



An Analysis of Consumer Purchasing Behavior for ESG-Related Products: Based on Big Data from HKTVMall

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Abstract. This paper primarily focuses on Environmental, Social, and Governance (ESG) related products, employing Python for regression analysis to systematically study the differences in consumer purchasing behavior between positive and negative ESG categories (categories that conform to ESG principles). It further explores the key factors influencing consumer decisions regarding these two categories. The study focuses on analyzing the quantitative differences in the purchase of both positive and negative ESG categories. It selects appropriate variables from five factors—price, membership, delivery, packaging, and time—as independent variables, emphasizing the degree of influence of different factors on consumer behavior in purchasing ESG categories. This research can provide data support for optimizing corporate ESG product operation strategies and a practical basis for guiding consumers to form sustainable consumption preferences and continuously promoting the sustainable development of society as a whole.

Keywords: ESG products, Consumer behavior, Regression analysis, Logarithmic regression model

1 Introduction

ESG (Environment, Social, Governance) originated in 2004 and has become a core global sustainable development framework, serving as a key non-financial indicator for measuring enterprises' long-term sustainable development capabilities.

Driven by the "dual carbon" goals and the global concept of sustainable development, its product market in China has expanded rapidly with diversified growth. Firstly, at the policy level, the Shanghai Stock Exchange's "Special Action Plan for Promoting the Improvement of ESG Ratings of Listed Companies in Shanghai" has promoted the improvement of ESG ratings for listed companies, laying the institutional foundation for market development. In terms of scale, ESG products are showing comprehensive growth. According to data on government websites, green loans in China have grown rapidly this year, reaching 6.47 trillion yuan by the end of the third quarter of 2025, with an outstanding balance of 43.51 trillion yuan, precisely meeting

the financing needs of enterprises for low-carbon transformation. Meanwhile, data published in the Securities Times shows that the scale of ESG funds continues to expand, and the issuance of green bonds has significantly increased, with an inventory of 13.20 trillion yuan, becoming an important pillar of the ESG market. It can be said that the current ESG product market has reached a considerable size, with policy guidance and capital inflows forming a two-way driving force. Although still in its development stage, it has become an important vehicle connecting the capital market and enterprises' green transformation. Besides, its development has gradually extended from the financial investment field to the consumer market, giving rise to ESG categories such as new energy vehicles, biodegradable packaging, zero-carbon milk and organic food. The influencing factors of their consumption behavior and their real impact are of research significance. Past literature has yielded findings in two aspects: regarding influencing factors, scholars have identified cognition, emotion, and ability as core drivers of green food consumption intention—shaped by gender and trust [1]. The influence and role of perceived sustainability on consumer attitudes are also emphasized [2]; some scholars focus on environmental awareness and social impact [3]. And some scholars have analyzed the factors affecting purchasing behavior from the perspectives of ESG-related product categories such as willingness to pay for health products [4], factors affecting the purchase of energy appliances [5], and health awareness of purchasing functional foods [6]. In addition, some scholars have also focused on the indirect role of ESG management in influencing purchasing intention in e-commerce live streaming [7], and in different fields such as electronic products [8] and green marketing strategies [9], they have focused on analyzing the key factors affecting consumers' purchase of green products. Some scholars have further enriched the research perspective based on the motivation-opportunity-ability framework [10] and the behavior of consumers resisting fast fashion consumption [11]. In addition to analyzing the influencing factors, relevant scholars have made relevant analyses on the possible impact of purchasing ESG products: some scholars believe that green products, as the key carrier of ESG products at the consumer end, have a double-edged sword effect on people's real life and consumption habits. [12]. Some scholars emphasize their positive value from the perspectives of lifestyle transformation [13] and promoting the reduction of carbon emissions [14]. Few scholars focus on the guiding role of ESG charitable projects on consumption habits [15]. These studies have different focuses, but have not yet studied the factors affecting the differences in purchasing from the perspective of classifying ESG products into positive and negative categories.

Consequently, this study will undertake research in accordance with the premise, focusing on the relevant factors that influence consumer purchasing behavior, identifying similarities and differences, and providing corresponding data support for product marketing planning.

2 Data and Methodology

2.1 Data Sources and Variable Summary

The research data in this paper mainly comes from HKTV mall, Hong Kong's largest comprehensive B2C e-commerce platform, covering all categories of goods and boasting a massive user base. The overall data period is primarily concentrated between December 1, 2022, and February 28, 2023. After filtering, the data retained information such as total sales volume, membership level, purchase quantity, and purchase time period, with a remaining sample size of 1,493,070, providing data support for analyzing consumer purchasing behavior. Table 1 summarizes the variables required for the selected data analysis, providing detailed classification and explanations.

Table 1. Summary of Variables

Category	Variables	Detailed Explanation
ESG Classification	ESG_classification	Classification of ESG Products into Two Categories: Positive (compliant with ESG principles) and Negative (not compliant)
Quantity	quantity	Product Purchase Quantity
Order Information	order_date; total_price; delivery_timeslot	Order Date and Total Transaction Price Delivery Information about Delivery Time
User Information	membership_level	Membership Level Information

The main variables extracted were: ESG classification (divided into true/false), membership level (including GOLDVIP, NORMAL, SENIOR, and VIP), total price range (e.g., 0–200, 200–400, 400–600), quantity, and time factors order date (divided into weekdays and weekends) and delivery timeslot (used to distinguish between daytime and nighttime, with the time concentrated between 9:00 and 18:00). Descriptive statistical analysis and comparative analysis were conducted to explore the differences in consumer purchasing behavior under multiple dimensions. Meanwhile, data visualization (bar charts, stacked charts) was used to intuitively display the quantity and trend of consumer purchases.

2.2 Data Analysis

First, this paper analyzes the overall sample data. As shown in Table 2, we defined price ranges based on total_price. As this range increases, the table clearly shows the sales differences between positive and negative ESG product categories: overall sales peaked in the [400-600] price range (379,096 units), followed by the [200-400] range (263,483 units), showing an overall trend of first rising and then falling; sales above 800 yuan continued to decline as prices increased, indicating that the market demand for products in the mid-price range [400-600] was the strongest. Specifically, in the low-price range, negative products sell significantly more than positive products. In the

high-price range, especially starting from 800-yuan, positive ESG products have surpassed negative products.

Table 2. Comparison of Sales Share in Different Price Ranges

Price Range	Total Sales	ESG Sales	Non-ESG Sales	ESG Percentage	Non-ESG Percentage
0-200	199059	53537	145522	26.90%	73.10%
200-400	263483	123818	139665	46.99%	53.01%
400-600	379096	185040	194056	48.81%	51.19%
600-800	209726	104358	105368	49.76%	50.24%
800-1000	137358	69543	67815	50.63%	49.37%
1000-1200	85684	43747	41937	51.06%	48.94%
1200-1400	60200	31375	28825	52.12%	47.88%
1400-1600	41476	21286	20190	51.32%	48.68%

Next, this paper studies the impact of time on sales. Figures 1 and 2 compare the sales of various ESG categories during the day and night, and during the week and weekend, respectively. For ESG categories, the daytime sales share is 69.24%, significantly higher than the nighttime share (30.76%) (38.48%); the weekday sales share is 47.04%, slightly higher than the weekend share (43.40%). For non-ESG categories, the daytime sales share (71.45%) far exceeds the nighttime sales share (28.55%) (42.9%); surprisingly, the weekday sales share is 52.96%, slightly lower than the weekend share (56.60%). This shows that ESG category sales are relatively concentrated during the week, while non-ESG category sales are concentrated on weekends, with a clear difference in consumption patterns. Therefore, based solely on the figures, both weekday and weekend, daytime and nighttime, have a certain impact on people's purchase of ESG products. The specific impact in practice will be analyzed in detail in the subsequent regression model.

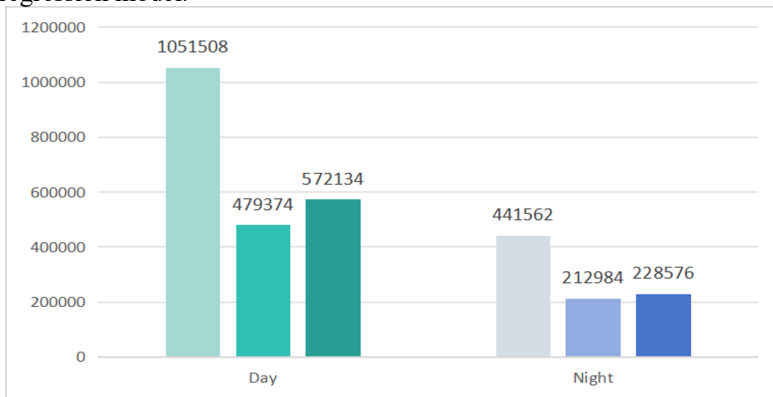


Fig. 1. Sales comparison of various product categories during the day and night.¹

¹ The colors of the bars in the bar chart represent different categories: from left to right (from light to dark), they represent all categories, ESG categories, and non-ESG categories respectively.

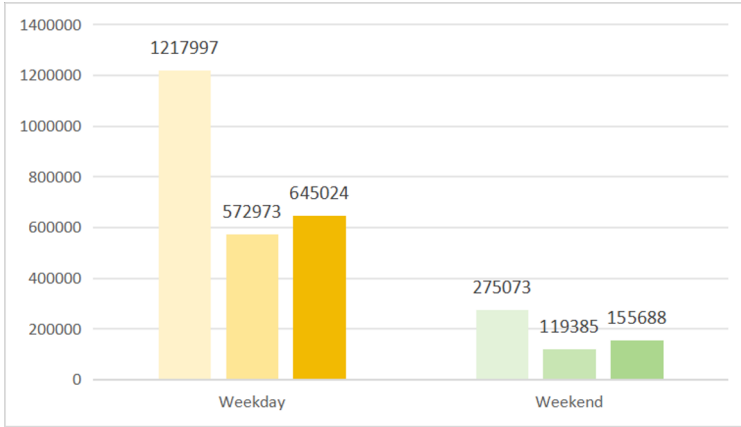


Fig. 2. Comparison of sales of different product categories during the week and at the weekend.

In addition, membership level correlates closely with sales volume. As clearly seen in the stacked Figure 3, in the low-price range (0-50 yuan), NORMAL leads (82.3%), followed by VIP (67.9%), GOLDVIP (68.7%), and SENIOR has the lowest (61.9%). In the mid-to-low-price range (50-100 yuan), SENIOR ranks highest (19.9%), GOLDDVIP and VIP are both at 16.5%, and NORMAL has the lowest (9.1%). In the mid-to-high-price range (100-200 yuan), SENIOR tops (15.5%), followed by VIP (13.1%), GOLDDVIP (11.9%), and NORMAL has the lowest (7.1%).

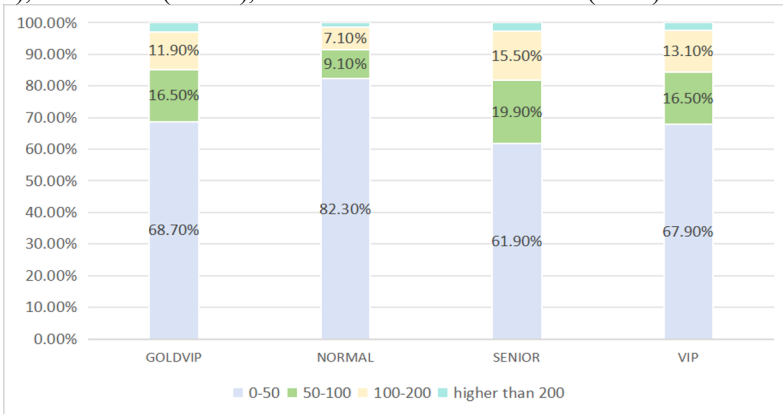


Fig. 3. Percentage distribution of ESG product category unit price for different membership levels

Clearly, NORMAL members prefer low-priced ESG products most, while higher-level members are far more receptive to mid-to-high average prices than lower-level members. This difference provides some basis for membership-based differentiated pricing of ESG products, though its truly significant requires further regression analysis.

3 Regression Analysis

To analyze factors influencing purchase quantity differences between ESG-positive and non-ESG products, and compare their specific impacts, this paper primarily employs Python-based Log-OLS regression with logarithmic transformation, modeling each category separately for precise insights.

The independent variables mainly revolve around specific variables under five major factors: price, delivery, membership, packaging, and time—only price-related variables are log-transformed, others remain intact. The system demonstrates the varying degrees of influence these variables have on products with different ESG attributes. After preprocessing and cleaning the raw data, multicollinearity was checked via variance inflation factor (VIF), with variables having VIF > 10 removed to avoid result distortion, ultimately selecting independent variables with significant explanatory power and high independence, as shown in Table 3.

Table 3. Summary of Independent Variables

Category	Variables	Detailed Explanation
price factor	unit_price = total_price/quantity	The product unit price is calculated by dividing the total price (total_price) by the purchase quantity (quantity).
	unit_discount = total_discounts/quantity	The unit discount is calculated by dividing the total discount amount (total_discounts) by the purchase quantity (quantity). The average price range value is taken.
	cash_voucher_applied_value	The actual amount of the coupon used by the consumer
Delivery factors	delivery_cost	Order delivery cost
	merchant_delivery_fee	Delivery costs borne by the merchant
Member Benefits	member-ship_encoded=membership_level	Convert membership levels to ordered numerical values (membership-encoded), with NORMAL=0, VIP=1, SENIOR=2, and GOLDVIP=3.
	loyalty_point_rate	The percentage of points that can be redeemed from your purchase amount
	ESG factor	ESG Category
Packaging factors	packing_box_type	Packaging types (processed with unique heat coding): The top 3 sales ranking packaging types are pack_H and pack_K, while the rest are categorized as pack_Other.
Time factor	is_weekend_order	Is it a weekend order?
	is_night_delivery	Is it night delivery?

Table 4 presents factors influencing ESG and non-ESG product purchases, with core coefficients and p-values enabling quick intuitive assessment of impact degree and significance.

Table 4. Regression Analysis Results for ESG and Non-ESG Product Categories

Variables	ESG	P-value	Non-ESG	P-value
const	1.159	0***	1.1861	0***
unit_price	-0.0504	0 ***	-0.0789	0***
unit_discount	-0.4692	0 ***	-0.3764	0***
cash_voucher_applied_value	0.4322	0***	0.355	0***
delivery_cost	0.0041	1.055e-23 ***	0.0045	2.423e-37 ***
merchant_delivery_fee	0.0001	0.2598	-0.0001	0.2688
membership_encoded	-0.0039	9.569e-12 ***	-0.0036	1.322e-12 ***
loyalty_point_rate	0.0049	1.010e-09 ***	0.0055	0.8166
is_night_delivery	-0.0018	0.1382	-0.0018	0.0920*
is_weekend_order	0.0519	1.822e-45 ***	0.0262	3.525e-17 ***
pack_H	0.0136	1.101e-23 ***	0.0479	8.536e-295 ***
pack_K	-0.0623	6.278e-20 ***	-0.0789	1.433e-172 ***
pack_Other	-0.0628	1.711e-28 ***	-0.0684	2.106e-113 ***

Note: ***, **, and * in the table indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively.

Based on the Log-OLS model, price-related variables' logarithmic transformation makes their regression coefficients demand elasticity coefficients, quantifying consumers' price sensitivity. Other untransformed variables' coefficients reflect marginal effects, avoiding logarithmic transformation-induced meaning distortion.

3.1 Price Factor Analysis

First, we analyzed the log-transformed price-related variables. Table 4 shows that the coefficients of `unit_price`, `unit_discount`, and `cash_voucher_applied_value` all passed the 1% significance test, reflecting consumers' sensitivity to price signals. In `unit_price`, the coefficients for both ESG positive and negative categories are negative, indicating an inverse relationship between price and purchase quantity. Coefficients are negative for both categories (inverse price-purchase relationship). Non-ESG products have a 56.2% higher absolute demand elasticity (0.0789 vs. ESG' s 0.0504), meaning non-ESG consumers are far more price-sensitive—each 1% price hike cuts non-ESG purchases by 0.0789% and ESG' s by 0.0504%. This stems from ESG buyers prioritizing the products' environmental and social values, tolerating higher premiums, while non-ESG products are more affected by premium fluctuations. In `unit_discount`, the coefficients for both categories are still negative. Looking at the absolute value of demand elasticity, ESG products are higher than non-ESG products, indicating that ESG products are more sensitive to the combination of high unit price and high discounts. This may be because high prices inherently dampen purchases, and excessive discounts may make ESG consumers doubt product attributes, while non-ESG buyers focus more on cost-effectiveness. In `cash_voucher_applied_value`, the coefficients for both categories are positive, indicating that discounts can stimulate consumption to

some extent. It is evident that ESG's elasticity (0.4322) is 1.22 times non-ESG's (0.3550), with each 1% coupon increase boosting ESG purchases by 0.4322%. This may be because coupons, to some extent, offset the premium of ESG attributes in ESG products, thereby increasing demand. In contrast, the premium for non-ESG products is much lower than that for ESG products, thus the effect of coupons is relatively weaker.

3.2 Non-Price Factor Analysis

Next, we focus on non-price factors. These were not log-transformed, so our analysis centers on marginal effects. Starting with delivery factors: for `delivery_cost`, the coefficients for both categories are positive and pass the 1% significance test, contradicting the notion that higher costs suppress demand. This suggests consumers value timeliness enough to pay more, with non-ESG products (0.0045) having a slightly higher marginal effect than ESG ones (0.0041)—likely tied to merchants' free shipping thresholds, where consumers increase purchases to qualify. For `merchant_delivery_fee`, both coefficients are very close to 0, and insignificant, indicating that this variable does not affect consumer purchasing behavior. Moving to membership factors: `membership_encoded` shows negative coefficients for both categories—each membership level increase reduces purchases by 0.36% (non-ESG) and 0.39% (ESG). Unlike prior data trends, this indicates higher-tier members prioritize quality over quantity, leaning toward rational, need-based consumption. Only ESG products have a significant `loyalty_point_rate` (1% level): each unit increase in points ratio boosts purchases by 0.49%, as ESG consumers value long-term benefits (aligning with ESG attributes), while non-ESG buyers focus on immediate needs and are less responsive to points. Next, we analyze the relevant variables related to the time factor: `is_weekend_order` has positive, significant coefficients, with ESG products' marginal effect 1.98 times that of non-ESG—ESG purchases concentrate on weekends, while non-ESG products (for immediate needs) are less focused on weekends. Besides, `is_night_delivery` is only significant for non-ESG (10% level), with marginal effects near 0 for both categories, indicating minimal impact. Finally, there is a correlation analysis of packaging factors. All three packaging types have consistent, significant coefficient directions. H-type packaging promotes purchases, with non-ESG's marginal effect 3.52 times that of ESG—its low cost and convenience appeal to non-ESG consumers (who prioritize packaging experience over ESG values), while ESG buyers focus more on product attributes. K-type and other packaging have negative coefficients, inhibiting purchases versus H-type—K-type uses higher-cost eco-materials, leading to price premiums that deter consumers, especially non-ESG buyers.

3.3 Summary & Discussion

Overall, the two ESG product categories have distinct purchasing factors, requiring differentiated operations in practice. Non-ESG products are far more price-sensitive than ESG products, while ESG products respond better to discounts and membership incentives. Based on consumers' differentiated purchasing preferences for the two categories, appropriate marketing methods can be adopted. Specifically: ESG products

gain from coupons, weekend promotions and points; non-ESG from reasonable pricing and H-type packaging. Most importantly, if the product's inherent ESG attributes can be enhanced, along with increased public awareness and value perception, more people will participate in purchasing ESG products, thus promoting sustainable development.

4 Conclusion

This paper concentrates on purchasing behavior disparities between ESG-positive and ESG-negative products, investigating the primary influencing factors. Using 1,493,070 valid HKTVmall samples (December 2022—February 2023), it adopted descriptive statistics, data visualization (bar/stacked charts) and a Log-OLS model (after addressing multicollinearity) to analyze five factors (price, membership, delivery, packaging, time), distinguishing elasticity and marginal effects, and revealing ESG attributes' moderating role, providing data support for targeted operations by enterprises.

The data reveals that price sensitivity is the primacy difference: Non-ESG products are more price-sensitive, with 800 yuan as a turning point (non-ESG dominates below, ESG above), confirming ESG consumers' higher premium tolerance. ESG products respond more to coupons but wary of large discounts (non-ESG opposite; higher memberships prioritize quality over quantity. Both categories pay more for delivery timeliness and packaging integrity, with H-type packaging boosting purchases.

The paper's value resides in ESG classification and large samples, to some extent, compensating homogenized research gaps. The analytical results can provide data support for marketing strategies: ESG products benefit from certification, weekend coupons, and reward zones; non-ESG products from price control and H-type packaging, with guidance toward ESG products. However, this study's data is confined to a single Hong Kong e-commerce platform, restricting representation of ESG awareness, purchasing power and product range, with incomplete seasonal coverage. Future research should expand samples/platforms, compare cross-cultural/policy differences, refine factors and explore discrepancies for comprehensiveness.

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