

Intergenerational attitude–behavior linkages in household energy saving:**Gender inequality perspective**

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Abstract

Households are pivotal to demand-side conservation, yet how parental gender and gender inequality shape the translation of environmental attitudes into everyday energy saving is not well understood. Using 51,110 parent–adolescent dyads from PISA 2018 across 13 countries and an Actor–Partner Interdependence Model, this study examines how parents’ and adolescents’ attitudes relate to their own and each other’s home energy-saving behaviors. Results indicate that environmental attitudes positively predict own behaviors for both generations. The country-level Gender Inequality Index significantly attenuates this attitude–behavior consistency. This dampening effect constrains both mothers and fathers. Regarding intergenerational transmission, partner effects are weak or negative. However, a significant interaction indicates that adolescent-to-parent associations appear primarily in higher-inequality contexts. These findings suggest that gender inequality is a contextual condition associated with weaker household attitude–behavior consistency. From a policy perspective, the results are consistent with the value of complementing awareness-based approaches with interventions that reduce structural barriers to household conservation.

Keywords: Gender Inequality; Intergenerational Transmission; Household Energy Saving; Environmental Behavior; Environmental Attitude

1. Introduction

Rising energy demand and the emissions associated with household consumption make everyday energy-saving behavior an important component of climate mitigation and sustainable development (Dietz et al., 2013; Khanna et al., 2021; Niamir et al., 2020). Yet household energy use is not simply the product of individual preference. It is embedded in daily routines, shaped by perceptions of comfort and convenience, and constrained by family rules, material resources, and decision-making arrangements (Frederiks et al., 2015; Klöckner, 2013; Pothitou et al., 2016; Steg & Vlek, 2009).

At the micro level, environmental attitudes remain a central starting point for understanding behavior. The Theory of Planned Behavior (TPB) suggests that individuals with stronger environmental attitudes should be more likely to engage in conservation practices (Ajzen, 1991; Nguyen et al., 2022). At the same time, parents may shape adolescents' orientations and practices through role modeling, norm setting, and resource allocation, whereas adolescents may also introduce school-, media-, and peer-derived environmental knowledge into the household, thereby influencing parental awareness and conduct through reverse socialization (Damerell et al., 2013; Grusec, 2011; J. Liu et al., 2022; Meeusen, 2014; Singh et al., 2020). What remains less clear is whether household energy-saving behavior is driven primarily by individuals' own environmental attitudes, by cross-generational influence, or these processes are conditioned by broader structures.

These processes are likely to be conditioned by macro-level gender inequality. In

settings with higher gender inequality, women may have less authority over household routines and investments, while both women and men may face more rigid expectations regarding who performs, values, or controls domestic energy practices (Kennedy & Kmec, 2018; Lachance-Grzela & Bouchard, 2010). Gender inequality may thus widen the attitude-behavior gap by making pro-environmental preferences more difficult to enact in daily life. It may also shape intergenerational transmission by affecting whose voice carries authority within the household and under what conditions adolescents influence parental behavior or parents successfully transmit norms to children (Casaló & Escario, 2016; Kong & Jia, 2023; Yu, 2024).

To address this question, the present study analyzes linked parent-adolescent reports across a large international sample (51,110 parent-adolescent dyads from 13 countries) using Actor-Partner Interdependence Models. The analysis examines whether parents' and adolescents' environmental attitudes are associated with their own household energy-saving behavior, whether one generation's attitudes are associated with the other generation's behavior, and whether these patterns vary with the country-level gender inequality. The findings show that environmental attitudes are positively associated with individuals' own household energy-saving behavior in both generations, whereas cross-generational associations are generally weak. Higher gender inequality is further associated with weaker attitude-behavior consistency among both parents and adolescents.

This study contributes to the literature in several important respects. First, it

shifts the focus of research on household environmental behavior from whether pro-environmental attitudes exist to the question of when such attitudes are consistently enacted in everyday family practice. Second, it challenges the common assumption that similarity between parents and adolescents necessarily reflects intergenerational transmission by showing the importance of distinguishing family resemblance from cross-generational influence. Third, it offers a more bounded interpretation of reverse socialization, suggesting that adolescent influence on parental behavior should not be treated as a universal pattern but as a context-dependent process. Finally, the study reconceptualizes household energy-saving behavior as a relational and institutionally conditioned practice, shaped not only by environmental attitudes but also by unequal positions.

2. Literature Review

2.1 Household energy-saving behavior and the attitude-behavior link

Household energy-saving behavior is a central component of demand-side climate mitigation because many everyday actions—such as reducing heating and cooling, switching off lights, minimizing standby power, and limiting hot-water use—are low-cost, repeatable, and scalable across households (Khanna et al., 2025; Kola-Bezka & Leki, 2024). Recent scholarship has reinforced the importance of this domain. Cross-national evidence shows that environmental concern, perceived responsibility, and climate awareness are positively associated with household energy-saving behavior (Verachtert, 2022). A recent meta-analysis further indicates that

attitudes, self-efficacy, and personal norms are among the most consistent psychological correlates of domestic energy saving, whereas many sociodemographic variables are comparatively weak predictors (Zawadzki et al., 2025). OECD survey evidence similarly shows that environmentally concerned and environmentally motivated households are more likely to report conservation practices, while psychological barriers, habits, and conflicting goals reduce the probability of acting on those orientations (OECD, 2023, 2024).

These findings are well aligned with the Theory of Planned Behavior (TPB). In TPB, attitudes toward the behavior, subjective norms, and perceived behavioral control shape behavioral intentions, and behavior is expected to occur when intention is supported by sufficient actual control (Ajzen, 1991; Bosnjak et al., 2020). Recent applications of TPB to energy-related behavior continue to show that cognitive attitude, subjective norm, and especially perceived behavioral control are important predictors of energy-saving intentions and practices (Nguyen et al., 2022). At the same time, the growing literature on the attitude-behavior gap emphasizes that favorable environmental attitudes do not automatically produce action when behavior is costly, inconvenient, uncertain, or embedded in competing routines (Hoffmann et al., 2024; Mannoni, 2025). The present study conceptualizes the actor paths between environmental attitudes and household energy-saving behavior as attitude-behavior consistency links, that is, the extent to which favorable environmental attitudes are translated into reported household practice.

2.2 Family socialization and intergenerational transmission

Household energy-saving behavior is produced within families rather than by isolated individuals. Family socialization theory, therefore provides a second essential lens for understanding why environmental attitudes may become household practices (Grusec, 2011; Kong & Jia, 2023). Parents communicate environmental norms through role modeling, direct instruction, shared routines, and the allocation of resources and responsibilities. A growing body of recent work continues to confirm that parents are important socialization agents in the development of young people's environmental attitude and behavior. A systematic review by Liu and Green (2024) shows that children's pro-environmental behavior is shaped by both internal factors, such as attitudes and self-efficacy, and external factors, including environmental education and social context.

Recent dyadic and family-level studies also show that intergenerational influence is not strictly top-down. Research on reverse socialization argues that adolescents can act as environmental socialization agents for their parents by bringing school-based knowledge, peer ideas, media information, and moral claims into family discussion (Moore et al., 2001; Moschis, 1985; Singh et al., 2020). In China, Wang et al. (2022) show that parenting style predicts children's willingness to save energy and that, under some family conditions, children also influence parents' willingness to save energy. Kong and Jia (2023) report that children's environmental knowledge tends to influence parents' pro-environmental behavior more strongly than the reverse pattern.

Using Japanese and Chinese parent-child pairs, Liu and Kaida (2024) likewise find bidirectional within-family transmission of environmental attitudes, psychological barriers, and pro-environmental behaviors. More recent longitudinal evidence indicates that adolescent environmental passion can positively shape parent pro-environmental behavior through adolescent behavior and knowledge transfer, with these effects depending on family communication patterns (Z. Wang & Li, 2024). Experimental and survey evidence also suggests that children's trans-education can encourage parents' green and low-carbon behavior through mechanisms such as moral elevation and environmental commitment (F. Chen et al., 2025; Zhang et al., 2025).

At the same time, this literature does not imply that cross-generational transmission should be expected to dominate within-generation consistency. Recent dyadic studies commonly report actor effects that are larger and more stable than partner effects, while partner effects vary depending on parenting style, communication climate, cultural context, and the specific environmental domain under study (Kong & Jia, 2023; X. Liu & Kaida, 2024; Z. Wang & Li, 2024). This is particularly relevant for household energy saving, because many conservation behaviors are routine, fragmented, and domain specific. One family member's positive attitude may therefore align strongly with that person's own behavior without necessarily spilling over to the other generation.

2.3 Gender inequality as a structural constraint

In the present study, gender inequality is conceptualized not as a proxy for any

single mechanism, but as a broader macro-structural condition that shapes the distribution of authority, resources, opportunities, and social expectations between women and men. It encompasses several interrelated dimensions, including intrahousehold bargaining power, institutional exclusion from education, employment, and decision-making, the persistence of traditional gender-role norms, and wider governance contexts that condition everyday agency (Gutiérrez-Martínez et al., 2021; Yu, 2024). Research on gender and household energy use has shown that many domestic conservation acts are embedded in unequal divisions of labor, unequal access to decision-making authority, and unequal exposure to the routines through which energy is consumed (Chicombo & Musango, 2024; Ng'ombe et al., 2026; Pieper et al., 2025). Women are often more directly involved in cooking, laundry, cleaning, and thermal management, while men more often retain authority over higher-cost purchases, household infrastructure, and formal decision-making processes (Kennedy & Kmec, 2018; Shrestha et al., 2021). Recent evidence confirms that these intrahousehold power arrangements matter for energy outcomes. Female-dominated or gender-neutral households report lower direct energy use and stronger adoption of energy-efficient products than male-dominated households (J. Wang et al., 2021). Similarly, greater female bargaining power increases households' adoption of clean cooking fuels, partly through changes in housework division and traditional gender norms (J. Chen et al., 2024).

Inequality can weaken the link between attitudes and behavior in several ways.

First, structural constraints may limit the translation of pro-environmental attitudes into action. In more gender-unequal settings, women often have less bargaining power over household expenditures and energy decisions while also carrying a disproportionate share of unpaid domestic labor. Under these conditions, even strong environmental attitudes may be harder to convert into concrete behavior because the authority, time, and routine control needed to set rules, make purchases, or reorganize everyday practices are unequally distributed (J. Chen et al., 2024; Flechtner et al., 2024; Pieper et al., 2025). Second, normative constraints may further weaken this link. More traditional gender-role beliefs can shape who is expected to manage domestic work and what kinds of household practices are seen as appropriate for women and men. As a result, pro-environmental commitments may be expressed differently across genders or may fail to be enacted in everyday domestic routines at all. In this respect, recent research on domestic energy saving suggests that gendered behavior patterns are context-dependent and mediated by domain-specific self-efficacy, rather than reflecting a simple universal female advantage (Henriksen et al., 2025; Rainisio et al., 2022; Schubert et al., 2025; Xia & Li, 2023). Third, opportunity-based constraints matter because household energy-saving behavior depends not only on willingness but also on repeated access to situations in which conservation can be enacted. Individuals who are less involved in everyday domestic routines have fewer opportunities to switch off appliances, regulate laundry practices, or reduce hot-water use, whereas those with less household authority have fewer opportunities to

influence thermostat settings, appliance purchases, or broader conservation rules.

More generally, recent experimental evidence on the value–action gap shows that pro-environmental behavior becomes less likely when actions are effortful, inconvenient, or only weakly linked to salient outcomes (Hoffmann et al., 2024).

2.4 Integrating TPB with family socialization and gender inequality

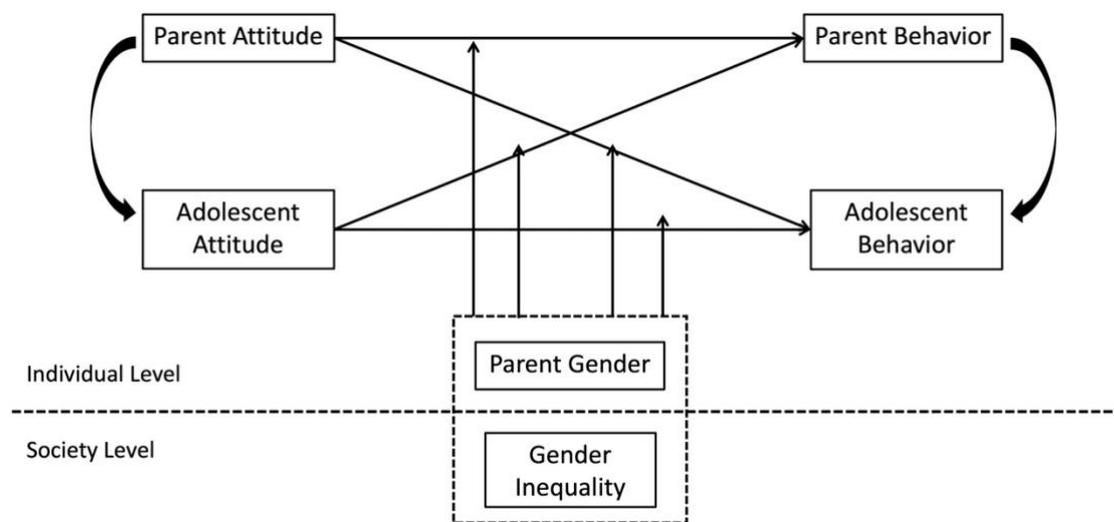
The present study integrates these perspectives by combining TPB, family socialization theory, and a macro-sociological account of gender inequality. TPB specifies the motivational basis of actor effects: individuals with stronger pro-environmental attitudes should be more likely to engage in their own household energy-saving behavior. Family socialization theory specifies why partner effects may also emerge: parents and adolescents observe, instruct, and sometimes influence one another. Gender inequality then enters as a distal contextual moderator that shapes whether these micro-level tendencies can be realized in practice.

This integrated framework leads to three hypotheses. First, stronger environmental attitudes are expected to predict stronger own household energy-saving behavior for both parents and adolescents. Second, cross-generational associations are expected to exist, but they should generally be weaker and more contingent than actor effects because family influence depends on communication, authority, and domain-specific opportunities for enactment. Third, higher gender inequality is expected to weaken the actor-level attitude-behavior link. The moderated pathway of interest is the downstream translation from environmental attitudes to reported behavior. The

empirical strategy therefore focuses on whether parent and adolescent links differ across societal contexts of gender inequality and whether these patterns vary between mother-adolescent and father-adolescent dyads. The research framework is illustrated in Figure 1.

Figure 1.

Research Framework of This Study.



3. Method

3.1 Participants

This study utilizes data from the Programme for International Student Assessment (PISA) 2018 (Schleicher, 2019), an international large-scale assessment coordinated by the Organization for Economic Co-operation and Development (OECD). PISA evaluates the knowledge and skills of 15-year-old students in reading, mathematics, and science, while also collecting extensive background information from students, their households, and schools. The PISA 2018 included a student and parent questionnaire that captured environmental attitudes and behaviors. After selecting cases in which both adolescents and at least one parent responded to the environmental attitudes and household energy saving behavior questionnaire, the final sample comprised 51,110 adolescent–parent pairs across 13 countries (see Table 1). Among them, 9,250 were adolescent–father pairs, and 41,860 were adolescent–mother pairs. The adolescent sample included 26,382 females and 24,728 males.

Table 1.

Sample Proportions by Countries.

Country and Region	Sample (N)	Adolescent (Female %)	Parent (Mother %)
Brazil	4,642	54.30%	80.80%
Chile	4,230	51.20%	85.50%
Croatia	4,259	53.10%	83.40%
Dominican Republic	1,451	51.10%	79.20%
Germany	1,260	52.80%	85.00%
Hong Kong and Macau	7,905	51.00%	74.00%
Ireland	3,899	52.30%	85.40%
Italy	6,360	50.80%	81.40%
Korea	2,069	53.30%	84.60%
Malta	3,678	52.30%	82.50%
Mexico	1,240	52.90%	82.70%
Panama	4,159	51.30%	83.60%
Portugal	5,958	48.90%	85.20%

Note: ^aData for Hong Kong and Macao are combined, as these regions did not have corresponding Gender Inequality Index values. The GII for China was used as a substitute.

3.2 Measurement

3.2.1 Environmental Attitudes

The following items, operationalized in a manner consistent with Liu et al. (2022), were used to assess adolescents' environmental attitudes: "When I see the poor conditions that some people in the world live under, I feel a responsibility to do something"; "I think my behavior can impact people in other countries"; "I can do something about the problems of the world"; "Looking after the global environment is

important to me” (1 = Strongly disagree, 4 = Strongly agree; Cronbach’s $\alpha = 0.790$; CFI = 0.961, TLI = 0.883, RMSEA = 0.328, SRMR = 0.094). The scale showed good loading invariance (CFI = 0.990, TLI = 0.983, RMSEA = 0.092, SRMR = 0.029) and acceptable structural invariance (CFI = 0.986, TLI = 0.990, RMSEA = 0.071, SRMR = 0.030).

Parents’ environmental attitudes, operationalized in a manner consistent with Liu et al. (2022), were measured with four items asking how interested parents were in the following issues: ‘Political or social issues in your country,’ ‘Political or social issues in other countries,’ ‘Environmental issues in your country,’ and ‘Environmental issues in other countries’ (1 = Not interested at all, 4 = Very interested; Cronbach’s $\alpha = 0.825$; CFI = 0.981, TLI = 0.972, RMSEA = 0.071, SRMR = 0.022).¹ The scale showed good loading invariance (CFI = 0.999, TLI = 0.999, RMSEA = 0.034, SRMR = 0.006) and structural invariance (CFI = 0.995, TLI = 0.997, RMSEA = 0.057, SRMR = 0.001).

3.2.2 Household Energy-Saving Behavior

Household energy-saving behavior was measured dichotomously using the following item: “I reduce the energy I use at home (e.g. by turning the heating or air conditioning down, or by switching off lights when leaving a room) to protect the

¹ Because the parental and adolescent attitude measures are based on non-parallel item batteries, these confirmatory factor analyses were used to evaluate the internal structure of each scale separately rather than to establish strict cross-generational measurement equivalence.

environment” (1 = Yes; 0 = No).

3.2.3 Gender Inequality

The Gender Inequality Index (GII), introduced by UNDP in 2010, summarizes gender-based disadvantage in reproductive health, empowerment, and the labor market. For each sex, a composite score (G_F for females, G_M for males) is formed as the geometric mean of the three dimension terms; these two sex-specific scores are then combined via a harmonic mean (penalizing imbalance) and compared with an equality reference $G_{F,M}$ constructed by averaging female and male indicator values within each indicator (then taking a geometric mean across dimensions). The overall index is

$$\text{GII} = 1 - \frac{\frac{2}{G_F} + \frac{1}{G_M}}{G_{F,M}}$$

By construction, GII ranges from 0 to 1: 0 indicates women and men fare equally across the three dimensions (no measured inequality), while values closer to 1 indicate greater gender inequality—i.e., more severe disadvantage for women in the measured dimensions (Gutiérrez-Martínez et al., 2021).

3.3 Statistical Analysis

The Actor-Partner Interdependence Model (APIM) was used to investigate the dyadic process of intergenerational transmission (Kenny & Ledermann, 2010). The APIM accounts for interdependencies by measuring the associations between scores within dyads and assessing the extent to which each dyad member influences the other member’s responses (McCabe, 2017). The APIM is well-suited to understand

how parents' and children's environmental attitudes contribute to their environmental behaviors (Actor effect) and whether the environmental behaviors of one partner affect the other (Partner effect).

The APIM was estimated as an observed-variable structural equation model. In the pooled model, parent behavior was regressed on parent attitude, adolescent attitude, and their respective interactions with the country-level GII; adolescent behavior was specified analogously. The residual covariance between parent and adolescent behavior was freely estimated to account for within-dyad interdependence. The main model was estimated in the full sample, and the Multi-Group Structural Equation Modeling (MG-SEM) was used for subgroup comparison. Because GII is an observed country-level characteristic merged to each dyad, moderation was modeled through manifest cross-level interaction terms rather than random slopes. To quantify between-country clustering, we first estimated intercept-only models; the resulting ICCs were 0.032 for parent behavior and 0.025 for adolescent behavior. All models were estimated using final student weights, and standard errors were adjusted for clustering at the school level using robust maximum likelihood in *lavaan* (Rosseel, 2012). Additional robustness checks included predicted-probability analyses for the binary outcomes, a Weighted Least Squares Mean and Variance adjusted (WLSMV) re-estimation, and leave-one-country-out sensitivity analyses. In addition, because the observed-variable APIM is just-identified or near-saturated at the covariance level, perfect global fit indices are expected by construction and are not used as the primary

basis for model evaluation. (Colin Cameron & Miller, 2015; Elff et al., 2021; Peugh et al., 2013).

4. Results

Figure 2 and Table 2 present the results of the APIM regarding household energy-saving behaviors. Environmental attitudes were significant positive predictors of one's own energy-saving behaviors for both generations. Specifically, parents' environmental attitudes significantly predicted their own reported energy-saving actions ($\beta = 0.056, p < .001$). This effect was significant for both mothers ($\beta = 0.058, p < .001$) and fathers ($\beta = 0.058, p < .001$). Similarly, adolescents' environmental attitudes were positive predictors of their own energy-saving behaviors ($\beta = 0.126, p < .001$), a pattern that held for adolescents in both mother ($\beta = 0.124, p < .001$) and father ($\beta = 0.135, p < .001$).

The GII significantly and negatively moderated the actor attitude-behavior link for parents ($\beta = -0.139, p < .001$). This effect was significant for both mothers ($\beta = -0.146, p < .001$) and fathers ($\beta = -0.100, p < .05$). A Wald test indicated that the difference between the mother and father coefficients was not statistically significant ($\chi^2 = 0.203, p = .652$). This indicates that the dampening effect of gender inequality on the attitude-behavior gap is not gender-specific but acts as a universal constraint on parents. For adolescents, GII also significantly and negatively moderated the relationship between their own attitudes and behavior ($\beta = -0.167, p < .001$). This dampening relationship was observed across both subsamples (Mother-dyads: $\beta = -$

0.164, $p < .001$; Father-dyads: $\beta = -0.181$, $p < .05$).

Cross-generational partner effects were generally weak or non-significant in the overall sample. Parents' attitudes did not significantly predict adolescents' energy-saving behaviors in the overall model ($p > .05$). However, fathers' higher environmental attitudes significantly predicted lower energy-saving behavior in adolescents ($\beta = -0.031$, $p < .01$), whereas the link for mothers was non-significant ($p > .05$). The moderating effect of GII was not statistically significant in the overall sample or the parent subgroups ($p > .05$).

Regarding reverse socialization, adolescents' attitudes did not significantly predict parents' energy-saving behaviors in the main effect model ($p > .05$). However, GII showed a significant positive moderating effect ($\beta = 0.040$, $p < .05$), particularly for mothers. Simple slope analysis clarified the interaction (see Figure 3). At low levels of gender inequality (-1 SD GII), the association between adolescents' attitudes and mothers' behavior was negligible and non-significant ($p > .05$). At high levels of gender inequality ($+1$ SD GII), this association became positive ($p = .002$). To make the substantive size of the actor interactions easier to interpret, we re-estimated the parent and adolescent behavioral equations as survey-weighted logit models and computed predicted probabilities at low and high values of own attitude under low and high GII. For parents, moving from low to high own attitude was associated with an 11.0-point increase in predicted energy-saving probability at low GII, compared with a 5.0-point increase at high GII. For adolescents, the corresponding increase fell

from 17.8 points to 12.1 points.

Figure 2.

Model of Intergenerational Transmission with Gender Inequality as the Moderator.

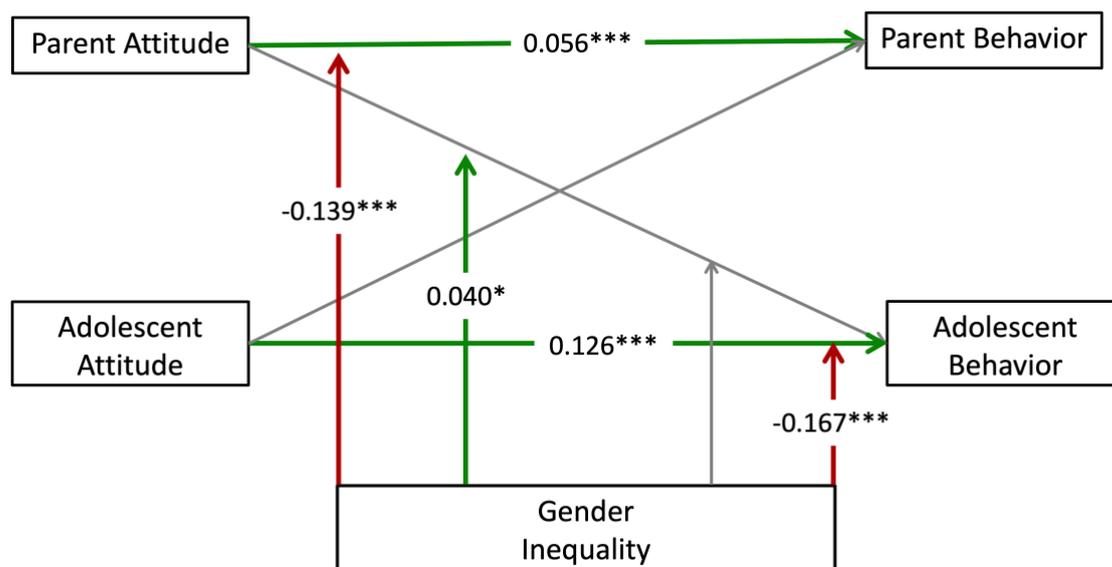


Table 2.

Actor-partner Interdependence Model of Energy-saving Behavior.

	Overall	Mother	Father
pAttitude -> pBehavior	0.056*** (0.003)	0.058*** (0.004)	0.058*** (0.008)
pAttitude * GII -> pBehavior	-0.139*** (0.022)	-0.146*** (0.024)	-0.100* (0.051)
aAttitude -> pBehavior	0.005 (0.003)	0.006 (0.003)	0.002 (0.007)
aAttitude * GII -> pBehavior	0.040* (0.019)	0.044* (0.020)	0.020 (0.046)
aAttitude -> aBehavior	0.126*** (0.005)	0.124*** (0.006)	0.135*** (0.013)
aAttitude * GII -> aBehavior	-0.167*** (0.036)	-0.164*** (0.039)	-0.181* (0.087)
pAttitude -> aBehavior	-0.003 (0.005)	0.003 (0.006)	-0.031** (0.012)
pAttitude * GII -> aBehavior	-0.011 (0.033)	-0.034 (0.036)	0.101 (0.074)
CFI	1.000	1.000	1.000
χ^2	0.000	0.000	0.000
RMSEA	0.000	0.000	0.000
N(obs)	51110	41860	9250

Note. * $p < .05$. ** $p < .01$. *** $p < .001$. aAttitude and aBehavior refer to

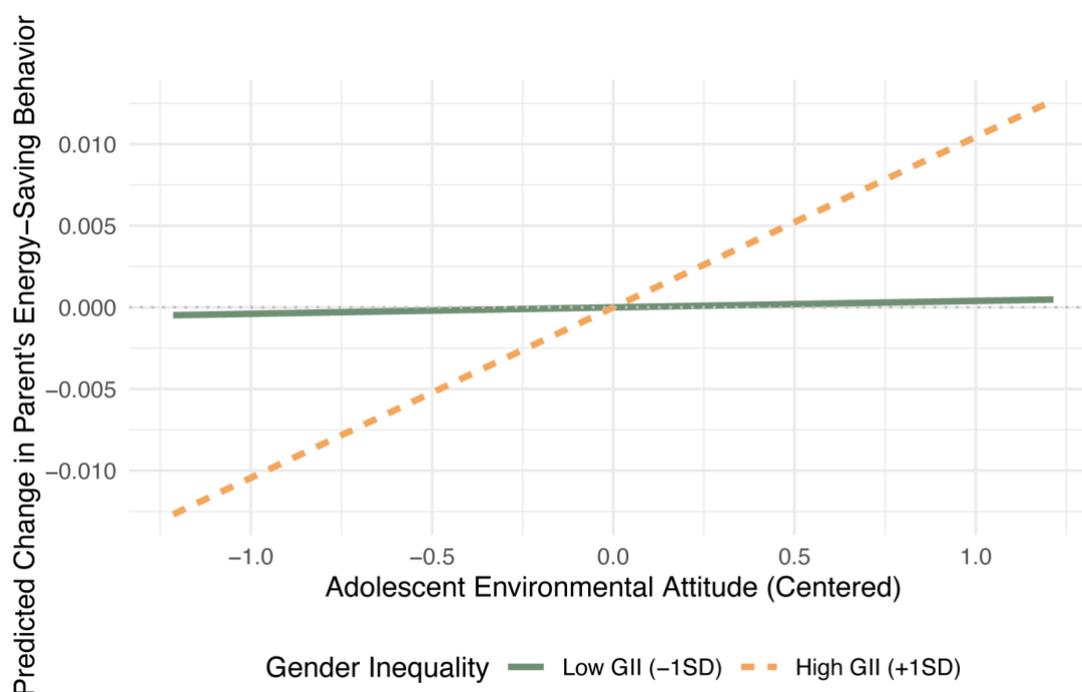
adolescents' environmental attitudes and energy-saving behaviors; pAttitude and

pBehavior refer to parents' environmental attitudes and energy-saving behaviors. GII

refers to the Gender Inequality Index.

Figure 3.

Interaction between adolescent environmental attitudes and gender inequality in predicting parents' energy-saving behaviors.



To verify the robustness of our findings, we conducted two sensitivity analyses.

First, given that the outcome variables (household energy-saving behaviors) were measured dichotomously, we re-estimated the models using the WLSMV estimator.

This approach treats the outcome as ordinal rather than linear. The results were largely consistent with the main linear probability model findings in terms of direction and significance (Table S1). Second, to ensure that the results were not driven by specific countries with potential outliers in sample size or inequality metrics, we conducted a leave-one-out sensitivity analysis. Specifically, we re-estimated the models, systematically excluding one country from the dataset in each iteration. The results remained virtually unchanged compared to the full sample (see Tables S2 to S14).

We re-estimated the pooled APIM separately by adolescent gender, by household socioeconomic status, and by maternal occupational status. Household socioeconomic status was captured using ESCS (Index of Economic, Social and Cultural Status), a continuous PISA 2018 composite indicator reflecting students' family economic, social, and cultural resources. Maternal occupational status was captured using ISEI (International Socio-Economic Index of Occupational Status) score of mothers, a continuous occupational-status indicator in which higher values denote higher occupational socioeconomic standing. In the present study, household socioeconomic status and maternal occupational status were divided into sample-based tertiles to form low-, middle-, and high- groups, and the main heterogeneity comparisons focused on the low- and high-groups. Tables S15–S17 present the analysis results. Among both girls and boys, parents' own attitudes remained positively associated with their own behavior, and the interaction between parent attitude and GII remained negative and statistically significant. Likewise, the adolescent actor effect was positive for both girls and boys, although the GII dampening of adolescents' own attitude-behavior link was stronger for girls than for boys. A similar pattern appeared across the lower and higher household socioeconomic status tertiles: the parent actor effect and its negative interaction with GII were present in both groups, and the adolescent actor interaction with GII remained negative in both tertiles.

For the subgroup analysis by maternal occupational status, the key moderation result remained in both groups: the interaction between parent attitude and GII term

was negative and statistically significant for low maternal ISEI households and for high maternal ISEI households. The interaction between adolescent attitude and GII term also remained negative in both groups. These results suggest that the dampening pattern is not confined to households in which mothers occupy lower occupational-status positions.

5. Discussion

This study examined associations among environmental attitudes, household energy-saving behavior, and the macro-context of gender inequality using a large-scale cross-national dataset. Environmental attitudes were positively associated with reported household energy-saving behavior, and this attitude–behavior consistency was weaker in more gender-unequal contexts. A similar attenuation pattern was observed for both mothers and fathers.

The positive actor associations are broadly consistent with the Theory of Planned Behavior and with prior work showing that environmental attitudes are related to conservation practices in domestic settings (Ajzen, 1991; Clement et al., 2014; X. Liu et al., 2020; Nguyen et al., 2022; Qalati et al., 2022). The present analysis focuses on the downstream translation of existing attitudes into reported behavior rather than on the upstream formation of those attitudes. Environmental attitudes are shaped not only within families but also through schools, public communication, media exposure, peer interaction, and broader educational and institutional environments (Damerell et al., 2013; J. Liu & Green, 2024). The results indicate that once favorable attitudes exist, their behavioral expression inside the home remains contingent on family roles and on wider societal conditions, including the gendered organization of authority, responsibility, and everyday practice.

This study identified that higher GII is associated with weaker attitude–behavior consistency among parents, and that this attenuation appears for both mothers and

fathers. In countries with high GII, both mothers and fathers struggle to translate their environmental attitudes into consistent energy-saving actions. This similarity in the direction of moderation does not imply that the underlying mechanisms are identical. For mothers, the pattern may reflect the combination of unequal unpaid labor burdens, tighter time constraints, and weaker bargaining power over household routines or enabling purchases, all of which may make it more difficult to convert environmental attitude into repeated daily action (Kennedy & Kmec, 2018; Lachance-Grzela & Bouchard, 2010). For fathers, the same statistical pattern may arise through a different channel. In more gender-unequal settings, routine domestic energy-saving practices may be more tightly coded as feminine, low-status, or outside the expected male role, which may narrow men's participation in precisely those repeated household practices through which energy conservation is enacted (Carbone & Cahn, 2016; Mason, 1987; McCright, 2010; Vicente-Molina et al., 2018). In this sense, higher gender inequality may increase the friction costs of conservation for multiple family members (Gifford, 2011; Kollmuss & Agyeman, 2002), but it may do so through different combinations of role expectations, domestic exposure, and decision authority. The present results are therefore more consistent with the interpretation that gender inequality constrains enactment opportunities than with the interpretation that one sex is uniformly less environmentally motivated.

We also found that adolescents' own attitude-behavior consistency was weaker in higher-GII contexts. One possible interpretation is that adolescents in more

hierarchical family settings have fewer opportunities to act on their environmental attitudes within the home (Kulik, 2002). This pattern is consistent with the possibility that restricted autonomy may weaken the alignment between environmental attitudes and reported household practices during adolescence (Dotti Sani & Quaranta, 2017; Krettenauer, 2017).

Contrary to the socialization (or reverse socialization) hypothesis—which posits that parents transmit pro-environmental behaviors to children and vice versa (Bain et al., 2016; Grønhøj & Thøgersen, 2009)—our results show that the direct partner effects were non-significant and for fathers, the relationship was significantly negative. This negative father-to-adolescent association may be consistent with reactance-based interpretations (Brehm, 1966; Hart & Robinson, 1994; Macleod & Lesch, 2024), although the present data do not allow a direct test of that mechanism. An alternative explanation is that household energy use is fragmented across family members' domains of control, so one person's attitudes may have limited correspondence with another person's reported behavior (Gram-Hanssen, 2010; Li & Sunikka-Blank, 2023)..

We found that adolescents' attitudes significantly predicted mothers' energy-saving behaviors only in high-GII contexts. This pattern implies that gender inequality may paradoxically create a niche for adolescent agency through the dynamics of epistemic authority within the household. This pattern should be interpreted cautiously. It is consistent with the possibility that adolescents may sometimes serve

as information conduits within households, particularly where women have more limited access to environmental information or public discourse, but the present data do not directly observe this mechanism (Damerell et al., 2013).

5.1 Theoretical Implications

This study advances the literature on household environmental behavior and gender sociology. First, we refine the application of Social Role Theory in the context of environmental management. Previous scholarship has largely framed gender inequality as a constraint specifically on women's agency, positing that the burden limits women's capacity to act on their environmental values. Our finding of a universal dampening effect, whereby GII attenuates the attitude-behavior link also for fathers, suggests a theoretical shift is needed. Second, this research contributes to Intergenerational Transmission Theory by identifying the boundary conditions of Reverse Socialization. While existing theories often debate whether children influence parents (socialization and reactance), results have been inconsistent. By integrating a macro-micro perspective, we resolve some of these inconsistencies: we demonstrate that reverse socialization is context-dependent, emerging significantly only in high-inequality environments. This adds nuance to theories of family socialization, suggesting that upward influence is not a universal phenomenon but a strategic response to information asymmetry caused by macro-social stratification. Third, we extend the TPB by empirically demonstrating the cross-level interaction between individual psychology and macro-institutional structure. While TPB focuses on

individual precursors to behavior, our multi-level analysis shows that the translation coefficient of attitudes into behavior is not constant but is functionally dependent on the macro-level. This highlights the limitations of purely psychological models in explaining global variations in energy saving and underscores the necessity of incorporating sociological moderators into behavioral environmental research.

5.2 Environmental Management and Policy Implications

The findings of this study have implications for the design and implementation of demand-side energy management policies. It is worth noting that, since environmental attitudes are also shaped by education systems, training, the media, and public discourse, the present findings should not be interpreted as suggesting that parents are the sole or primary policy lever.

Current energy efficiency programs are often framed in gender-neutral terms, implicitly treating the household as a rational and unitary decision-making entity. The present findings suggest that macro-level gender inequality may constitute an important contextual condition under which the translation of environmental attitudes into household energy-saving behavior becomes less consistent. In such settings, interventions that do not take gendered household dynamics into account may have more limited effectiveness. From this perspective, governments and NGOs operating in higher-inequality contexts may benefit from incorporating gender-sensitive considerations into climate action plans (Clancy & Roehr, 2003). This may include strengthening women's participation in household energy-related decision-making

while also challenging role expectations that discourage men from engaging in routine domestic conservation. For example, public campaigns could portray fathers participating in everyday energy-saving practices, thereby helping to frame these behaviors as shared family responsibilities rather than gender-specific tasks.

Schools may also matter not only because they shape environmental knowledge and concern, but also because they can strengthen perceived efficacy and provide more concrete scripts for action. Programs that move beyond abstract awareness and help adolescents navigate or negotiate everyday conservation within the home may be especially relevant in contexts where young people have limited domestic authority. More broadly, international environmental organizations (e.g., IEA, OECD) may need to interpret the likely effectiveness of behavior-change interventions in light of national inequality contexts (Eom et al., 2016). An intervention that performs relatively well in a lower-inequality setting may be less effective in a higher-inequality setting if it relies primarily on attitudinal engagement alone. Relatedly, funding mechanisms may benefit from greater attention to projects that address gender inequality and environmental sustainability in tandem, given that progress in one domain may help support progress in the other.

A further implication is that policy design may need to distinguish between strengthening environmental attitude and strengthening behavioral enactment. The present analysis speaks more directly to the latter. In more gender-unequal contexts, policies may need to lower the domestic costs of action and broaden the range of

actors who can participate meaningfully in household conservation. This may involve combining school curricula, media messaging, utility feedback, and household-level tools rather than assuming that one channel will suffice. It may also involve treating gender equality not as an external social issue disconnected from environmental management, but as part of the social context within which household conservation is more or less feasible. Such an interpretation remains associative rather than causal, but it points to the practical value of integrating behavioral and social-policy perspectives.

5.3 Limitations

This study has several limitations. First, due to the limitations of the PISA data, there were some differences in the environmental attitudes and interest indicators provided by parents and adolescents in the questionnaire, preventing an exact one-to-one correspondence. Although there is a high correlation between different indicators of environmental attitudes (Manoli et al., 2019), future studies should consider designing more detailed and consistent parent-child measurement tools to assess multiple dimensions of environmental awareness. Additionally, the father sample in this study was relatively small, which may have caused some imbalance in the statistical models. Future research could focus more on father samples to ensure the generalizability and robustness of the conclusions. Finally, the design does not permit a reliable analysis of single-parent households. In the PISA parent questionnaire, the presence of one responding parent does not necessarily indicate that the adolescent

lives in a single-parent household; it may also reflect differential survey response within a two-parent family or another household arrangement. For this reason, the present results should not be generalized uncritically to single-parent families. This is an important area for future research, because family structure may shape authority patterns, time pressure, and the opportunities for intergenerational influence in ways not captured here.

6. Conclusion

Using linked parent–adolescent data from 13 countries, this study showed that stronger environmental attitudes were associated with higher reported household energy-saving behavior, but that these associations were weaker in more gender-unequal contexts for both parents and adolescents. Cross-generational partner associations were generally limited, although a positive adolescent-to-mother association appeared in higher-GII settings. Overall, the findings suggest that gender inequality is an important contextual condition for understanding when household conservation attitudes are more or less likely to be reflected in reported behavior.

Data Availability

Programme for International Student Assessment (PISA) 2018 is publicly accessible, see <https://www.oecd.org/en/data/datasets/pisa-2018-database.html>.

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