REVISTA ECONOMÍA Y POLÍTICA

Revista Economía y Política
Issue 44, July-December 2026, ISSN L: 2477-9075, ISSN: 1390-7921
Universidad de Cuenca, Ecuador

Planned behavior and environmental action: A causal approach for Ecuador

Comportamiento planificado y acción ambiental: Un enfoque causal para Ecuador

Pablo Ponce
Universidad Nacional de Loja, Ecuador
pablo.ponce@unl.edu.ec
https://orcid.org/0000-0003-2717-0176

Michelle López
Universidad Nacional de Loja, Ecuador
michelle.lopez@unl.edu.ec
https://orcid.org/0000-0003-1202-132X

Jessica Guamán
Universidad Nacional de Loja, Ecuador
jessica.guaman@unl.edu.ec
https://orcid.org/0000-0001-8973-2184

Danny Granda-Beltrán
Universidad Católica del Norte, Chile
danny.granda@unl.edu.ec
https://orcid.org/0000-0002-0434-1115

Received: 07 August 2025
Accepted: 07 April 2026
Published: 23 July 2026
Spanish version here

DOI: https://doi.org/10.25097/rep.n44.2026.06

Cómo citar/How to cite: Ponce, P., Guamán, J., López, M. and Granda-Beltrán, D. (2026). Planned behavior and environmental action: A causal approach for Ecuador. *Revista Economía y Política*, (44), 92-106. https://doi.org/10.25097/rep.n44.2026.06

Abstract

This study evaluates the causal effect of environmental awareness on the adoption of pro-environmental practices among Ecuadorian households during the period 2010–2014, using the Propensity Score Matching method. Based on official microdata, the analysis controls for self-selection bias and provides empirical evidence in a Latin American context where correlational approaches have predominated. The results indicate that environmentally aware households exhibit a higher probability of saving water (6% to 9%), saving energy (5% to 8%), and sorting waste (7% to 11%) compared to otherwise similar households without this characteristic. These findings support the Theory of Planned Behavior, showing that environmental awareness acts as a key mechanism in the transition from intention to action. The study offers relevant evidence for the design of public policies aimed at strengthening environmental education and awareness strategies differentiated by socioeconomic group.

Keywords: environmental awareness, pro-environmental behavior, propensity score matching, impact evaluation

Resumen

Este estudio evalúa el efecto causal de la conciencia ambiental sobre la adopción de prácticas proambientales en los hogares ecuatorianos durante el período 2010–2014, utilizando el método de Propensity Score Matching. A partir de microdatos oficiales, se controla el sesgo de autoselección y se aporta evidencia empírica en un contexto latinoamericano donde predominan enfoques correlacionales. Los resultados indican que los hogares con conciencia ambiental presentan una mayor probabilidad de ahorrar agua (6% y 9%), ahorrar energía (5% a 8%) y clasificar residuos (7% a 11%), en comparación con hogares similares sin dicha característica. Estos hallazgos respaldan la Teoría del Comportamiento Planificado, al mostrar que la conciencia ambiental actúa como un mecanismo clave en la transición de la intención a la acción. El estudio aporta evidencia relevante para el diseño de políticas públicas orientadas a fortalecer estrategias de educación y sensibilización ambiental diferenciadas por grupo socioeconómico

Palabras Clave: conciencia ambiental, comportamiento proambiental, Propensity Score Matching, evaluación de impacto

1. Introduction

In the context of global climate change, mitigation efforts are unevenly distributed among different economic actors. Evidence shows that businesses bear greater responsibility due to their scale of production and their greater economic and institutional capacity to reduce emissions, particularly in developed countries. At the same time, households in developing countries have considerably lower consumption levels and carbon footprints than those in developed countries.

However, recent literature highlights that households' everyday practices constitute a complementary component of climate policies, especially in contexts where regulatory actions targeting the productive sector face institutional constraints. In this regard, understanding the determinants of household adoption of pro-environmental practices is relevant not as a substitute for corporate action but as an additional mechanism that can reinforce climate change mitigation and adaptation strategies in developing economies such as Ecuador.

According to the IPCC (2021), it is urgent to change current consumption patterns to achieve the goals of the Paris Agreement and limit global temperature increase to 1.5°C. In countries such as Ecuador, 61.5% of households sorted at least one type of waste in 2019, compared to 47.7% in 2017 (INEC, 2020), indicating progress in the adoption of environmentally friendly practices. However, more than 64% of these households end up mixing their sorted waste with regular trash, reflecting a gap between environmental intentions and actions.

This disconnect has been extensively addressed in environmental psychology. In particular, the Theory of Planned Behavior (TPB) proposed by Ajzen (1991) posits that pro-environmental behavior is determined by intention, which is formed based on attitudes, subjective norms, and perceived behavioral control. Various studies have found that environmental awareness influences the propensity to adopt pro-environmental practices, but it does not always translate into concrete actions (Bamberg & Möser, 2007; Klöckner, 2013). This gap between intention and behavior has been attributed to structural and economic factors that inhibit the adoption of environmentally responsible behaviors, particularly in contexts of socioeconomic vulnerability (Zen et al., 2022; Carvalho et al., 2021). In developing countries, such as Ecuador, educational policy has not yet integrated environmental education as a fundamental pillar of youth education (Salazar et al., 2024). However, the literature suggests that environmental education is most effective when introduced at an early age, as the lessons learned during childhood and adolescence play a crucial role in shaping the values and beliefs that determine long-term behavior (Salazar et al., 2024).

Despite the growing body of literature on the determinants of environmental behavior, there is an empirical gap in studies addressing the causal effect of environmental awareness on pro-environmental practices, while controlling for self-selection bias and unobserved factors. Most research uses correlational models, which limit inferences about the net effect of environmental awareness. In this regard, various authors have noted that structural and situational factors introduce biases into correlational analyses, thereby preventing them from adequately capturing the complexity of environmental behavior (Diekmann & Preisendörfer, 2003). To overcome these limitations, this study contributes to the literature by estimating the average treatment effect on the treated (ATET) of environmental awareness on pro-environmental practices among households in Ecuador using a quasi-experimental model. As proposed by Rosenbaum and Rubin (1983) and Stuart (2010), the *Propensity Score Matching (PSM)* methodology enables the construction of a robust counterfactual that reduces self-selection bias by comparing households with high levels of environmental awareness to similar households without such awareness. This approach yields a more precise estimate of the causal effect of environmental awareness on the probability that Ecuadorian households will adopt pro-environmental practices during the 2010–2014 period.

In this context, environmental awareness can be understood as an attitudinal construct that, in terms of the TCP, triggers the intention to engage in pro-environmental behaviors, such as conserving water and energy or sorting waste. This relationship has also been supported by recent meta-analyses (Klöckner, 2013; Bamberg & Möser, 2007), which highlight that intention—reinforced by personal norms, perceived behavioral control, and biospheric values—constitutes a robust predictor of environmental behavior. In Ecuador, despite progress in the legal framework for environmental protection—as evidenced by the recognition of the rights of nature in the 2008 Montecristi Constitution—policies to raise environmental awareness have been insufficient. Although the introduction of these rights has helped address critical issues such as deforestation and illegal mining, equal attention has not been paid to the impact that households' daily habits have on environmental degradation. This is particularly concerning, given that everyday behaviors—such as the use of plastics and waste management—play a significant role in environmental sustainability (Bamberg & Möser, 2007; Ponce et al., 2019).

The results of this study provide useful evidence for designing policies that promote changes in household environmental behavior. In particular, they justify investing in environmental education programs and awareness campaigns, as environmental awareness significantly influences the adoption of pro-environmental practices. Furthermore, they highlight the need for policies tailored to socioeconomic conditions, recognizing that behavioral change depends on both attitudes and actual opportunities to act. Therefore, it is recommended to coordinate inter-institutional actions that reinforce environmental awareness and eliminate structural barriers to sustainable behavior, especially in a context such as Ecuador's, where institutional weaknesses in implementing effective environmental policies persist.

The article is organized as follows. Section 2 presents a review of the literature, with an emphasis on approaches that explain the adoption of pro-environmental practices from an individual behavior perspective. Section 3 describes the data, variables, and methodological strategy, detailing the application of the *PSM* method to estimate the effect of environmental awareness. Section 4 discusses the main empirical results. Finally, Section 5 presents the conclusions, policy implications, and future research directions.

2. Literature Review

The acceleration of economic development has intensified environmental pressures, prompting growing academic interest in understanding the determinants of pro-environmental behavior. In this context, the Theory of Planned Behavior (TPB) is the most robust conceptual framework

for explaining the relationships among attitudes, social norms, perceived behavioral control, and behavioral intention (Ajzen, 1991). Studies confirm that PBT retains strong explanatory power in the analysis of environmental action, especially when adapted to specific socioeconomic contexts (La Barbera & Ajzen, 2020).

The literature shows that pro-environmental behavior is influenced not only by individual factors but also by normative and contextual factors. In this vein, environmental awareness and perceived behavioral control are identified as determinants of practices such as recycling and energy conservation (Müller et al., 2021; Wijekoon & Sabri, 2021). Similarly, the inclusion of personal moral standards and ethical obligations strengthens the relationship between intention and action, thereby expanding the explanatory power of the TCP in environmental decisions involving short-term costs (Kumar et al., 2023).

Empirical evidence indicates that environmental education is a key factor in the adoption of sustainable behaviors. Studies across various contexts show that higher levels of education are associated with more favorable attitudes toward sustainability and greater consistency between intentions and environmental action, particularly in areas such as responsible consumption and climate change mitigation (Suárez-Perales et al., 2021; Situmorang et al., 2023). Similarly, sociodemographic variables such as age and Gender have significant effects, with women and older individuals tending to exhibit more consistent environmental behaviors (Mertens et al., 2021; Szulc-Obłoza & Żurek, 2024).

Studies applying the TCP in various contexts report consistent findings regarding its determinants. The evidence indicates that attitudes and perceived behavioral control help explain behaviors such as recycling, energy conservation, and sustainable consumption, whereas the influence of social norms tends to vary across socioeconomic and cultural contexts (Juliana et al., 2022; Mohamad et al., 2022). Likewise, in the agricultural sector and water management, the explanatory utility of the TCP is confirmed when structural constraints and contextual factors are incorporated (Mahdavi, 2021).

In emerging economies and Latin American contexts, empirical evidence remains limited but is growing. Available studies highlight that educational, sociodemographic, and cultural factors significantly influence the effectiveness of behavioral models, reinforcing the need for context-specific empirical analyses. In particular, the scarcity of causal research in the Ecuadorian context reveals a significant gap in the literature that this study aims to address.

3. Data and Methodology

3.1. Data

The data used in this study come from official sources of the National Survey on Employment and Underemployment (ENEMDU) – INEC (2025), which is conducted at the household level and covers the period 2010–2014 in Ecuador. A pooled dataset was used, comprising observations from each year, as described in Table A1. Information on sociodemographic and demographic characteristics was obtained from this source. Next, the Household Environmental Information Module (MIAH) – INEC (2015) was used; this module, part of the ENEMDU database, provides information on households' pro-environmental practices and environmental awareness. Based on this information, the database was constructed; to do so, a household head identifier was generated to link the sociodemographic, demographic, and environmental characteristics for each observation. Subsequently, the variable measuring pro-environmental practices is defined by water conservation, energy conservation, or waste sorting. In other words, when a household meets any of these three conditions, it is considered to engage in pro-environmental practices.

Furthermore, the theoretical framework of this study draws on the Theory of Planned Behavior (TPB) established by Ajzen (1991), which states that pro-environmental practices are determined by the intention to perform a specific action (planned behavior). Consequently, following previous studies (Hagger & Hamilton, 2024), this research uses the variable "environmental awareness" as a proxy for planned behavior. Subsequently, a set of covariates was used to calculate treatment propensity scores, which are later employed in econometric modeling. Propensity scores are used to compare household heads with and without environmental awareness (treatment). This approach allows comparisons based on observable household characteristics and adjusts for potential bias in estimating the treatment's causal effect. Table 1 presents a detailed description of the variables used in the model.

Table 1

Description of variables used in the model

Variable		Abbreviation	Description
Dependent variable	Pro-environmental practices	Ppaa	A household is considered to engage in pro-environmental practices if it meets at least one of the following three conditions: water conservation, energy conservation, or waste sorting. Water conservation takes the value 1 when the household engages in water conservation practices, 0 otherwise. Energy conservation takes the value 1 when the household engages in energy conservation practices, 0 otherwise. Waste sorting takes the value 1 when waste is sorted in the household, 0 otherwise.
Treatment variable (theoretical)	Environmental awareness	Camb	A household is considered environmentally conscious if it has received some form of training or is concerned about environmental issues. It takes the value 1 when the household is environmentally conscious, 0 otherwise.
Matching covariates	Log of labor income	Lingrl	Natural logarithm of the household head's labor income.
	Industry	sector	Defines the economic sector in which the head of household works. 1: Agriculture, 2: Manufacturing, 3: Services.
	Education	Ed	Number of years of schooling completed by the head of household.
	Age	Age	Age of the head of household.
	Female	female	Gender of the head of household. 0 if male, 1 if female.
	Indigenous	indigenous	Ethnic self-identification of the head of household. 0 if white or mixed-race, and 1 if Indigenous.
	Married	married	Marital status of the head of household. 0 if single or not living with a partner, and 1 if married.
	Rural	rural	Location of the head of household's residence. 0 if in an urban area and 1 if in a rural area.
	Natural region	regn	Indicates the geographic region where the head of household lives. 1: Coast, 2: Highlands, 3: Amazon, 4: Islands.

Note: Author's own compilation (2025)

Before estimating the causal effect of environmental awareness on pro-environmental practices, a t-test was conducted to compare the means between households with environmental awareness (treatment group) and those without (control group). The objective was to examine the distribution of the observable variables in both groups. Table 2 presents the p-values associated with the covariates in the matching model. The results show significant differences at the 0.01% level for most variables, except for the variable indicating female Gender. This indicates that the distribution of the covariates differs substantially, confirming the presence of selection bias. This situation supports the use of PSM, since, as Rosenbaum and Rubin (1983) point out, the propensity score balances covariates and reduces bias between the treatment and control groups.

Table 2

Difference in means between the treatment and control groups, by environmental awareness variable

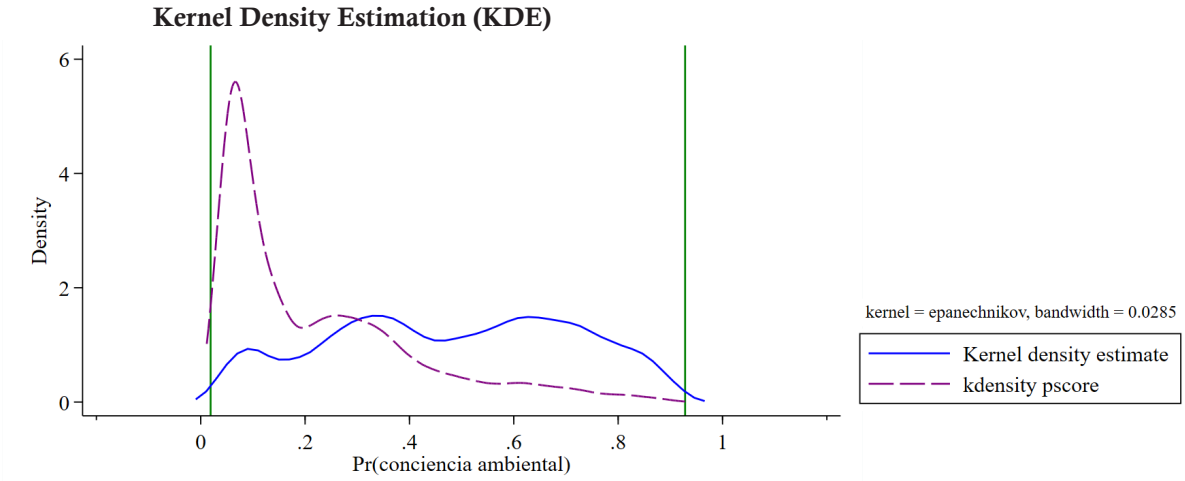
Variables	Difference	p-value
Log of labor income	-0.1943	0.000
Economic sector	-0.1720	0.000
Education	-1.5913	0.000
Age	0.4465	0.000
Female	0.0001	0.970
Indigenous	0.0301	0.000
Married	-0.0163	0.000
Rural	0.0691	0.000
Natural region	0.0062	0.000

Note: Author's own calculations (2025). Significant difference at the 0.01% confidence level.

Figure 1 below shows the distribution of propensity scores for both groups: the treatment group (with environmental awareness) and the control group (without environmental awareness). The density function is obtained using a logistic model with selected covariates. The observable overlap between the two groups suggests the application of the propensity score matching method, particularly in the range of 0.1–0.85; that is, there are sufficient comparable observations between the groups. The green vertical lines denote the boundaries of the common support to be used in the analysis. From a methodological standpoint, this is highly relevant, as the common support assumption is a necessary condition for estimating the effect using PSM. The analyses to be conducted later focus on the common support area, thereby ensuring that estimates of the treatment effect are obtained using comparable units and reinforcing the validity of the applied quasi-experimental design.

Figure 1

Distribution of propensity scores before matching



Note. Author's own work (2025). The figure shows the estimated probability density function of the propensity score for the environmentally conscious group (blue line) and the non-environmentally conscious group (purple line).

3.2. Methodology

To evaluate pro-environmental practices, the PSM method is used, a statistical technique that estimates the causal effect of a treatment or intervention by comparing treatment and control groups that are similar in observable characteristics. In this regard, the use of PSM in the evaluation of pro-

environmental practices is widely justified by its ability to address selection bias in observational studies, allowing for a more precise estimation of the causal effect of such practices. The method was introduced by Rosenbaum and Rubin (1983) and is based on Rubin's (1974) causal model for observational studies. Therefore, PSM compares variables by evaluating the probability of participating in the treatment (*T*) based on observed characteristics (*X*), as detailed in Equation 1.

$$P(X) = Pr(T = 1|X) \tag{1}$$

Thus, the PSM is estimated using a logistic regression model, calculating the probability that a household will adopt pro-environmental practices based on the observable variables. Equation 2 formalizes the model, where T is the dichotomous variable indicating the adoption of pro-environmental practices, X is the vector of covariates, and β are the estimated coefficients.

$$Pr(T = 1|X) = probit(X'\beta) \tag{2}$$

Additionally, Rosenbaum and Rubin (1983) note that the PSM is based on two assumptions that must be met for the identification of the causal effect. The first, related to conditional independence (CIA), states that given a set of observable covariates X_i that are unaffected by the treatment, the potential outcomes Y_i are strictly independent of the treatment assignment . Fulfillment of this assumption guarantees the consistency of the causal effect estimator, to the extent that all relevant heterogeneity that simultaneously affects treatment assignment T_i and the outcome of interest is captured by the observable covariates included in the model. This is expressed in Equation 3, where Y_i^T represents the treated group and Y_i^c represents the untreated ("control") group.

$$(Y_i^T, Y_i^C) \perp T_i \,|X_i \tag{3}$$

The second assumption corresponds to the common support or overlap condition. Heckman et al. (1999) state that this assumption guarantees the existence of close comparison counterparts in the distribution of propensity scores, which ensures that the treatment effect is estimated without resorting to extrapolations beyond the range of the observed data. Therefore, the PSM method is effective when there is a significant number of observations of treated and untreated groups, allowing for the identification of a common support region. Consequently, the effect of environmental awareness is evaluated by comparing treated and untreated households. Formally, the model specification is given in Equation 4.

$$ATET = E(\Delta) = E(Y_i^T \,|X_i, T_i = 1) - E(Y_i^C \,|X_i, T_i = 0) \tag{4}$$

Where *ATET* is the average effect of the treatment on the treated group, Δ captures the difference between the effects of the treated group Y_i^T and the control group without the treatment Y_i^c. Next, we applied the *exact matching* or *coarsened exact matching* technique proposed by Iacus et al. (2012), in which covariates were grouped into intervals (*coarsening*) to allow for exact matches within those categories. This improved the balance between groups without requiring strict parametric specifications and ensured that matching occurred only between comparable units. The covariates are captured in the function *p(X)* , so the model conforms to Equation 5.

$$ATET = E(Y_i^T \mid p(X), T_i = 1) - E(Y_i^C \mid p(X), T_i = 0) \quad (5)$$

Therefore, for the empirical estimation, each treated household i is matched with household j, and their outcomes Y_i^c are weighted by$w$, as indicated in Equation 6, which corresponds to the sample analogue of the ATET defined in Equations 4 and 5, since it operationalizes it as a weighted average of the differences in observed outcomes between each treated household and its matched counterparts in the control group. The weights w_{ij} reflect the matching algorithm used and allow us to construct an empirical counterfactual for the treated households.

Subject to compliance with the CIA and the common support condition, the matching ensures that the control units are comparable to the treated units. Thus, Equation (6) approximates the expected value of the unobserved potential outcome in the absence of the treatment, thereby enabling the empirical estimation of the ATET. This methodology has been widely used in empirical impact evaluation studies based on observational data, particularly in the analysis of environmental policies and behaviors, where assignment to treatment is not random (Ferraro & Miranda, 2013).

$$ATET = \frac{1}{N_T} \sum_{i \epsilon \{T=1\}}^{i} \left(Y_i^T \sum_{j}^{i} w_{ij} Y_{ij}^C \right) \quad (6)$$

Despite its advantages, the PSM method has limitations inherent to its identification framework. In particular, the causal validity of the estimates depends on compliance with the CIA. In this study, this assumption implies that all relevant variables that simultaneously influence environmental awareness and the adoption of pro-environmental practices are adequately captured by the covariates included in the model. If there were unobservable factors affecting both the probability of developing environmental awareness and pro-environmental behavior, the CIA would be violated, and the estimates of the causal effect could be biased. In this regard, the results should be interpreted as valid estimates under the assumption of selection on observables. However, provided that the CIA and the common support condition are satisfied, propensity score matching is sufficient to identify the ATET.

4. Results and Discussion

4.1. Profile of Households with Environmental Awareness

The results of the probit model shown in Table 3 confirm that environmental awareness in households is conditioned by economic, educational, demographic, and territorial factors, and these results are consistent with the empirical evidence. In particular, labor income has a positive and statistically significant effect on the probability of developing environmental awareness, which is consistent with studies showing that better economic conditions facilitate access to environmental information, clean technologies, and sustainable goods. However, income alone does not guarantee sustainable pro-environmental behaviors; it must be accompanied by other factors such as institutional incentives, social norms, and cultural contexts (Powdthavee, 2021; Szulc-Obłoza and Żurek, 2024).

Education emerges as one of the most robust determinants, reinforcing the assumption that higher levels of education strengthen environmental knowledge, perceptions of self-efficacy, and the alignment between environmental intentions and actions. This finding aligns with evidence

from various global contexts, where formal and higher environmental education has proven to be an essential factor in promoting sustained practices at the household and civic levels (Suárez-Perales et al., 2021; Situmorang et al., 2023).

Table 3
Probit Model of Treatment – PPAA

Variables	*dy/dx*	Robust Std. Err.
Log of labor income	0.0253***	(0.0019)
Economic sector		
Manufacturing	0.0134**	(0.0046)
Services	0.0284***	(0.0044)
Education	0.0103***	(0.0003)
Age	0.0008***	(0.0001)
Female	0.0276***	(0.0050)
Indigenous	0.0107**	(0.0039)
Married	0.0254***	(0.0043)
Rural	-0.0018	(0.0038)
Natural region		
Mountain	0.0529***	(0.0030)
Amazon	0.0610***	(0.0058)
Island	0.0776***	(0.0261)
Wald test	0.0000	
Pseudo R^2	0.2261	

Note: Author's own calculations (2025). ***, **, *significance levels at 0.1%, 1%, and 5%.

Age, on the other hand, has a positive effect, consistent with studies that associate greater concern for environmental legacy and stability of values with later stages of the life cycle (Zhang et al., 2024). Another key factor is gender; the results indicate that female-headed households are more likely to develop environmental awareness, consistent with empirical evidence documenting greater environmental sensitivity, ethical concern, and a predisposition toward sustainable behaviors among women. However, the literature acknowledges that gender differences may be constrained by domestic burdens and inequalities in access to resources (Mertens et al., 2021; Szulc-Obłoza and Żurek, 2024).

Indigenous ethnic background shows a positive effect, aligning with studies that highlight how local and indigenous knowledge can enrich the understanding of environmental attitudes and practices by providing cultural perspectives and behavioral approaches (Gadgil et al., 2021). Meanwhile, marital status indicates that households headed by married individuals exhibit greater environmental awareness, which can be explained by family dynamics, intergenerational responsibilities, and socialization that reinforce sustainable habits (Zhang et al., 2024). Finally, regional differences are identified, consistent with studies indicating that territorial conditions, urban planning, environmental infrastructure, and cultural contexts have a decisive influence on the adoption of pro-environmental behaviors. These results confirm that environmental awareness is a multidimensional phenomenon shaped by structural and sociocultural factors, underscoring the importance of comprehensive and context-specific approaches to achieve greater effectiveness (Zhang and Song, 2024).

4.2. Analysis of the effect of environmental awareness on household pro-environmental practices

After identifying the household characteristics associated with the propensity to develop environmental awareness, the analysis focuses on evaluating its effect on pro-environmental practices. To this end, various matching algorithms were applied, as shown in Table 4, all with the

aim of ensuring model consistency by comparing households with similar characteristics between the treatment and control groups. Model "M1" shows the results of the nearest-neighbor method. Model "M2" presents the results of caliper matching with a propensity score distance of 0.049. And model "M3" includes up to ten households from the control group for the effect estimation. The three models, M1–M3, were estimated using the nearest-neighbor matching rule with common support.

Table 4

Average Effect of Environmentally Conscious Households

Variables	M1	M2	M3
	ATET	*ATET*	*ATET*
Environmentally Friendly Practices	0.0395***	0.0392***	0.0382***
	(0.0031)	(0.0030)	(0.0022)
Treaties	21,552	21,551	21,438
Control	12212	12212	38,471

Note: Author's own calculations (2025). ***denotes the significance level at 0.1%. Robust standard errors are reported in parentheses. Estimates are calculated to the units within the common support area. ATET: average treatment effect on the treated.

The results of the matching analysis for the implementation of a PSM show that households with environmental awareness are significantly more likely to adopt pro-environmental practices, with positive and consistent effects across the three matching models applied, showing a 3.82% to 3.95% higher probability of adopting sustainable behaviors compared to comparable households without such awareness. This finding empirically supports the tenets of the TCP by confirming that environmental awareness and intention are key predictors of actual behavior (Ajzen, 1991; Juliana et al., 2022; Mohamad et al., 2022).

The magnitude of the estimated effect is comparable to the results of studies conducted in Asia and Europe, where it has been shown that environmental awareness increases the adoption of practices such as recycling, energy conservation, and responsible consumption; although effectiveness depends on the existence of incentives, social norms, and positive structural conditions (Powdthavee, 2021; Zhang and Song, 2024). These results indicate that the gap between intention and action can be narrowed through public policies that strengthen the perception of behavioral control and provide tangible benefits associated with sustainable practices. In the context of developing economies, empirical evidence remains limited, which underscores the relevance of this study. The consistency of the results with empirical evidence from other regions helps to bridge this empirical gap for the Ecuadorian case, providing evidence on the importance of environmental awareness in the adoption of pro-environmental practices at the household level. Finally, the balance of covariates was assessed using standardized mean differences and graphically represented using a balance-of-covariates plot (Figure B1). Additionally, the common support condition was verified by comparing the distributions of propensity scores between treatment and control groups before and after matching, revealing greater overlap after matching (Figure B2).

5. Conclusions

This study provides empirical evidence on the causal effect of environmental awareness on the adoption of pro-environmental practices by Ecuadorian households. Using the PSM method, we estimated average treatment effects for the treated group ranging from 3.82% to 3.95%, confirming that environmentally conscious households are more likely to engage in sustainable practices than households with similar observable characteristics. These results support the TCP by demonstrating that intention, as measured by environmental awareness, translates into concrete actions in the household setting.

From a public policy perspective, the results suggest that strengthening environmental awareness is an important tool for promoting behavioral changes in households. In particular, environmental education policies, awareness campaigns, and information programs can positively influence the adoption of pro-environmental practices, especially when tailored to socioeconomic, geographic, and cultural conditions. In contexts such as Ecuador's, where regulatory and enforcement mechanisms are limited, promoting environmental awareness can serve as an effective complement to other sustainability-oriented environmental policy instruments.

However, the results must be interpreted with the study's methodological limitations in mind. The identification of the causal effect in PSM relies on the CIA; therefore, the presence of unobservable variables could bias the estimates. Consequently, the estimated effects are valid under the assumption of selection by observables and should not be interpreted as causal evidence in the absence of that assumption. Future research could complement this analysis by using alternative identification strategies or robustness analyses to assess the sensitivity of the results to potential biases from unobserved factors.

Acknowledgments

This study was conducted as part of project 40-DI-FJSA-2023 titled "Assessment of the Factors Determining Pro-Environmental Practices in Ecuador: A Roadmap Toward Sustainable Development," funded by the National University of Loja.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Bamberg, S., y Möser, G. (2007). Twenty years after Hines, Hungerford, and Yomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, *27*(1), 14–25. https://doi.org/10.1016/j.jenvp.2006.12.002

Carvalho, A. M. de, Verly, E., Marchioni, D. M., y Jones, A. D. (2021). Measuring sustainable food systems in Brazil: A framework and multidimensional index to evaluate socioeconomic, nutritional, and environmental aspects. *World Development, 143*, 105470. https://doi.org/10.1016/j.worlddev.2021.105470

Diekmann, A., y Preisendörfer, P. (2003). Green and greenback: The behavioral effects of environmental attitudes in low-cost and high-cost situations. *Rationality and Society, 15*(4), 441–472. https://doi.org/10.1177/1043463103154002

Ferraro, P. J., y Miranda, J. J. (2013). Heterogeneous treatment effects and mechanisms in information-based environmental policies: Evidence from a large-scale field experiment. *Resource and Energy Economics*, *35*(3), 356–379. https://doi.org/10.1016/j.reseneeco.2013.04.001

Gadgil, M., Berkes, F., y Folke, C. (2021). *Indigenous knowledge: From local to global.* Ambio, *50*(5), 967–969. https://doi.org/10.1007/s13280-020-01478-7

Hagger, M. S., y Hamilton, K. (2024). Longitudinal tests of the theory of planned behaviour: A meta-analysis. *European Review of Social Psychology*, *35*(1), 198–254. https://doi.org/10.1080/10463283.2023.2225897

Hansen, A. R., y Jacobsen, M. H. (2020). Like parent, like child: Intergenerational transmission of energy consumption practices in Denmark. *Energy Research & Social Science, 61*, 101341. https://doi.org/10.1016/j.erss.2019.101341

Heckman, J. J., LaLonde, R. J., y Smith, J. A. (1999). The economics and econometrics of active labor market programs. In O. Ashenfelter y D. Card (Eds.), *Handbook of labor economics*, 3 (pp. 1865–2097). Elsevier. https://doi.org/10.1016/S1573-4463(99)03012-6

Iacus, S. M., King, G., y Porro, G. (2012). Causal inference without balance checking: Coarsened exact matching. *Political Analysis*, *20*(1), 1–24. https://doi.org/10.1093/pan/mpr013

Instituto Nacional de Estadística y Censos (INEC). (2015). *Encuesta Nacional de Empleo, Desempleo y Subempleo (ENEMDU).* https://www.ecuadorencifras.gob.ec/enemdu-iv-trimestre-de-2023/

Instituto Nacional de Estadística y Censos (INEC). (2020). *Resultados principales del Módulo de Información Ambiental para Hogares (MIAH) 2019 [Informe técnico].* https://www.ecuadorencifras.gob.ec/

Instituto Nacional de Estadística y Censos. (2025). *Principales resultados del mercado laboral – ENEMDU*. https://www.ecuadorencifras.gob.ec/estadisticas-laborales-enemdu/

IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. *Cambridge University Press.* https://www.ipcc.ch/report/ar6/wg1/

Juliana, N., Lada, S., Chekima, B., y Abdul Adis, A. A. (2022). Exploring determinants shaping recycling behavior using an extended theory of planned behavior model: An empirical study of households in Sabah, Malaysia. *Sustainability, 14*(8), 4628. https://doi.org/10.3390/su14084628

Kumar, R., Kumar, K., Singh, R., Sá, JC, Carvalho, S. y Santos, G. (2023). Modelado del comportamiento de compra con conciencia ambiental: Análisis del rol de la obligación ética y la autoidentidad ecológica. *Sustainability*, *15* (8), 6426. https://doi.org/10.3390/su15086426

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Global Environmental Change*, *23*(5), 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014

La Barbera, F., y Ajzen, I. (2020). Control interactions in the theory of planned behavior: Rethinking the role of subjective norm. *Europe's Journal of Psychology*, *16*(3), e2056. https://doi.org/10.5964/ejop.v16i3.2056

Mahdavi, T. (2021). Application of the theory of planned behavior to understand farmers' intentions to accept water policy options using structural equation modeling. *Water Supply, 21*(6), 2720–2734. https://doi.org/10.2166/ws.2021.138

Mertens, A., von Krause, M., Denk, A., y Heitz, T. (2021). Gender differences in eating behavior and environmental attitudes: The mediating role of the Dark Triad. *Personality and Individual Differences, 168*, 110359. https://doi.org/10.1016/j.paid.2020.110359

Mohamad, N. S., Thoo, A. C., y Huam, H. T. (2022). The determinants of consumers' e-waste recycling behavior through the lens of extended theory of planned behavior. *Sustainability, 14*(15), 9031. https://doi.org/10.3390/su14159031

Müller, J., Acevedo-Duque, Á., Müller, S., Kalia, P. y Mehmood, K. (2021). Modelo predictivo de sostenibilidad basado en la teoría del comportamiento planificado que incorpora la conciencia ecológica y la obligación moral. *Sustainability*, *13* (8), 4248. https://doi.org/10.3390/su13084248

Ponce, P., Alvarado, R., Ponce, K., Alvarado, R., Granda, D., y Yaguana, K. (2019). Green returns of labor income and human capital: Empirical evidence of the environmental behavior of households in developing countries. *Ecological Economics*, *160*, 105–113. https://doi.org/10.1016/j.ecolecon.2019.02.012

Powdthavee, N. (2021). Education and pro-environmental attitudes and behaviours: A nonparametric regression discontinuity analysis of a major schooling reform in England and Wales. *Ecological Economics, 181*, 106931. https://doi.org/10.1016/j.ecolecon.2020.106931

Rosenbaum, P. R., y Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41–55. https://doi.org/10.1093/biomet/70.1.41

Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of Educational Psychology, 66*(5), 688–701. https://doi.org/10.1037/h0037350

Salazar, C., Jaime, M., Leiva, M., y González, N. (2024). Environmental education and children's pro-environmental behavior on plastic waste: Evidence from the green school certification program in Chile. *International Journal of Educational Development*, *109*, 103106. https://doi.org/10.1016/j.ijedudev.2024.103106

Situmorang, R. O. P., Hussain, M., y Chang, S. C. (2023). Assessment of environmental orientations of urban Taiwanese and their relation to climate change mitigation behaviour in central Taiwan. *Climate Services, 30*, 100366. https://doi.org/10.1016/j.cliser.2023.100366

Suárez-Perales, I., Valero-Gil, J., Leyva-de la Hiz, D. I., Rivera-Torres, P., y Garcés-Ayerbe, C. (2021). Educating for the future: How higher education in environmental management affects pro-environmental behaviour. *Journal of Cleaner Production, 321*, 128972. https://doi.org/10.1016/j.jclepro.2021.128972

Stuart, E. A. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Scienc*e, *25*(1), 1–21. https://doi.org/10.1214/09-STS313

Szulc-Obłoza, A., y Żurek, M. (2024). Attitudes and sustainable behaviors with special consideration of income determinants. *European Research on Management and Business Economics, 30*(1), 100240. https://doi.org/10.1016/j.iedeen.2023.100240

Wijekoon, R. y Sabri, MF (2021). Determinantes que influyen en la intención y el comportamiento de compra de productos ecológicos: Revisión bibliográfica y marco de referencia. *Sustainability*, *13* (11), 6219. https://doi.org/10.3390/su13116219

Zen, I. S., Uddin, M. S., Al-Amin, A. Q., Majid, M. R. bin, Almulhim, A. I., y Doberstein, B. (2022). Socioeconomics determinants of household carbon footprint in Iskandar Malaysia. *Journal of Cleaner Production*, *347*, 131256. https://doi.org/10.1016/j.jclepro.2022.131256

Zhang, J., y Song, J. (2024). The impact of government support and farmers' pro-environmental intention on water-saving irrigation techniques adoption: Evidence using propensity score matching. *Water Policy, 26*(2), 154–169. https://doi.org/10.2166/wp.2024.089

Zhang, J., Yao, Y., Xie, X., y Peng, M. Y. P. (2024). Green for us: Parental compensation for children's unsustainable behaviors. *Frontiers in Psychology, 15*, 1529563. https://doi.org/10.3389/fpsyg.2024.1529563

Additional Information

JEL Code: Q56. Q01. D12

Appendices

Appendix A.

Table A1

Number of observations per year examined

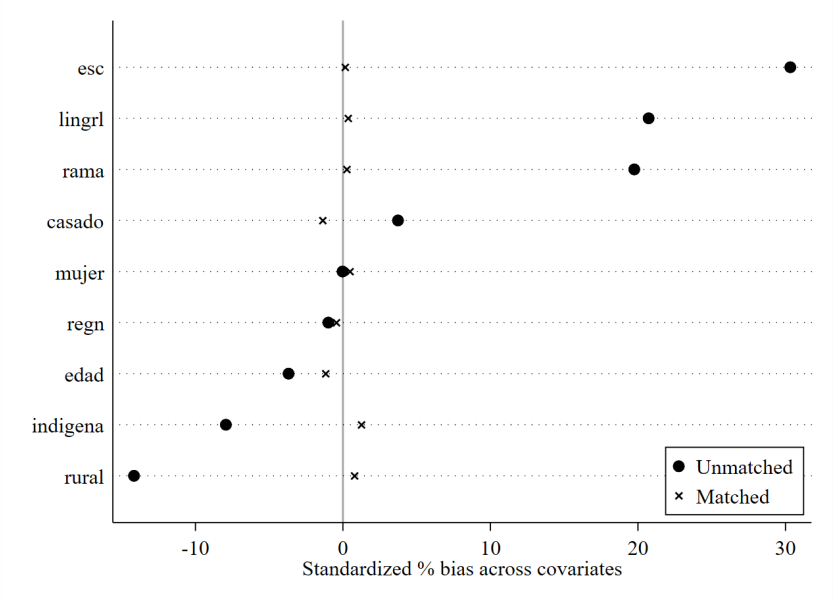
Year	Observations
2010	15,212
2011	13,757
2012	12,587
2013	16,343
2014	23,934

Note: Author (2025)

Appendix B.

Figure B1

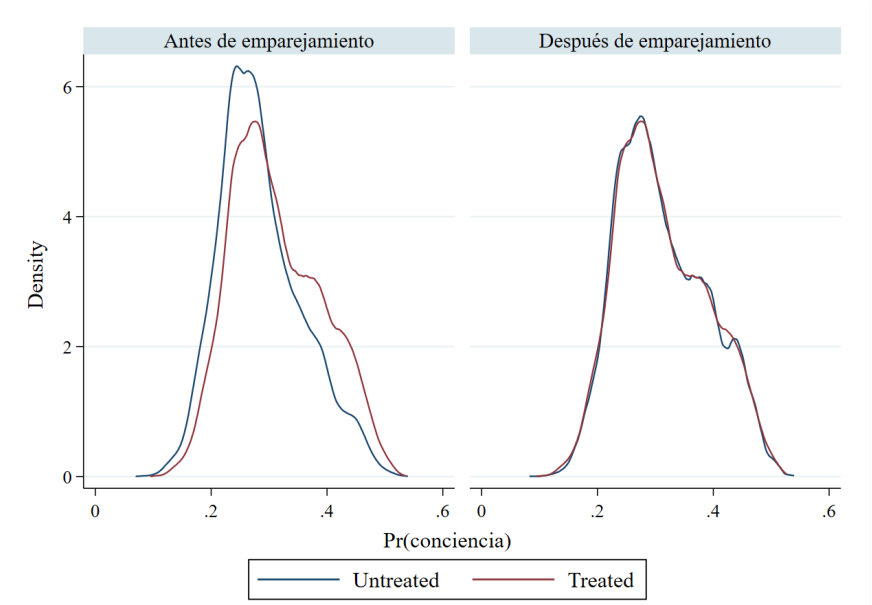
Balance of covariates before and after matching.



Note: Author's own work (2025). The vertical axis is coded using the abbreviations for the variables reported in Table 1. *"Unmatched"* represents the values before matching, and *"Matched" represents* the values after matching.

Figure B2

Verification of common support for treated and control groups, before and after matching



Note. Author's own work (2025). "Untreated" = Control group; "Treated" = Treated group.