, a rural tourism association, and coffee cooperatives. Interviews confirmed that these bodies were considered important channels of political engagement and economic support, as in the case of the cooperatives. Moreover, being a state-level PES scheme, the managers of *ProdutorES* recognized from the start that effective partnerships with local and representative organizations were necessary to reach farmers in their localities.

A similar situation was found in *Oásis*, where 42.3% of the farmers were members of a representative body, though here concentrated in a single local rural union of the region. Farmers generally claimed to be aware of the activities of the union and recognized its

406 role in influencing PES scheme design. This connection was clearly facilitated by the fact
407 that the current president of the farmers' union has personal links with the local
408 environmental manager and coordinator of the *Oásis* PES scheme, who was a former
409 president of the union himself. However, the assignment of a single organization as the
410 only representative excluded some members of the farming community. Some rural
411 dwellers – farmers with very small properties and a high share of off-farm income –
412 declared that they did not feel represented by the local farmers' union. They argued that
413 their interests were not properly reflected in the PES scheme design and, therefore, this
414 PES policy was detrimental to their particular cases, favoring instead larger and more
415 professionalized farmers. As can be expected, lower satisfaction levels were found
416 among this group, even leading to formal complaints to the local environmental agency.
417
418 4.3 *Governance structures*
419
420 The way the PES schemes are governed proved to be extremely relevant in influencing
421 participation. In *Extrema*, the local environmental agency is responsible for all stages of
422 the scheme. Although legislation with respect to the scheme was discussed and approved
423 by the local municipal council, this process was led by the local environmental agency.
424 Further, all implementation steps – identifying potential areas and contracting partners,
425 concluding contracts, monitoring, sanctioning, and carrying out conservation measures –
426 are exclusively conducted by this agency. This top-down approach has advantages and
427 disadvantages with respect to farmer participation. On the one hand, a rather high level of
428 participation has been achieved with this governance structure; an estimated 43% of the

429 total eligible area was already under contract by the fourth year of PES scheme operation.
430 On the other hand, in comparison to the other two PES schemes, farmers participating in
431 the *Extrema* scheme are proportionally less satisfied and more doubtful about whether to
432 renew their contracts or not. Here, almost a quarter of the interviewed farmers declared
433 that they were engaged in the scheme involuntarily. They felt either obliged or were
434 threatened with possible future sanctions if they decided not to participate. In all cases,
435 these were the most unsatisfied farmers, regardless of their payment levels or opportunity
436 costs.
437 In contrast, in *ProdutorES* a greater division of responsibilities for scheme development
438 and implementation between different organizations was observable. Here, policy
439 development is also almost completely concentrated at the state level, but with policy
440 implementation being shared between the state environmental agency, local state
441 authorities, local public-private bodies, and two environmental NGOs. Further,
442 interventions – if necessary, since the majority of contracts so far demand 'only' keeping
443 the forest intact – are carried out by farmers themselves. Basic technical support can be
444 provided to farmers to carry out conservation activities, but this support has been much
445 lower than expected or necessary, according to interviewed farmers.
446 In the case of *Oásis*, as with *Extrema*, both PES scheme development and
447 implementation are concentrated in one organization, the municipal environmental
448 agency (SEMATUR). In *Oásis*, however, legislation was more extensively discussed in
449 cooperation with the farmers, resulting in a higher feeling of ownership of the scheme
450 among the latter. Moreover, the environmental agency responsible for conducting the
451 scheme there is not the same state agency that is in charge of monitoring and sanctioning

452 noncompliance with environmental legislation. In contrast, in *Extrema*, both the PES
453 scheme and environmental law enforcement are being executed by the same local
454 environmental agency, with support from state-level authorities. In *Extrema*, many
455 farmers mentioned that their initial level of aversion towards the PES scheme had been
456 high because the managers were the same people who, years ago, had tried to change the
457 farmers' land use practices by command-and-control policies. This complaint was not
458 found in either the *Oásis* or *ProdutorES* schemes, because different state agencies have
459 been executing different policies there.
460
461 *4.4 Determinants of participation*
462
463 The estimated coefficients of the third and final run of the logistic regression model –
464 which included only the significant variables found in the second run of the model – are
465 reproduced in Table 6.
466
467 **HERE TABLE 6**
468
469 In all logistic regression trials carried out for this study, income differences were never
470 found to be a significant explanatory factor for participation. In all three PES schemes,
471 poor households could participate in the same proportion as better-off households.
472 In contrast, the logistic regression results do indicate that labor intensity is a significant
473 factor for explaining different participation rates, yet with a very low odds ratio of 0.038.
474 More precisely, the probability of farmers participating decreases significantly for

475 households that are more dependent on family labor. This suggests that the
476 transformation of the farming system, which is required when a farmer joins a PES
477 scheme, is more costly when dependency on family labor is high. This could be explained
478 by the necessity of looking for new off-farm jobs by some members of such families.
479 The highest odds ratio was found for the variable of access to information. The odds of a
480 farmer participating in a PES scheme are augmented by a factor of 6.015 if there is a one-
481 point increase in this constructed variable. General environmental concern seems to be a
482 very important determinant also, with an odds factor of 1.827.
483 Further, the odds of a farmer participating in a PES scheme are reduced by a factor of
484 0.134 if his/her farm does not have a registered Legal Reserve and by a factor of 0.198 if
485 the farm land includes a Legal Reserve without it being registered[6]. This can be explained
486 by the local contexts in which the PES schemes were negotiated. The PES scheme of
487 *Extrema*, for example, has required the restoration of native vegetation in the Legal
488 Reserves for those farmers that are interested in renewing their contracts after expiration.
489 Meanwhile, the *Oásis* scheme specifically targets those farmers that have already
490 registered their Legal Reserves. And even in the case of *ProdutorES*, which does not
491 requires Legal Reserves or other environmental designations for participation, a
492 substantial number of participants interviewed declared that they respect and agree with
493 this legal stipulation. Therefore, it was revealed that Legal Reserves are not only an
494 important element for targeting PES schemes but also that compliance with Legal
495 Reserves is an important driver of PES participation.

[6] According to the Forestry Code, farmers are obliged to register the Legal Reserve on their farm land at the local notary. Nevertheless, it is common for farmers to keep the mandatory proportion of native vegetation but opt for not registering these specific areas, thus avoiding the registration costs.

496 Finally, opportunity costs were found to be significant, at 0.01, meaning that farmers with
497 lower opportunity costs have a higher probability of participating in a PES scheme. The
498 results indicate that an increase in the average opportunity costs of a farmer by R$ 1/ha[7]
499 would decrease the odds of participating by a factor of 0.995. This is consistent with
500 earlier studies (Arriagada et al., 2009), nevertheless, one has to take these opportunity
501 costs results with extreme caution, given the assumptions used to construct opportunity
502 costs values.
503

504 **5. Discussion**

505

506 Whether poor households can, in comparison to more affluent families, equally
507 participate in PES schemes is an important question raised in the literature. Distributional
508 implications are also a common concern expressed by PES managers in Brazil. Similar to
509 Pagiola et al. (2010), the results from our study suggest that poor households can indeed
510 participate in PES schemes. In contrast with Zbinden and Lee (2005), neither the logistic
511 model results nor the qualitative analysis suggest that economic factors such as income or
512 farm size determine participation in the three studied cases. This obviously does not
513 guarantee that PES are equitable instruments *per se*, since equity goes beyond just
514 distribution of benefit and costs, touching upon issues of decision making and
515 overcoming of structural constrains (McDermott et al., 2012). Moreover, it does not
516 guarantee that poor households always benefit from PES schemes, given that in some
517 cases participation can imply changes in an existing agricultural system and production
518 which might not be fully compensated by PES payments. But it is certainly a positive

[7] Approximately USD 0.59/ha. In 2011 the annual average exchange rate was USD 1 = R$ 1.67.

519 argument for those promoting PES schemes, not only as an instrument to address
520 environmental issues but also as a rural development instrument with potential poverty
521 alleviation features (Grieg-Gran et al., 2005).
522 As described above, a considerable number of farmers – participants and non-participants
523 – have expressed dubious perceptions about whether increasing forest cover implies
524 improvement in water quality and quantity. This result differs from Kosoy et al. (2007),
525 who find a rather homogenous and almost consensual perception among participants and
526 non-participants that "more forest leads to better water quantity and quality", although
527 the authors also point out that mismatch between scientific evidence and popular belief is
528 potentially higher regarding water quality than quantity. Doubts about and resistance to
529 accepting the basic theory of change proposed by PES schemes can originate from the
530 complexity and uncertainties related to their hydrological or environmental functioning.
531 But it can also represent a strategic position adopted by some landholders to voice their
532 discontent with coercion and pressure applied by PES managers, as seemed to be the case
533 in *Extrema* presented in this paper.
534 Access to information emerged as an extremely relevant factor driving participation. This
535 is not surprising, since other studies have pointed towards to the importance of effective
536 communication strategies between scheme managers and rural communities (Garbach et
537 al., 2012; Zbinden and Lee, 2005). But the relationship between information and
538 participation is not straightforward. While analyzing voluntary conservation programs in
539 Germany, Frondel et al. (2012) concluded that information can have positive and
540 negative influences on decisions to join the programs. Farmers may opt to decline
541 participation when, for instance, they are informed that the program may imply negative

consequences for themselves, that is, when opportunity costs outweigh PES payments. Moreover, in some contexts, farmers may have limited ability to absorb information transmitted through written and other formal channels. And intensifying communication certainly has its limits, given that becoming informed about a scheme is merely the entry point for a farmer's decision about whether to join it or not.

The present study, however, found that, even when controlled for opportunity costs, access to information appeared to be the most important single factor explaining higher propensity to participate in the PES schemes. In all three schemes, meetings and direct contact through technicians and extension officers were preferred as the main communication channel. While, on one hand, this approach favors information transmission in areas where formal education is restricted, on the other hand, it can be costly and demanding in terms of personnel. But regardless of the nuances in the communication strategies tried by PES managers in the three schemes, there still seemed to be insufficient communication. In fact, while in the field, it was many times easier to find farmers who had never even heard of the PES schemes than those who were minimally informed. This is particularly relevant because, being a controllable factor from the point of the view of the PES manager – compared for instance with environmental concern – it indicates a likelihood that communication strategies are being overlooked in the Brazilian context. Indeed, in many situations, interviewed managers demonstrated themselves to be more concerned with finding the right payment level or polish optimal contract terms than with effective communication with rural dwellers.

Our results also support recent studies which stress increased attention to the governance structures of PES schemes (Matzdorf et al., 2013; Muradian et al., 2013). We found that

565 more centralized and top-down approaches, such as the case of *Extrema*, may have
566 advantages in reaching a higher share of land users in a relatively short period. However,
567 this may also put relationship and trust building in jeopardy, as indicated by the
568 significantly lower levels of satisfaction among *Extrema* farmers, in comparison with
569 those in *ProdutorES* or *Oásis*. This cannot be explained by the payment levels or
570 opportunity costs involved, since they were higher and lower, respectively, than in the
571 other two cases, but by the lack of ownership of the decision to participate in the PES
572 scheme for the farmers. The development of more disaggregated governance structures
573 might be time consuming, requiring presence on the ground, and it might prove difficult
574 to manage. However, as indicated by Sommerville et al. (2010), poor governance can be
575 detrimental to trust building, endangering the sustainability of a scheme in the long term
576 (Muradian et al., 2013).
577 Certainly, trust is a highly contextual factor, strongly affected by past interactions and
578 social relationships between actor groups, as the cases have evidenced. In *Extrema*, the
579 fact that the agency coordinating the scheme was the same responsible for monitoring
580 compliance with environmental legislation was not a conducive aspect. But trust can also
581 be developed. In *Oásis*, convincing farm union leaders was crucial to reducing entry
582 barriers caused by suspicion or misunderstanding. In *ProdutorES*, distribution of
583 responsibilities with local associations facilitated contact between the state-level agency
584 and land users. This demonstrates that accommodating existing institutions and
585 organizations in scheme design and implementation can be a meaningful way of
586 developing ownership and trust between managers and communities.
587

588 ## 6. Conclusions

589

590 Results from this study confirm findings made by other authors that non-economic
591 factors, such as trust and participation in scheme design, play a crucial role in
592 determining decision by land users on whether to participate in PES schemes in a
593 sustained way (Corbera and Pascual, 2012; Van Hecken and Bastiaensen, 2010).
594 Although economic factors cannot be disregarded – as confirmed by the results regarding
595 opportunity costs – this study has demonstrated that other features, such as the process of
596 designing and implementing PES schemes, are critical for successfully engaging farmers
597 in them. Moving beyond *homo economicus* (Gintis, 2000) will assist PES scheme
598 managers in shaping better schemes.
599 Some factors identified in this study are apparently out of reach for PES scheme
600 managers in the short run, for example levels of environmental concern and farm
601 characteristics, exogenous in the short term.
602 However, some highly relevant factors are distinctively within the scope of such
603 programs and could have profound implications for policymaking. Access to information,
604 identified as the single most important explanatory factor for the probability of farmers to
605 join PES schemes, is not receiving the deserved attention, at least in the Brazilian
606 context. In addition, decentralized and multi-level governance structures proved to be
607 more effective in trust building, in contrast to more centralized approaches. We conclude
608 that greater investment in effective interaction activities between PES scheme managers
609 and land users should be designed. This could, we believe, lead to a much higher pay-off
610 than simply increasing payment levels.

611

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618

619

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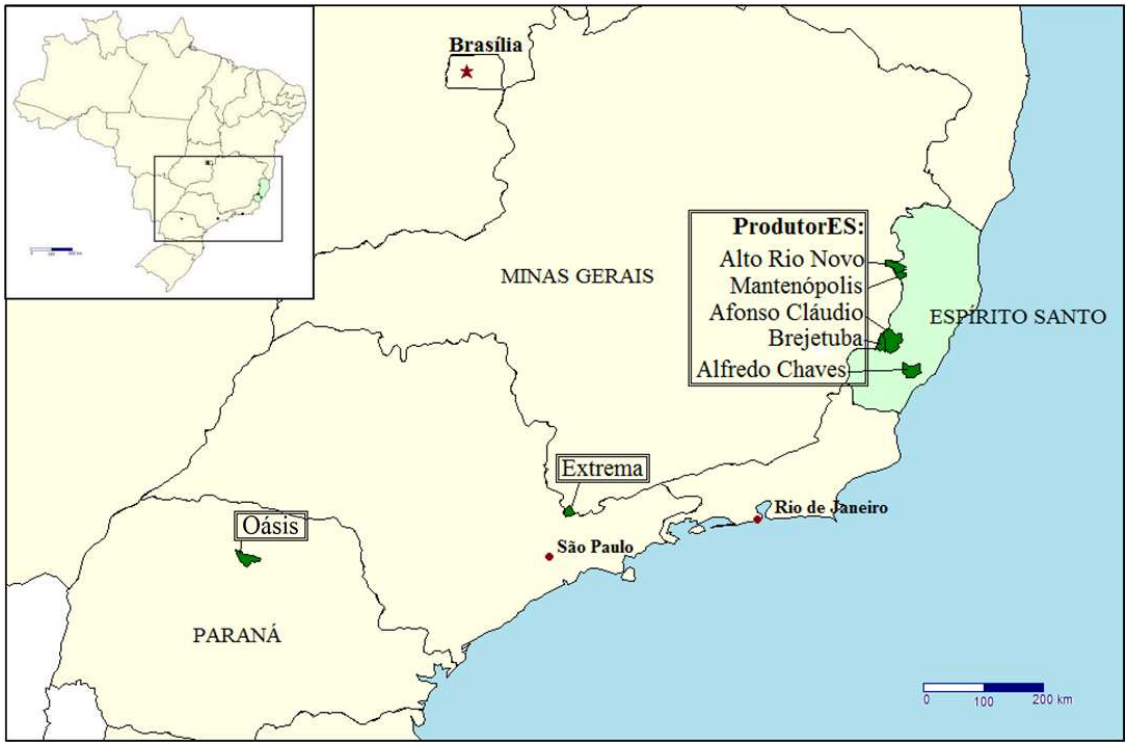
760

761 **Figure 1:** *Extrema, ProdutorES and Oásis locations*

762

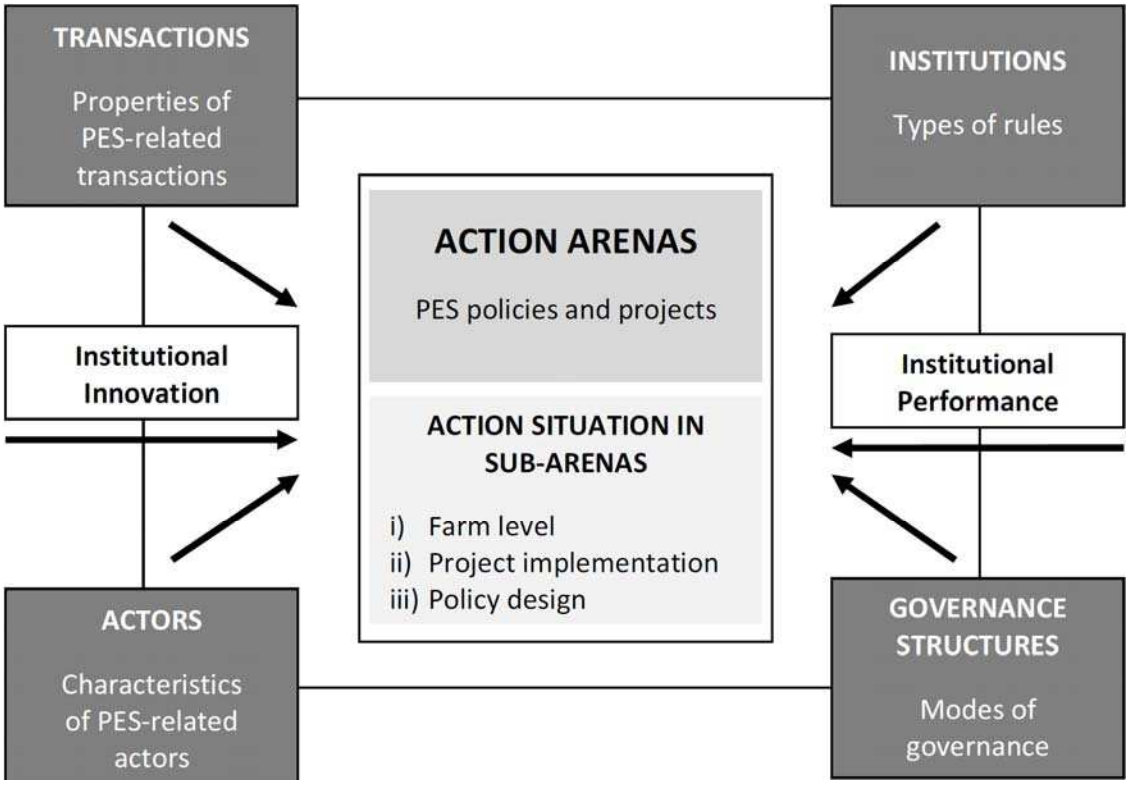


763

764

765 **Figure 2:** *Institutions of sustainability (IoS) framework applied to PES*

766



767

768

769 **Table 1**. Main characteristics of *Extrema*, *ProdutorES* and *Oásis*

	Extrema	ProdutorES	Oásis
Funding sources	Primary source: municipality budget. Secondary source: public–private partnerships and funds from a regional watershed committee (*Piracicaba and Jaguari River Basin Committee – Comitê PCJ*)	State Fund for Water Resources (FUNDAGUA), financed by a 3% transfer of oil and gas royalties, with complementary funding from the State budget	Tax on local water company gross profit (1%), channeled to the Municipal Environmental Fund
Organizations and roles	Municipal Environmental Agency leads the process	State Environmental Agency (IEMA) leads the process but relies strongly on partnerships formed with municipal councils, river basin committees, farmers associations, and NGOs	Municipal Environmental Agency leads the process but relies strongly on a partnership established with an NGO
Main contract features	4 years, renewable; fixed payment of R$ 176/year[a] (proxy of the estimated opportunity costs: OCs) per hectare of total farm area	3 years; payment determined by an equation subject to plot slope, forest stage level, and an estimation of the OCs in the region; premiums paid per hectare of forest within 100m from a water body; average value is R$ 146 per hectare enrolled	4-years; payment defined by a table of ecosystem services valuation, where preservation of water springs is the main factor; annual payments vary from R$ 864 to R$ 7,250 per farm (R$ 20/ha to more than R$ 200/ha)

[a] In 2011, the annual average of the exchange rate was USD 1 = R$ 1.67.
Source: authors' field data

770

771 **Table 2**. Latent variables and constituent indicators

Variable	Description	Unit/Measurement
ACI (x_{12}): access to information on PES scheme		
ACI1	Have you heard about the PES scheme?	0 = no, 1 = yes
ACI2	Have you participated in meetings about the scheme?	0 = no, 1 = yes
ACI3	Have you been visited to discuss the scheme?	0 = no, 1 = yes
GEC (x13): general environmental concern		
GEC1	How important is to take care of forests in general?	5-point Likert scale
GEC2	How important are forests for water quantity/quality?	5-point Likert scale
GEC3	How interested are you in the environment?	5-point Likert scale
KEL (x14): knowledge about environmental legislation		
KEL1	Do you know what a Legal Reserve is?	0 = no, 1 = yes
KEL2	Do you know what Permanent Protection Areas (APPs) are?	0 = no, 1 = yes
KEL3	How much do you know about the Forestry Code?	5-point Likert scale
CRED (x15): access to credit		
CRED1	New farm investment in the past five years?	0 = no, 1 = yes
CRED2	Has total cultivated/pasture area increased in the past five years?	0 = no, 1 = yes
CRED3	Credit was taken in the past five years?	0 = no, 1 = yes

772 *Source*: authors' field data

773

774 **Table 3**. Opportunity cost estimations: formulas and sources

General formula:

$$OC_i = \frac{(B_i - PES_i)}{A_i}$$

Where: OC_i is the Opportunity Cost of farmer *i* in R$/hectare
PES_i is the PES value of farmers i [a]
A_i is the total farm area of famer i [b]
B_i is the potential income of alternative economic activity of farmer *i*, defined as:

1) Extrema:

$$B_i = APP_i * 150$$

Where: APP_i is the Permanent Protection Area of farmer i [b], in practice, the area that receives intervention from the PES schemes[c]
R$ 150/ha is the reference value for renting land in the region. No slope correction is used, since dominant activity is pasture grazing[c]

2) ProdutorES:

$$B_i = IA_i * 740s$$

Where: IA_i is the intervention area of farmer i [d]
R$ 740/ha is the reference value of best alternative forgone in the region, *s* is a slope correction factor, assumed as[c]:

- 1.00 if variable SLOPE (x_{20}) = 1, 2 or 3
- 0.75 if variable SLOPE (x_{20}) = 4: high amount in slope area (60-90%)
- 0.50 if variable SLOPE (x_{20}) = 5: almost all in slope area (<90%)

3) Oásis:

$$B_i = A_i * 0.25 * PF_j$$

Where: A_i is the total farm area of farmer i [b]
0.25 is an assumption of the intervention area (20% for RL, plus 5% for additional APP areas)
PF_j is the reference value of dominant activity conducted by farmers:

- R$ 1666/ha for grains[c]
- R$ 1180/ha for coffee, which is the average profitability of 2010 and 2011 (DERAL/SEAB, 2011)
- R$ 148/ha for pasture[c]

[a] For farmers participating in the PES scheme, payment level is as stipulated in the contract. For farmers not participating in the PES scheme, the median value per hectare of PES payments and the minimum and maximum limits per farmer were assumed. [b] As stipulated in the contract. [c] According to interviewees (farmers and project managers). [d] For farmers participating in the PES scheme, intervention area is as stipulated in the contract. For farmers not participating in the PES scheme, the median proportion of the intervention area of the total farm area was assumed.
Source: authors´ field data

775 **Table 4**. Population, sample, and participation rates in PES schemes

	Extrema		ProdutorES		Oásis	
	Pop.	Sample	Pop.	Sample	Pop.	Sample
Participating[a]	96 (32.4%)	37	180 (9.3%)	27	133 (19.1%)	27
Non-Participating[b]	200	17	1752	30	562	25
Total	**296**	**54**	**1932**	**57**	**695**	**52**

	3 PES cases	
Participating[a]	409 (13.2%)	91
Non-Participating[b]	2694	72
Total	**3103**	**163**

[a] Figure in parenthesis refers to proportion of participants in total number of eligible farmers.

[b] While the number of participants is an easy-accessible and reliable data given by local managers, the number of non-participants was estimated from Agricultural Census data. These figures have high chances of overestimation, since they are based on self-declaratory farmers' responses, which generally declare to contain more forest area in their farms than in reality in order to comply with environmental legislation. An exception is the case of *Extrema*. For this PES scheme, detailed geo-referenced maps of the two eligible micro watersheds were produced, with reliable information also about non-participants.

Sources: authors' field data, Agricultural Census 2006.

776 **Table 5**. Variables, units of measurement, and summary statistics

Variable	Units of Measurement	Participating	Non-participating	Sig.
Dependent variable				
PARTICIPATION (z)	0 = no, 1 = yes	n = 91	n = 72	
Farmer and household characteristics				
AGE (x_1)	years	57.1 (14.4)	54.2 (12.3)	[a] 0.180
GENDER (x_2)	in %			[b] 0.022**
Female		13.2	27.4	
Male		86.8	72.6	
TIME LIVING IN THE REGION (x_3)	years	43.84 (20.77)	40.75 (21.12)	[a] 0.350
EDUCATION (x_4)	years of formal study	6.10 (4.88)	6.48 (4.93)	[a] 0.624
HOUSEHOLD SIZE (x_5)	number of members	3.11 (1.52)	3.06 (1.54)	[a] 0.822
FAMILY LABOUR INTENSITY (x_6)	worker/hectares	0.10 (0.27)	0.20 (0.52)	[c] 0.126 [d] 0.050** [e] 0.053*
DEPENDENCY RATIO (x_7)	children/elderly per total number of household members	0.22 (0.30)	0.17 (0.24)	[a] 0.269
HOUSEHOLD INCOME (x_8)	in %			[b] 0.486
< 1 min. salary (R$ 545)		2.7	2.2	
1-3 min. salaries		49.3	37.8	
4-10 min. salaries		34.2	44.4	
> 10 min. salaries		13.7	15.6	
OFF-FARM INCOME SHARE (x_9)	in %			[b] 0.051*
almost nothing	>10%	14.4	20.8	
low amount	10-30%	15.6	2.8	
considerable amount	30-60%	16.7	20.8	
high amount	60-90%	32.2	26.4	
almost everything	>90%	21.1	29.2	
RESIDENCE AT FARM (x_{10}) –	head of the household main residence			[b] 0.408
no	in %	23.1	17.8	

yes		76.9	82.2	
ASSOCIATION MEMBERSHIP (x_{11})	in %			[b] 0.496
no		49.5	54.8	
yes		50.5	45.2	
ACCESS TO INFORMATION (x_{12})	Latent variables (see supplementary material 2)	0.58 (0.68)	-0.73 (0.83)	[a] 0.000***
GENERAL ENVIR CONCERN (x_{13})		0.25 (0.91)	-0.32 (1.02)	[a] 0.000***
KNOWLEDGE OF ENVIR LEGISLATION (x_{14})		0.04 (0.93)	-0.05 (1.07)	[a] 0.598
ACCESS TO CREDIT (x_{15})		0.07 (0.98)	-0.08 (1.01)	[a] 0.308
Farm structure/practices				
FARM SIZE (x_{16})	hectares	45.65 (58.61)	42.69 (116.7)	[a] 0.833
DIVERSIFICATION (x_{17})	number of agricultural activities	2.66 (1.10)	2.38 (1.07)	[a] 0.109
DOMINANT AGRI ACTIVITY (x_{18}) [f,g]	in %			[b] 0.045**
dairy/beef cattle		35.2	27.4	
grain		6.6	13.7	
other crops		1.1	8.2	
coffee		31.9	26.0	
planted forest		7.7	7.7	
leisure/residence		9.9	15.1	
aquaculture		3.3	0.0	
rural tourism		3.3	5.5	
others				
FARM MAIN ACTIVITY IS (x_{19})	Dominant Extrema = dairy/beef cattle			[b] 0.310
dominant in the region	Dominant ProdutorES = coffee	62.6	54.8	
alternative in the region	Dominant Oásis = coffee/grains	37.4	45.2	
FARM SLOPE AREA(x_{20}) [d]	in % of total farm area			[b] 0.041**
almost nothing & low share	>10% + 10-30%	26.7	39.7	
considerable share	30-60%	25.6	31.5	
high share	60-90%	37.8	17.8	
almost all in slope area	<90%	10.0	11.0	
FOREST AREA (x_{21})	in % of total farm area			[b] 0.007***
<10%		13.2	36.1	
10-24%				

25-50%		52.7	37.5	
>50%		19.8	16.7	
		14.3	9.7	
Legal Reserve: RL (x_{22})	in %			[b] 0.028**
no		23.1	32.9	
yes		44.0	52.1	
yes and registered		33.0	15.1	
Permanent Protection Area: APP (x_{23})	in %			[b] 0.038**
none		22.0	16.4	
only riparian vegetation		13.2	26.0	
only vegetation in high slope areas		14.3	23.3	
all required APPs		50.5	34.2	
PES scheme factors				
OPPORTUNITY COSTS (x_{31})	See section 2.2.1	-80.93 (387.82)	30.11 (198.63)	[a]0.028**

Parenthesis are standard deviations

* significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$

[a] Independent t-test (continuous variable, equal variances assumed); [b] Pearson chi-square test (categorical variable); [c] independent-samples Mann-Whitney U test (continuous variable, unequal variances assumed); [d] independent-samples median test (continuous variable, unequal variances assumed); [e] independent-samples Kolmogorov-Smirnov test (continuous variable, unequal variances assumed); [f] cells without count were eliminated; [g] cells with less than three counts were merged into 'others' or into the subsequent category

Source: authors' field data

777 **Table 6**. Model results: third run

Variables	B	S.E.	Wald	df	Sig.	Odd ratio(e^{β})
Family Labor Intensity (x_6)	-3.262	1.431	5.200	1	.023**	.038
Access to Information (x_{12})	1.794	.321	31.164	1	.000***	6.015
General Environmental Concern (x_{13})	.603	.275	4.803	1	.028**	1.827
No Legal Reserve (x_{22})			5.788	2	.055*	
Unregistered Legal Reserve (x_{22})_1	-2.010	.890	5.105	1	.024**	.134
Registered Legal Reserve (x_{22})_2	-1.620	.740	4.789	1	.029**	.198
Opportunity Costs (x_{31})	-.005	.002	8.072	1	.004***	.995
Constant	2.078	.687	9.149	1	.002***	7.991

Seven involuntary participants and seven outliers were eliminated (n = 149)
Reference category for RL (x_{22}): no [Indicator]
Hosmer and Lemeshow Test: chi-square = 8.663, df = 8. Sig. .371
-2 Log likelihood = 103.447, Cox & Snell R Square = .497, Negelkerke R Square = .663. Overall percentage of right prediction = 86.6%
* significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$
Source: authors' field data

778

779 **Supplementary material 1**. Interview guide

780 *Launching question*: Who are the main actors and actor groups in the PSE discussion, and who represents them?

781

Objectives / keywords	Questions
Sub-theme: characteristics of actors and actor groups	
• Motivations	What are the main motivations for each group to engage in the negotiation process?
• Innovative actors	Was there any key actor who introduced, suggested, or supported this institutional innovation? Who were the founding parents?
• Unsupportive groups	Was there any actor group that was against it and had acted against the development of the negotiating process?
• Power relations	What are the distinct power relations between the different groups, public and private? Are these differing power relations significant for the final [result of] policy design?
• Involuntary exclusion	Are there farmers that wished to participated, but could not?
• Voluntary non-participants	Are there farmers that are against and who wish to keep holding exclusive rights over the land use under their properties? Are these influential farmers?
Sub-theme: resource characteristics and transactions	
• Ecosystem rationale	What is the ecosystem rationale behind the PSE scheme in the region?
• Forest–water connection	In what manner do you expect that forest cover increases and recovery could contribute to increases in water quality?
• Direct–indirect measurement	Are there bio-physical targets for measuring this direct effect? Or do you expect to perform only indirect measurement?
Sub-theme: property rights and institutions	
• Buyer definition	Who pays for the environmental service provision? In which way?
• Property rights: land & water	Are the property rights exclusively related to land or are rights also attached to rivers and water springs?
• Social function	Who holds water rights? Also society/public? In the case of water, is there any clear mandate like "land use with a social function"?
• Government as intermediary	Does the public service act as an intermediary between water buyers and consumers?
Sub-theme: governance structures	
• Negotiating parties	Who are the negotiating parties of the contracts?
• Policy design	What organisations are responsible for policy design?
• Policy implementation	What organisations are responsible for policy implementation and payment definition? Where do the resources come from?
• Standard or case-by-case	Are there standard procedures, or are contracts negotiated case-by-case? Is there a "proposal–counter proposal" procedure?
• Procedures	What are the necessary steps for farmer inscription and payment? What is necessary for applying? (transactions costs)
• Monitoring	Who performs the monitoring? How?

782 • **Bonus question**: After recovery is completed, how to engage farmers in long term strategies of water quality and forest conservation? How to
783 maintain positive results in the long term, if the financial incentive is ceased? *Source*: authors.

784 **Supplementary material 2**: Construction of latent variables

785

786 Four attitude variables – belonging to the group of farmer and household characteristics –
787 are not directly observable and, therefore, were estimated through the use of latent
788 variables. Different scaling techniques can be employed to construct unobserved
789 variables. In this study, we grouped indicators and validated each constructed variable
790 using factor analysis. Nonetheless, it is important to note that the combination of
791 indicators should not follow a subjective selection process, since indicators have to
792 represent a "single underlying continuum of meaning" (Garson, 2011a, p.7). In the
793 context of farmers' motivations, this continuum of meaning is represented by opinions,
794 preferences, or perceptions related to a particular attitude, and the chosen indicators have
795 to connect to these opinions. This continuum of meaning may also represent other non-
796 observable categories, such as information or knowledge access. The complete list of
797 latent variables and their constituent indicators is reproduced in Table 1 of this
798 supplementary material. Some of the indicators were directly measured by binary
799 response; others were qualitatively measured using a 5-point Likert scale.

800

801 **Table 1**. Latent variables and constituent indicators

Variable	Description	Unit/Measurement
ACI (x_{12}): access to information on PES scheme		
ACI1	Have you heard about the PES scheme?	0 = no, 1 = yes
ACI2	Have you participated in meetings about the scheme?	0 = no, 1 = yes
ACI3	Have you been visited to discuss the scheme?	0 = no, 1 = yes
GEC (x13): general environmental concern		
GEC1	How important is to take care of forests in general?	5-point Likert scale
GEC2	How important are forests for water quantity/quality?	5-point Likert scale
GEC3	How interested are you in the environment?	5-point Likert scale

KEL (x14): knowledge about environmental legislation		
KEL1	Do you know what a Legal Reserve is?	0 = no, 1 = yes
KEL2	Do you know what Permanent Protection Areas (APPs) are?	0 = no, 1 = yes
KEL3	How much do you know about the Forestry Code?	5-point Likert scale
CRED (x15): access to credit		
CRED1	New farm investment in the past five years?	0 = no, 1 = yes
CRED2	Has total cultivated/pasture area increased in the past five years?	0 = no, 1 = yes
CRED3	Credit was taken in the past five years?	0 = no, 1 = yes

Source: authors' field data

Following Toma and Mathijs (2007, p. 1492007, p. 149), testing the validity of latent variables followed a two-step procedure. First, a factor analysis using Principal Component Analysis and varimax rotation was applied to the full set of 12 indicators to assess the appropriateness of defining four latent variables. According to the Kaiser criterion (Eigenvalues > 1) and interpretation of the screen plot, the reduction to four factors was appropriate. The total variance explained with four factors accounted for 68.68%. Second, a separate factor analysis for each of these factors was performed to assess the indicators' total variance explained by each of the generated factors. All indicators present factor loadings higher than .65, and the total variance explained by each factor varied between 59% and 82%, confirming the appropriateness of reducing the indicators to the selected factors. These high values indicate that the study's logistic regression can be modeled with the scores of the four proposed latent variables without losing too much information. The results for this validation exercise are presented in Table 2 of this supplementary material.

Table 2. Separate factor analyses[a] of constituent indicators for each latent variable

Factor/Component		Total Variance Explained
ACI (x12): access to information on PES scheme		*59.275%*
	Component Matrix	
ACI1	.764	
ACI2	.753	
ACI3	.792	
GEC (x13): general environmental concern		*82.005%*
	Component Matrix	
GEC1	.924	
GEC2	.915	
GEC3	.877	
KEL (x14): knowledge about environmental legislation		*61.340%*
	Component Matrix	
KEL1	.738	
KEL2	.773	
KEL3	.836	
CRED (x15): access to credit		*63.704%*
	Component Matrix	
CRED1	.877	
CRED2	.841	
CRED3	.659	

[a] Extraction method: Principal Component Analysis

Source: author's field data

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