Why Is the "Polluter Pays Principle" Difficult to Implement in Rural Areas? A Study on Pig Farmers' Payment Behavior in Third-Party Governance of Pig Farming Pollution in Nanping (Postprint)

Authors: Zheng Huangshan, Chen Shufeng, Sun Xiaoxia, Su Shipeng

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Abstract

In third-party governance of livestock pollution, timely payment of pollution treatment fees by polluters is both a requirement of the "Polluter Pays Principle" and critical for the sustained operation of third-party governance. However, in practice, there exists a phenomenon of pig farmers not paying pollution treatment fees in a timely manner. To investigate the reasons behind this, this study surveyed the third-party governance fee payment behaviors of 117 pig farmers across seven villages in Luxia Town, Nanping City, Fujian Province, applied a logistic regression model to analyze the key factors influencing payment behavior, and explored the reasons why the "Polluter Pays Principle" is difficult to implement in rural areas. The results indicate: (1) The "Polluter Pays Principle" is difficult to implement in rural third-party governance of livestock pollution, with a low payment ratio among pig farmers, which severely impacts the normal operation of third-party governance. Although 73.50% of pig farmers believe they should pay, only 61.54% have actually paid the treatment fees. The main reasons are: farmers use their own requirements for living environment as the basis for judgment, neglecting the environmental negative externalities generated by local farming practices; pig farmers have not truly understood the connotation and requirements of the "Polluter Pays Principle" ; the mentality of conformity, comparison, and "law does not punish the masses" in rural acquaintance societies; the perceived effectiveness of third-party governance differs significantly from pig farmers' expectations; and grassroots governments lack the means and mechanisms to implement the "Polluter Pays Principle." (2) Production and operation characteristics, household characteristics, and individual characteristics significantly influence pig farmers' payment behavior, with the degree of influence in descending order: operation type > average education level >

household head age > proportion of external breeding capital > farm area > net breeding income. (3) Due to minimal differences in individual external factors, they do not significantly influence pig farmers' payment behavior. Therefore, it is necessary to enhance pig farmers' environmental awareness and sense of responsibility, promote scaled and corporate operation of the livestock industry, strengthen the cultivation of new-type professional farmers, establish and strictly enforce grassroots implementation mechanisms for the "Polluter Pays Principle," thereby promoting the third-party governance of livestock pollution and the sustainable development of the livestock industry.

Full Text

Preamble

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Why Is the "Polluter-Pays Principle" Difficult to Implement in Rural Areas?
—A Case Study of Pig Farmers' Payment Behavior Under Third-Party Governance of Pig-Farming Pollution in Nanping

ZHENG Huangshan, CHEN Shufeng, SUN Xiaoxia, SU Shipeng**
(Institute of Sustainable Development, Fujian Agriculture and Forestry University, Fuzhou 350002, China)

Abstract: In third-party governance of livestock breeding pollution, timely payment of pollution treatment fees by polluters is not only a requirement of the "polluter-pays principle" but also crucial for the sustainable operation of third-party governance systems. However, in practice, many pig farmers fail to pay these fees promptly. To investigate the underlying reasons, this study surveyed the payment behaviors of 117 pig farmers across seven villages in Luxia Town, Nanping City, Fujian Province, applying logistic regression analysis to identify key factors influencing payment behavior and exploring why the polluter-pays principle faces implementation challenges in rural areas. The results indicate: (1) The polluter-pays principle is difficult to enforce in rural livestock pollution third-party governance, with low payment rates seriously affecting normal operations. While 73.50% of farmers believed fees should be paid, only 61.54% actually paid. Primary reasons include farmers judging environmental requirements based on their own living conditions while ignoring negative environmental externalities from local breeding activities; lack of genuine understanding of the polluter-pays principle' s 内涵和要求; conformity, comparison, and "law cannot punish the masses" mentality in rural acquaintance societies; large gaps between perceived and expected third-party governance effectiveness; and lack of mechanisms and tools for local governments to implement the polluter-pays principle. (2) Production and operation characteristics, household characteristics, and individual characteristics significantly affect payment behavior, with

influence degree ranking as: operation type > average education level > household head age > proportion of external capital > farm area > net breeding income. (3) Due to minimal variation in external factors among individuals, their influence was not significant. Therefore, enhancing farmers' environmental awareness and responsibility, promoting scaled and corporate livestock operations, strengthening new vocational farmer training, and establishing strict grassroots implementation mechanisms for polluter-pays are needed to advance third-party pollution governance and sustainable livestock development.

Keywords: Livestock breeding pollution; Polluter-pays principle; Third-party governance; Payment behavior; Pig farmers

1. Theoretical Analysis and Research Design

In third-party governance of livestock breeding pollution, third-party enterprises treat pollutants according to contract requirements, improve water environments, and generate primary revenue from pollution treatment fees and waste recycling income. According to the polluter-pays principle, pig farmers as polluters should bear most governance costs. Therefore, timely payment of pollution treatment fees is critical for third-party enterprises' normal operation. Extensive international research shows that gender, age, social class, and external environmental factors primarily influence farmers' environmental awareness; domestic studies indicate that education level, farm scale, and public awareness affect pig farmers' environmental consciousness. Larger-scale farms tend to implement better environmental practices to increase profits, with operation duration and management model closely related to environmental behavior. Based on theoretical analysis and existing research, this paper argues that pig farmers' payment behavior for livestock pollution treatment fees depends mainly on individual characteristics, household characteristics, production/operation characteristics, and external factors, as shown in Figure 1 [Figure 1: see original paper].

Figure 1. Analysis framework and research methods of influencing factors of payment behavior of pig farmers for pollution fees

To identify significant factors influencing pig farmers' payment behavior for livestock pollution treatment fees, this study applied a binary logistic regression model:

$$\ln\left(\frac{P}{1-P}\right) = \alpha + \sum_{i=1}^{n} \beta_i X_i$$

Where:
- P is the probability of pig farmers paying third-party pollution treatment fees
- $1-P$ is the probability of not paying

- $X_i (i = 1, 2, 3, \ldots, n)$ are factors influencing payment behavior
- α is the constant term
- $\beta_i (i = 1, 2, 3, \ldots, n)$ is the regression coefficient for factor i; positive values indicate positive correlation with payment behavior, negative values indicate negative correlation

The dependent variable is pig farmers' pollution treatment payment behavior, denoted as Y ($Y = 0$ for non-payment, $Y = 1$ for payment). Independent variables include: household head age (X_1), gender (X_2), health status (X_3), number of household members engaged in breeding (X_4), average education level (X_5), operation type (X_6), distance from farm to river (X_7), proportion of external capital (X_8), operation years (X_9), farm area (X_{10}), net breeding income (X_{11}), pig market risk (X_{12}), third-party governance effectiveness (X_{13}), and government supervision/enforcement strength (X_{14}).

Variable explanations and expected effects:
- **Individual characteristics:** Younger household heads, good health, and male gender are expected to have higher payment rates.
- **Household characteristics:** More household members engaged in breeding (higher livelihood dependence) may reduce payment willingness; higher average education level should deepen understanding of polluter-pays principle and increase payment likelihood.
- **Production/operation characteristics:** Longer operation years may increase reliance on traditional methods and reduce payment willingness; joint operations (larger scale, closer to breeding zones, higher demolition opportunity costs) may increase payment likelihood; larger scale means higher fees and potentially lower willingness; higher external capital proportion may reduce payment willingness; greater distance from river reduces detection risk and payment willingness; higher net income increases payment capacity and likelihood.
- **External environment:** Stronger policy enforcement increases punishment risk for direct discharge; better third-party governance effectiveness increases perceived value; lower market risk provides stable income and payment ability.

Expected directions for each variable are shown in Table 1 .

Table 1. Characteristic variables affecting payment behavior for pollution fees of pig farmers and expected direction

Variable	Assignment	Expected Direction
Household head age	Years	+
Gender (0=female, 1=male)	Binary	+

Variable	Assignment	Expected Direction
Personal health (1=poor, 2=normal, 3=good)	Ordinal	+
Population engaged in pig breeding	Persons	-
Average education level	Years	+
Operation type (0=single; 1=joint)	Binary	+
Distance to river	km	-
Proportion of external capital	%	-
Operation years	Years	-
Pig farm area	m^2	-
Net income of feeding pig	¥	+
Pig market risk (1=large, 2=normal, 3=small)	Ordinal	+
Third-party governance effectiveness (1=poor, 2=worse, 3=normal, 4=good, 5=better)	Ordinal	+
Government supervision and law enforcement (1=poor, 2=worse, 3=normal, 4=good, 5=good)	Ordinal	+

"+" and "-" indicate positive and negative effects, respectively.

2. Study Area Overview and Data Sources

Luxia Town in Nanping City, Fujian Province (26°15 -26°34 N, 118°14 - 118°21 E) comprises 10 administrative villages with 3,312 households and 13,072 people. Since the 1990s, when the government promoted breeding to resettle reservoir migrants, livestock production has become the pillar industry, accounting for 70% of local GDP. In 2016, nearly 300,000 pigs were slaughtered, mostly from small-scale scattered farms rather than large operations. Pollution control remained ineffective due to land constraints, capital shortages, and incomplete government supervision. Influenced by traditional water-flush discharge practices and located in the Min River headwaters, breeding pollution has degraded most rivers to Grade V- water quality.

In late 2014, the town government introduced a third-party pollution control enterprise through bidding, signing contracts to delegate polluted waters to third-party governance for constructing a zero-emission resource-recycling economy and water restoration project. Government support included: farmland rent subsidies (4,500 kg · hm ^{2} · a ^{1}, with government and third party each bearing 2,250 kg · hm ^{2} · a ^{1}); construction land subsidies (750,000 yuan for 2 hm^{2} factory land at industrial park standards); tax reductions on environmental service VAT; and project reward subsidies. The town established 42 treatment sites across 7 villages covering 11.778 hm^{2}, serving 1,195 pig farmers in the upper Min River Duxi watershed. The fee standard was 2 yuan · m ^{2} · month ^{1}, collected by government every 3 months. A breeding pollution control office tracked watershed progress, verified farm areas, and assessed third-party results. In practice, only 26% of farmers actively paid pollution fees (Table 2).

Table 2. Situation of payment for pollution fees of pig farmers in the first quarter of 2016 in the study area

Village	Payable Households	Paid Households	Percentage (%)	Ranking
[Data preserved from original table]				

To investigate non-payment reasons, we conducted face-to-face interviews in September 2016 with Nanping Yanping District government, Luxia Town government, the breeding pollution control office, environmental protection bureau, and the third-party enterprise Zhengda Orixin. In December 2016, we surveyed 7 villages (Luxia, Shecun, Xiajing, Tiantou, Yangwei, Guanzhuang, Longcun), randomly selecting 132 pig farmers for questionnaires covering basic household information, breeding conditions, income/costs, biogas digester

usage, and attitudes toward third-party governance. We obtained 117 valid questionnaires (88.6% response rate). Sample statistics show most household heads were middle-aged or elderly, with primary or junior high school education, operating small-scale farms of 100–500 head. Additionally, 95 households (81.1%) had biogas digesters, but usage was poor: 9 never used them, 46 never cleaned them, and 40 cleaned them only every two years, making ecological improvement impossible.

Table 3. Descriptive statistics of variables of payment behavior for pollution fees of pig farmers in the study area

Variable	Category	Sample Number	Proportion
Household head age	20–29, 30–39, 40–49, 50–59	[Data preserved]	[Data preserved]
Gender	Male, Female	[Data preserved]	[Data preserved]
Educational level	Illiteracy, Primary school, Junior high school, High school, College and above	[Data preserved]	[Data preserved]
Quantity of live hogs	50–100, 100–200, 200–500	[Data preserved]	[Data preserved]

3. Results and Analysis

3.1 Pig Farmers' Cognition of Pollution Control Responsibility and Payment Behavior

Farmers' cognition of their pollution control responsibility is key to behavior selection. Table 4 shows 73.50% of respondents believed they had responsibility to control breeding pollution and accepted third-party governance, indicating some environmental awareness. However, actual timely payment rates were low: after repeated government reminders, door-to-door persuasion, and ideological work, only 61.54% had paid fees. Given that many non-payers refused interviews, the actual payment proportion among all liable households was likely even lower.

Table 4. Pollution control responsibility cognition and payment behavior of pig farmers

Item	Visited Farmers	Proportion (%)
Responsibility for pollution control: Yes / No	[Data preserved]	73.50 / 26.50
Payment status: Paid / Not paid	[Data preserved]	61.54 / 38.46

3.2 Analysis of Factors Influencing Payment Behavior

Using SPSS 17.0, we conducted binary logistic regression analysis on factors influencing payment behavior, with results shown in Table 5 .

Table 5. Influential factors of pig farmers' payment behavior for pollution fees

Variable	Regression Coefficient	Standard Error	Chi-square Test	Degree of Freedom	Significance
Household head age (X)	0.072**	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Gender (X)	-0.350	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Personal health (X)	0.456***	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Population engaged in breeding (X)	-2.831**	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Average education (X)	0.020**	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Operating type (X)	0.002*	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]

Variable	Regression Coefficient	Standard Error	Chi-square Test	Degree of Freedom	Significance
Distance to river (X)	0.000*	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Proportion of foreign capital (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Operation years (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Pig farm area (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Net income (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Pig market risk (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Third-party governance effectiveness (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Government supervision (X)	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]
Constant	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]	[Data preserved]

Note: **,** , *and* represent significance at 1%, 5%, and 10% levels, respectively.

Results show six factors significantly influenced payment behavior: operation type (X), average education level (X), household head age (X), proportion of external capital (X), farm area (X), and net income (X), with influence strength decreasing sequentially.

3.3 Reasons for Refusing Third-Party Governance Fees

Based on interviews and Table 6 data, five main reasons emerged for non-payment.

First, farmers argued breeding pollution wasn' t the main local pollution source and didn't directly affect their lives, so it shouldn't be the primary control target. Most households in Luxia Town drink mountain spring water; pig wastewater mainly impacts downstream water bodies and residents. With pig farming common since the 1990s and a source of wealth, farmers are accustomed to the pollution. Low education levels lead them to consider household waste and factory discharge as primary pollution sources rather than breeding.

Second, farmers didn't genuinely understand or accept the polluter-pays principle. They viewed governance fees as extra costs rather than necessary expenses, worrying they couldn' t afford them during poor market conditions. In sample villages where pig farming accounts for 80–90% of GDP, unstable hog prices create resistance to fee payment, especially after years of low prices and losses. Additionally, while 73.50% agreed farmers had pollution control responsibility, only 8.55% believed they should bear governance costs, with 36.75% thinking government should pay. This reveals most farmers don' t fundamentally understand the polluter-pays principle' s requirements. More education and stronger incentive-constraint measures are needed to internalize environmental costs previously borne by government or the public.

Third, farmers exhibited conformity, 观望 (wait-and-see), procrastination, comparison, and "law cannot punish the masses" mentality. Among 45 non-paying households, 46.67% were unwilling to pay first, hoping to be the last. Small-scale farmers thought large farms should pay; large farms insisted everyone must pay together, creating mutual shirking and delays. Although many recognized their responsibility, in rural acquaintance societies they didn' t want to appear as "zealots" or "fools." The mentality was: better to pay late than early, better not to pay than pay late—delay if possible, evade if possible. Without payment incentives or constraints, few paid voluntarily, resulting in slow collection and high costs.

Fourth, third-party governance effectiveness was unsatisfactory. Forty-seven percent of respondents rated effectiveness as average or poor, reporting issues like enterprise sewage theft, poor-quality pipes, and treatment sites too close to villages worsening air quality. They felt third-party governance had little effect and shouldn' t be paid for. In reality, governance effectiveness varied signifi-

cantly across villages, affecting farmers' acceptance of third-party governance and causing obvious inter-village differences in payment behavior. Villages with better results had higher payment rates.

Fifth, local governments lacked tools and mechanisms to implement the polluter-pays principle. All 117 interviewed households reported never being punished for breeding pollution. Government interviews revealed enforcement couldn' t adopt compulsory measures, making publicity, guidance, and persuasion ineffective.

Table 6. Reasons for pig farmers' failure to pay pollution fees

Reason	Visited Farmers	Proportion (%)
No responsibility for pollution control	[Data preserved]	[Data preserved]
Pig income cannot cover costs	[Data preserved]	[Data preserved]
Most people don' t pay	[Data preserved]	[Data preserved]
Poor third-party governance effect	[Data preserved]	[Data preserved]
Fewer pigs	[Data preserved]	[Data preserved]

4. Influences on Pig Farmers' Third-Party Governance Fee Payment Behavior

Operation type, proportion of external capital, farm area, net income, average household education level, and household head age significantly influenced payment behavior. Absolute influence coefficients ranked: operation type > average education > household head age > external capital proportion > farm area > net income (Table 5). Specific analysis follows:

Operation characteristics were the most critical factor, with four significant factors (two-thirds of total) and operation type showing the strongest effect (coefficient = -2.831). Regarding operation type, joint operations are relatively larger scale with higher fees requiring collective decision-making among participants. In individualistic group decisions, members only care about personal benefits, leading to decisions that avoid fee payment. The positive effect of

external capital proportion contradicts initial assumptions: higher external capital ratios correlate with larger scales and greater industry dependence, creating fear of greater losses from non-payment and thus more "cooperative" payment behavior. Similarly, larger-scale farms have higher dependence and lower evasion likelihood, facing greater demolition or punishment risks for non-payment. Therefore, despite higher fees, large-scale farms show higher payment rates, creating positive effects opposite to expectations. Net income positively correlated with payment behavior, consistent with expectations.

Household characteristics, particularly average education level, significantly and positively influenced payment behavior (coefficient = 0.456, significant at 1% level). Higher education improves non-breeding employment capacity and understanding of the polluter-pays principle, increasing acceptance of third-party governance. Although household members engaged in breeding showed no significant effect (coefficient = -0.350), lower education combined with multiple breeders reduces polluter-pays principle acceptance, emphasizes self-interest, and decreases payment willingness—these households should be priority policy targets.

Individual characteristics, especially household head age, had some positive effect (coefficient = 0.072), while gender and health status showed no significant effects, contrary to initial hypotheses. Older household heads have stronger local breeding dependence, lower out-migration likelihood, and stronger pollution perception, thus more willing to pay third-party fees. Elders often serve as clan leaders with strong influence in rural society and can play exemplary roles in environmental governance. Therefore, leveraging older farmers' social influence is valuable.

External environment showed non-significant effects due to minimal individual differences. Market risk, third-party governance effectiveness, and government supervision strength were not significant, contrary to expectations, because all surveyed farmers were in Luxia Town, Yanping District, with similar external environments. However, regression coefficients and interviews revealed that better market conditions in 2016 significantly increased payment rates. Additionally, over-promising governance effectiveness created expectations that reality couldn' t meet, harming fee collection and government credibility. Therefore, governments should emphasize farmers' pollution control responsibilities and third-party governance efficiency, clarify governance goals, and establish payment mechanisms based on actual effectiveness to improve understanding and payment rates.

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5. Discussion and Conclusion

Introducing third-party governance represents a major future trend in livestock pollution control. This study focuses on farmers' governance behavior choices after third-party involvement, exploring key factors influencing payment behavior

to enrich rural environmental governance theory. Logistic regression analysis shows household head age, external capital proportion, average education level of breeders, and farm area positively affect payment behavior, while net income and operation type have negative effects. Average education level is particularly significant. This case study of Yanping District couldn' t fully analyze external environmental factors, though rural social culture, clan relations, economic levels, and industry types may substantially influence payment behavior. Future research should expand geographic coverage using villages as sampling units to reveal external factor influences. Considering rural social changes during urbanization, dynamic analysis using time-series data is also important.

Conclusions:

First, polluter-pays principle implementation in rural livestock pollution third-party governance is unsatisfactory. Primary reasons include farmers ignoring downstream environmental externalities, lacking genuine polluter-pays principle understanding, conformity and "law cannot punish the masses" mentality in acquaintance societies, gaps between perceived and expected third-party governance effectiveness, and local governments' lack of implementation tools and mechanisms. Therefore, strengthening publicity and education to enhance environmental awareness, improve public cognition of breeding pollution hazards, and help farmers understand that paying third-party fees is a wise win-win choice is crucial. Leveraging rural social networks and fully utilizing rural social capital in implementing polluter-pays principle is essential. Increasing farmer participation in third-party governance decisions, enhancing their cognition, and strengthening local governments' enforcement authority in rural environmental policy are necessary.

Second, factors influencing third-party fee payment behavior include operation characteristics, household characteristics, and individual characteristics. Six factors were significant, ranked as: operation type > average education > household head age > external capital proportion > farm area > net income. Therefore, targeted policies based on these characteristics can improve polluter-pays implementation. (1) Promote scaled, intensive, and corporate livestock operations to enhance farmers' pollution control capacity and responsibility awareness while clarifying responsible entities. (2) Strengthen new vocational farmer training to improve breeders' environmental awareness and capabilities. (3) Fully leverage rural elders' social capital for exemplary and leading roles in third-party governance.

Third, although external factors showed non-significant individual effects due to minimal variation, they substantially influence overall behavior. Therefore, stabilizing hog market prices, reducing breeding risks, improving farmers' capacity to bear governance costs, establishing reasonable polluter-pays implementation mechanisms with strict enforcement, and improving third-party governance assessment and information disclosure to form transparent, service-level-based pricing mechanisms will enhance polluter-pays principle implementation in rural areas.

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Note: Figure translations are in progress. See original paper for figures.