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The Effects of Payment for Environmental Services on Environmental Improvement and Poverty Reduction: A Meta-Regression Analysis

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Abstract: Based on the empirical literature of the payments for environmental services (PES) projects for the environmental improvement and poverty reduction, this paper uses a meta-regression analysis method to study whether PES can achieve the effects of improving environmental quality and reducing poverty levels. For the meta-regression analysis, the literature was mainly searched by the Web of Science core journal database. The explanatory variables of meta-regression analysis are the hypothesis and related features of the models in the original literature by generally taking the binary dummy variables or categorical variables. The dependent variables used in this paper are environmental improvement and poverty reduction. The results show that PES projects based on private ownership rights are more conducive to poverty reduction and environmental improvement. If the country is a buyer of a PES project, it is more likely to achieve the effects of environmental enhancement and poverty alleviation. PES projects based on local conditions can also achieve a win–win situation for the two effects. The effects are more effective as policy implementation time is extended. The findings suggest that in developing countries, the government should set different PES projects according to different regions conditions, to promote project implementation through individual voluntary participation, and to achieve the dual purpose of environmental governance and poverty alleviation based on the expectation of long-term implementation of participant projects.

Keywords: payment for environmental services; environmental improvement; poverty reduction; meta-regression analysis

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1. Introduction

During the past 20 years, the payments for environmental services project have become an important policy tool for the sustainable improvement of the environment in many developing countries, such as Latin America, Asia, and Africa. Most environment management methods can be divided into Pigou mode and Coase mode. The Pigou mode internalizes the externalities of environmental services through government taxation (fees) or subsidies, while the Coase mode eliminates the externalities of the environment by introducing negotiation and trading mechanisms based on clear public property rights. In addition to the two modes, Ostrom [1] proposed a mode of community autonomy. It is generally believed that the Pigou mode is biased towards command-and-control policy tools, whereas the Coase approach is biased towards market-oriented environmental governance tools, and that the market-oriented governance tools are more motivating.

In order to eliminate the negative externalities of environmental services, the negative externalities of the environment must be internalized. To this end, Wunder [2,3] proposes a theory of payments for environmental services for market-based solutions to environmental externalities. In the past 20 years, the theoretical expansion and practical

summary of PES have been greatly enriched. The traditional theory of PES states that buyers and sellers negotiate for environmental services, which is conducive to protecting and improving the environment. Where privately owned property rights exist, the implementation of PES could help reduce deforestation rates, improve river water quality, improve biodiversity, and even improve the living standards of residents in poor areas and promote economic development. However, on the question of whether PES is conducive to poverty alleviation and regional economic development, there is still debate in the literature. The differing international practices of PES also show that different institutional designs and different implementation efforts may have different impacts on the environment and economic development.

In general, most of the literature equates payment for environmental services with payment for ecosystem services, and environmental services with ecosystem services. Therefore, there is little difference between the two, and the literature on payment for environmental service is generally narrow, focusing solely on whether water quality has improved or whether forest coverage has increased. However, the study of ecosystem services is generally relatively broad, and forest coverage and water quality improvement may be designed at the same time because the improvement of forest coverage rate often promotes the improvement of water quality. Both forests and rivers are part of the ecosystem. This paper uses a meta-regression analysis, which requires collecting different references and is a comprehensive concept. Thus, PES is defined as ecosystem services in this paper.

PES has made great strides from developing to developed countries, from Latin America to Asia. With the development of PES theory and practice, PES has gradually become the mainstream method of environmental governance, and more and more regions have added the goals of promoting economic development and poverty reduction in the process of PES. Despite the rapid development of PES theory and practice, there is still a lack of experience summary on the practical effects of PES. Therefore, this paper uses a meta-analysis to study the environmental improvement and poverty reduction effects of PES projects, and the possible marginal contributions are as follows. First, in terms of the research content, scholars tend to study the environmental effect and poverty reduction effects of PES separately, and seldom study the two together. Most studies also focus more on environmental improvement and poverty alleviation in small areas (mostly single or multiple rural areas). In this paper, the meta-regression is used to analyze the overall effect of PES project implementation worldwide. Second, with regard to the data and method, a meta-regression analysis is used in this paper, and the conclusions are more comprehensive and reliable. For the meta-regression analysis, the literature is mainly searched using the Web of Science core journal database (SCI, SCI-E, SSCI, A&HCI). The literature remaining in our sample of PES projects and therefore used in our meta-regression analysis comprises 13 articles featuring empirical research on poverty alleviation and 14 articles on environmental empirical research. The explanatory variables of meta-regression analysis are the hypothesis and related features of the models in the original literature. The dependent variables used in this paper are environmental improvement and poverty reduction. Additionally, the data for the meta-regression analysis generally take the form of binary dummy variables or categorical variables.

The remainder of this paper is organized as follows. The next section presents a summary of the literature. Section 3 provides more detail of the data and methodology used. Section 4 presents the results. Section 5 features the discussion. Section 6 concludes the paper.

2. Literature Review

Based on the concept introduced by Wunder [2,3], the development of PES has progressed through four stages. The first stage was the narrow PES concept stage. At this stage, the Coase theorem was applied to environmental governance, creating a Coase-style environmental governance approach. However, the simple Coase-style PES is difficult to implement in practice, especially in developing countries. The second phase was the

connotative expansion phase. The PES concept at this stage was based on the pure Coase-style PES concept combined with the PES practices of developing countries to expand the application of Wunder's [2,3] concept of marketization. The third stage was the extensional expansion of the original narrow conception of PES. The PES concept at this stage gradually departed from Coase's pure market theory and explored PES from a broader perspective. The fourth stage was the rational regression stage. At this stage, Wunder [4] combines the theoretical development of the first three stages with the core of Coase marketization. It is argued that the government can also participate in PES projects. After the practical and theoretical development of PES projects, Wunder [4] resummarized five conditions for PES in 2015, including voluntary transactions, users of environmental services, providers of environmental services, conditional natural resource management rules, and additional services.

The implementation effect of PES mainly analyzes whether it has achieved environmental improvement and poverty alleviation. The PES theory states that the cost effectiveness of the project can be maximized by making the payment directly to the environmental service provider. In the face of severe degradation of the environment, the primary goal of PES is to create positive economic incentives for environmental beneficial behaviors by means of payments to environmental service providers, guiding firms to change behaviors that damage the environment, and adopt more environmentally friendly behaviors (for example, reducing grazing, reducing deforestation, and strengthening forest management) to achieve protection and improvement of the environment. After the environmental provider voluntarily registers the PES project, it must abide by the land use behaviors stipulated by the PES provisions to protect the environment, otherwise the corresponding economic remuneration is not awarded.

Although Cambodia is the country with the most biodiversity in Southeast Asia, it is facing problems such as deforestation and declining biodiversity. For this reason, Cambodia has implemented a variety of PES projects. Chervier and Costedoat [5] used the difference-in-differences (DID) method to prove that after the implementation of the Conservation Agreement project in Cambodia, the rate of deforestation in the PES area was significantly lower than that in the non-PES area. The Pago por Servicios Ambientales (PSA) project in Costa Rica has been a focus of research for the improvement of forest coverage in the implementation area, but the conclusions were not consistent. Most prior studies were based on national-level data for Costa Rica and used early implementation data. Arriagada et al. [6] used a survey of Sarapiquí region of Costa Rica residents and found that the implementation of the PSA project increased forest coverage in the area. Scullion et al. [7] used a combination of remote sensing satellites and field research to study the use of the DID method. The Mexican Forest PES project slowed down deforestation but did not prevent the net loss of forest resources. The implementation of PES does not take place in a vacuum, but is affected by the geographical, political, and economic characteristics of the implementation area. Only by better designing PES and its objectives in combination with actual circumstances in the implementation region can we better alleviate the pressure on the environment.

With the gradual deepening of practical and theoretical understanding, PES projects in developing countries, especially government-funded PES projects, have increasingly incorporated the goals of promoting regional development and poverty reduction into the implementation process, and scholars have gradually incorporated poverty reduction into the scope of their work. The framework for PES policy therefore explores how PES can achieve economic development and poverty alleviation in areas where environmental services are provided. Although protecting and improving the environment is the primary goal of PES, it can also effectively improve the livelihood conditions of rural residents as a "byproduct" [8]. Increasing number of researchers see economic development or poverty reduction as one of the main goals of PES policies, rather than merely one of its subsidiary goals. Since PES projects operate in complex economic, social, and environmental systems, the intertwining of various factors may lead to unexpected or even adverse effects on policy

implementation [9]. Therefore, the implementation of a PES project is more conducive to achieving regional economic development and poverty reduction goals when it is designed to take account of the local area's characteristics and comparative advantages [10]. It is generally believed that PES projects can not only promote the income of environmental service providers through the direct payment for environmental services, but also promote the agricultural production skills of residents in the compensated areas and improve agricultural production capacity through training [11], improve local levels of human capital [12], increase agricultural and non-agricultural employment opportunities, increase labor productivity, and increase the level of wealth of local residents. The implementation of PES projects can also effectively alleviate financial pressures and promote the increase of social capital [13], which is also conducive to raising income levels. For PES projects where the land is collectively owned, the community collective is likely to have a high organizational capacity and can coordinate collective actions. Implementing a PES project based on the shared property rights of the community can also promote the increase of social capital, improve income status, and make the income distribution more equitable [14].

In the initial stage of the project, most studies analyzed the implementation effect of PES based on case studies of the interviews or questionnaires due to the lack of data. As PES gradually improves project design and data collection, the studies used the *t*-test and chi-square test, gradually transitioning to OLS regression method to analyze the implementation effect of PES. At present, in order to reduce the missing variables, data measurement error, and reverse causation of endogenous problems, some studies used the DID method and RD analysis. These have gradually moved from simple measures of environment and poverty to more measures of the effectiveness of PES projects, such as forest coverage, deforestation rate, river water quality, grazing reduces, income, property ownership, consumption, wealth, poverty levels, comprehensive index of life, and welfare. Thus, this paper employs a meta-regression analysis to investigate the effects of PES on environmental improvement and poverty alleviation from the perspective of farmers.

3. Data and Method

By collecting empirical literature on environmental effect and poverty reduction effect in environmental service payment from Web of Science core journal database (SCI, SCI-E, SSCI, and A&HCI), we used the Probit model to estimate the meta-regression and examined whether PES has realized the effect of environmental improvement and poverty reduction.

3.1. Selection of Empirical Literature

For meta-regression analysis, the literature was mainly searched using the Web of Science core journal database (SCI, SCI-E, SSCI, A&HCI). Search terms for the literature included payment for environmental services, payments for environmental services, payment for ecosystem services, payments for ecosystem services, payments for watershed services, payments for forest services, payments for biodiversity conservation, PES, etc. We identified a total of 477 papers. We further screened the empirical literature according to the following ways.

A. Much of the literature on the subject of PES was primarily based on theoretical analysis, literature reviews, and case studies. However, meta-regression analysis requires empirical literature, and so the non-empirical literature was excluded from the sample.
B. We excluded the literature that does not use regression analysis for relevant studies.
C. We excluded the literature whose subject and author(s) are both the same as another identified paper. For example, two studies were identified on the environmental impact of PES in the Páramo region of Ecuador [15,16]. They presented the same conclusion, arrived at using different methods.
D. We excluded the literature where a later study had been based on the earlier study, with different authors in the same subject area.

E. We deleted the literature that studies the factors affecting farmers' participation in PES projects, as well as the literature on farmers' environmental protection motivation and social capital in the implementation of PES projects.

F. We separated out the empirical results attributable to different types of PES projects where they are reported in a single study. Although they belonged to the same study, the implementation time, purpose, geographic area, results, and sample size of different projects were significantly different and distinct. Therefore, different types of PES projects in the same literature could be distinguished according to their classification, such as three different PES projects in Cambodia (Ibis Rice, Ecotourism, Bird Nest).

G. Chen and Wang [17] noted that the journals with influence factor of less than one should be excluded in order to ensure the quality of the selected studies. Xie and Zhang [18] also asserted that it is necessary to exclude lower quality articles, but do not mention the evaluation criteria for article quality. Fortunately, all of the empirical literature remaining in our sample was ranked in the second quartile of the JCR (Journal Citation Reports) classification. We did not, therefore, exclude any of the studies identified for reasons of quality.

After the above filtering, the literature remaining in our sample of PES projects and, therefore used in our meta-regression analysis, comprised 27 articles featuring empirical research on poverty alleviation and environment. As shown in Figure 1, the selected cases of PES for environmental protection and improvement in this paper were mainly concentrated in Central and South America, with up to 7 cases in Mexico and 3 cases in Costa Rica. In Figure 2, the case of PES for poverty reduction was also mainly concentrated in Central and South America, but the case distribution was more balanced, and the number of cases in African countries and Southeast Asian countries has increased. Among them, there were still up to 5 cases in Mexico, 2 cases in Costa Rica, 2 cases in Mozambique in Africa, 1 case in Tanzania, Rwanda, and Malawi, 1 case in Indonesia, and 3 cases in Cambodia in Asia.

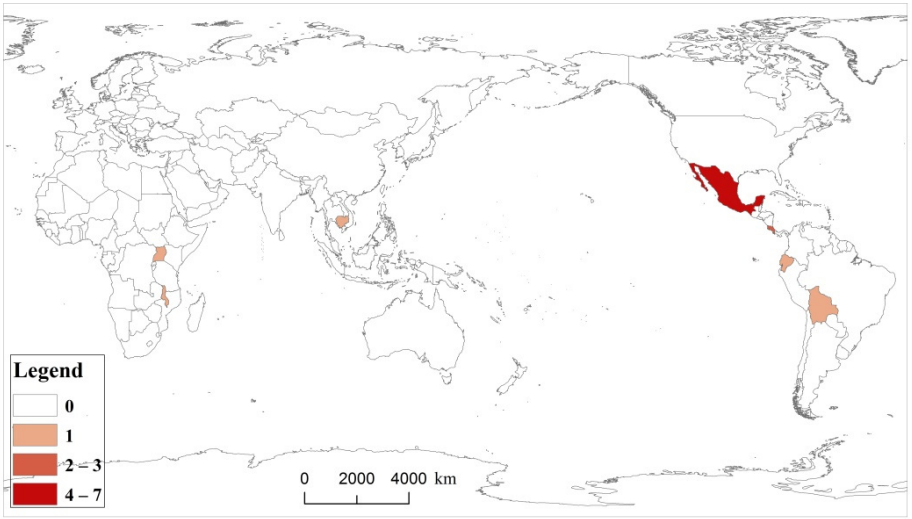

Figure 1. The map of environment effect cases of PES in meta-regression analysis.

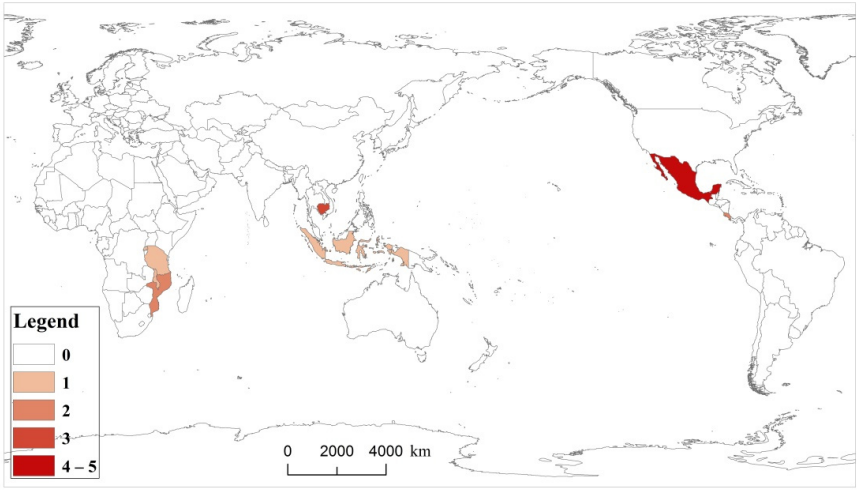

Figure 2. The map of poverty reduction cases of PES in meta-regression analysis.

3.2. Selection of Variables

This paper used meta-regression analysis to study the effects of PES projects on environmental improvement and poverty alleviation from the perspective of farmers. Therefore, the selection of variables must be based on the data available from the results of prior empirical literature.

The dependent variable of meta-regression analysis was the regression coefficient, or conversion value, which were the core explanatory variables derived from the original empirical literature. The explanatory variables of meta-regression analysis were the hypothesis and related features of the models in the original literature. Therefore, the data for the meta-regression analysis generally took the form of binary dummy variables or categorical variables.

3.2.1. Selection of Dependent Variables

With regard to studying the impact of PES projects on environmental improvement and poverty reduction, it was first necessary to determine the indicators that could be used to measure these outcomes. The main indicators for environmental improvement were forest coverage and deforestation rate, and some of the literature use land use behavior as a proxy variable. This was consistent with previous studies' belief that the monitoring and measurement of PES projects should mainly be performed using proxy variables, and in particular the main indicators of forest coverage and deforestation rate. Land use behavior measurements and indicators were used less often. The measurement of poverty reduction in the existing literature was mainly based on property and income. Table 1 summarizes the indicators for environmental improvement and poverty reduction that are used in the selected sample literature.

Table 1. Indicators used in the literature on environmental improvement and poverty reduction effects of PES.

Topics	Indicators	Representative Article
Environmental improvement	Forest coverage	Scullion et al. [7]
	Deforestation rate	Velly et al. [19]
	River water quality	Pynegar et al. [20]
	Land use behavior	Hayes et al. [16]
	Land management	Arragada et al. [21]
Poverty reduction	Property	Arriagada et al. [22]
	Income	Jindal et al. [23]
	Wealth comprehensive indicator	Diswandi [24]
	Poverty indicator	Alix-Garcia and Sims [25]
	Consumption	Martin et al. [26]
	Economic status	Beauchamp et al. [11]

The dependent variables used in this paper are environmental improvement and poverty reduction. According to the regression results in the empirical literature, both the improvement of the environment and poverty reduction have both positive and negative indicators that cannot be effectively unified according to the regression coefficients. Therefore, this paper adopts two-category variables as the dependent variables. If a study from the sample selection finds an observed improvement of the environment that is statistically significant (i.e., the identified signage of the regression coefficient is found to be statistically significant, indicating increased forest coverage, reduced deforestation rate, river water quality improvement, grazing reduces), the environmental improvement variable takes a value of 1, otherwise 0. If a study from the sample selection finds an observed reduction in poverty that is statistically significant (i.e., the identified signage of the regression coefficient is found to be statistically significant) as a result of participation in a PES project (indicated by increased income, property ownership, consumption, or wealth, by an increase in the composite index, by the decrease in poverty levels, or the improvement in the comprehensive index of life and welfare), the reduction in poverty variable takes a value of 1, otherwise 0. Specifically, forest coverage rate, wealth, land use behavior, and land management are stock indicators, while flow indicators include river water quality, deforestation rate, property, income, wealth comprehensive indicator, poverty indicators, consumption, and economic status.

The effects of PES on environmental improvement and poverty reduction identified in the existing empirical literature are not consistent with theoretical research. Table 2 summarizes the empirical literature on PES for environmental improvement and poverty alleviation, according to author, journal, whether environmental improvement is identified, and whether poverty alleviation is identified. As shown in Table 2, most PES projects have achieved environmental improvements. Only two studies found that the projects studied failed to achieve environmental improvement. In contrast to the significant effect of PES projects on environmental improvement, only six PES projects studied in the empirical literature were found to have achieved poverty reduction outcomes. However, if we only look at the signage of the regression coefficients identified and do not consider the statistical significance of the findings, most PES projects studied reported a reduction in poverty or increase in the welfare level of participants. Only three studies found that the regression coefficients of the PES variables for property ownership or economic status are not statistically significant.

3.2.2. Selection of Study Variables

Property rights indicator: If the land in the PES project was privately owned, this dummy variable was assigned a value of 0. If the land in the PES project was jointly owned by the community, this variable was assigned a value of 1. Usually, for privately owned land, the PES project contract was entered into with the land owner. If the community share property rights, it was entered into with the community, and the community then regulated the private use of land through collective action rules.

Type of funder: The value of this dummy variable was 0 if the project was funded by the government of the country, and the value was 1 if it was funded by a corporation, non-governmental organization, or international organization. The traditional Coase theorem was dominated by negotiations between land owners, but more and more countries appeared as representatives of the beneficiaries of ecological environment services to negotiate and paid with the development of theory and practice.

Project period: This referred to the timespan over which the project was conducted in the region or country. Over time, PES programs could be understood and supported by increasing numbers of participants and non-participants, and it could become easier to achieve the goals of environmental improvement and poverty reduction.

Table 2. Empirical literature on environmental improvement and poverty reduction effects of PES.

Author	Publication	Journal	Environmental Improvement or Poverty Reduction
Panel A: Environmental improvement			
Scullion et al. [7]	Yes	Environmental Conservation	Yes
Arriagada et al. [6]	Yes	Land Economics	Yes
Chervier et al. [5]	Yes	World Development	Yes
Velly et al. [19]	Yes	Land Economics	Yes
Robalino & Pfaff [27]	Yes	Land Economics	No
Costedoat et al. [28]	Yes	PLoS ONE	Yes
Jayachandran et al. [29]	Yes	Science	Yes
Pynegar et al. [20]	Yes	PEERJ	No
Alix-Garcia et al. [30]	Yes	Land Economics	Yes
Hayes et al. [16]	Yes	World Development	Yes
Arriagada et al. [21]	Yes	Ecosystem Services	Yes
Alix-Garcia et al. [25]	Yes	American Economic Journal: Economic Policy	Yes
Jack and Santos [12]	Yes	Land Use Policy	Yes
Robalino et al. [31]	Yes	PLoS ONE	Yes
Sims & Alix-Garcia [32]	Yes	Journal of Environmental Economics and Management	Yes
Panel B: Poverty reduction			
Diswandi [24]	Yes	Ecosystem Services	No
Robalino et al. [33]	No		No
Arriagada et al. [22]	Yes	PLoS ONE	No
Alix-Garcia et al. [34]	No		No
Jindal et al. [23]	Yes	World Development	Yes
Hegde and Bull [35]	Yes	Ecological Economics	Yes
Lokina and John [36]	Yes	African Journal of Economic Review	Yes
Arriagada et al. [21]	Yes	Ecosystem Services	No
Alix-Garcia & Sims [25]	Yes	American Economic Journal: Economic Policy	Yes
Martin et al. [26]	Yes	Global Environmental Change	No
Jack and Santos [12]	Yes	Land Use Policy	No
Sims & Alix-Garcia [32]	Yes	Journal of Environmental Economics and Management	Yes
Beauchamp et al. [11]	Yes	World Development	Yes

Project area: If the PES project was promoted at the national level, this dummy variable took a value of 0, otherwise it was 1 at the regional level. Projects such as those in Mexico (the National Programme for Hydrological Environmental Services) and Costa Rica (PSA) were promoted at the national level.

Sample area: If the empirical literature examined the project effects of the implementation at the national level, this dummy variable took a value of 0. The dummy variable took a value of 1 if the regional effect of the PES project was investigated.

Publication year: This variable referred to the year in which the literature was published (or for unpublished work paper, the time of the work paper). Generally speaking, variables with publication characteristics were selected to add to the model, and most studies chose the year of publication [37]. In addition, the publication year was also selected to reduce the degree of publication bias.

The sample size: For studies using normal OLS regression, this variable was the study's total sample size. If the DID method was used, the variable was the total size of the experimental group and control group.

A statistical description of these variables is presented in Table 3.

Table 3. Descriptive statistics.

Variables	Obs.	Mean	S. D.	Min.	Max.
Panel A: Environmental improvement					
Environmental improvement	15	0.8667	0.3519	0	1
Property rights	15	0.6000	0.5071	0	1
Type of funder	15	0.2667	0.4577	0	1
Project period	15	7.4000	3.3764	3	13
Project area	15	0.4000	0.5071	0	1
Sample area	15	0.6667	0.4880	0	1
Sample size	14	12,953.9286	30,967.6362	33	105,648
Publication year	15	2015.4000	2.3543	2011	2018
Panel B: Poverty reduction					
Poverty reduction	16	0.3750	0.5000	0	1
Property rights	16	0.5625	0.5123	0	1
Type of funder	16	0.4375	0.5123	0	1
Project period	16	6.6875	3.0049	3	12
Project area	16	0.5625	0.5123	0	1
Sample area	16	0.6875	0.4787	0	1
Sample size	16	14,285.6250	31,291.2751	44	105,648
Publication year	16	2015.2500	2.4900	2011	2018

3.3. Method

Based on an empirical case of paying for environmental services, this paper further studies whether paying for environmental services achieves the dual effects of environmental improvement and poverty reduction from the perspective of farmers by using a meta-regression analysis method. The meta-regression analysis is a comprehensive literature analysis method based on the collation and summary of empirical literature, which is widely used in management in the field of social sciences, but less frequently in the field of economics, especially in the field of resource and environment economics [38].

With the gradual improvement of PES project design and data collection, some studies have verified the effect of implementation of PES projects on the environment and poverty reduction by means of the *t*-test and chi-square test, and the ordinary least squares (OLS) regression. In order to reduce the incidences of missing variables, data measurement errors, and endogeneity problems of reverse causality, some studies have gradually started to use the DID method and the regression discontinuity design method. This paper uses meta-regression analysis to study the impacts of PES on environmental improvement and poverty alleviation for farmers. The models used in the meta-regression analysis are as follows:

$$environment = \alpha + \gamma X + \varepsilon \quad (1)$$

$$poverty = \beta + \delta Z + \epsilon \quad (2)$$

where environment represents an explanatory variable for the improvement of the environment. If a study finds a statistically significant improvement, this variable takes a value of 1, otherwise 0. Poverty represents whether or not the explained variable for poverty reduction is achieved. If a study finds a statistically significant reduction in poverty, this variable takes a value of 1, otherwise 0. X and Z represent some variables, including property rights, type of funder, project period, project area, sample area, sample size, and publication year. ε and ϵ are the random error terms that are clustered at the national level. Because environmental improvement and poverty reduction are binary dummy variables, the Probit model for meta-regression analysis is used.

4. Meta-Regression Results

To study the effect of PES on environmental improvement from Equation (1), the Probit regression results are displayed in Table 4. Column (1) considers the impact of these variables on environmental governance, such as property rights, type of funder, project period, and project area. Column (2) continues to add the variables of the sample area and sample size for investigation. Column (3) contains all variables.

Table 4. The results of PES for environmental improvement.

Variables	(1)	(2)	(3)
Property rights	−0.3530	−0.3096	−0.7568
	(1.0689)	(1.0099)	(1.4292)
Type of funder	−5.0232 ***	−4.7416 ***	−3.0942 **
	(1.0573)	(1.1462)	(1.4121)
Project period	0.1559 *	0.1031	0.3729
	(0.0912)	(0.2359)	(0.3789)
Project area	5.0644 ***	5.1981 ***	6.9130 **
	(1.0573)	(0.9745)	(3.4070)
Sample area		0.0000	−0.0000
		(0.0000)	(0.0000)
Sample size		−0.3029	−1.8021
		(1.2243)	(1.9968)
Publication year			−0.4989
			(0.8103)
Constant	0.0059	0.1435	1003.5238
	(1.0791)	(1.4329)	(1630.6554)
Observations	15	14	14

Notes: ***, **, and * imply significance at the 1%, 5%, and 10% level. The standard error of all models is the national clustering standard error.

As shown in column (3) of Table 4, the regression coefficient for the type of funder is −3.0942, and this is found to be statistically significant at the 5% level, indicating that privately funded PES projects are not as effective as PES projects funded by the national government. Results for the dummy variable project area are positive and statistically significant in all three models. The regression coefficient for project area in model 3 is 6.9130, and the effect of project area is found to be statistically significant at the 5% level, indicating that studies sampling regional areas identify a more likely effect on the environment than studies sampling at the national level. The effect of project implementation shows that regional programs are more likely to have impacts on the environment than national programs. The length of project implementation period has a statistically significant positive effect on environmental indicators in column (1), but its effect was not found to be statistically significant in columns (2)–(3). However, the regression coefficient remained positive in each of these models. Although the project implementation period generally failed to yield a statistically significantly improvement in environment, the environmental improvement effect continues to improve with the extension of the project implementation time. The regression coefficient for the property rights indicator does not pass the test for statistical significance at the 10% level but is found to be negative. This suggests that PES projects based on privately owned land are more conducive to environmental improvement than those based on nation-owned land. The regression coefficients for sample size and the publication year also fail to be statistically significant at the 10% level, but negative.

With regard to the impact of PES payment on poverty reduction, the regression coefficient of the property rights indicator is −2.7361 at the 5% significance level. This suggests that PES projects based on land that is privately owned achieve greater poverty reduction than PES projects based on land in community ownership. The regression coefficient for the dummy variable type of funder is −1.2751, but it is not statistically significant. The negative coefficient, however, suggests that privately funded PES projects may not be as effective for poverty reduction as nationally funded projects. The coefficient for the project

implementation period is not statistically significant, but is positive, indicating that project duration may have a positive effect on poverty alleviation. The regression coefficient for the project implementation area is positive and is found to be statistically significant at the 1% level, indicating that regional programs are more effective in the realization of poverty reduction than national programs. The coefficient of the sample area is 9.0361 and is statistically significant at the 1% level, indicating that studies sampling regional areas identify a more likely effect on alleviation of poverty than studies sampling at the national level. The regression coefficient for sample size is 0.0025 and is statistically significant at the 1% level. The regression coefficient for publication year is −0.7311 and is statistically significant at the 5% level. This speaks volumes about the impact of these variables on poverty studies.

5. Discussion

5.1. The Effect of PES on the Environment

The narrow concept of PES states that providers and buyers of environmental services must be individuals. The internalization of externalities is required only when private property rights are clear. However, there is a large amount of land held in shared community ownership in developing countries. Therefore, PES projects have gradually emerged for land held by this form of community ownership. For PES projects based on privately owned property, participation is based on the individual owner's wishes. Agreements for such projects are more restrictive and enforceable than agreements relating to community-owned land and can better mobilize the enthusiasm of private landowners. In the PES projects based on community-owned land, not all individuals are willing or motivated to participate in the project, so there could be "free riders" who do not fully contribute to the process of environmental improvement. In order to achieve greater impact on environmental governance, PES projects based on community property rights therefore require a robust system of community, allowing effective enforcement to improve the efficiency of the implementation of the agreement. Only a robust and strong community management system can maximize the efficiency of collective action, increase the participation rate of residents, and effectively guide residents' environmentally friendly behavior of the land use. The projects of environmental service payment in China and Vietnam do not meet the definition of PES project used in this paper because Vietnam and China's environmental service payment projects actually restrict land use patterns through legal systems, etc., rather than promoting land through economic incentives. Nevertheless, land users change behaviors that are not conducive to environmental improvement [39]. The implementation of environmental governance projects is based on state ownership of land, and forest coverage has improved significantly, achieving more effective environmental governance. China and Vietnam have strong environmental governance policies and high efficiency implementation.

Table 5 shows that nationally funded PES projects are more effective in terms of environmental improvements than privately funded projects. A possible reason is that developing countries are not able to fully implement market mechanisms to implement PES projects as effectively as developed countries. In the case of PES in developing countries, nationally funded projects also accounted for a larger proportion of projects than in developed countries, which also appears to compensate for the lack of market mechanisms, and these projects gradually introduce and improve the market mechanisms for PES through project implementation and government guidance. Payments made by the country on behalf of the direct beneficiaries of environmental services are not only conducive to saving transaction costs, supervision costs, and implementation costs, but can also increase the probability of PES contracts being created. Nationally funded PES are more suitable for large-scale environmental governance and allow countries to negotiate as representatives. From the perspective of environmental service buyers, the free-riding problem can also be reduced. However, nationally funded projects also face other costs. Therefore, in order to give full play to its advantages for the nationally funded payments, it

is necessary to improve the system design and find a more favorable balance in terms of reducing transaction costs and realizing differentiated and precise payment.

Table 5. The results of PES for poverty reduction.

Variables	(1)	(2)	(3)
Property rights	0.3951	−0.2765	−2.7361 **
	(0.6234)	(0.9954)	(1.2287)
Type of funder	0.4409	−0.1650	−1.2751
	(0.8650)	(1.1159)	(0.9921)
Project period	−0.0060	−0.0153	0.2067
	(0.1103)	(0.1745)	(0.2410)
Project area	−0.3341	84.6718 **	138.5460 ***
	(0.9393)	(41.9092)	(47.7850)
Sample area		0.0016 **	0.0025 ***
		(0.0007)	(0.0008)
Sample size		8.0895 ***	9.0361 ***
		(1.2866)	(1.3143)
Publication year			−0.7311 **
			(0.3505)
Constant	−0.4740	−92.8591 **	1326.4753 *
	(0.8020)	(41.5022)	(685.8635)
Observations	16	16	16

Notes: ***, **, and * imply significance at the 1%, 5%, and 10%. The standard error of all models is the national clustering standard error.

The effectiveness of national-level projects is less than that of local-level projects. The reason is that at the local level, buyers and sellers are more aware of each other's circumstances, and they can obtain more information, achieve greater accuracy, transparency, and fairness of the transaction process, as well as the project implementation. In this way, a more suitable PES agreement can be formed, which improves the efficiency and effectiveness of implementation of PES. Through the meta-regression analysis in this paper, it is found that the implementation of PES projects at the local level achieves a higher proportion of environmental improvement. PES projects implemented at the regional level generally include not only direct cash payments, but also non-cash indirect payments. Although direct cash payments are the more effective type in achieving environmental protection [40], the addition of non-cash payments can effectively reduce the "crowding-out" effect of cash payment on individual environmental protection motivations and behaviors and can also effectively reduce the damage of regional environmental systems and social norms.

The longer the project implementation period, the greater the environmental improvement effect of the PES project. Environmental governance needs to take a long time, especially for water management and soil management. Participants in long-term projects believe that through participation in PES projects, they can continue to receive cash or non-cash support. Therefore, such projects can create continuous expectations from participating farmers or communities, and then help to create long-term changes in land use behavior. Environmental behavior could not revert to the original behavior until the project is completed, and after long-term implementation of the project, the environmental service market and supporting mechanisms of developing countries can be gradually established and improved so that the market mechanism can play a greater role in the process of environmental protection and improvement in the future.

5.2. The Effect of PES on Poverty

The regression results in column (3) of Table 5 show that the poverty alleviation effect of PES projects is related to privately owned land, which is greater than the effect of such projects relating to land in community ownership. This may be due to that payment agreements for environmental services that are signed on the basis of private property rights are clearer. Where land is shared by the community, a resident representative could

generally sign the contract on behalf of the community. Although this reduces the cost of private negotiation and improves the success of agreeing project contracts, the community could be required to undertake collective action in the implementation of the PES project, and in some cases may not be able to mobilize individual enthusiasm.

Moreover, the meta-regression analysis indicates that the effects of the type of funder are not statistically significant. However, the coefficient suggests that the government-funded PES projects are more conducive to poverty alleviation than privately funded payments. In developing countries, the national government often gives greater importance to the goal of promoting regional development and poverty alleviation in the implementation of PES projects. This not only helps to improve the understanding and support of residents of the project, but also helps to obtain political support. PES projects funded by governments tend to be concerned with a balance between environmental protection, payment amounts, and regional economic development. Therefore, a degree of environmental improvement could be sacrificed to some extent to support regional economic development and increase the income and property of local residents. PES projects funded by the government generally entail not only direct cash transfers, but also technical guidance, employment training, and even the provision of cash crop seeds. On the one hand, direct cash transfers and the provision of crop seeds and seedlings alleviate the financial constraints of residents. On the other hand, technical guidance, employment training, etc., improve agricultural technology and labor productivity, liberated rural labor, and promoted non-agricultural employment.

Similarly, the longer the project implementation period, the greater the effect on poverty. For one thing, environmental service providers require a certain conversion period in order to be able to participate in non-agricultural employment. The longer the agricultural planting time of a project, the longer the conversion period. Moreover, landowners who have been engaged in non-agricultural cultivation for a longer period of time, or landowners with non-agricultural employment opportunities, are more likely to participate in PES projects. For another, it is time-consuming to change land use behavior by participating in PES projects. Forest plantation or economic forest benefits are cyclical, and the initial investment is large. Hence, it is necessary that the PES project contract gives participants a certain length of duration. If the project duration is expected to increase in the future, this may help participants to benefit from participating in non-agricultural employment and from land-use change.

6. Conclusions

This paper sorts out the empirical literature of PES on environmental improvement and poverty reduction. The statistics of dummy variables are carried out on whether to achieve environmental improvement and poverty reduction, and a meta-regression analysis is used to explore their influencing factors. The findings show that PES projects based on land in private ownership are more conducive to poverty reduction and environmental improvement than those based on land in community ownership. If the national government is paying for environmental services, poverty reduction and environmental improvement are shown to be achieved more effectively. If PES projects are not implemented at the national level, the implementation of these projects can also achieve a win–win situation in environmental improvement and poverty reduction in accordance with local conditions. With the extension of policy periods, the effects of PES projects on environmental improvement and poverty reduction can be more effectively achieved.

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