

Green FinTech and Sustainable Consumption: Does Digital Financial Innovation Encourage Environmentally Responsible Consumer Behavior?

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Abstract

Digital financial innovation is changing how households pay, borrow, save, compare products, and receive information. These changes can support environmentally responsible consumption by lowering transaction costs, improving access to environmental information, enabling digital incentives, and making low-carbon products easier to purchase. However, these technologies can also increase total consumption by making transactions more convenient, relaxing liquidity constraints, and encouraging frequent purchases. This study develops an evidence-based framework for examining whether Green FinTech encourages sustainable consumer behavior. The available evidence does not establish a universally positive environmental effect. Digital financial services may reduce emissions by changing consumption patterns while simultaneously increasing emissions through higher overall consumption. Consequently, the net environmental outcome may vary across households, countries, and economic contexts. The paper proposes a dual-mechanism model in which Green FinTech influences sustainable consumption through access, convenience, information, incentives, and financial capability while also affecting total consumption through scale expansion. It formalizes the net consumer environmental effect using a scale, composition, and technique decomposition, derives a break-even condition for consumption growth, and develops research propositions, an empirical design, and a Green FinTech Sustainability Index (GFSI) for household-level research. The central implication is that digital financial innovation becomes environmentally responsible only when improvements in consumption composition and resource efficiency outweigh the additional environmental burden created by increased consumption.

1. Introduction

Household consumption is a major source of environmental pressure because purchasing decisions determine demand for energy, transport, food, manufactured goods, housing services, and other resource intensive activities. Pu and Fei (15) note that the United Nations Environment Programme’s Emissions Gap Report 2020 links about two thirds of global greenhouse gas emissions to residential consumption activities. Digital financial innovation is changing the conditions under which these decisions are made. Mobile payments, digital wallets, online banking, digital credit, embedded finance, digital savings products, and financial information services reduce transaction frictions and speed up financial decisions. These technologies may therefore influence not only financial inclusion but also the environmental characteristics of household consumption.

The environmental role of digital finance is ambiguous. On one side, digital financial innovation can support environmentally responsible behavior. Digital payment systems provide information about purchases and transaction histories. Digital platforms can connect consumers with low carbon mobility, sharing services, repair services, environmentally preferable products, and digital incentives. Digital finance can also reduce the information barriers that keep households from adopting efficient products. Niu et al. (14) examine mobile payment adoption as an eco friendly transaction choice and show that the relationship with sustainable consumption depends on social and functional motivations. Yuan et al. (24) investigate mobile payment and sustainable consumption behavior with survey evidence from Chinese higher education students.

On the other side, digital finance can make consumption easier and more frequent. Li et al. (10) find that digital finance promotes household consumption, with larger effects for households that hold fewer assets, earn less, or have lower financial literacy. Yue et al. (25) show that digital finance increases household participation in credit markets and can increase consumption while creating financial distress risks. Research on household carbon emissions provides a direct environmental warning. Qin et al. (18) find that digital finance raises consumption based household carbon emissions through a scale effect and lowers them through a composition effect associated with greener consumption,

and that the scale effect is larger. Pu and Fei (15) report, for 186 Chinese cities, that digital finance raises residential carbon emissions, mainly through electricity consumption and transportation.

The evidence is not uniformly adverse. Xu et al. (23) find that households with greater digital inclusion have higher energy use and carbon emissions because digital inclusion raises consumption, yet the same study finds that digital inclusion improves green consumption in categories with higher energy efficiency. Zhou et al. (26) report a mitigation effect of digital financial inclusion on household carbon emissions in a province panel. Aggregate studies of FinTech point in a favorable direction: Awais et al. (4) use data from 66 countries, Qin et al. (19) identify green finance as a partial mediator, Siddik et al. (21) study firm sustainability performance, and Pu et al. (17) study BRICS countries. By contrast, Sadiq and Ali (20) report that digital financial inclusion is associated with higher CO₂ emissions in a South Asian panel that includes Bangladesh. These differences indicate that the environmental effect depends on the mechanism, the context, the level of development, and the outcome measure.

This paper therefore asks: *Does digital financial innovation encourage environmentally responsible consumer behavior?* The question is framed at the consumer level and is broken into four research questions.

- RQ1** Does digital financial innovation shift household consumption toward lower environmental intensity (green composition)?
- RQ2** Does it raise the total quantity of household consumption (scale)?
- RQ3** Under what conditions does the composition effect outweigh the scale effect?
- RQ4** How can the two effects and the behaviors behind them be measured at the household level?

The paper makes five contributions. First, it integrates Green FinTech and sustainable consumption into one behavioral framework. Second, it separates the green composition effect from the consumption scale effect through an exact accounting decomposition and derives a break even condition. Third, it organizes the mechanisms through

which digital financial innovation affects consumer behavior. Fourth, it proposes measurable indicators and a composite index for household level research. Fifth, it states testable propositions for future work with panel data, household surveys, and transaction level information.

The evidence boundary is 31 December 2024: publications from 2025 onward are not used as evidence. The paper proceeds as follows. Section 2 reviews the literature. Section 3 develops the theoretical framework. Section 4 describes the methodology and measurement. Section 5 synthesizes the evidence and illustrates the framework. Section 6 discusses implications, Section 7 sets out limitations and a research agenda, and Section 8 concludes. Figure 1 summarizes the proposed framework.

2. Literature Review

2.1 Green FinTech and Environmental Sustainability

Green FinTech refers to the use of financial technologies to deliver financial services while improving environmental outcomes or enabling environmentally responsible decisions. The concept covers digital payments, digital banking, digital investment platforms, green financial information, digital credit assessment, carbon related financial incentives, and tools that connect financial transactions with environmental information.

FinTech can contribute to environmental outcomes through several channels. It can improve resource allocation by reducing information costs. It can lower transaction costs and ease access to sustainable products. Digital platforms can create incentives for lower carbon behavior. Financial technology can support green investment and environmental risk assessment. Digital finance can also widen access to products that finance household investment in energy efficiency.

Awais et al. (4) analyze panel data from 66 countries for 2010–2021, build a green growth index, and report a positive impact of FinTech on green growth. Qin et al. (19) report a positive relationship between FinTech and a green environmental index, with green finance acting as a partial mediator. Siddik et al. (21) find that FinTech adoption is positively related to firm environmental and social sustainability performance. Pu et al. (17) report that financial technologies contribute to lower emissions in BRICS countries. These findings support the possibility that digital finance contributes to sustainability, but they do not establish that household consumers behave more responsibly, because aggregate outcomes can improve through production, energy, and financial system channels that do not involve consumer choices.

2.2 Digital Finance and Household Consumption

Digital finance changes household consumption by improving access to payments, credit, savings, and information. Using the China Household Finance Survey for 2013, 2015, and 2017 together with a digital financial inclusion index, Li et al. (10) find that digital finance promotes household consumption, that the effect is larger for households with fewer assets, lower income, and less financial literacy, and that it mainly raises recurring expenditures such as food, clothing, and household maintenance. Online shopping, digital payment, and online credit are identified as the main mediating channels. Using a spatial model for 31 Chinese provinces over 2013–2018, Li et al. (11) estimate that a 1% increase in digital financial inclusion raises household consumption by about 0.22%, that the effect is larger for rural than urban residents, and that spillovers to neighboring provinces are negative. Yue et al. (25) show that digital finance widens participation in credit markets and can create financial distress.

These effects have two environmental consequences. Higher consumption raises demand for goods and services and therefore resource use. At the same time, better access may allow households to replace inefficient products with efficient ones. The environmental effect depends on which mechanism is stronger, which is why consumption levels and consumption composition must be studied together.

2.3 Digital Finance and Household Carbon Emissions

The direct evidence on digital finance and household carbon emissions is mixed. Qin et al. (18) combine household and regional data, use instrumental variable estimation, and identify two opposing mechanisms:

digital finance raises household emissions by stimulating consumption scale and lowers them by promoting greener consumption patterns, with the scale effect prevailing overall. Pu and Fei (15) estimate residential emissions for 186 Chinese cities over 2011–2019 and find that digital finance exacerbates them, mainly through electricity consumption and transportation, with consumption and employment effects as mechanisms. Zhou et al. (26) use panel data for 30 Chinese provinces over 2011–2020 and report a significant and robust mitigation effect of digital financial inclusion on household carbon emissions. Sadiq and Ali (20) examine Pakistan, India, Bangladesh, and Afghanistan over 2011–2021 with a GMM estimator and report that digital financial inclusion is associated with higher CO₂ emissions.

The literature therefore suggests that Green FinTech should not be evaluated only by its ability to enable green purchases. The total effect depends on whether digital access makes households consume more, consume differently, or both.

2.4 Digital Inclusion and Green Consumption

Xu et al. (23) provide direct household level evidence linking digital inclusion with green consumption. Households with greater digital inclusion tend to have higher energy use and carbon emissions because digital inclusion raises consumption. The study also finds that digital inclusion reshapes consumption patterns, affects consumption categories differently, and improves green consumption in categories with higher energy efficiency. This finding is central to the present framework because it shows that environmental and consumption effects can move in opposite directions: a household can become more likely to buy efficient appliances while raising total expenditure and resource use. Environmentally responsible behavior should therefore be measured with both composition indicators and absolute environmental indicators.

2.5 Mobile Payment and Sustainable Consumer Behavior

Mobile payment is one of the most visible consumer level forms of FinTech. It reduces the time and effort needed to complete a transaction and connects consumers with platforms that provide product information and incentives. Yuan et al. (24) use 574 valid survey responses from Chinese higher education students and model perceived risk, perceived usefulness, perceived ease of use, sustainable consumption intention, and sustainable consumption behavior, showing that payment technology characteristics can be built into a behavioral model of sustainable consumption. Niu et al. (14) study eco friendly transactions through mobile payment adoption in Taiwan and the Philippines and find that the determinants of adoption differ across the two contexts, with social and functional motivations playing different roles. FinTech therefore does not operate independently of culture, motivation, and consumer context.

2.6 Scale, Composition, Technique, and Rebound

The distinction between scale and composition has a long history in environmental economics. Grossman and Krueger (9) separated the environmental effects of economic activity into a scale effect from larger output, a composition effect from changes in the mix of activities, and a technique effect from changes in production methods, and Copeland and Taylor (6) review the approach. Index decomposition methods allow such changes to be attributed exactly; Ang (3) compares methods and discusses the properties of log mean Divisia decomposition. A related literature on rebound effects shows that efficiency improvements can be partly offset by higher use, because lower effective costs or higher income encourage additional consumption (8). Digital finance raises the same issue at the household level: an efficiency or composition gain can be offset if digital access also increases total consumption. Section 3 adapts the scale, composition, and technique logic to the consumer decision pathway.

2.7 Environmental Concern and Green Consumer Behavior

Technology alone does not create consumer environmental responsibility. The theory of planned behavior (1) and value belief norm theory (22) emphasize attitudes, perceived behavioral control, personal norms, and beliefs. Choudhury et al. (5) apply machine learning to survey data

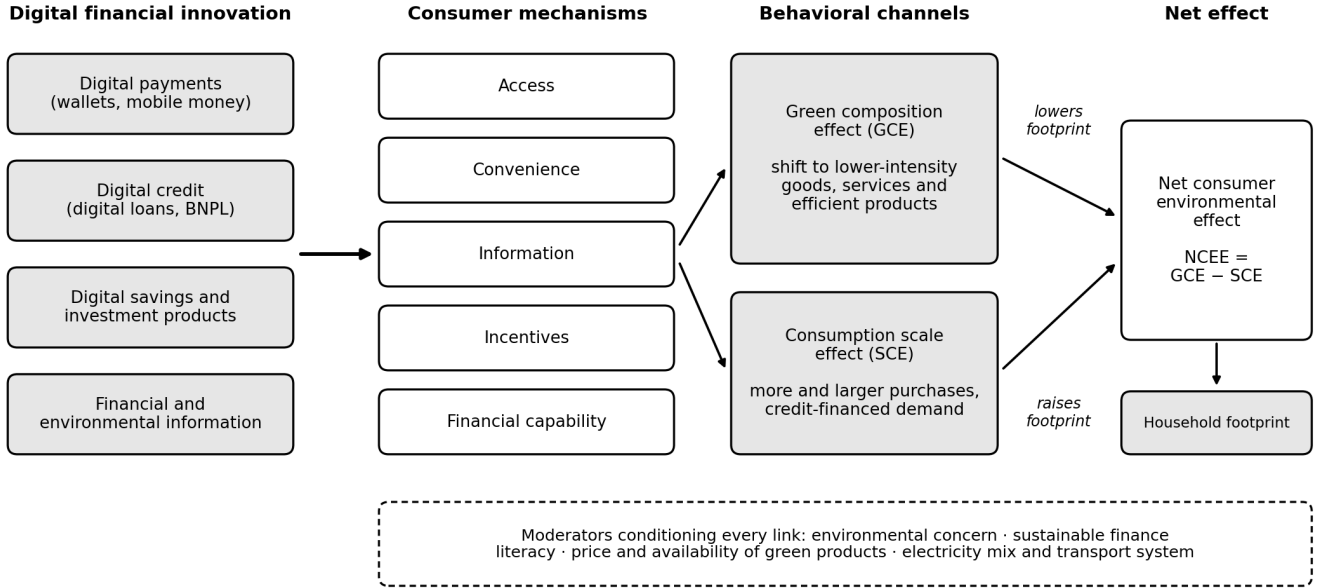


Figure 1. Conceptual framework linking digital financial innovation with sustainable consumption.

from India and report that green self identification and environmental consciousness are the most influential factors for green purchase intention, while social and health consciousness matter less. Aldaihani et al. (2) combine value belief norm theory and the theory of planned behavior in a study of 357 Generation Z consumers and examine how green marketing strategies work through green attitudes and generative artificial intelligence use. Malhotra and Srivastava (13) show that cross channel integration raises green purchase intention through psychological ownership, consumer skepticism, environmental knowledge, and price sensitivity. Green FinTech may therefore work best when financial technology strengthens existing environmental motivation instead of trying to create it from nothing.

2.8 Sustainable Finance Literacy

Financial knowledge is a further mechanism. Filippini et al. (7) study sustainable finance literacy among Swiss households and find that households with high general financial literacy can still have limited knowledge of sustainable financial products. This distinction matters for Green FinTech: digital access without sustainable finance literacy may increase financial activity without improving environmental decisions.

2.9 Research Gap

Five gaps are identified. First, much FinTech research concerns firms, financial markets, or macroeconomic environmental indicators rather than consumer behavior. Second, household studies often examine carbon emissions without measuring environmentally responsible behavior directly. Third, mobile payment research often focuses on adoption rather than environmental consequences. Fourth, green composition and consumption scale effects are not always examined together. Fifth, a unified measurement framework connecting financial innovation, consumer behavior, consumption structure, and environmental outcomes is still missing. This study addresses these gaps through a dual effect framework. Table 1 summarizes the evidence base.

3. Theoretical Framework

3.1 Digital Financial Innovation as Environmental Decision Infrastructure

The paper treats digital finance as an environmental decision infrastructure rather than an inherently green technology. A digital wallet can support a lower carbon transaction but can also facilitate additional purchases. A digital credit product can finance an energy efficient appliance but can also raise discretionary consumption. A financial application can provide carbon information, but the information changes behavior only if the consumer values and uses it.

The framework includes five consumer mechanisms: access, convenience, information, incentives, and financial capability (Table 2).

Access is the ability to use financial services and purchase products that were previously hard to obtain. Convenience is the reduction in time and transaction effort. Information is the financial and environmental information available through digital interfaces. Incentives are rewards, discounts, carbon points, or other mechanisms that encourage particular actions. Financial capability is the ability to compare costs, understand financing terms, and plan consumption.

3.2 Accounting Framework: Scale, Composition, and Technique

Let a household's environmental footprint be

$$F = X \sum_{k=1}^n s_k e_k = X \bar{I}, \quad \bar{I} = \sum_{k=1}^n s_k e_k, \quad (1)$$

where X is total consumption expenditure, s_k is the expenditure share of category k with $\sum_k s_k = 1$, e_k is the environmental intensity of category k per unit of expenditure, and $\bar{I}$ is the average intensity of the consumption basket. Superscripts B and A denote the situation before and after exposure to digital financial innovation.

The consumption scale effect is the change in footprint caused by a change in total expenditure at baseline shares and intensities:

$$SCE = (X^A - X^B) \sum_k s_k^B e_k^B. \quad (2)$$

The green composition effect has two parts. The composition term captures shifts in expenditure shares toward lower intensity categories, and the technique term captures reductions in intensity within categories, such as adopting efficient appliances. Both are defined as footprint reductions, so a positive value is favorable:

$$GCE^{\text{comp}} = -X^A \sum_k (s_k^A - s_k^B) e_k^B, \quad (3)$$

$$GCE^{\text{tech}} = -X^A \sum_k s_k^A (e_k^A - e_k^B), \quad (4)$$

$$GCE = GCE^{\text{comp}} + GCE^{\text{tech}}. \quad (5)$$

The net consumer environmental effect is then

$$NCEE = GCE - SCE = F^B - F^A. \quad (6)$$

The last equality is an exact identity: adding the three terms telescopes to $X^A \sum_k s_k^A e_k^A - X^B \sum_k s_k^B e_k^B$. The decomposition is sequential, with scale first, then composition, then technique, so the split between terms depends on that ordering, although their sum does not. Log mean Divisia methods (3) give an order independent alternative and are recommended for empirical work. This is an accounting identity rather than an empirical estimate. A positive NCEE means that the footprint falls, and a negative value means that additional consumption outweighs the green gains. Curves use assumed parameters, $\rho(d) = 0.16(1 - e^{-5d})$ and $g(d) = 0.22d^{1.3}$, with $GCE = (1 + g)\rho$ and $SCE = g$ as shares of the baseline footprint. They are not estimates.

Table 1. Selected Pre 2025 Evidence Relevant to Green FinTech and Sustainable Consumption

Study	Context and data	Main evidence	Interpretation
Li et al. (10)	China households, CHFS 2013–2017	Digital finance promotes consumption, more so for lower asset, lower income, and lower literacy households; mainly recurring expenditures	Consumption scale mechanism
Li et al. (11)	31 Chinese provinces, 2013–2018	About 0.22% higher consumption per 1% rise in digital financial inclusion; stronger for rural residents; negative spillover to neighbors	Consumption scale mechanism
Yue et al. (25)	China households	Digital finance expands credit participation and changes consumption; financial distress risk	Consumption scale and risk mechanism
Qin et al. (18)	China households and regions	Digital finance raises emissions through scale and lowers them through greener composition; scale prevails	Dual environmental effect
Pu and Fei (15)	186 Chinese cities, 2011–2019	Digital finance raises residential emissions via electricity and transport; consumption and employment effects	Adverse net effect
Xu et al. (23)	Households	Digital inclusion raises energy use and emissions but improves selected high efficiency consumption	Mixed household effect
Zhou et al. (26)	30 Chinese provinces, 2011–2020	Digital financial inclusion mitigates household carbon emissions	Favorable net effect
Sadiq and Ali (20)	Pakistan, India, Bangladesh, Afghanistan, 2011–2021	Digital financial inclusion associated with higher CO ₂ emissions (GMM)	Adverse regional evidence
Awais et al. (4)	66 countries, 2010–2021	FinTech positively affects a green growth index	Macro sustainability channel
Qin et al. (19)	Country panel	FinTech positively related to a green environmental index; green finance partial mediator	Macro sustainability channel
Pu et al. (17)	BRICS	Financial technology contributes to lower emissions in the reported models	Cross country environmental channel
Siddik et al. (21)	Firms	FinTech adoption positively associated with environmental and social sustainability	Organizational sustainability channel
Yuan et al. (24)	574 Chinese students	Mobile payment characteristics linked with sustainable consumption behavior	Consumer behavior mechanism
Niu et al. (14)	Taiwan and Philippines	Mobile payment examined as an eco friendly transaction choice	Context and motivation matter
Filippini et al. (7)	Swiss households	Sustainable finance literacy distinct from general financial literacy	Knowledge mechanism

Table 2. Five Consumer Mechanisms and Their Environmental Pathways

Mechanism	Definition	Green pathway (composition)	Scale pathway	Example indicator
Access	Ability to use financial services and reach products	Financing of efficient appliances, solar systems, and transit passes	Wider purchasing capacity and credit participation	Digital credit access; product availability
Convenience	Lower time and effort per transaction	Easy payment for shared mobility, repair, and reuse	Frictionless repeat purchasing	Payment frequency; app sessions
Information	Financial and environmental data at the point of decision	Visible carbon or energy labels; spending dashboards	Greater product discovery and purchase prompts	Use of dashboards; label lookups
Incentives	Rewards, discounts, and carbon points	Rewards for verified green actions	Promotion driven purchasing	Reward redemption by category
Financial capability	Ability to compare costs and plan	Comparing lifetime cost of efficient options	Over commitment to consumption credit	Financial and sustainable finance literacy scores

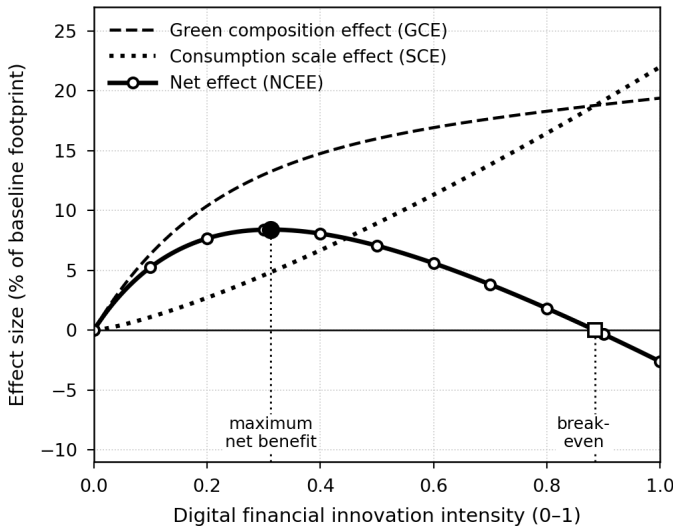


Figure 2. Illustrative trade off between the green composition effect, the consumption scale effect, and the net effect.

3.3 Break Even Condition

Because $F = X\bar{I}$, the footprint does not rise if and only if consumption growth is no larger than the proportional fall in average intensity. Writing $g = X^A/X^B - 1$ for consumption growth and $\rho = 1 - \bar{I}^A/\bar{I}^B$ for the proportional reduction in average intensity, the net effect is non-negative when

$$1 + g \leq \frac{\bar{I}^B}{\bar{I}^A} \iff g \leq g^* = \frac{\rho}{1 - \rho}. \quad (7)$$

The break even growth rate g^* is the largest increase in consumption that a given composition and technique improvement can absorb. If digital finance lowers average intensity by 6%, for example, consumption can grow by about 6.4% before the footprint starts to rise. Figure 2 shows how the pattern can arise when composition gains have dimin-

ishing returns while scale effects keep accumulating: net benefits first rise, peak, and then fall below zero.

3.4 Behavioral Mechanism

The behavioral pathway runs from the digital financial service through a signal, an intention, and a changed behavior to a net environmental outcome (Figure 3). If p_1 is the probability that a relevant signal is received, p_2 that it leads to an intention, p_3 that the intention becomes behavior, and p_4 that the behavior produces a net environmental benefit after rebound, the share of users completing the chain is

$$\Pi = \prod_{j=1}^4 p_j. \quad (8)$$

Because the probabilities multiply, modest failure at every stage compounds into a small overall effect. The pathway is expected to be stronger when consumers have environmental concern, environmental knowledge, sustainable finance literacy, and perceived behavioral control.

3.5 Moderators and Boundary Conditions

The framework expects environmental concern and sustainable finance literacy to moderate the pathway, and it treats price, product availability, income, the electricity mix, and the transport system as boundary conditions. The same digital payment service can have different environmental consequences where electricity generation is carbon intensive, where public transport is limited, or where green products are unavailable or expensive.

4. Methodology

4.1 Research Design

The study is a structured secondary evidence synthesis. The evidence boundary is 31 December 2024, and sources published from 1 January 2025 onward are excluded. Peer reviewed journal articles, established academic databases, and authoritative institutional materials are prioritized. The unit of analysis is the consumer decision pathway. The

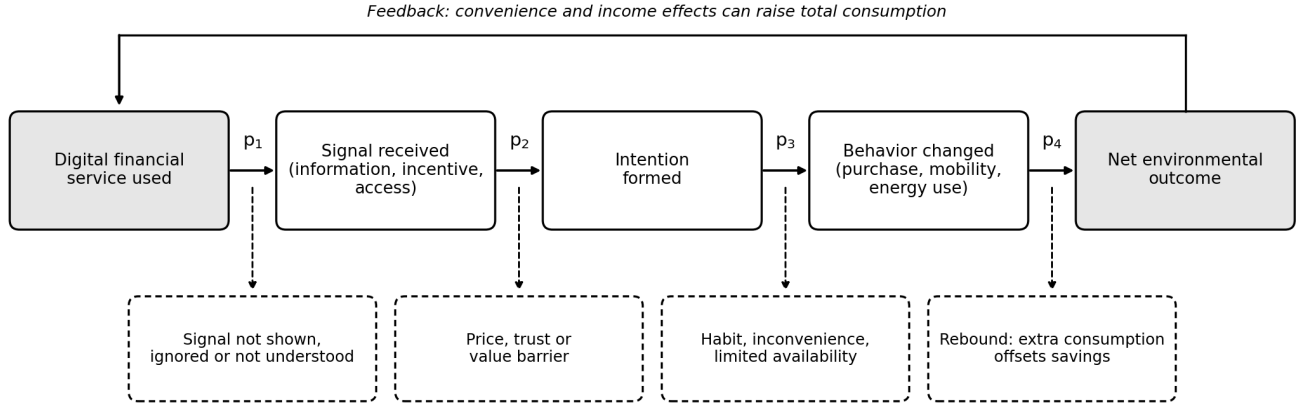


Figure 3. Behavioral pathway from digital financial services to environmental outcomes.

study does not claim a new household dataset or a new causal estimate; it develops a framework for future empirical testing.

Four evidence groups are used: household studies connecting digital finance with consumption or carbon emissions; consumer studies on mobile payment and sustainable consumption; FinTech studies connecting financial innovation with environmental performance; and behavioral studies on green purchase intention, environmental knowledge, and sustainable finance literacy. Each study was coded by level of analysis (household, city or province, country, firm), by the digital finance measure used, and by the direction of its reported findings on consumption, consumption composition, and environmental outcomes (Section 5.1).

Table 3. Evidence Selection Framework

Criterion	Included	Excluded
Date	Published before 2025	Published in 2025 or later
Quality	Peer reviewed research and authoritative evidence	Unsupported commentary
Topic	FinTech, digital finance, green consumption, environment	Unrelated digital technologies
Outcome	Behavior, consumption, emissions, resource use	Outcomes without environmental relevance
Unit	Household, consumer, firm, city, country	Purely technical model studies

4.2 Measurement Variables

The primary independent construct is digital financial innovation (DFI). It can be measured with digital financial inclusion indices, mobile payment frequency, digital wallet use, online banking use, digital credit access, or composite exposure measures. The main dependent construct is environmentally responsible consumer behavior, which can include green purchase frequency, energy efficient product adoption, public transport use, repair and reuse, low waste consumption, sustainable financial product use, and willingness to choose environmentally preferable alternatives. Environmental outcomes should include both intensity and absolute measures. Table 4 lists the constructs.

4.3 Green FinTech Sustainability Index

The study proposes a Green FinTech Sustainability Index (GFSI) built from five components: green purchase behavior (*GP*), energy efficiency behavior (*EI*), low carbon mobility behavior (*LI*), waste reduction behavior (*WI*), and sustainable finance literacy (*SL*). Each raw indicator z_{jh} for household h is first rescaled to $[0, 100]$,

$$\tilde{z}_{jh} = 100 \frac{z_{jh} - z_j^{\min}}{z_j^{\max} - z_j^{\min}}, \quad (9)$$

and the index is the weighted sum

$$GFSI_h = w_1 GP_h + w_2 EI_h + w_3 LI_h + w_4 WI_h + w_5 SL_h, \quad \sum_{j=1}^5 w_j = 1. \quad (10)$$

Equal weights may be used in exploratory work, while factor analysis or expert weights may be used in more advanced studies. Weights

matter because they can change rankings. Figure 4 shows three hypothetical households: under equal weights, household C (mobility and waste focused) scores 60.0 and household B (efficiency focused) scores 50.0, but under weights that emphasize energy efficiency, as might be appropriate in a carbon intensive electricity system, B scores 58.0 and C scores 53.5, so the ranking reverses. Weight sensitivity should therefore be reported. The GFSI describes behavior and knowledge; it does not replace the absolute outcome measure NCEE, which is estimated separately. Legend values give the GFSI under equal weights and under energy weighted weights ($w = 0.15, 0.40, 0.15, 0.10, 0.20$). The profiles are illustrative and show how weights can reverse rankings.

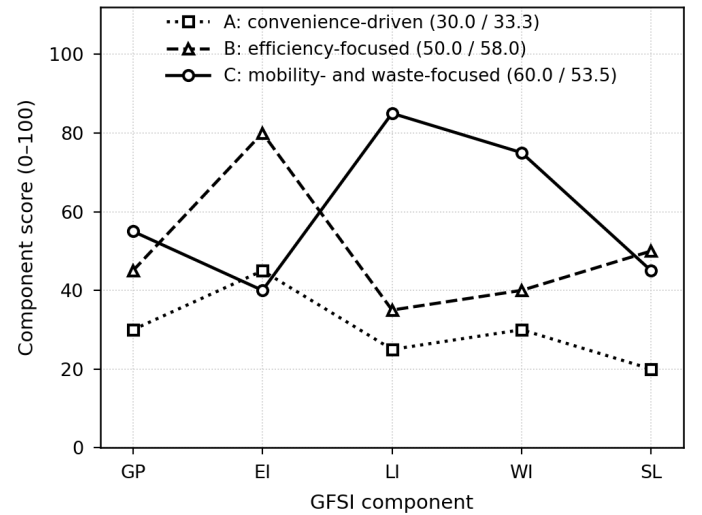


Figure 4. Component profiles of three hypothetical households.

4.4 Empirical Models for Future Testing

A household panel model for green consumer behavior can be specified as

$$GCB_{it} = \beta_0 + \beta_1 DFI_{it} + \beta_2 EC_{it} + \beta_3 FL_{it} + \beta_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (11)$$

where EC is environmental concern, FL is financial literacy, X is a vector of controls, μ_i represents household effects, and λ_t represents time effects. To examine the consumption scale mechanism, a second model is estimated:

$$CON_{it} = \gamma_0 + \gamma_1 DFI_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + v_{it}. \quad (12)$$

The environmental outcome is then modeled as

$$CE_{it} = \delta_0 + \delta_1 DFI_{it} + \delta_2 GCB_{it} + \delta_3 CON_{it} + \delta_4 X_{it} + \mu_i + \lambda_t + \eta_{it}. \quad (13)$$

This structure separates direct effects from behavioral and consumption pathways. Household fixed effects remove time invariant differences, but adoption of digital finance is not random. Credible identification therefore calls for instrumental variables based on plausibly

Table 4. Constructs, Indicators, and Candidate Data for Household Level Research

Construct	Symbol	Example indicators	Unit	Candidate data source
Digital financial innovation	DFI	Mobile wallet use frequency; digital payment share of spending; digital credit access; online banking use; composite inclusion index	Index or count	Household survey; provider records; regional inclusion index
Green consumer behavior	GCB	Green purchase frequency; efficient appliance adoption; public transport use; repair and reuse; low waste practices	Index (0–100)	Household survey; transaction categories
Consumption	CON	Total expenditure; expenditure by category; credit financed purchases	Currency; shares	Expenditure survey; payment records
Environmental outcome	CE	Household carbon footprint; electricity use; transport emissions; waste generated	kg CO ₂ e; kWh; kg	Utility bills; fuel and transport data; emission factors
Environmental concern	EC	Environmental attitude and consciousness scales; green self identification	Standardized score	Survey scales
Sustainable finance literacy	SFL	Knowledge of green financial products, labels, and financing terms	Score (0–100)	Survey knowledge items
Controls	X	Income, household size, education, age, location, electricity price, dwelling type	Various	Survey; administrative data

Table 5. GFSI Components and Example Scoring

Component	Example indicators	Scoring
GP: green purchases	Share of spending on certified or lower intensity products; frequency of green purchases	Min–max
EI: energy efficiency	Efficient appliance ownership; energy saving practices; smart meter use	Min–max
LI: low carbon mobility	Share of trips by public or shared transport; walking and cycling	Min–max
WI: waste reduction	Repair and reuse; refill and reusable use; recycling	Min–max
SL: sustainable finance literacy	Correct answers on green products, labels, and financing terms	% correct

exogenous variation in infrastructure or service roll out, event study designs around service launches, and placebo tests on outcomes that should not respond.

4.5 Moderation and Mediation Tests

Environmental concern is expected to strengthen the relationship between digital financial innovation and green behavior,

$$GCB_{it} = \beta_0 + \beta_1 DFI_{it} + \beta_2 EC_{it} + \beta_3 (DFI_{it} \times EC_{it}) + \beta_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (14)$$

and a positive β_3 would indicate that the association is stronger among consumers with greater environmental concern. The same specification with sustainable finance literacy (*SFL*) in place of *EC* tests proposition P5.

The green composition and consumption scale pathways are tested with a parallel mediation structure. Let a_1 and a_2 be the effects of *DFI* on *GCB* and *CON*, and b_1 and b_2 the effects of *GCB* and *CON* on *CE*. The total effect of digital finance on the environmental outcome is

$$c = c' + a_1 b_1 + a_2 b_2, \quad (15)$$

where c' is the direct effect, $a_1 b_1$ is expected to be negative (the green composition path lowers emissions), and $a_2 b_2$ is expected to be positive (the scale path raises emissions). The sign of c depends on which indirect effect is larger, which mirrors NCEE in Equation (6). Figure 5 presents the recommended measurement architecture.

4.6 Data for a Bangladesh Application

A study in Bangladesh could combine a household expenditure survey module, mobile financial service usage records, and utility data. Candidate sources include the Household Income and Expenditure Survey of the Bangladesh Bureau of Statistics, published mobile financial service statistics, and household electricity billing records, supplemented by a purpose built survey that measures environmental concern, financial literacy, and sustainable finance literacy. Emission factors for the national electricity mix should be applied consistently to convert consumption into e_k . Access, sampling, and consent conditions must be confirmed before fieldwork.

4.7 Validation Plan

The index and the decomposition should be validated before they are used for inference. For the GFSI, content validity can be reviewed by experts, dimensionality tested with confirmatory factor analysis, measurement invariance checked across urban and rural or income groups,

and reliability examined through repeated measurement. For the decomposition, results should be reported under alternative orderings and with a log mean Divisia decomposition, under alternative intensity factors, and with and without credit financed purchases.

5. Analysis and Results

5.1 Evidence Synthesis

The pre 2025 literature provides no single direction of effect. Figure 6 classifies the reported findings of the reviewed studies by level of analysis and by type of finding, and four patterns emerge.

First, evidence that digital finance raises household consumption is consistent across studies that measure it (10; 11; 25; 15; 23). Second, of the four studies that examine household or residential carbon emissions directly (18; 15; 23; 26), three report higher emissions and one reports mitigation. Third, the aggregate studies of FinTech at the country and firm level mostly report favorable environmental associations (4; 19; 17; 21), although Sadiq and Ali (20) report adverse evidence for South Asia. Fourth, consumer behavior studies focus on the determinants of adoption and intention (24; 14; 7) rather than environmental outcomes. The contrast between the second and third patterns may reflect differences in what is measured (consumption based household emissions versus aggregate indices) as much as real differences in effects, and it supports measuring composition and absolute consumption outcomes together.

Qin et al. (18) provide the clearest demonstration of the dual effect: digital finance can reduce household emissions through greener consumption patterns while raising them through greater consumption scale, and the scale effect dominates. Xu et al. (23) show the same tension in the form of rising emissions alongside improved efficient consumption. At the consumer level, Yuan et al. (24) and Niu et al. (14) show that mobile payment can be studied as part of sustainable consumption behavior and that psychological, social, and functional factors matter, so the environmental effect of FinTech depends partly on whether consumers use digital financial tools for sustainable decisions. Circles from figure 6 mark higher consumption or greener composition, downward triangles mark adverse environmental outcomes, upward triangles mark favorable environmental outcomes, and squares mark behavioral determinants. Blank cells mean the finding is not reported. The classification is by the authors and is not a pooled effect estimate.

5.2 Scale and Composition: A Numerical Illustration

The decomposition in Section 3.2 can be illustrated with a hypothetical household. The numbers below are assumed for exposition and are not estimates from data. The household spends 100 units per period across five categories. Baseline shares are 25%, 15%, 30%, 20%, and 10% for electricity and fuels, private transport, food, manufactured goods, and services, with intensity indices of 1.00, 0.80, 0.45, 0.50, and 0.15, so the baseline footprint is $F^B = 62.0$. After exposure to digital finance, expenditure rises by $g = 4\%$, spending shifts from private transport to services, and electricity intensity falls by 8% through efficient appliances. Table 6 reports the decomposition.

In this example the scale effect raises the footprint by 2.48, while composition lowers it by 2.03 and technique by 2.08, so $SCE = 2.48$,

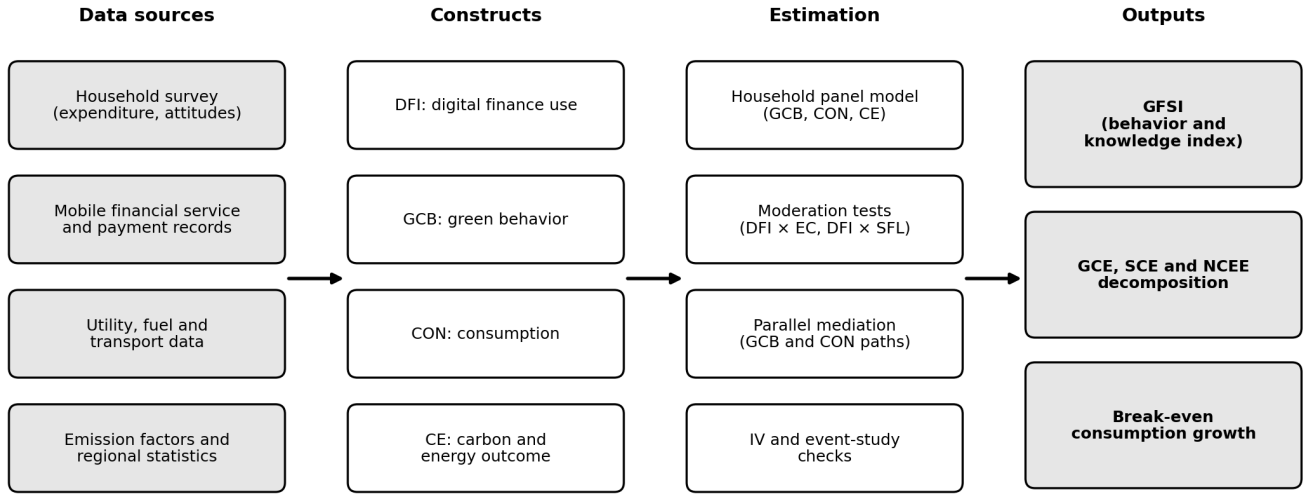


Figure 5. Recommended empirical measurement architecture for household level Green FinTech research.

Theme	Study	Higher consumption	Greener composition	Adverse environmental outcome	Favorable environmental outcome	Behavioral determinants
Household	Li, Wu and Xiao (2020)	●				
	Yue et al. (2022)	●				
	Xu et al. (2024)	●	●	▼		
	Qin, Wu and Li (2022)	●	●	▼		
	Yuan et al. (2023)					■
	Niu et al. (2023)					■
	Filippini et al. (2024)					■
Firm and province	Pu and Fei (2022)	●		▼		
	Li, Long and Ouyang (2022)	●				
	Zhou et al. (2023)				▲	
Country	Awais et al. (2023)				▲	
	Pu et al. (2024)				▲	
	Qin et al. (2023)				▲	
	Sadiq and Ali (2024)			▼		
Firm	Siddik et al. (2023)				▲	

● = Addresses this theme ▲ = Mentions (limited focus) ▼ = Focus on negative outcome ■ = Focus on behavioral determinants

Figure 6. Findings reported in selected pre 2025 studies, by level of analysis.

Table 6. Hypothetical Decomposition for One Household ($X^B = 100$, $g = 4\%$; effects on footprint, index units)

Category	s^B	s^A	e^B	e^A	Scale	Composition	Technique	Total change
Electricity and fuels	0.25	0.25	1.00	0.92	+1.00	0.00	-2.08	-1.08
Private transport	0.15	0.12	0.80	0.80	+0.48	-2.50	0.00	-2.02
Food and groceries	0.30	0.30	0.45	0.45	+0.54	0.00	0.00	+0.54
Manufactured goods	0.20	0.20	0.50	0.50	+0.40	0.00	0.00	+0.40
Services and repair	0.10	0.13	0.15	0.15	+0.06	+0.47	0.00	+0.53
Total	1.00	1.00	$\bar{f}$: 0.620	→ 0.581	+2.48	-2.03	-2.08	-1.63

GCE = 4.11, and NCEE = +1.63: the footprint falls from 62.00 to 60.37. The same household would have a negative NCEE if it made no green shift at all, because scale alone would raise the footprint by 2.48. Table 7 and Figure 7 show how the outcome depends on the strength of the green shift and on consumption growth. The break even growth rate rises from 2.7% under a weak shift to 16.7% under a strong shift, so the same rate of consumption growth can be environmentally beneficial in one setting and harmful in another.

Table 7. Scenario Results for the Hypothetical Household

Green shift	$\bar{f}^A$	ρ (%)	g^* (%)	NCEE, $g=4\%$	NCEE, $g=10\%$
None	0.620	0.0	0.0	-2.48	-6.20
Weak	0.604	2.7	2.7	-0.76	-4.39
Moderate	0.581	6.4	6.8	+1.63	-1.86
Strong	0.532	14.3	16.7	+6.72	+3.53

The digital finance instruments differ in how they affect the two effects, as Table 8 summarizes. For example, a digital payment ap-

plication may encourage a consumer to use public transport through a discount and easy payment, which is a composition effect, and the same application may make frequent purchases easier, which is a scale effect. The net effect depends on the intensity of the additional consumption and of the consumption that is displaced. Squares mark the break even growth rate g^* where NCEE equals zero. Scenarios are those in Table 7

5.3 Consumer Behavior as the Missing Link

Digital financial innovation should not be expected to change environmental outcomes automatically. The consumer must first receive or discover a relevant signal, evaluate it, form an intention, and change behavior, as in Equation (8). The chain can fail at any stage: a consumer may receive carbon information and ignore it, may intend to buy a green product and reject it because of price, or may buy an efficient product and raise total consumption enough to offset the benefit. Figure 8 illustrates the compounding with assumed stage probabilities. Under payment convenience alone, with $p = (0.55, 0.30, 0.50, 0.60)$,

Table 8. Green Composition and Consumption Scale Mechanisms by Digital Finance Instrument

Instrument	Green composition mechanism	Consumption scale mechanism	Expected environmental direction
Payment	Enables low carbon services and digital incentives	Makes repeated purchases easier	Depends on use
Credit	Finances efficient durable goods	Relaxes liquidity constraints and expands consumption	Depends on financed use
Information	Improves awareness of environmental attributes	Increases product discovery and purchase opportunities	Mixed
Rewards	Encourages green actions	Can increase promotional purchasing	Mixed
Financial inclusion	Improves access to efficient products	Expands purchasing capacity	Mixed

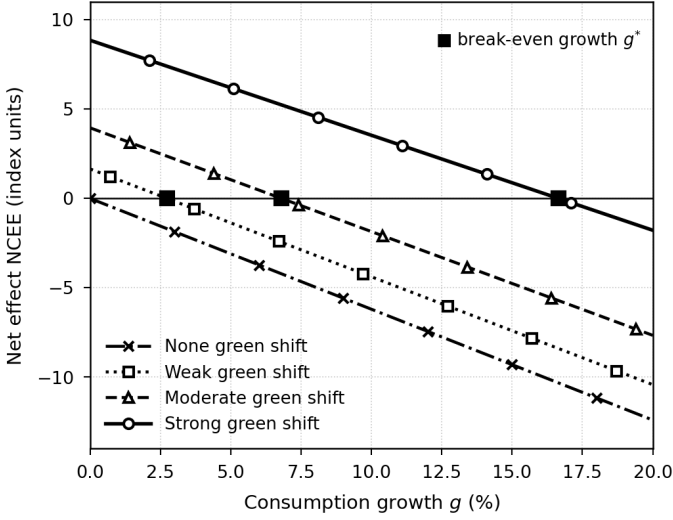


Figure 7. Net effect (NCEE) of the hypothetical household as consumption growth rises, for four strengths of green shift.

about 5.0% of users complete the chain. With information and incentives, $p = (0.80, 0.45, 0.60, 0.70)$ gives 15.1%, and adding targeted green credit, $p = (0.85, 0.55, 0.75, 0.85)$ gives 29.8%. The values are hypothetical, but the arithmetic shows why designs that address several stages together can matter more than any single feature.

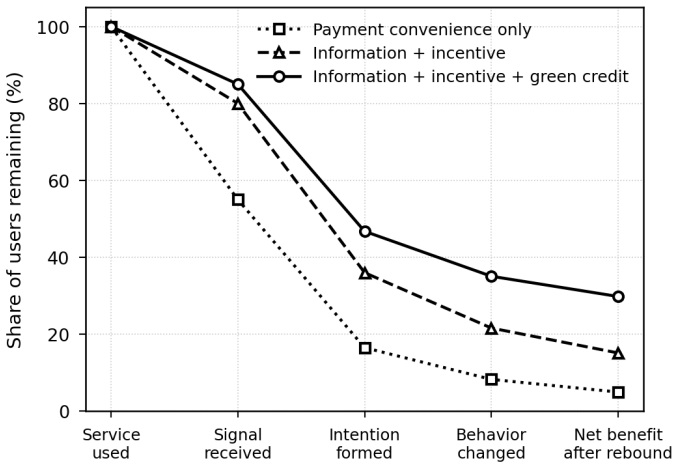


Figure 8. Illustrative attrition along the behavioral chain for three service designs.

5.4 Environmental Concern and Sustainable Finance Literacy as Moderators

Environmental concern is likely to be an important moderator. Consumers with stronger concern may respond more to information and incentives that emphasize environmental consequences, while consumers with weak concern may use the same services mainly for convenience or price. The green purchase intention literature supports this interpretation: Choudhury et al. (5) identify environmental consciousness and green self identification as the leading predictors, and Aldaihani et al. (2) connect green attitudes, value belief norm theory, and planned behavior.

Financial literacy can improve the ability to compare financing costs and consumption tradeoffs, but Filippini et al. (7) show that general financial literacy does not imply high sustainable finance literacy. A consumer may understand interest rates and budgeting while lacking knowledge of sustainable products or environmental labels. Green FinTech platforms should therefore present environmental information in a

form that is understandable, comparable, and verifiable. Figure 9 illustrates the expected interaction pattern using assumed coefficients: with $\beta_1 = 4.0$ and $\beta_3 = 3.0$, the slope of green behavior on digital innovation is 1.0 for low concern, 4.0 at the mean, and 7.0 for high concern, and with $\beta_3 = 2.5$ for literacy the slopes are 1.5, 4.0, and 6.5.

5.5 Cross Country Context

The environmental effect of digital finance may vary across countries because electricity systems, income levels, financial inclusion, environmental regulation, digital infrastructure, and consumer norms differ. Evidence from China is prominent because digital finance developed rapidly there and household data are available, but results from China should not be generalized automatically to Bangladesh, India, Europe, Africa, or North America. The same service can have different consequences where the electricity mix, transport system, product market, and income distribution differ. The Sadiq and Ali (20) result for South Asia, which includes Bangladesh, illustrates the need for regional evidence.

5.6 Research Propositions

The synthesis supports five propositions. Table 9 states each proposition with the model and expected sign used to test it, and Figure 10 maps them onto the framework.

6. Discussion

The answer to the research question depends on which type of digital financial innovation is considered and how consumer behavior is measured. Digital payment, digital credit, digital savings, and digital information services have different behavioral mechanisms.

Digital payment can encourage sustainable behavior when linked to public transport, shared mobility, reusable products, repair services, or green rewards, but payment convenience can also increase purchasing frequency. Paperless payment alone should therefore not be treated as a sustainability outcome. Digital credit can support household investment in efficient appliances, renewable energy systems, and other durable improvements, yet credit access can also expand discretionary consumption, and the environmental effect depends on the financed activity. Digital financial information can improve consumer knowledge, but information is not enough when green products are much more expensive or hard to obtain. Green FinTech therefore has to combine information with suitable financial products, incentives, and market availability.

Responsibility should be measured behaviorally and environmentally. Green purchase intention is useful but is not actual consumption, and a reduction in carbon intensity is not necessarily a reduction in total emissions. The break even condition in Equation (7) makes this concrete: an intensity gain of a given size is beneficial only if consumption growth stays below the corresponding g^* . Because Li et al. (10) find that consumption effects are larger for lower income and less financially literate households, some of the additional consumption may reflect welfare gains from relaxed constraints, so environmental evaluation must be balanced against distributional and welfare considerations.

6.1 Managerial Implications

FinTech providers should integrate environmental information into transaction interfaces only when it is reliable and understandable, and green labels should rest on transparent methodologies. Digital rewards should encourage verifiable environmental behavior rather than engagement for its own sake. Banks and digital lenders can incorporate environmental criteria into product design: financing for energy efficiency, renewable energy, repair, reuse, and low carbon mobility creates stronger environmental pathways than unrestricted consumption credit. Consumer

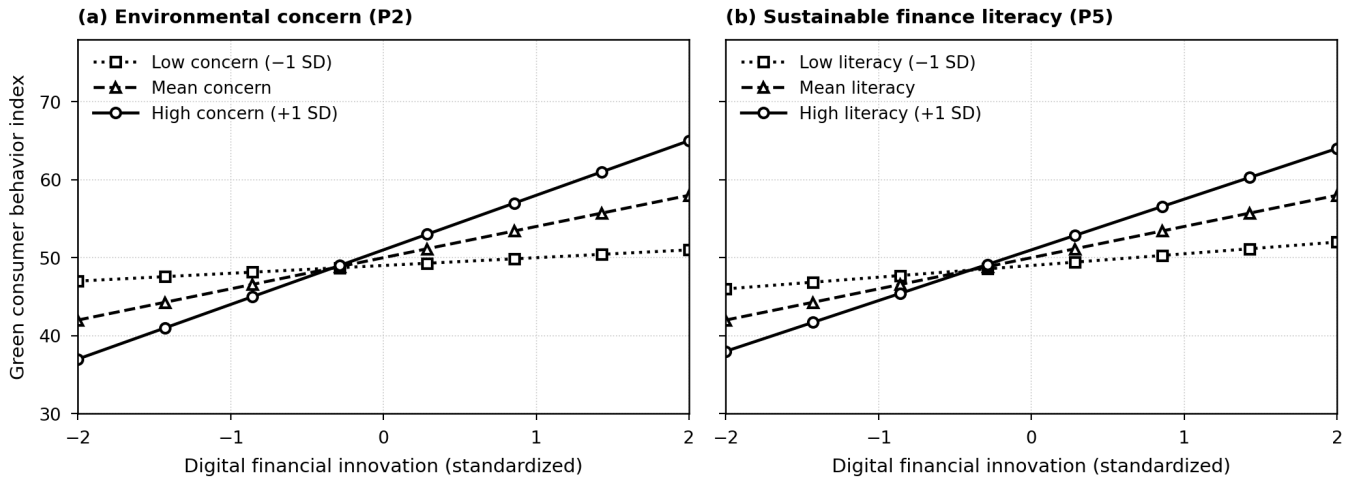


Figure 9. Illustrative simple slope plots for the moderation propositions, computed from assumed coefficients rather than estimated from data: (a) environmental concern (P2) and (b) sustainable finance literacy (P5). Lines show predicted green consumer behavior at -1, 0, and +1 standard deviations of the moderator.

Table 9. Research Propositions and Their Empirical Tests

No.	Proposition	Test	Expected sign	Key data
P1	Digital financial innovation is positively associated with environmentally responsible consumer behavior when services provide relevant environmental information, incentives, or access to lower intensity products and services	Eq. (11): β_1	+	Panel of household DFI and GCB
P2	Environmental concern strengthens the association between digital financial innovation and environmentally responsible behavior	Eq. (14): β_3	+	DFI, GCB, EC scales
P3	Digital financial innovation can increase total household consumption through convenience and improved financial access	Eq. (12): γ_1	+	Expenditure by category
P4	The environmental effect depends on the relative size of the green composition and consumption scale effects	Eq. (15): a_1b_1 vs. a_2b_2 ; NCEE	Sign of c varies	Consumption, footprints, emission factors
P5	Sustainable finance literacy strengthens the ability of consumers to turn digital financial access into environmentally responsible decisions	Eq. (14) with SFL	+	DFI, GCB, SFL items

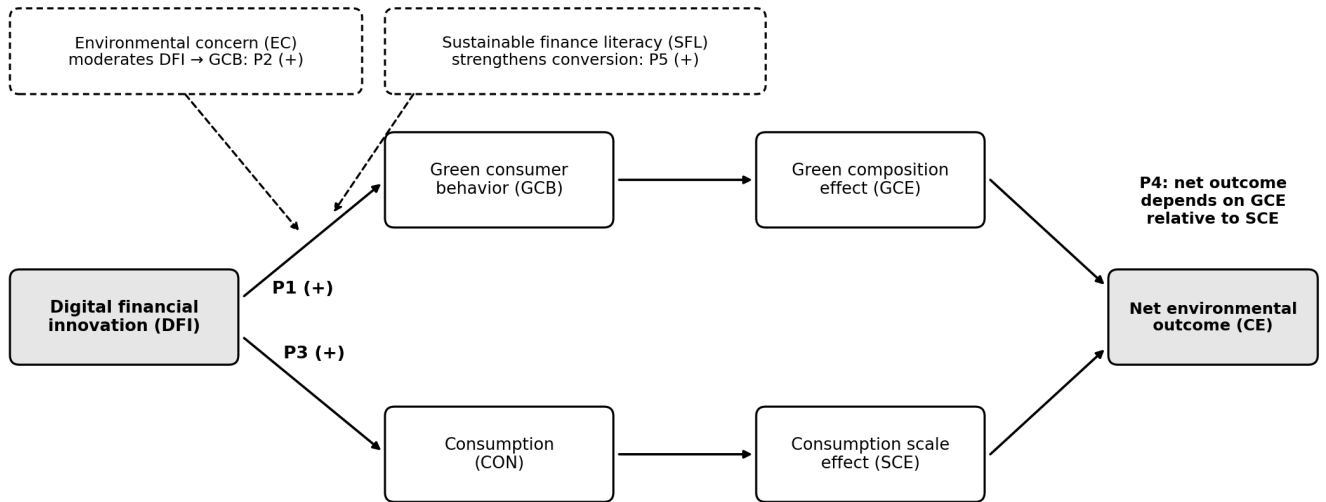


Figure 10. Research propositions P1 to P5 mapped onto the framework, for future empirical testing.

platforms can offer spending dashboards that distinguish environmentally intensive from lower intensity categories. Financial institutions should avoid presenting digital access as automatically sustainable and should measure environmental performance through actual household outcomes.

6.2 Policy Implications

Policy makers can encourage Green FinTech through standards for environmental information, digital financial literacy, consumer protection, green product verification, and responsible digital credit. Digital financial inclusion policies should be evaluated with environmental indicators as well as access and transaction indicators, and a policy that increases access but also increases carbon intensive consumption may need complementary green consumption measures. Public agencies can support interoperable environmental information systems so that consumers can obtain reliable information about product energy use, emissions, reparability, and lifecycle impacts. Table 10 links actions

to the mechanisms they target and the indicators that show whether they work.

6.3 Implications for Bangladesh and Emerging Economies

Emerging economies are an important setting for future research because digital financial inclusion can expand rapidly while household income, infrastructure, and environmental regulation change at the same time. In Bangladesh, digital financial services can support low cost payments, access to formal finance, and environmental information, but the environmental effect should be tested with household level data rather than assumed from digital adoption alone. A Bangladesh study could combine mobile financial service usage, household expenditure categories, electricity use, transport behavior, environmental concern, financial literacy, and green purchase behavior, and could distinguish financial inclusion effects from environmental behavior effects. Given the regional result of Sadiq and Ali (20), the composition and scale components should be examined separately, and the electricity mix

Table 10. Implications for Actors: Actions, Targeted Mechanisms, and Monitoring Indicators

Actor	Recommended action	Mechanism targeted	Indicator to monitor
FinTech providers	Show verified carbon or energy information at the point of payment; reward verified green actions rather than engagement	Information; incentives	Share of transactions in lower intensity categories; reward redemption by category
Banks and digital lenders	Offer purpose restricted credit for efficiency, renewables, repair, and low carbon mobility	Access; financial capability	Share of credit financing efficient goods; repayment performance
Consumer platforms	Provide spending dashboards separating high and low intensity categories	Information	Dashboard use; change in category shares
Regulators	Set standards for green claims, digital financial literacy, and responsible digital credit	Information; financial capability	Complaints on green claims; literacy scores
Statistical agencies	Publish household expenditure and energy data linkable to digital finance measures	Measurement	Availability of linked data; update frequency
Researchers	Report composition and absolute outcomes together with decomposition and break even growth	Measurement	NCEE; g^* ; weight sensitivity of GFSI

should be treated explicitly when intensities are assigned.

7. Limitations and Future Research

The study has several limitations. First, it is a structured evidence synthesis rather than a new causal household level study. Second, much of the strongest empirical evidence comes from China, which limits generalization. Third, digital financial innovation is measured differently across studies. Fourth, sustainable consumption measures are heterogeneous. Fifth, environmental effects may appear with a time lag. Sixth, transaction level environmental data are rarely available. Seventh, the numerical illustrations are hypothetical and use assumed parameters; they demonstrate the logic of the framework and are not estimates. The classification in Figure 6 summarizes reported directions and does not weight studies by quality or sample size. Table 11 pairs each limitation with a response.

Table 11. Limitations and Proposed Responses

Limitation	Proposed response
No new causal estimate	Test P1–P5 with household panels, instruments, and event studies
Concentration of evidence in China	Replicate in South Asia, including Bangladesh, and other settings
Heterogeneous DFI measures	Use common core indicators and report sensitivity
Heterogeneous green consumption measures	Combine composition indicators with absolute outcomes
Time lags	Use multi year panels and dynamic specifications
Limited transaction level data	Link payment categories to expenditure and utility data
Illustrative numbers	Replace assumed values with estimated shares and intensities

The proposed GFSI is a measurement framework rather than a validated universal scale. Future research should validate it with confirmatory factor analysis, panel data, and observed consumption records. Priority questions include how large the break even growth rate g^* is in practice for different household types, whether digital credit restricted to efficient goods produces larger composition effects than unrestricted credit, how the effects differ between urban and rural households, and how long rebound effects last.

8. Conclusion

This study examines whether digital financial innovation encourages environmentally responsible consumer behavior. The evidence available before 2025 indicates that the relationship is neither automatically positive nor automatically negative. Digital financial innovation can support sustainable consumption through improved access, payment convenience, environmental information, digital incentives, and sustainable finance capability. These mechanisms can encourage green purchases, low carbon mobility, efficient energy use, reduced waste, repair, reuse, and other responsible behaviors. At the same time, digital finance can raise total consumption: easier payments, wider credit access, and greater purchasing convenience can create a scale effect that increases household resource use and carbon emissions. Qin et al. (18) provide direct evidence of this tension by identifying both a green composition effect and a consumption scale effect, with the scale effect prevailing in their Chinese sample, and Xu et al. (23) show that digital inclusion can increase household carbon emissions while improving selected forms of green consumption. The main conclusion is therefore conditional. Green FinTech can encourage environmentally responsi-

ble consumer behavior when financial innovation is designed to make sustainable choices easier, more visible, financially accessible, and personally relevant. Environmental responsibility cannot be inferred from digitalization alone. The paper's decomposition gives a simple test: a composition and technique gain that lowers average intensity by a proportion ρ is beneficial only if consumption growth stays below

$$g^* = \frac{\rho}{1 - \rho}. \quad (16)$$

The environmental effects of digital financial innovation may also vary across households and consumption contexts. Households with greater environmental awareness, stronger sustainable finance literacy, or better access to green financial products may be more likely to convert digital financial convenience into environmentally responsible choices. In contrast, households primarily exposed to conventional digital credit and consumption-oriented platforms may experience stronger scale effects. Similarly, the environmental consequences may differ across essential consumption, discretionary consumption, transportation, household energy use, and online purchases. This suggests that future studies should avoid treating digital finance and consumer behavior as homogeneous categories and instead examine differences across income groups, regions, age groups, levels of financial inclusion, and types of consumption. The findings also have implications for financial institutions, digital platforms, and policymakers. Expanding digital financial access alone may not be sufficient to achieve environmental objectives. Digital payment and financial platforms could integrate carbon information, green product recommendations, sustainability-linked incentives, and financing options for energy-efficient products into existing services. Policymakers could complement financial digitalization policies with environmental standards and consumer-protection measures that reduce incentives for excessive consumption. Such approaches would allow the convenience and inclusion benefits of digital finance to be retained while directing a larger share of digitally enabled consumption toward lower-impact alternatives. An additional consideration is the potential rebound effect. Efficiency improvements enabled by digital technologies may reduce the environmental intensity of individual purchases while simultaneously lowering their effective cost or increasing their frequency. Consequently, a reduction in emissions per unit of consumption does not necessarily translate into a reduction in total household emissions. Evaluating digital financial innovation therefore requires both intensity-based and absolute environmental indicators. The distinction is particularly important when assessing whether improvements in green consumption are large enough to offset additional consumption generated by greater financial convenience. There are also important limitations to the available evidence. Much of the existing literature relies on observational data, regional samples, or aggregate measures of digital finance and environmental outcomes. These approaches can identify associations but may not fully establish the causal mechanisms connecting financial innovation, consumption decisions, and environmental impacts. Differences in the measurement of digital financial inclusion, green consumption, and household carbon emissions also make direct comparison across studies difficult. Moreover, rapid changes in mobile payments, digital lending, artificial intelligence, and green financial products mean that findings from earlier periods may not fully represent current digital consumption environments. Future empirical research should therefore test the framework with household panel data, digital transaction measures, environmen-

tal concern, sustainable finance literacy, green purchase behavior, consumption categories, and household carbon footprints. Where possible, researchers should distinguish between digital financial services that facilitate productive or sustainable investment and those that primarily increase discretionary consumption. Natural experiments, policy changes, transaction-level data, and longitudinal household surveys could further help identify causal effects and reveal whether changes in consumption behavior persist over time. Research could also examine whether digital environmental information and financial incentives interact with consumers' existing environmental preferences or whether they are effective in changing behavior among consumers with limited environmental awareness. Overall, the environmental consequences of digital financial innovation depend not only on how much finance becomes digital, but also on how digital finance shapes the composition, intensity, and scale of household consumption. The central policy and research question is therefore not whether digital finance is inherently green, but under what institutional, technological, and behavioral conditions its benefits can outweigh its consumption-expanding effects. The paper's framework provides a basis for making this distinction and for identifying when digital financial innovation becomes an environmental enabler and when it becomes a mechanism for additional consumption.

Data Availability

No new primary dataset was collected for this evidence synthesis. The paper is designed to support future empirical testing with publicly available household surveys, digital financial inclusion measures, consumer surveys, and environmental statistics. The code used to produce the illustrative figures and numerical example is available from the authors on request.

Conflict of Interest

The authors declare no conflict of interest.

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