

Cognitive-Behavioural Gap in Climate-Smart Forestry Intention: A Theory of Planned Behaviour Analysis in Nigeria

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Abstract

Smallholder afforestation is essential to global carbon sequestration targets, yet climate-smart forestry (CSF) adoption in fire-prone savannah ecosystems remains theoretically under-specified and empirically constrained. This study tests whether perceived structural barriers attenuate the psychological pathways linking attitudes, subjective norms, and perceived behavioural control (PBC) to CSF adoption intention. Employing a pragmatist paradigm, a cross-sectional survey (N = 344) was administered to smallholder tree growers in Nigeria's forest-savannah transition zone. Data were analysed using ordinary least squares (OLS) regression to test both direct TPB effects and moderation boundary conditions. The measurement model demonstrated adequate internal consistency for the core constructs. Path analysis indicated Attitude ($\beta = .41, p < .001$), PBC ($\beta = .27, p < .001$), and Subjective Norms ($\beta = .23, p < .001$) significantly predict adoption intention, accounting for 29.0% of the variance ($R^2 = .29$). Contrary to hypothesized structural constraint models, perceived barriers neither directly reduced intention ($p = .518$) nor significantly moderated the attitude-intention ($p = .468$) or PBC-intention ($p = .221$) pathways. The findings suggest subjective psychological drivers operate independently of perceived material constraints in this context, challenging the assumption whereby input-market failures inherently neutralize positive attitudes. Policy interventions must simultaneously target socio-cognitive drivers alongside structural input provision, while addressing profound cognitive-behavioural implementation gaps.

Introduction

Global reliance on terrestrial carbon sinks increasingly depends upon the decentralized land-use decisions of smallholder tree growers operating in climatically volatile biomes (Liu et al. 2020). Within Nigeria's forest-savannah transition zone, a fire-prone, bimodal rainfall mosaic historically classified as the Derived Guinea Savannah, the imperative to transition from conventional woodlot exploitation to climate-smart forestry (CSF) is acute. In contrast, national afforestation strategies predominantly reflect industrial, top-down logic, which frequently fails to account for the cognitive and material frictions governing smallholder adoption (Karsenty 2017). This persistent policy focus on industrial plantation models creates an empirical gap regarding non-industrial private forestry, effectively treating smallholder behavioural architectures as invisible within climate adaptation discourse (Truant & Tondasi 2024). Given the perennial asset specificity and decadal time horizons inherent to silviculture, understanding the precise mechanisms translating abstract climate awareness into concrete operational intention is an urgent priority.

Extant scholarship examining adaptation behaviours has progressively narrowed toward socio-cognitive antecedents, predominantly utilizing the Theory of Planned Behaviour (TPB) to explain variance in agricultural settings (Borges & Oude Lansink, 2016; Mamba & Deressa, 2025). Synthesizing this literature reveals three distinct thematic threads. First, the cognitive-evaluation thread links positive attitudes regarding climate risk mitigation to higher adoption intentions, though this effect exhibits severe contextual heterogeneity (Obi & Baiyegunhi, 2023; Ojo et al., 2023). Second, the normative-pressure

thread demonstrates subjective norms strongly dictate behaviour in communally governed agrarian landscapes, where peer validation acts as an informal risk-insurance mechanism (Zamasiya et al. 2014). Finally, the volition thread highlights perceived behavioural control (PBC) as a critical determinant, particularly where technical complexity deters uptake (Zampier & Rossi 2024). Figure 1 synthesizes these reviewed theoretical strands into an integrative model which proposes three sequential pathways linking socio-cognitive antecedents to adoption intention, while operationalizing structural barriers as a moderating boundary condition.

Despite these advancements, the existing literature leaves a critical void regarding the interaction between psychological agency and structural constraint. Whereas prior studies have treated TPB constructs as universally efficacious, the present study examines their contextual variation because smallholder forestry in input-scarce savannahs is gated by profound market failures (Dillon & Binswanger-Mkhize, 2016). The implicit volition assumption, whereby PBC adequately captures material constraints like seedling scarcity or capital absence, remains empirically untested in perennial forestry contexts (Ajzen 2002). Consequently, it remains equivocal whether positive attitudes and high self-efficacy can survive the attenuating pressure of severe structural barriers, or whether such barriers neutralize psychological agency entirely.

Building on the preceding argument, this study seeks to determine whether structural barriers attenuate the policy-practice pathway observed in prior Northern samples, to evaluate the moderating role of institutional capacity, and to assess the generalizability of the agency-outcome model in an understudied population. Drawing on the instrument described in the methodology below, the analysis tests whether subjective norms, attitudes, and PBC predict CSF intention above and beyond structural limitations. Concurrently, it examines the hypothesis wherein perceived barriers moderate these pathways, such that high barriers significantly reduce the predictive power of attitudes and PBC on final adoption intention.

The findings propose a theoretical refinement to the TPB by demonstrating cognitive antecedents maintain their predictive efficacy irrespective of structural barrier severity in this specific context. Empirically, the study provides a validated smallholder behavioural baseline for CSF in the region. Practically, it guides extension agencies to pivot away from purely technical information dissemination toward combined normative-cognitive interventions. The remainder of this paper proceeds by detailing the methodological framework, presenting the findings and their interpretation, and concluding with the theoretical and policy implications of the analysis.

Methodology

Research Design and Paradigm

This study adopts a pragmatist research paradigm, justified by the dual necessity of post-positivist psychometric measurement and the formulation of policy-relevant interventions for climate adaptation (Morgan 2014). A cross-sectional, single-wave survey design was deployed, utilizing multi-stage

stratified random sampling to capture the behavioural variance among smallholder tree growers across the Derived Guinea Savannah.

Population and Sampling

The target population comprised individual adult decision-makers responsible for private woodlot management. An a priori power analysis using G*Power 3.1 dictated a minimum sample size of 300 to detect medium effect sizes ($f^2 = 0.15$) at $\alpha = .05$ with .95 power (Faul et al. 2009). Data collection occurred between February 10 and April 15, 2026. The sampling procedure involved three stages: purposive selection of three Local Government Areas (LGAs) representing the ecological gradient, random selection of six rural communities per LGA, and systematic random sampling of households from community registers. The final validated sample yielded 344 complete responses. Ethical clearance was secured, ensuring informed consent, data anonymization, and the right to withdraw without prejudice.

Data Collection Instrument

Data were collected using a structured, interviewer-administered questionnaire translated into the local language (Yoruba) via a strict forward-backward translation protocol to ensure cultural equivalence (Brislin, 1970; Colina et al., 2019). Content and face validity were established through a pre-submission expert panel review comprising two agronomists and a local forestry extension officer, followed by a pilot test of 25 non-sample farmers to refine ambiguity. Table 1 summarizes the questionnaire structure, demonstrating all core constructs are operationalized through validated scales drawn from prior literature and adapted for the savannah forestry context.

Table 1
Summary of Data Collection Instrument Structure

Section / Construct	Items	Scale Type	Theoretical Grounding	Reliability Target (α)
Sociodemographic	13	Categorical / Ratio	Baseline controls	N/A
Objective Knowledge (OK)	4	Binary (0/1)	KAP Framework	> .70
Subjective Knowledge (SK)	4	7-point Likert	TPB Extension	> .70
Attitude (ATT)	6	7-point Likert	TPB Core	> .70
Subjective Norms (SN)	4	7-point Likert	TPB Core	> .70
Perceived Behav. Control (PBC)	6	7-point Likert	TPB Core	> .70
Perceived Barriers (PB)	6	7-point Likert	Boundary Condition	> .70
Adoption Intention (INT)	5	7-point Likert	Dependent Variable	> .70

Data Analysis Approach

Raw data were pre-processed to remove unengaged responses, utilizing reverse-coded items to verify cognitive attention. Composite scores were computed for the latent constructs via simple item averaging, appropriate for standard parametric modeling (Field 2013). Ordinary least squares (OLS) regression with standardized variables was employed to test the direct and moderated pathways.

The analytical workflow rigorously checked OLS assumptions prior to structural estimation. Multicollinearity was assessed using Variance Inflation Factors (VIF), with all variables yielding $VIF < 2.0$, well below the conservative threshold of 5.0. Normality of residuals was assessed via the Shapiro-Wilk test ($W = 0.98$, $p = .005$); while technically significant due to the large sample size ($N = 344$), visual inspection of Q-Q plots confirmed the deviations were negligible and acceptable for OLS. Homoscedasticity was verified using the Breusch-Pagan test, which failed to reject the null hypothesis of constant variance ($p = .284$).

Finally, to address the potential for Common Method Bias (CMB) inherent in single-wave self-reported surveys, Harman's single-factor test was conducted. The unrotated single factor explained only 13.9% of the total variance, well below the 50% threshold. Consequently, a theoretically unrelated marker variable included in the survey exhibited a near-zero, non-significant correlation with the dependent variable ($r = -0.006$, $p = .913$), confirming that CMB did not systematically inflate the observed relationships.

Results and Discussion

Sample Characteristics

Table 2 presents the descriptive sociodemographic profile of the sample. The population is heavily male-dominated (75.0%), which accurately reflects the highly restrictive, patriarchal land-tenure systems governing perennial crop investment in the region (Ranjan et al. 2019). The reliance on exceedingly small landholdings (< 2 hectares for 83.4%) corroborates the structural constraint hypothesis, emphasizing the precarious economic foundation upon which these respondents attempt to operationalize climate-smart practices.

Table 2
Sociodemographic Characteristics of the Sample (N = 344)

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	258	75.0
	Female	76	22.1
	Prefer not to say	10	2.9
Age	Mean (SD)	51.1 (12.4)	-
Education Level	Primary or below	171	49.7
	Secondary	137	39.8
	Post-Secondary	36	10.5
Farm Size	< 2 hectares	287	83.4
	2–5 hectares	48	14.0
	> 5 hectares	9	2.6

Measurement Model Evaluation

Prior to evaluating the structural propositions, the internal consistency of the constructs was assessed. Table 3 presents the descriptive statistics and reliability coefficients. Cronbach's α exceeded the .70 threshold for almost all TPB dimensions, validating the psychometric integrity of the adapted instrument. Subjective Norms returned a marginally lower reliability ($\alpha = .678$), which is generally accepted in exploratory savannah contexts where peer-pressure mechanisms are culturally diffuse rather than formal (Nunnally 1978).

Notably, the Objective Knowledge (OK) construct failed psychometric validation entirely ($\alpha = 0.41$) and was consequently excluded from the regression models. This failure suggests that smallholder technical vocabulary regarding CSF is highly fragmented, precluding a unidimensional knowledge scale.

Table 3
Construct Descriptive Statistics and Reliability

Construct	Mean	SD	Items	Cronbach's α
Attitude (ATT)	5.31	1.12	6	0.798
Subjective Norms (SN)	4.44	1.05	4	0.678
Perceived Behav. Control (PBC)	4.04	1.18	6	0.766
Perceived Barriers (PB)	3.97	1.25	6	0.799
Adoption Intention (INT)	4.05	1.21	5	0.766

Base Structural Model: Direct Effects

The first proposition hypothesized attitude, subjective norms, and PBC directly and positively predict CSF adoption intention. As shown in Fig. 2, the path analysis strongly supports this baseline TPB architecture.

Figure 2 demonstrates a clear dominance of the attitudinal pathway ($\beta = .41$, $p < .001$). This finding confirms smallholders who perceive CSF as intrinsically beneficial are highly likely to intend adoption, extending prior assertions regarding cognitive evaluation superseding normative pressure in private forestry decisions (Kreye et al. 2018). Subjective norms also exerted a significant positive effect ($\beta = .23$, $p < .001$), indicating peer validation remains an essential informal insurance mechanism within these communities. The significant positive influence of PBC ($\beta = .27$, $p < .001$) aligns with established agricultural models (Zampier & Rossi 2024), demonstrating technical self-belief is prerequisite to intentionality. The model explains 29.0% of the variance in intention ($R^2 = 0.290$), a strong effect size for socio-psychological field studies.

Moderation Analysis: The Boundary Condition of Structural Barriers

The central analytical objective was to determine whether perceived structural barriers moderate the translation of attitudes and PBC into adoption intentions. Table 4 presents the standardized regression coefficients for the interaction model, indicating the moderation hypotheses are rejected.

Table 4
Moderated Regression Analysis for Adoption

Predictor	Coefficient (β)	Std. Error	t-value	p-value	95% CI
(Constant)	0.009	0.048	0.196	0.845	[-0.085, 0.104]
Attitude (ATT)	0.409	0.047	8.650	< .001	[0.316, 0.502]
Subjective Norms (SN)	0.232	0.046	5.047	< .001	[0.141, 0.322]
Perceived Behav. Control (PBC)	0.274	0.048	5.692	< .001	[0.179, 0.368]
Perceived Barriers (PB)	-0.031	0.048	-0.648	0.518	[-0.126, 0.064]
ATT $\times$ PB	-0.034	0.047	-0.727	0.468	[-0.126, 0.058]
PBC $\times$ PB	0.052	0.043	1.225	0.221	[-0.032, 0.136]

Table 4 indicates the negative coefficient for perceived barriers ($\beta = -.031$, $p = .518$) lacks statistical significance, suggesting structural constraints do not systematically reduce adoption intentions on their own. The non-significant interaction terms (ATT $\times$ PB: $p = .468$; PBC $\times$ PB: $p = .221$) decisively reject the attenuation hypothesis. This outcome challenges the assumption in the existing literature whereby input-market failures inherently neutralize psychological agency (Dillon & Binswanger-Mkhize, 2016). Instead, the data tentatively indicate a phenomenon of cognitive resilience: smallholders maintain their intentionality driven by internal attitudes and community norms regardless of the external difficulties they perceive.

To visually confirm this lack of attenuation, Fig. 3 plots the simple slopes of the interaction between Attitude and Perceived Barriers.

As illustrated in Fig. 3, the relationship between Attitude and Intention remains identically positive whether barriers are perceived as high (+ 1 SD) or low (-1 SD). This visualizes the failure of structural constraints to depress the cognitive drive toward adaptation. In contrast, to systematically understand the cognitive inconsistencies which might explain this resilient intention in the face of known poverty, Fig. 3 plots the discrepancy between subjective self-assessed knowledge and actual objective knowledge scores across the sample.

As illustrated in Fig. 4, respondents exhibit high subjective confidence regarding climate-smart practices despite demonstrating remarkably low objective technical accuracy (indicated by the heavy right-skew of the red objective knowledge distribution versus the left-skew of the green subjective distribution). This suggests the high adoption intention observed may be predicated on an overestimation of technical capacity, a classic manifestation of the Dunning-Kruger effect, or optimism bias, common in complex

agroecological transitions. Consequently, while attitudes strongly drive intention, the operationalization of those intentions in the field is likely to encounter severe implementation failures due to this cognitive-behavioural gap.

Conclusion

This study engineered an integrated psychometric assessment of the socio-cognitive pathways governing climate-smart forestry adoption among smallholder tree growers in Nigeria's forest-savannah transition zone. The evidence confirms intrinsic attitudes, peer-driven subjective norms, and perceived behavioural control significantly predict adoption intention, accounting for nearly 30% of the variance. Crucially, the analysis rejects the hypothesis wherein perceived structural barriers attenuate these cognitive pathways, documenting a psychological resilience where intention persists despite acknowledged input constraints.

These findings theoretically refine the boundary conditions of the TPB by demonstrating cognitive agency in perennial forestry operates independently of perceived material hardship. Practically, the divergence between subjective confidence and objective technical knowledge reveals a critical vulnerability in the extension architecture. Overconfidence acts as a cognitive buffer against structural despair, but it inevitably leads to maladaptation. State forestry departments must act deliberately to correct technical misconceptions through intensive, localized demonstration plots rather than generic awareness campaigns. Non-governmental organizations facilitating REDD+ readiness should leverage the strong attitudinal pathways by framing interventions around intrinsic livelihood protection rather than external carbon metrics. Consequently, acknowledging the heavy gender imbalance (75% male) in the sample highlights that interventions must be deliberately engineered to bypass restrictive patriarchal land-tenure bottlenecks if female smallholders are to participate in the CSF transition.

The cross-sectional design precludes absolute causal inference, bounding the generalizability of these mechanisms to comparable savannah ecosystems. The surprisingly low reliability of the objective knowledge scale indicates the construct requires substantial contextual recalibration. A longitudinal panel design with multi-wave measurement would effectively test whether the observed attitude-intention gap ultimately manifests as an implementation failure over time.

Declarations

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Consent to Participate Informed consent was obtained from all individual participants included in the study.

Data Availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' Contributions:

Lawal Adewale Idris: Conceptualization, Methodology, Project administration, Formal analysis, Writing - original draft.

Abdbazeez Abdbaasit Ololade: Investigation, Data curation, Writing - review & editing.

Abdulrahaman Mayowa Amir: Investigation, Validation, Writing - review & editing.

Owolabi Nurudeen Alabi: Software, Formal analysis, Visualization, Writing - review & editing.

Oyelekan Sunday: Validation, Resources, Writing - review & editing.

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Figures

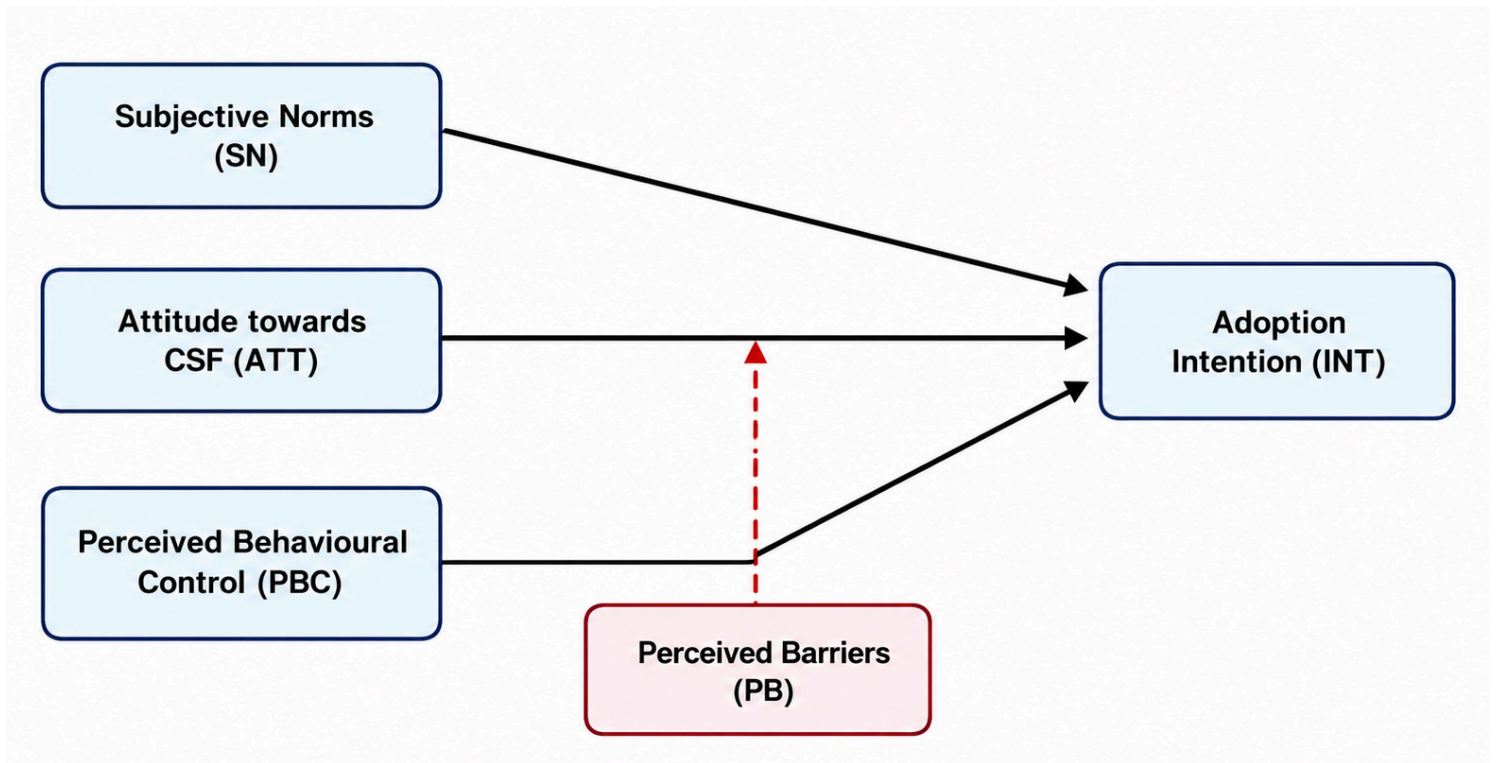


Figure 1

Conceptual Framework of the Moderated TPB Model

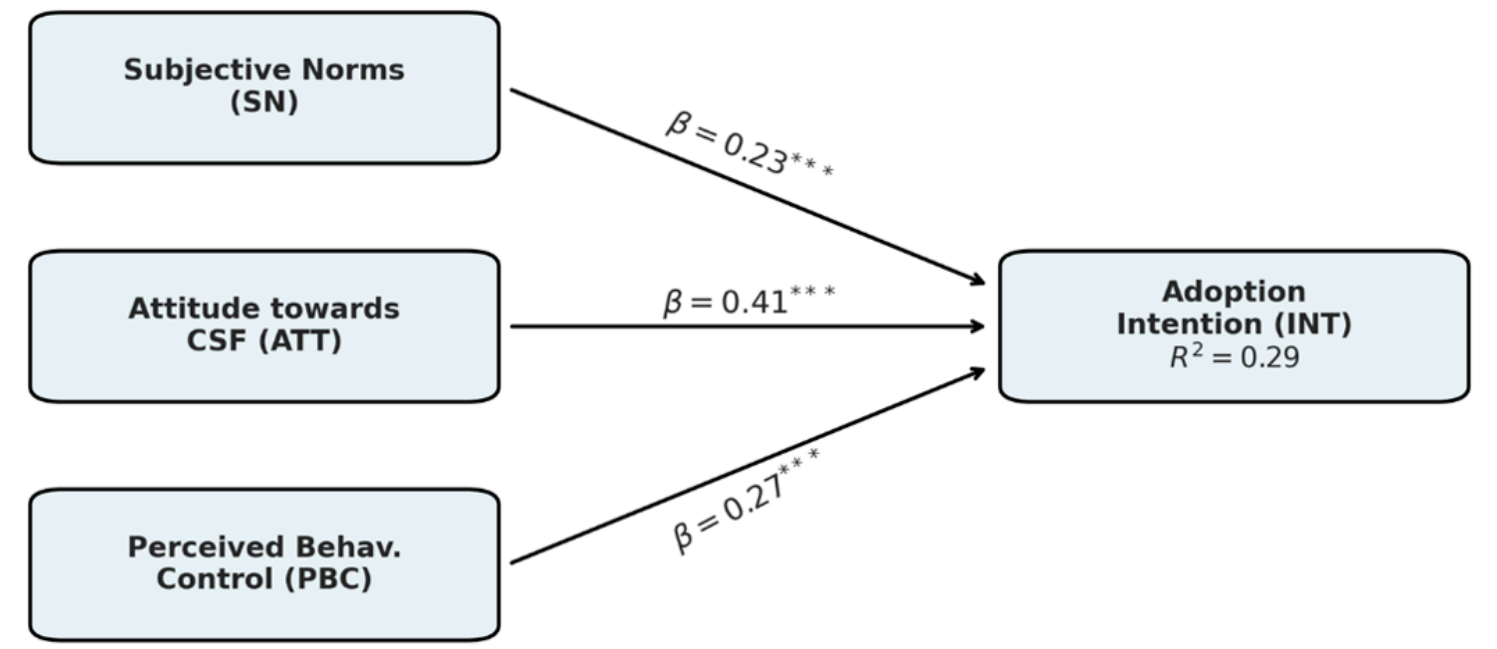


Figure 2

Standardized Path Coefficients for the Base TPB Model.

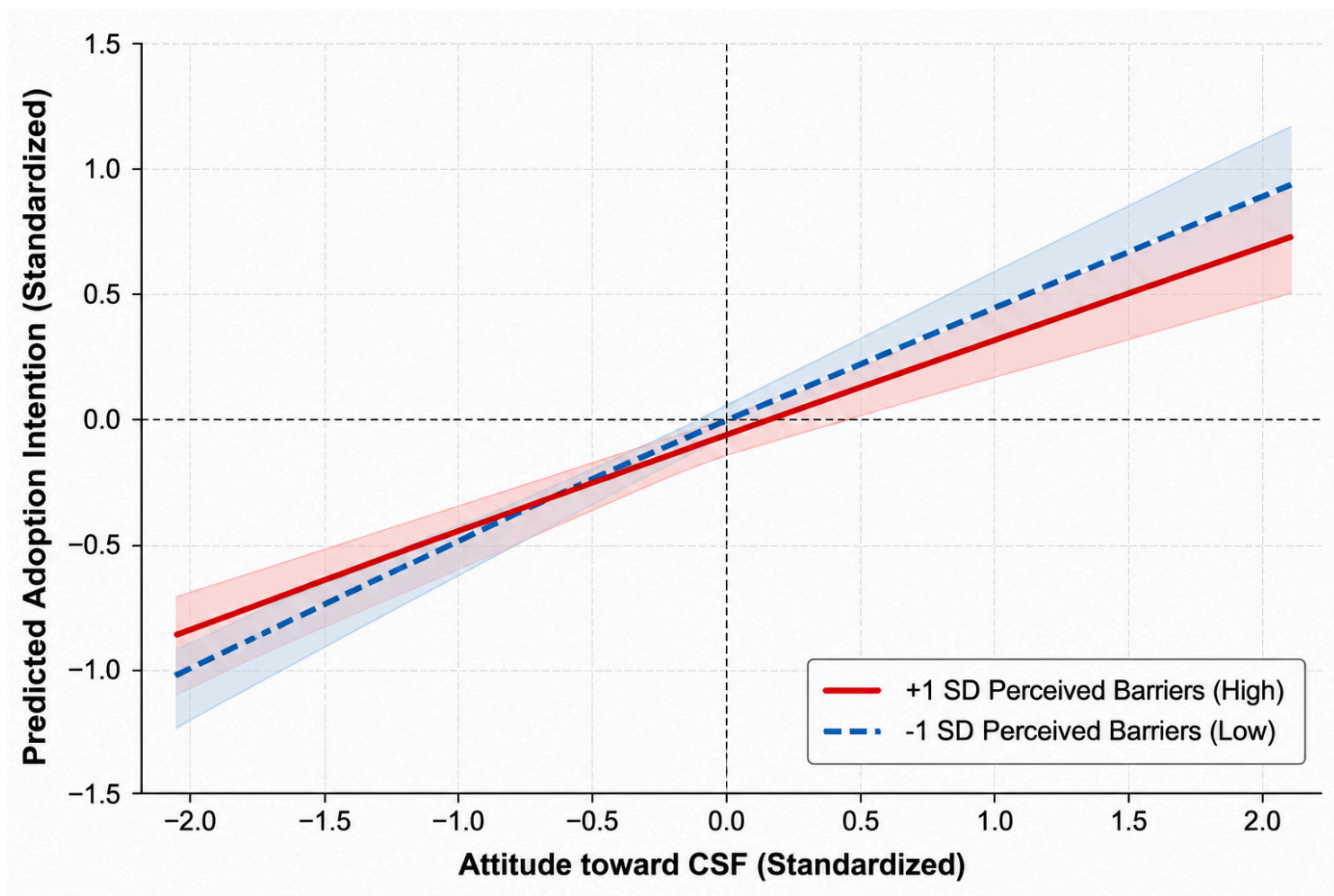


Figure 3

Simple Slopes: Interaction of Attitude and Perceived Barriers.

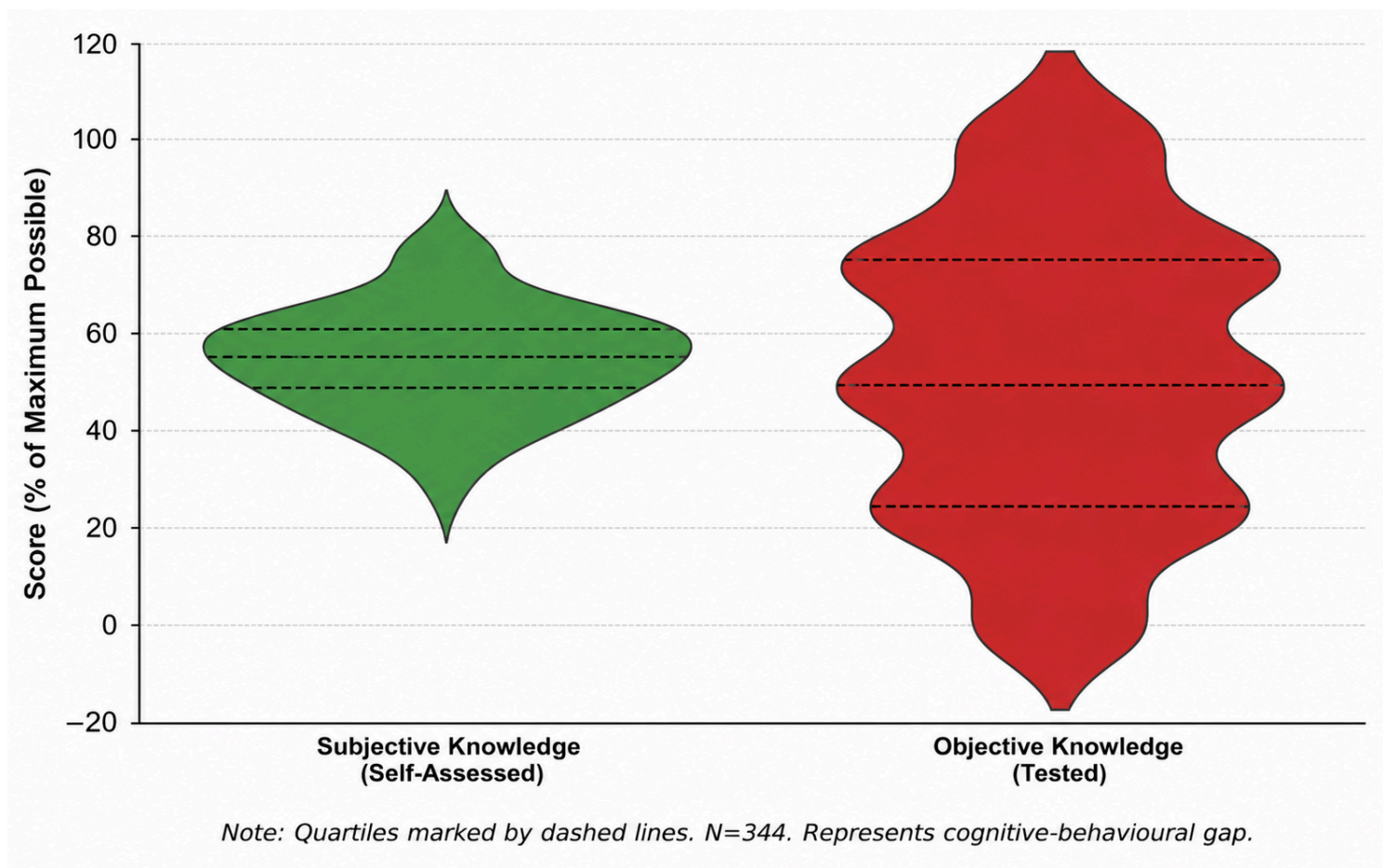


Figure 4

Divergence Between Perceived vs. Actual Technical Knowledge.