



Analysis of Hong Kong Consumers' Purchase Behavior of ESG Products and Its Influencing Factors Based on Big Data

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Abstract. This study analyzes consumer purchase behavior for ESG-related products using over 500,000 transaction records from HKTV Mall. Key findings indicate that fundamental economic factors remain primary drivers, including unit price exerts a strong negative effect, discounts have a positive but limited impact, and free shipping significantly increases purchase quantity. Product category matters greatly, with "Health" products dominating purchases. Also, products manufactured in China command a substantial positive premium. Behavioral patterns also show that purchases are higher on web platforms compared to mobile apps and peak during daytime working hours. By employing real behavioral data, this research helps bridge the "intention-behavior gap" in sustainable consumption, confirming the practical influence of price signals and green premiums, and provides empirical evidence for optimizing e-commerce platform strategies.

Keywords: Environmental, Social, and Governance (ESG), consumer behavior, green product, e-commerce

1 Introduction

In recent years, with the deepening of the global sustainable development concept, ESG (Environmental, Social, and Governance) has risen to a core business strategy [1]. There has been a significant increase in consumer market attention to ESG products, with more and more purchasers beginning to incorporate the sustainability attributes of products into their decision-making considerations [2]. However, there remains a significant gap between their attitudes and actual purchasing behaviors. [3] This "intention-behavior gap" is a core challenge in the study of sustainable consumption. Scholars have explored its causes from multiple dimensions, including the Theory of Planned Behavior [4], emotions and social influence [5], as well as the purchase intentions of specific groups, such as Generation Z [6].

Existing literature provides a theoretical basis for exploring how ESG products affect consumer behavior. First, the consumer psychology perspective applies the Theory of Planned Behavior (TPB) to show that attitude, subjective norm, and perceived be-

havioral control significantly influence consumer decisions [1][4]. However, a significant gap persists between intentions and actual purchases[3]. Second, the marketing perspective examines how enterprises stimulate sustainable consumption. Recent research reveals that marketing is oriented towards ESG significantly impacts consumer trust and loyalty. [7] Third, corporate governance perspective focuses on ESG information disclosure effects. Research shows that high-quality ESG information disclosure can enhance brand credibility and prominence, thereby increasing purchase intentions.[8] Leonelli et al. verified through 24,000 US households that consumers respond positively to environmental and social signals but less to governance information. [1] Notably, the major customer-driven ESG diffusion theory posits that downstream corporate customers drive suppliers' green innovation via green procurement pressure and green innovation collaboration [9]. Corporate ESG practices must cultivate consumer trust for this impact [7][10].

This study aims to fill the academic gaps by analyzing over 500,000 real transaction records from Hong Kong's HKTV Mall. In terms of contextual selection, this study focuses on the Asian market of Hong Kong, which has both Eastern and Western consumption characteristics. Recent studies have shown that in the context of e-commerce [11] and across different Asian cultures [12], there are differences in consumers' green preferences and behavioral patterns. Therefore, the context of this study will provide new insights into how cultural contexts shape ESG consumption behaviors, and provide empirical evidence for e-commerce platforms to optimize their ESG product operation strategies.

2 Data and Methodology

2.1 Data Source

This dataset comes from HKTV Mall, one of Hong Kong's leading e-commerce platforms, offering a diverse range of product categories. This dataset provides an important empirical basis for studying consumer purchase behavior related to ESG products, which compiles detailed transaction records from the platform spanning December 1, 2022 to February 28, 2023, covering multi-dimensional features such as order information, delivery details, payment information, promotional activities, and manufacturer information. All of these were collected and organized through the platform's backend order management system and product database.

2.2 Variables

This study focuses on analyzing consumer purchase behavior regarding ESG-related products. The independent variables are unit price, delivery cost, discount mean, sub cat 1, area, device type, day type, month group, week group, and manufactory country, with quantity as the dependent variable to measure consumers' actual purchase intention and behavior intensity for ESG-related products. The detailed information is shown in Table 1.

Table 1. List of Variables

Variable	Description
order_date	Creation date of the order
order_time_range	Creation timeslot of the order
app_type	Indicates it is a Main app user or Lite app user
device_type	Indicates the type of device the order was made on
sales_application	The sales channel
area	The area of delivery address
delivery_cost	The standard delivery cost (HKD) for the stated membership level
total_discounts	The range of total discounts
quantity	Quantity of SKU ordered
total_price	The range of total gross merchandise value
sub_cat_1_name_en	The product first-level subcategory in English
manufacturer_country_en	The country of the manufacturer in English

2.3 Research Methods

Before processing the independent and dependent variables, this study first selected product SKUs that meet ESG criteria from the original dataset based on the definition of ESG products. Through this process, the final ESG product dataset was formed for following regression analysis.

Prior to model estimation, several variable processing steps were conducted. First, unit price was derived from total price divided by quantity, discount mean was calculated as total discounts divided by quantity. Second, temporal variables were extracted from order date: day type, month group, and week group. Finally, categorical variables were transformed into dummy variables through one-hot encoding.

This study employs Ordinary Least Squares (OLS) multiple regression analysis to examine the effects of selected factors on ESG product purchase quantity. All independent variables were standardized using StandardScaler prior to model estimation. The regression model was estimated using Python StatsModels (sm.OLS) with a constant term. Model fit was assessed through R-squared, and the significance of individual predictors was evaluated using p-values.

3 Research Process and Results

3.1 EDA

3.1.1 By Unit Price: Unit price shows a Significant Negative Correlation with Purchase Quantity.

As shown in Figure 1, the unit price of a product has a decisive impact on the quantity purchased per transaction. When the unit price falls within the lowest range (0.00594, 43.0], the average purchase quantity reaches approximately 3.0 items, the highest among all ranges. As the price range increases, the average purchase quantity

shows a decreasing trend, dropping to about 1.2 items in the highest price range (250.0, 9750.0]. This clearly indicates that, despite products having ESG attributes, consumer purchasing decisions still follow the basic law of price elasticity, demonstrating significant price sensitivity.

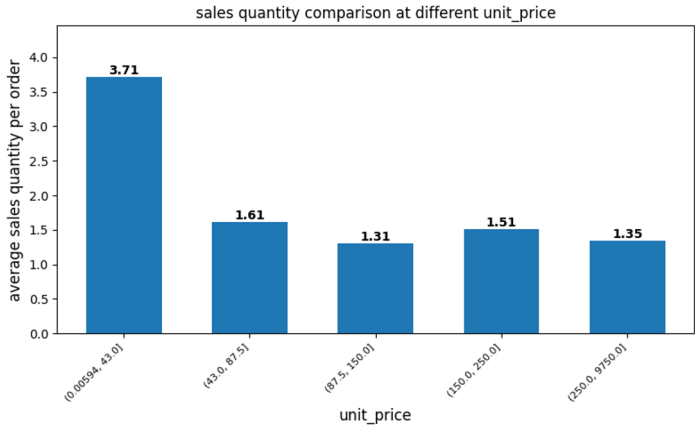


Fig. 1. Sales Quantity Comparison at Different Unit Prices

3.1.2 By Average Discount: Deep Discounts Significantly Stimulate an Increase in Purchase Quantity.

Figure 2 reveals a positive relationship between discount intensity and purchase quantity. The data shows that in the range with the highest average discount (67.5, 7750.0], the average purchase quantity reaches 1.93 items, significantly higher than average purchase quantity in other discount ranges. The overall trend indicates that offering attractive deep discounts is an effective promotional tool for encouraging consumers to increase their purchase quantity per transaction.

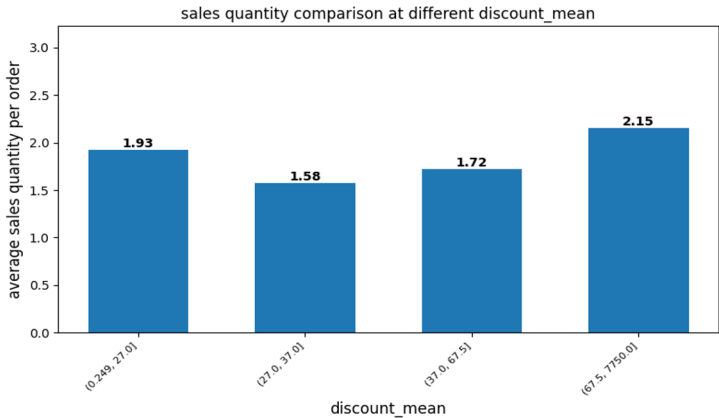


Fig. 2. Sales Quantity comparison at Different Discounts

3.1.3 By Product Sub-category: "Health" Category Products Hold an Absolute Dominant Position.

Figure 3 visually demonstrates the differences among various ESG product sub-categories. Among all categories, "Health" products have a significantly leading average purchase quantity (2.20 items), far exceeding other categories. This result highlights that, among the multiple value dimensions of ESG, product attributes directly related to personal health are the most effective in stimulating actual consumer purchasing behavior.

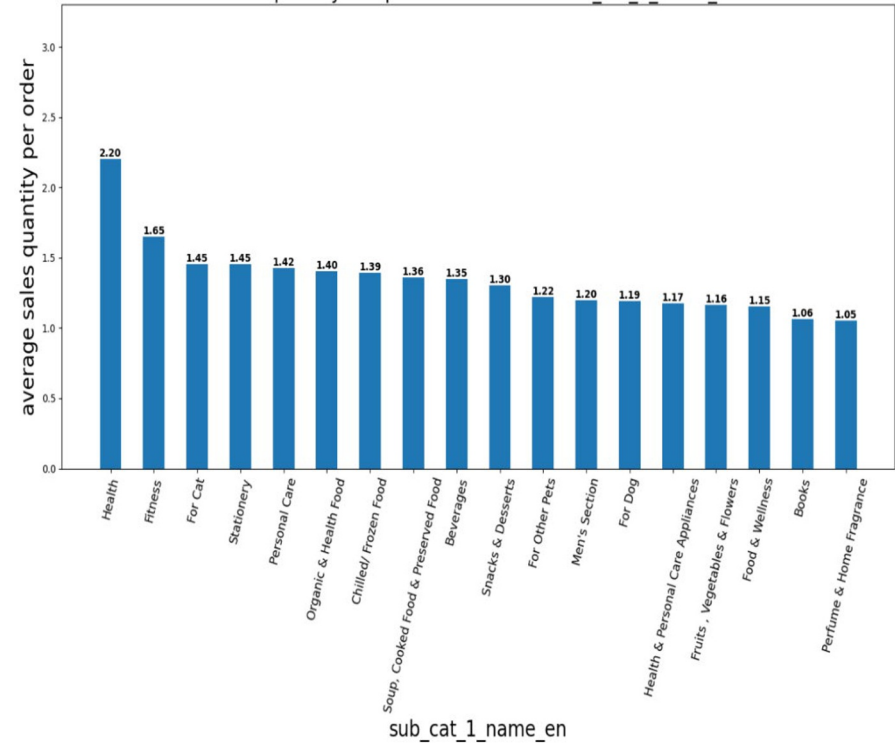


Fig. 3. Sales Quantity Comparison at Different sub-categories

3.1.4 By Temporal Factors: Purchase Patterns during the day and seasons.

Based on the analysis of purchase times throughout the day (see Figure 4), the quantity purchased shows clear cyclical fluctuations. The data indicates that purchase quantity peaks during the 09:00-12:00 (2.10 items) and 12:00-15:00 (2.09 items) time blocks. Subsequently, from the afternoon into the night, the purchase quantity gradually decreases, reaching its lowest point during the 21:00-24:00 block (1.65 items). This suggests that consumers are more inclined to make bulk purchases during working hours and the midday break period, which may be related to shopping decision-making habits during work hours.

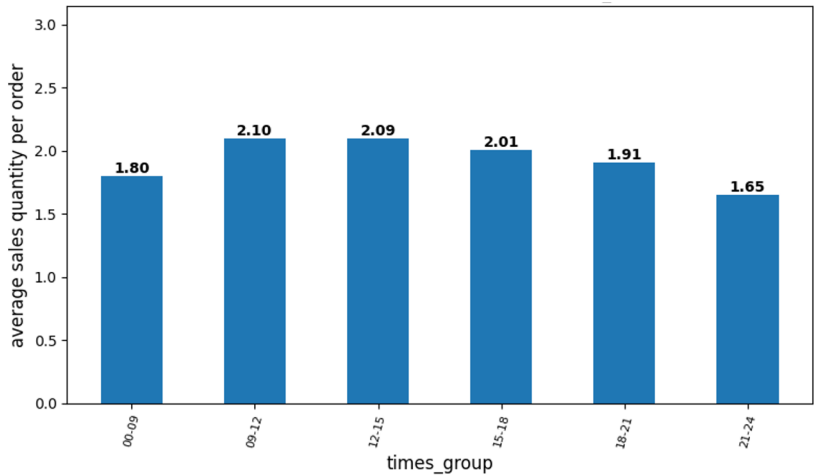


Fig. 4. Sales Quantity Comparison at Different times during the day

On a monthly scale, the purchase behavior for ESG products exhibits a strong seasonal character. Monthly data (see Figure 5) shows that the average purchase quantity in December 2022 (2.33 items) was significantly higher than other two months. This indicates that the year-end holiday season (e.g., Christmas, New Year) is a golden window for ESG product consumption. Consumers may significantly increase their purchase volume during this time for reasons such as gift-giving, household stocking, or enhanced holiday spending willingness.

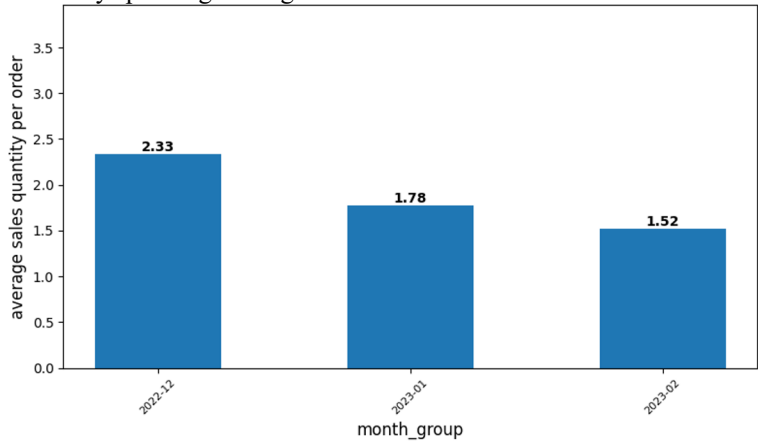


Fig. 5. Sales Quantity Comparison at Different months

3.1.5 By Manufacturer Country: China-made Products Demonstrate an Overwhelming Quantity Advantage.

Figure 6 presents a very prominent phenomenon: the average purchase quantity for ESG products manufactured in China (4.78 items) is far higher than for those from all

other countries and regions, such as the United States and France. This may stem from the high efficiency and completeness of China's supply chain, and it also likely reflects consumers' potentially higher familiarity and trust in domestic ESG brands or certification systems. Additionally, potential price advantages may encourage consumers to purchase China-made ESG products in larger quantities.

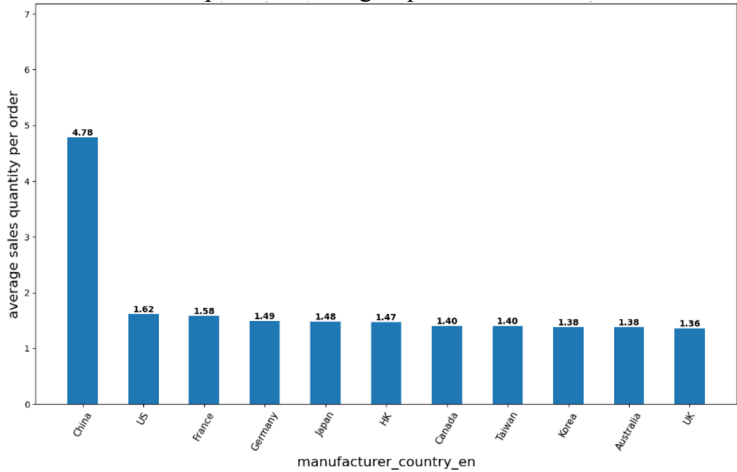


Fig. 6. Sales Quantity Comparison at Different Manufacturer Countries

3.1.6 By Delivery Cost: Free Shipping Strategy Effectively Increases Purchase Quantity.

Figure 7 compares the impact of delivery costs on purchasing behavior. The results show that when consumers enjoy free shipping (Delivery Cost = 0), their average purchase quantity (1.90 items) is higher than when a delivery cost is required (1.73 items). This finding confirms that a free shipping policy can effectively lower the consumer's final total payment and psychological decision threshold.

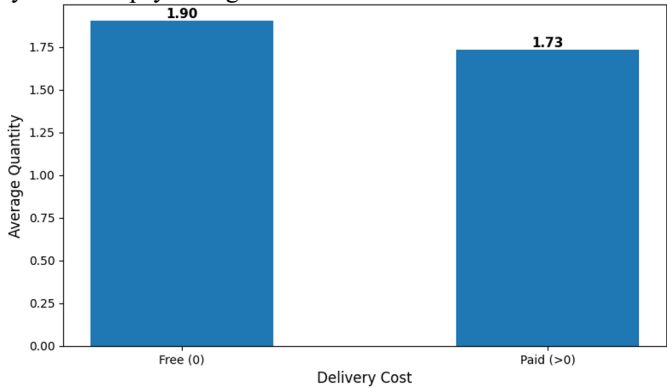


Fig. 7. Quantity Comparison between free delivery costs and paid delivery costs

3.2 Multiple Linear Regression

This study employs multiple linear regression analysis to examine the influence of various factors on consumer purchase behavior regarding ESG products. This statistical method allows for the estimation of the relationship between sales quantity (the dependent variable) and multiple independent variables, including unit price, delivery cost, discount mean, product subcategory, delivery area, device type, manufacturer country and temporal factors (day type, times group, month group).

Table 2. The results of Multiple Linear Regression

Variables	coef	p> t
const	1.9000	0.000
unit_price	-0.4274	0.000
discount_mean	0.0759	0.000
delivery_cost	-0.0501	0.000
sub_cat_1_name_en_Books	0.0019	0.811
sub_cat_1_name_en_Chilled/ Frozen Food	0.0482	0.001
sub_cat_1_name_en_Fitness	0.0945	0.000
sub_cat_1_name_en_Food & Wellness	0.0144	0.068
sub_cat_1_name_en_For Cat	0.1381	0.000
sub_cat_1_name_en_For Dog	0.0899	0.000
sub_cat_1_name_en_For Other Pets	-0.0083	0.296
sub_cat_1_name_en_Fruits, Vegetables & Flowers	-0.1887	0.000
sub_cat_1_name_en_Health	0.7266	0.000
sub_cat_1_name_en_Health & Personal Care Appliances	-0.1789	0.000
sub_cat_1_name_en_Men's Section	0.0021	0.781
sub_cat_1_name_en_Organic & Health Food	0.0234	0.159
sub_cat_1_name_en_Perfume & Home Fragrance	0.0164	0.036
sub_cat_1_name_en_Personal Care	-0.0585	0.002
sub_cat_1_name_en_Snacks & Desserts	-0.0323	0.001
sub_cat_1_name_en_Soup, Cooked Food & Preserved Food	-0.0444	0.000
sub_cat_1_name_en_Stationery	-0.0741	0.000
area_KLN	-0.0755	0.000
area_NT	-0.1416	0.000
device_type_Web	0.3088	0.000
device_type_iOS	-0.0013	0.888
sales_application_Web	-0.1645	0.001
sales_application_WebMobile	-0.0184	0.554
app_type_MAIN	0.0162	0.037
day_type_weekend	-0.0332	0.000
manufacturer_country_en_Canada	-0.0042	0.708
manufacturer_country_en_China	1.4837	0.000
manufacturer_country_en_France	0.0655	0.000
manufacturer_country_en_Germany	0.1697	0.000
manufacturer_country_en_HK	0.2089	0.000

Variables	coef	p> t
manufacturer_country_en_Japan	0.3167	0.000
manufacturer_country_en_Korea	0.0388	0.000
manufacturer_country_en_Taiwan	0.1716	0.000
manufacturer_country_en_UK	0.0494	0.000
manufacturer_country_en_US	0.0775	0.000
month_group_2023-01	-0.1170	0.017
month_group_2023-02	-0.0721	0.211
order_time_range_09-12	0.0898	0.000
order_time_range_12-15	0.0965	0.000
order_time_range_15-18	0.0704	0.000
order_time_range_18-21	0.0515	0.000
order_time_range_21-24	-0.0463	0.000
week_group	Controlled	Controlled
No. Observations:	823787	
R-squared:	0.042	

As shown in Table 2, the regression results verified and deepened the findings of the previous descriptive analysis. The number of total observations is 823787, and the R-squared is 0.042.

The product unit price exhibited a very strong negative effect on the purchase volume ($\beta = -0.427$, $p < 0.001$). This indicates that, under the condition of keeping other factors unchanged, for every 1 unit increase in the product unit price, the average purchase volume is expected to decrease by approximately 0.427 units. This result is in line with the basic expectation of the impact of price on demand and reveals that even in the ESG consumption context, price remains the primary and powerful constraint factor influencing consumers' purchase quantity.

The discount had a significant positive promoting effect on the purchase volume ($\beta = 0.076$, $p < 0.001$). However, the absolute value of its coefficient was much smaller than that of the negative coefficient of the unit price. This means that the positive effect brought by it is difficult to fully offset the negative effect caused by the unit price. The limited efficacy of promotional discounts in compensating for price increases suggests that consumers perceive price as a more persistent signal of value, whereas discounts are interpreted as temporary adjustments that do not fundamentally alter the value proposition. [13]

The increase in delivery cost significantly reduced the purchase volume ($\beta = -0.050$, $p < 0.001$). This finding confirmed that the free shipping policy is an effective operational strategy. Compared with the direct monetary incentives, the impact of shipping cost is relatively smaller, but it plays an indispensable role in optimizing consumers' purchase decisions. This result aligns with Yendola and Windasari (2022) who demonstrated that free shipping thresholds significantly influence impulsive buying behavior in e-commerce platforms. [14]

Taking beverages as the reference group, product categories showed significant heterogeneity in the purchase volume. Health food exhibited the strongest positive effect ($\beta = 0.726$, $p < 0.001$), followed by fitness ($\beta = 0.095$, $p < 0.001$). On the contrary, fruits, vegetables and flowers categories ($\beta = -0.189$, $p < 0.001$) significantly inhibited

the purchase volume. The pronounced strength of health-oriented categories aligns with research demonstrating that consumers exhibit heightened responsiveness to product categories associated with sustainability attributes. [15]

Geographic disparities show that, relative to Hong Kong Island, both Kowloon ($\beta = -0.076$, $p < 0.001$) and the New Territories ($\beta = -0.142$, $p < 0.001$) significantly reduced order volumes, with the latter exhibiting a stronger negative effect.

Channel analysis reveals divergent patterns: Web purchases significantly exceeded Android mobile transactions ($\beta = 0.309$, $p < 0.001$), consistent with Raphaeli et al. [16], who analyzed online consumer behavior across mobile and PC devices and found meaningful channel-related differences. Conversely, at the application level, web platforms significantly underperformed relative to POS terminals ($\beta = -0.165$, $p < 0.001$), while the web-mobile hybrid channel showed no significant effect ($p = 0.085$).

Manufacturer origin effects were pronounced, with Chinese manufacturing commanding a substantial positive premium ($\beta = 1.484$, $p < 0.001$) far exceeding Japan ($\beta = 0.316$, $p < 0.001$), Taiwan ($\beta = 0.171$, $p < 0.001$), South Korea ($\beta = 0.039$, $p < 0.001$), and Canada ($\beta = -0.005$, $p = 0.677$), indicating heterogeneous consumer preferences for "Made in China" products.

Temporal patterns demonstrate that weekend effects were marginally negative ($\beta = -0.033$, $p < 0.001$), with a significant decline in January 2023 compared to December 2022 ($\beta = -0.117$, $p = 0.017$), potentially reflecting post-holiday demand adjustments. Intraday analysis reveals peak purchasing during daytime working hours—specifically 09:00–12:00 ($\beta = 0.090$, $p < 0.001$) and 12:00–15:00 ($\beta = 0.097$, $p < 0.001$)—relative to the 00:00–09:00 baseline, whereas the nighttime period (21:00–24:00) significantly suppressed volumes ($\beta = -0.046$, $p < 0.001$).

4 Conclusion

This study examines ESG consumption determinants through visual analysis and multiple linear regression. Findings confirm price remains the primary constraint—consumers follow basic elasticity laws even for ESG products, with discounts exerting limited relative effects. Delivery costs significantly reduce purchase volumes, validating free-shipping threshold theory. Health-related ESG categories demonstrate dominant effects, consistent with heightened consumer responsiveness to sustainability in health contexts. Notably, web-channel purchases significantly exceed mobile transactions, while Chinese-manufactured products command substantial positive premiums. Theoretically, this study bridges the persistent "intention-behavior gap" by utilizing real transaction data rather than self-reported intentions. Analysis of HKTV Mall transactions demonstrates that ESG product labels significantly influence purchasing decisions and willingness to pay, verifying signal transmission and green premium formation mechanisms.

Enterprises should enhance ESG disclosure transparency to convert sustainability performance into consumer-trusted competitive advantages. E-commerce platforms are advised to optimize free-shipping thresholds, target midday peak hours for promotions, and prioritize health-related ESG products. For policymakers, price mechanisms prove

fundamental to sustainable consumption—subsidies or tax incentives outperform pure information campaigns, as consumers respond more strongly to tangible economic signals than to governance disclosures.

This study is constrained by single-platform data and a specific cultural context, limiting generalizability. Future research should incorporate multi-platform datasets and extended time spans. Additionally, the subjective ESG classification may introduce measurement bias; independent rating systems could enhance construct validity. Finally, the absence of individual consumer demographics and psychological traits (e.g., consumer innovativeness, moral norms, anticipated emotions) suggests opportunities for more targeted investigations.

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