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THE INFLUENCE PATH AND CONSUMPTION TREND ANALYSIS OF NEW PRODUCTIVITY ON GUANGXI AGRICULTURAL PRODUCTS CONSUMER BEHAVIOR-AN EMPIRICAL STUDY BASED ON MARKET SURVEY TAKING BAISE MANGO IN GUANGXI AS AN EXAMPLE

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Abstract: This study investigates how New Quality Productivity (NQP) influences consumer behavior in the agricultural sector, using mango consumption in Baise, Guangxi as a case study. Based on 500 valid questionnaires and employing multiple regression, structural equation modeling (SEM), and ridge regression, the research identifies key impact pathways.The findings reveal, first, that direct factors—including improved product quality, optimized pricing, enhanced accessibility, and product diversification—all significantly drive consumer behavior, with price and accessibility being the most influential. Second, the analysis confirms significant mediating roles of information transparency, brand value, and consumption scenario reconstruction. However, not all paths are effective; for instance, quality upgrades do not affect behavior through transparency. Third, digital literacy and consumption concepts are crucial moderators that strengthen the NQP effect, while regional economic level and policy support show more limited moderating impacts.Accordingly, recommendations are proposed: optimize pricing and accessibility, enhance brand storytelling, and improve consumers' digital literacy to better harness NQP for agricultural development.
Keywords: New quality productivity; Agricultural product consumption; Consumer behavior path; Moderating effect

1 INTRODUCTION

The 14th Five-Year Plan prioritizes digital rural development and the cultivation of agricultural industry chains. The 2023 Central Document No.1 further highlights "digital commerce for rural revitalization" and the development of commercial systems in county towns. China's agricultural consumption economy is now driven by dual engines of scale expansion and structural upgrading. In 2023, food products accounted for over 25% of total retail sales, while rural e-commerce sales reached 2.4 trillion yuan, a 2.3-fold increase over five years. Smart cold chain logistics reduced fruit and vegetable spoilage rates to 12%, live-streaming e-commerce drove annual online sales growth exceeding 30%, and the market size of green organic certified agricultural products surpassed 1.5 trillion yuan. Agricultural consumption has become a pillar of the national economy and a core aspect of people's livelihood.NQP, driven by cutting-edge technologies, emerging industries, and innovative business models, are reshaping agricultural consumption scenarios, optimizing supply chains, and enhancing user experiences to empower agricultural modernization. As a foundational industry, agriculture serves not only as a crucial domain for advancing these productive forces but also as a key testing ground for their effectiveness. However, the sector still faces multiple challenges in driving consumption upgrades for agricultural products, which may hinder the healthy development of the market.To achieve efficient supply-demand matching and upgrade consumption patterns, it is imperative to deepen the agricultural consumption system. Can new-type productivity truly meet consumers' demands for quality, safety, and experiential value? How can the supply side leverage technological empowerment and innovative models to precisely respond to market changes? These questions are crucial to agricultural modernization and further impact rural revitalization and common prosperity goals. Focusing on consumer behavior research not only reveals the "demand-side response mechanism" under technological penetration, providing a basis for precision marketing of agricultural products and supply chain upgrades, but also serves as a key solution to the dilemma of "high-quality yet low-priced" specialty agriculture in Guangxi.Baise mangoes are not only the cornerstone of Baise City's agricultural economy but also a significant symbol of regional development. As China's largest mango production base, Baise mangoes have become a key driver for the high-quality growth of the local economy. More than just an agricultural product, they represent Baise City's cultural identity and regional brand. Furthermore, the geographical indication status of Baise mangoes and their role as a model for industrial transformation provide a natural experimental setting for analyzing how new productivity factors reshape consumer preferences through quality visualization, diversified distribution channels, and interactive experiences. This holds practical urgency for revitalizing the "dual circulation" momentum in regional agricultural economies[1].

The consumption of agricultural products is an important part of the national economy, and the consumption upgrading is concerned. The scholars have explored the reform of the consumption of high-quality agricultural products, put forward the reform directions of the structure and mode of agricultural product consumption, and forecasted the development trend of a more efficient agricultural product consumption system.

In his 2025 study "Research on Synergistic Adaptation of New Agricultural Productivity Development from the Perspective of Agricultural Power," Liu Tao [2] conducted an in-depth analysis of consumption in agricultural production. The research highlights that direct consumption of agricultural products constitutes the core component of agricultural production consumption, with food safety remaining a primary concern for consumers.

In his 2024 paper "Digital Economy, New Quality Productivity, and High-Quality Agricultural Development," Gao Xiangxiao [3] demonstrates the underlying mechanisms linking digital economy and agricultural advancement through empirical analysis. The study reveals that new quality productivity acts as a significant intermediary, serving as a crucial bridge for high-quality agricultural development. Moreover, threshold effect tests indicate that the digital economy's impact on agricultural development follows a nonlinear pattern rather than a linear one. Notably, under the constraints of new quality productivity, this influence exhibits an increasing marginal effect—meaning its catalytic role for agricultural development grows progressively as productivity levels rise.

Drawing inspiration from Yang et al.'s research on digital empowerment in Heilongjiang's smart agriculture under new quality productivity, this study investigates its influence on consumer behavior for Guangxi agricultural products, using Baise Mango as a case[4]. New quality productivity, driven by digitalization and intelligence, influences consumption through key paths: 1) Enhanced Traceability & Trust: Digital supply chains provide transparent origin and quality data, increasing consumer confidence. 2) Quality Standardization & Perception: Smart technologies ensure consistent, high-quality produce, elevating perceived value. 3) Personalized Marketing: Data analytics enable targeted promotions, aligning with consumer preferences. Market trends indicate a shift towards premium, trusted, and sustainably produced goods. An empirical survey on Baise Mango will test these paths, analyzing how digital empowerment affects purchasing decisions, premium willingness, and brand loyalty, offering insights for Guangxi's agricultural digital transformation.

In his 2025 study "On the Realization of Data Elements as New Quality Productivity in Social Reproduction," Wang Jiesen [5] examines the role of data elements as new quality productivity in consumption. He notes that digital electronic payments have diversified consumers' purchasing methods while reducing costs, and rising incomes have simultaneously boosted consumption levels. These combined factors have stimulated consumer enthusiasm and driven consumption upgrades.

In his 2025 study "Agricultural New Quality Productivity Empowering High-Quality Agricultural Development: Theoretical Implications and Pathways", Han Wenlong [6] demonstrates that agricultural new quality productivity generates a "growth effect" through three mechanisms: elevating farmers 'consumption capacity, expanding rural markets, and optimizing agricultural supply structures. This effect manifests not only in significant income growth and enhanced consumption power among farmers, but also in meeting urban-rural residents' demand for premium agricultural products through technological empowerment.

In her 2024 study "New Quality Productivity Empowers Regional Agricultural Brand Enhancement: Theoretical Framework and Path Optimization," Zhang Qiannan [7] explores the development of regional public agricultural brands. She posits that new quality productivity introduces novel production factors to agricultural branding. These factors, when integrated with laborers, production materials, and work objects, drive collaborative innovation in brand development. This process simultaneously establishes new production relations, thereby elevating the overall quality of agricultural branding.

2 METHODS

In order to explore how the new quality productivity affects the consumer behavior of agricultural products in Guangxi, this paper takes the mango in Baise as an example to analyze the influence path of the NQP. The research ideas of this paper are as follows:

Firstly, according to the results of literature research and the research purpose, the corresponding questionnaire is designed. The scientificity of data collection is considered in the questionnaire design. Stratified sampling and simple random sampling are combined, so that the units in the population are separated according to the region, and each unit is randomly selected.

After data collection, the data was coded and entered, followed by reliability and validity testing of the questionnaire. Descriptive analyses were conducted on consumers' basic characteristics, their perceptions and attitudes toward Baise mangoes in Guangxi, purchasing behaviors, and their understanding of new quality productivity. Subsequently, path analysis was performed. Through factor analysis, the dependent variable (Y) of consumer behavior was constructed, and regression analysis was used to explore the direct effects of new quality productivity on consumer purchasing decisions. Additionally, structural equation modeling (SEM) was employed to further analyze the influence pathways of new quality productivity on consumer behavior, establishing a mediating effect pathway model to reveal key drivers and their interrelationships affecting consumer decisions. Finally, ridge regression was applied to examine the moderating effects of new quality productivity on consumer behavior, identifying potential variables and their interactions that influence consumer behavior.

Finally, combining the market survey data and statistical analysis results, this paper will put forward relevant suggestions on the consumption trend and consumer behavior changes driven by new quality productivity, which will provide theoretical support for the marketing strategy and product optimization direction of Baise mango.

2.1 Design and Implementation of the Survey Scheme on the Influence Path of New Productivity on Consumer Behavior

The paper collects the consumer's knowledge of Baise mango, the consumer's purchase decision, intention and satisfaction, the consumer's knowledge of new productivity, and the basic information of the consumer, including gender, age, occupation, monthly income and so on, and analyzes the basic characteristics of consumer behavior.
The paper collects the information about the impact of new quality productivity on consumer behavior, and analyzes the impact of new quality productivity on consumer behavior from three aspects: quality of agricultural products, price optimization and accessibility, and product diversification.
The paper collects the information about the influence of the mediating effect on consumer behavior, and probes into the direct factors and the influence of the mediating factors on consumer behavior from three aspects: information transparency, brand value enhancement and consumption scene reconstruction.
The paper collects the information about the degree of influence of the moderating effect on consumer behavior, and probes into the moderating effect from the aspects of digital literacy, regional economic level, policy support and consumption concept.
Based on the analysis of the three effects, the paper puts forward some suggestions on the change of consumer behavior driven by new quality productivity, which provides theoretical support for the marketing strategy and product optimization of Baise mango.

2.2 Survey Content

Based on the research objectives, our survey covers four key dimensions: basic information of survey participants, consumer behavior characteristics, the impact of direct, mediating, and moderating factors on consumer behavior, and consumers' perspectives on new productive forces. Given the methodological constraints, all research samples were collected exclusively from online sources. Therefore, we defined the survey subjects as internet users, with each individual participating in the online community serving as a survey unit.

2.2.1 Subjects and methods

This survey takes the potential consumers (i.e. the ones who have not bought Baise mango) and the actual consumers (i.e. the ones who have bought Baise mango) as the research object. The online questionnaire is made by using Questionnaire Star and the link is shared on the internet platforms.

2.2.2 Investigation and sampling methods

Through investigating consumers 'perceptions and satisfaction regarding direct effects, mediating effects, and moderating effects—including agricultural product quality, price optimization and accessibility, product diversification, information transparency, brand value enhancement, consumption scenario reconstruction, digital literacy, regional economic levels, policy support, and consumption concepts—we aim to explore the extent and pathways through which new quality productivity influences consumer behavior. To chart a sustainable development path for agricultural product sales, our survey should not only target consumers who have purchased Baise mangoes but also assess potential buyers' awareness and attitudes toward these products.

(1) Design of sampling frame

This survey targeted internet users who had purchased fresh fruits through mainstream e-commerce or community group-buying platforms within the past year, with both Baise mango buyers and non-buyers serving as the sampling frame. Using stratified quota sampling, the study controlled for age and geographic distribution, selecting consumers across different age groups and regions. Age groups were categorized as 18-25,26-35,36-45, and over 45, while urban, suburban, and rural areas were classified as distinct regional strata.

(2)Determination of sample size and sample allocation

The sample size of this survey is planned to be 500 people, based on industry research standards (the "2022 China Fresh Food Consumption Research Method White Paper") and stratified quota requirements (urban: suburban: rural = 5:2:3). This scale can support descriptive analysis of consumer behavior and multiple regression modeling, while also considering implementation costs and data quality. Given the varying levels of fruit purchase demand across regions, to improve sampling validity, we conducted quota sampling for pre-determined regional strata. For urban consumers, residents in urban areas have higher incomes and stronger purchasing power, leading to greater demand for fruits. According to the "2022 China Mango Industry Development Report" and data from fruit e-commerce platforms, urban consumers show higher demand for mangoes, with their purchases on e-commerce platforms exceeding 70%. For suburban consumers, mango demand remains relatively stable. Although the "2023 China Third-and Fourth-Tier Cities Fruit Consumption Trend Report" indicates significant growth in mango consumption in third-and fourth-tier cities, the consumption volume is still lower compared to first-tier cities. Additionally, with lower income levels in suburban areas, the share of mango consumption remains far below that in urban areas. For rural consumers, despite increasing income and improved logistics conditions, fruit consumption in rural areas is gradually rising. However, according to the "2022 China Rural Consumer Market Report," tropical fruits like mangoes account for less than 20% of consumption, with more consumers preferring cheaper and longer-preserved fruits. Nevertheless, since rural areas are also the primary growing regions for most fruits, their consumption volume is slightly higher than that in suburban areas. Therefore, the regional ratio is controlled as: urban: suburban: rural = 5:2:3.

2.3 Verification of Pre-Survey Data

2.3.1 Reliability test

According to the characteristics of the questionnaire, the Cronbach α coefficient was used to evaluate the reliability of the data, which is suitable for the reliability analysis of attitude and opinion scales.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right) \tag{1}$$

Here, K denotes the number $\sigma_{Y_i}^2$ of items in the scale, σ² represents σ_X^2 the variance of respondents 'scores for a specific item, and σ² represents the variance of total scores across all items. This coefficient measures internal consistency, also known as homogeneity or consistency reliability. Higher consistency indicates stronger reliability. Generally, Cronbach's α ≥ 0.9 signifies excellent reliability, while 0.7 <Cronbach's α <0.8 indicates insufficient reliability as shown in table 1.

Table 1 Reliability Analysis of the Subscales

reliability statistics		
Clonal Alpha	Cloning of the Alpha of Cronbach based on the standardized items	number of terms
0.897	0.900	17

The Cronbachα coefficient of the questionnaire is 0.900>0.8, which indicates that the reliability of the questionnaire is very good.

2.4Validity Test

Structural validity refers to the degree of match between the specific structure reflected by the measurement results and the actual measurement values. The higher the validity coefficient, the better the measurement effect of the questionnaire and the stronger the overall validity as shown in table 2.

Table 2 Structure Validity Analysis Table

KMO and Bartlett's test		
KMO sample adequacy measure		0.926
Bartlett sphericity test	approximate chi-square	3395.796
	free degree	136
	conspicuousness	0.000

The structural validity of the questionnaire was tested by KMO and Bartlett's test, and the KMO value was 0.926, which was higher than 0.7, indicating that the structural validity of the questionnaire was good as show in table 3.

Table 3 Reliability Analysis of Official Survey

reliability statistics		
Cronbach α	Cronbach α Based on Standardized Items	number of terms
0.890	0.890	17

The Cronbachα coefficient of the questionnaire is 0.890>0.8, which indicates that the reliability of the questionnaire is very good.

Table 4 Formal Survey Validity Analysis

KMO and Bartlett's test		
KMO sample adequacy measure		0.92
Bartlett sphericity test	approximate chi-square	3216.838
	free degree	136
	conspicuousness	0.000

The calculated results showed that the KMO value was 0.92, the Bartlett's test value was 3216.838, the degree of freedom was 136, and the p-value was 0.000, which indicated that the overall validity of the questionnaire was in a very high acceptable range as shown in table 4.

3 DATA PROCESSING

3.1 Questionnaire Data Processing

Since the highest score (5 points) is assigned to the first option and the lowest score (1 point) to the fifth option in the Likert scale, the original questionnaire results need to be adjusted first. The conversion should be: 1→5, 2→4, 3→3, 4→2, 5→1.

3.2 Construct Dependent Variable (Y): Consumer Behavior Indicators

Since our research aims to examine the impact pathways of new quality productivity on agricultural product consumer behavior, we need to construct consumer behavior indicators to measure the extent of its influence when analyzing direct effects, mediating effects, and moderating effects. This paper selects six questionnaire items for measurement: Q8, Q12, Q15, Q16, Q19, and Q23. These items reflect information on consumers' purchasing decisions, brand loyalty, product evaluation/satisfaction, and other aspects. Given the large number of indicators, we employ factor analysis to reduce the dimensionality of the indicators and then construct consumer behavior indicators based on the results of factor analysis. The following outlines the steps for constructing consumer behavior indicators as shown in table 5:

(1) Correlation analysis

Firstly, the correlation analysis of the six indexes was carried out by SPSS software, and the correlation matrix was obtained.

Table 5 Correlation Matrix of Consumer Behavior Indicators

dependency matrix							
		Q8	Q12	Q15	Q16	Q19	Q23
relativity	Q8	1.000	0.967	0.180	0.176	0.281	0.174
	Q12	0.067	1.000	0.057	0.067	0.144	0.138
	Q15	0.180	0.057	1.000	0.104	0.235	0.077
	Q16	0.176	0.067	0.104	1.000	0.539	0.417
	Q19	0.281	0.144	0.235	0.539	1.000	0.391
	Q23	0.174	0.138	0.077	0.417	0.391	1.000
Significance (one-tailed)	Q8		0.068	0.000	0.000	0.000	0.000
	Q12	0.068		0.103	0.068	0.001	0.001
	Q15	0.000	0.103		0.010	0.000	0.043
	Q16	0.000	0.068	0.010		0.000	0.000
	Q19	0.000	0.001	0.000	0.000		0.000
	Q23	0.000	0.001	0.043	0.000	0.000	

As shown in the table above, the six indicators show weak pairwise correlations, indicating that the relationships between variables are not strong. Most p-values are below 0.05, suggesting that even with weak correlations, these relationships are not random but follow certain patterns.

(2) KMO and Bartlett's test

Table 6 KMO and Bartlett's Test for Consumer Behavior Indicators

KMO and Bartlett's test		
KMO (Kaiser-Meyer-Olkin) Measure of Sampling Adequacy		0.695
Bartlett sphericity test	approximate chi-square	384.191
	free degree	15
	conspicuousness	0.000

As shown in Table 6, the KMO value exceeds 0.6 and the p-value of Bartlett's test for sphericity is below 0.05, indicating sufficient correlation for factor analysis.

(3) Analysis of the results from factor analysis

Table 7 Total Variance Explanation of Factor Analysis for Consumer Behavior-Related Indicators

Total Variance Explanation									
ingredient	initial eigenvalue			extract load square sum			The sum of the squares of the rotational loads		
	amount to	variance percentage	accumulative total %	amount to	variance percentage	accumulative total %	amount to	variance percentage	accumulative total %
1	2.150	35.839	35.839	2.150	35.839	35.839	1.878	31.295	31.295
2	1.019	16.991	52.831	1.019	16.991	52.831	1.251	20.846	52.141

Total Variance Explanation									
3	.968	16.126	68.957	.968	16.126	68.957	1.009	16.816	68.957
4	.809	13.486	82.443						
5	.621	10.344	92.787						
6	.433	7.213	100.000						

The results of factor analysis show that there are three components, and the cumulative variance contribution rate of these three components is 68.957%, which means that these three components can explain 68.957% of the total variance, and the initial eigenvalue is close to 1 as shown in table 7.

Table 8 Component Matrix of Consumer Behavior Indicators after Factor Analysis Rotation

Rotated Component Matrix			
	ingredient		
	1	2	3
Q8	.228	.642	.009
Q12	.082	.041	.990
Q15	-.021	.844	.039
Q16	.836	.077	-.056
Q19	.740	.344	.074
Q23	.756	-.007	.137

From the table 8, component 1 can be interpreted as purchase decision, component 2 as brand loyalty, and component 3 as product satisfaction.

(4) Constructing indicators of consumer behavior

The final consumer behavior index is calculated by averaging the scores of the three components. The first 10 rows of data are shown in Table 9 below.

Table 9 Constructing Consumer Behavior Indicators Based on Factor Analysis Scores

Component 1 score	Component 2 score	Component 3 score	Y(consumer behavior)
0.547	.913	0.126	0.529
-0.456	1.030	0.241	0.272
0.253	-0.289	-0.689	-0.242
0.635	0.689	0.014	0.446
0.213	0.776	0.135	0.374
1.148	1.208	1.900	1.419
-0.022	-0.722	-0.757	-0.500
0.477	0.193	0.105	0.258
-0.169	-0.203	-0.568	-0.313
-1.299	1.100	-1.696	-0.632

3.3 Data Analysis Methods

3.3.1 Qualitative analysis

Method of comparative analysis: In this survey, we compare two aspects: first, the personal information of potential consumers and actual consumers; second, the attitudes and opinions of consumers on the factors affecting the new productivity.

3.3.2 Quantitative analysis

(1) Validity and reliability analysis

After collecting the questionnaires, the reliability and validity of the questionnaire were tested.

(2) Descriptive analysis

After the processing of the questionnaire data, we have carried out the descriptive statistical analysis, and calculated the descriptive statistical indicators by the frequency analysis method, and made various frequency distribution charts, so as to have a general understanding of the distribution of consumer population characteristics, the cognition of Baise mango, the purchase behavior, the cognition of new productivity, etc.

(3) Multiple linear regression analysis

The multiple linear regression model is established to analyze the direct effect of new quality productivity on consumer behavior, i.e. the impact of agricultural product quality upgrading (X1), price optimization and accessibility (X2), product diversification and customization (X3) on consumer behavior.

(4) Structural equation model

This study establishes a structural equation model of mediating effects to analyze and test how direct effects influence consumer behavior through mediating factors, including the pathways and degrees of impact. Specifically, it examines

how agricultural product quality upgrading (X1), price optimization and accessibility (X2), and product diversification and customization (X3) affect consumer behavior through mediating factors: information transparency (X4), brand value enhancement (X5), and consumption scenario reconstruction (X6), as well as the extent of influence of information transparency (X4), brand value enhancement (X5), and consumption scenario reconstruction (X6) on consumers.

(5) Regression analysis

Using ridge regression models, we examine the moderating effects of new quality productivity on consumer behavior and test the significance of interaction terms. Specifically, we analyze the moderating effects of the following factors: consumer digital literacy (X7), regional economic level (X8), policy support intensity (X9), and consumption attitudes (X10). Additionally, we assess the moderating effects of interaction terms (X11, X12, X13, X14, X21, X22, X23, X24, X31, X32, X33, X34) on consumer behavior, with the significance of these interaction terms evaluated through cross-validation.

4 PATH ANALYSIS OF THE INFLUENCE OF NEW PRODUCTIVITY ON CONSUMER BEHAVIOR

4.1 Model Construction and Hypothesis Formulation

4.1.1 Model building approach

This study develops a comprehensive model to analyze the direct, mediating, and moderating effects of new quality productivity on consumer behavior. The independent variables include three dimensions of new quality productivity: agricultural product quality upgrading, price optimization and accessibility, and product diversification. Mediating variables consist of information transparency, brand value enhancement, and consumption scenario reconstruction. Moderating variables encompass consumer consumption literacy, regional economic levels, policy support intensity, and consumer consumption attitudes. The dependent variable is consumer behavior. Based on the theories of new quality productivity and consumer behavior, 19 research hypotheses are proposed to verify the existence and mechanisms of direct effects, mediating effects, and moderating effects.

4.1.2 Model hypothesis

(1) The Direct Effect Hypothesis

H1d: The quality upgrade of agricultural products (X1) significantly affects consumer behavior (Y).

H2d: Price optimization and accessibility (X2) significantly influence consumer behavior (Y).

H3d: Product diversification and customization (X3) significantly influence consumer behavior (Y).

(2) The hypothesis of mediating effect

H1a: The quality upgrade of agricultural products (X1) significantly affects information transparency (x4).

H1b: The quality upgrade of agricultural products (X1) significantly enhances brand value (x5).

H1c: The quality upgrade of agricultural products (X1) significantly impacts the restructuring of consumption scenarios (x6).

H2a: Price optimization and accessibility (X2) significantly affect information transparency (x4).

H2b: Price optimization and accessibility (X2) significantly enhance brand value (x5).

H2c: Price optimization and accessibility (X2) significantly influence the reconstruction of consumption scenarios (x6).

H3a: Product diversification and customization (X3) significantly affect information transparency (x4).

H3b: Product diversification and customization (X3) significantly enhance brand value (x5).

H3c: Product diversification and customization (X3) significantly influence the reconstruction of consumption scenarios (x6)

H4: Information transparency (X4) mediates the relationship between new quality productivity and consumer behavior (Y).

H5: Brand value enhancement (X5) serves as a mediator between new quality productivity and consumer behavior (Y).

H6: The consumption scenario reconstruction (X6) serves as an intermediary between new quality productivity and consumer behavior (Y).

(3) The Hypothesis of the Moderating Effect

H7: Consumer digital literacy (X7) moderates the effect of new quality productivity on consumer behavior (Y).

H8: The regional economic level (X8) moderates the effect of new productive forces on consumer behavior (Y).

H9: Policy support (X9) moderates the effect of new quality productivity on consumer behavior (Y);

H10: Consumer attitudes (X10) moderate the effect of new quality productivity on consumer behavior (Y).

4.2 The Model of Direct Effect of New Productivity on Consumer Behavior

4.2.1 Variable selection and theoretical basis

The following is a detailed explanation of the selected direct effect variables and their theoretical basis in this study:

(1) X1: Quality of agricultural products (Q7)

The questionnaire is designed to measure consumers 'perception of agricultural product quality. According to the theory of consumer perceived value, consumers' perception of product quality directly influences their purchasing decisions and willingness to pay. Meanwhile, the theory of signals suggests that high-quality agricultural products can enhance consumer trust and loyalty by conveying credible signals.

(2) X2: Price optimization and accessibility (Q9, Q10)

The survey measures two key factors: Q9 (Price Rationality) and Q10 (Purchase Convenience), with their average scores serving as the composite indicator. This approach aligns with price sensitivity theory, which posits that consumers' price sensitivity directly influences purchasing decisions, and channel convenience theory, which demonstrates that streamlined purchasing channels reduce time and effort costs, thereby stimulating consumer demand.
(3) X3: Product Diversity (Q11)
The questionnaire's Q11 item measures consumers' perception of product variety. According to consumer choice theory, diversified product selection can meet personalized needs and enhance purchasing experience. Meanwhile, the long-tail theory suggests that a wide range of products can cover more niche markets and boost overall sales.

4.2.2 Multiple linear regression model

To investigate the direct mechanisms of the three dimensions of new quality productivity (agricultural product quality upgrade X1, price optimization and accessibility X2, product diversification X3) on consumer behavior Y, a multiple linear regression model can be constructed for direct effect testing. The following section will systematically examine the four fundamental assumptions of the model, followed by parameter estimation and model evaluation. First, we will test the basic assumptions:
(1) Linear relationship test
The residual scatter plot is used to test the linear relationship between consumer behavior and new productivity.
The scatter points are symmetrically distributed around the zero point of the vertical axis, with no clustering of outliers. No nonlinear correlation patterns such as parabolas or exponential curves are observed, indicating that there is no systematic deviation between the predicted values and the residuals. The consumer behavior (Y) exhibits a linear additive relationship with the three dimensions of new quality productivity (X1-X3), and the model setup aligns with the data characteristics.
(2) Multicollinearity diagnosis
As shown in table 10, in multiple regression analysis, multicollinearity refers to a high correlation among independent variables, which leads to unstable regression coefficient estimates and larger standard errors, thereby affecting the model's explanatory power and the reliability of statistical inferences. To diagnose this issue, the variance inflation factor (VIF) can be used for testing. In the output results, check the VIF values of each independent variable. If VIF> 10, it indicates the presence of multicollinearity; otherwise, it does not.

Table 10 Multicollinearity diagnostic table for direct effects

coefficient		
model coefficient	collinearity statistic	
	tolerance	VIF
constant	0.736	1.359
X1	0.788	1.270
X2	0.779	1.284
X3	0.736	1.359

The results show that no independent variable has a VIF greater than 10, as multicollinearity is not present.
(3) Test of normality
The Q-Q diagram is used to judge the normality of the data.
As shown in the figure, the residual data points after regression analysis modeling are distributed along the diagonal, indicating that the residuals are approximately normally distributed.
(4) Test for homoscedasticity
The residual-prediction scatter plot is drawn to analyze whether the residual fluctuation shows systematic change with the increase of prediction value and to verify the homogeneity of variance.

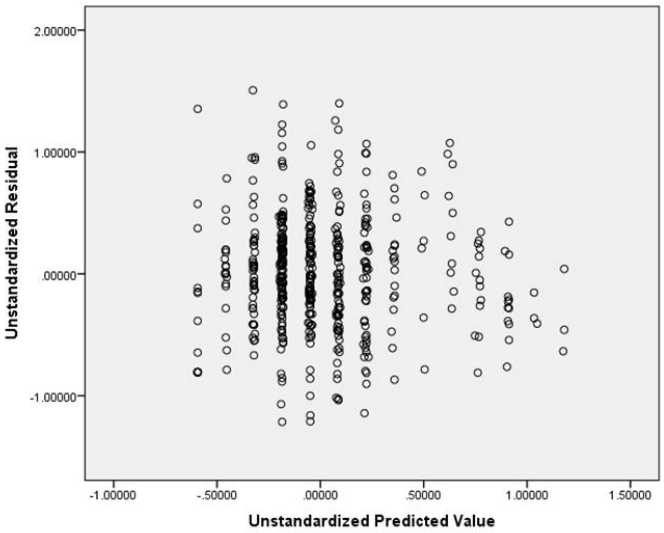

Figure 1 Residuals Versus Predicted Values Scatter Plot of Direct Effect

As shown in the figure 1, the residuals after regression analysis modeling are randomly distributed and have no obvious pattern or trend in the whole X-axis range. The scattered points of the residuals are evenly distributed around the zero line without systematic clustering or dispersion, so it can be concluded that the residuals satisfy the homoskedasticity.
Preliminary analysis indicates that X1 (agricultural product quality enhancement), X2 (price optimization and accessibility), and X3 (product diversification) exhibit linear relationships with Y (consumer behavior). To quantify these factors' specific impacts on consumer behavior, this study employs multiple linear regression modeling. The model uses the three dimensions of new quality productivity (X1: agricultural product quality enhancement; X2: price optimization and accessibility; X3: product diversification) as independent variables, with consumer behavior (Y) as the dependent variable as shown in table 11. The model formula is:

$$Y=\beta_0+\beta_1X1+\beta_2X2+\beta3X3+\varepsilon \quad (2)$$

In this paper, β1, β2, β3 are the direct effect coefficients of X1, X2, X3 on Y, and ε is the random error term.

4.3 Data Analysis and Result Presentation

Table 11 Results of Multiple Linear Regression Analysis

linear regression coeffficient	
Model independent variables	coefficient
constant term	-1.778
X1	0.054
X2	0.344
X3	0.105

The results show that the regression coefficients of X1, X2, X3 are 0.054,0.344,0.105 respectively, all have significant positive influence on Y, and X1 has the strongest influence.

Table 12 Results of Variance Analysis

ANOVAa						
	model	quadratic sum	free degree	mean square	F	conspicuousness
1	regression	53.483	3	17.828	78.357	0.000b
	residual	112.850	496	0.228		
	sum	166.333	499			

Model significance:
The variance analysis shows that the F value of the model is 78.357, and the significance level is 0.000 ($p < 0.05$), which indicates that the three dimensions of new quality productivity (agricultural product quality upgrading, price optimization and accessibility, product diversification) have a significant joint influence on consumer behavior as shown in table 12.

4.4 Test and Discussion of Direct Effect

The regression equation of direct effect was obtained from the regression analysis model above:

$$Y=-1.778+0.054X_1+0.344X_2+0.105X_3+\epsilon \quad (3)$$

Regression analysis revealed that X1 (agricultural product quality upgrading), X2 (price optimization and accessibility), and X3 (product diversification) all significantly positively influenced Y (consumer behavior). Notably, X2

demonstrated the highest standardized coefficient, indicating that price optimization and accessibility are the strongest determinants of consumer behavior. This further demonstrates consumers' heightened sensitivity to pricing and purchasing convenience. Products with reasonable prices and easy accessibility are more likely to attract consumers, reflecting their prioritization of cost-effectiveness and purchasing convenience in decision-making. X3 had the weakest impact, while X1 followed X2, though its impact was slightly weaker than price factors (X2). Specifically, the regression coefficient of X2 was 0.344, which was much higher than that of X1 (0.054) and X3 (0.105), yet quality upgrading still significantly drove consumer behavior. This indicates consumers increasingly value product quality and are willing to pay premium prices for high-quality products, reflecting the trend of consumption upgrading. While X3 had a relatively smaller impact, it remained statistically significant. Despite its weaker influence, product diversification still positively influenced consumer behavior, demonstrating that varied product options can meet diverse consumer needs and enhance purchasing intent.

4.5 Verify and Research the Conclusions

The validity of the model is verified by the goodness of fit test and the significance test of the regression equation. According to the ANOVA table, the F value of the model is 78.357, and the significance level is 0.000 ($p < 0.05$), which indicates that the combined influence of the three dimensions of new quality productivity on consumer behavior is statistically significant.

4.6 The Mediating Effect Model of New Productivity on Consumer Behavior

4.6.1 Theoretical background of the mediation effect theory

The intermediary effect refers to the indirect mechanism in which the independent variable (X) influences the dependent variable (Y) through the intermediary variable (M). The core logic is that the independent variable not only has a direct effect on the dependent variable but also produces an indirect effect through the intermediary variable.

The basic form of the mediation effect model:

Independent variable (X) → Mediator (M); Mediator (M) → Dependent variable (Y); Independent variable (X) → Dependent variable (Y)

The consumer behavior is influenced by many factors. The mediating effect analysis can reveal the indirect effect path of the independent variable (new quality productivity) through the mediating variable (consumer trust, brand identity) to the dependent variable (consumer behavior), which helps the researchers to understand the logic chain of consumer decision-making more comprehensively.

4.6.2 Introduction to Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) is a multivariate statistical analysis method capable of simultaneously addressing complex relationships among multiple independent variables, mediating variables, and dependent variables. Its core features include multivariate comprehensive analysis, integration of measurement and structural models, handling latent variables, and model fitting and modification. The mathematical framework of SEM comprises both measurement and structural models, with relationships between variables described through factor loadings and path coefficients as shown in table 13.

The following outlines the SEM analysis procedures and commonly used fitting metrics:

(1) Theoretical model construction. Based on the research problem and theoretical framework, the theoretical model including independent variable, mediator variable and dependent variable is constructed, and the relationship hypothesis among each variable is defined.

(2) Data collection and pre-processing. The scale was designed to measure the variables, and the reliability and validity of the data were ensured. The data were standardized to eliminate the difference of dimension.

(3) Measurement model test. The relationship between the observed variables and latent variables was tested by confirmatory factor analysis.

(4) Structural model testing, which is to test the path relationship between latent variables and verify the research hypothesis, and to evaluate the goodness of fit of the model.

(5) Model modification and optimization. Adjust the model according to the fitting index and correction index, and ensure the modified model has theoretical significance and statistical rationality.

(6) Result interpretation. The path coefficients and significance levels are interpreted to validate the research hypothesis.

Table 13 Common Fitting Indicators of SEM

fitting index	Recommended value	explain
χ^2/df	< 3.0	The ratio of chi-square to degrees of freedom reflects the fit between the model and the data.
GFI	>0.9	Fit index, reflecting the model's explanatory power for the data
AGFI	>0.9	Adjusted goodness-of-fit index, considering model complexity
RMSEA	<0.08 (Excellent)	Approximate root mean square error, reflecting the model fitting error
CFI	>0.9	Compare the fit indices to reflect the comparison results between the model and the benchmark model
NFI	>0.9	Standardized fit index, reflecting the comparison between the model and the independent

fitting index	Recommended value	explain
		model

4.7 Variable Selection and Theoretical Basis

In the mediation effect analysis, selecting appropriate variables and clarifying their theoretical basis is crucial to reveal the complex relationship between independent and dependent variables. The following is a detailed explanation of the selected mediating variables and their theoretical basis in this study:

（1）X4: Information Transparency (Q13, Q14). The composite indicator is calculated as the average score of Q13 (product traceability) and Q14 (quality inspection) in the questionnaire. According to information asymmetry theory, transparency enhances consumer trust and boosts purchase intent.

（2）X5: Brand Value Reinforcement (Q17). The Q17 question in the questionnaire measures brand value identification. Social identity theory suggests that consumers enhance their self-identity and social status by choosing high-value brands.

（3）X6: Consumption Scenario Reconstruction (Q18). The Q18 item in the questionnaire measures consumers 'perception of consumption scenarios, using a Likert scale to assess satisfaction. According to scenario marketing theory, reconstructing consumption scenarios can enhance purchase motivation through contextualized experiences. Experience economy theory further indicates that consumers' experiences in specific scenarios directly influence their purchasing decisions and satisfaction.

4.8 Constructing a Structural Equation Model of Mediating Effect

This study develops a path analysis model comprising independent variables (new quality productivity), mediating variables (information transparency, brand value enhancement, and consumption scenario reconstruction), and dependent variable (consumer behavior), to elucidate the complex mechanism through which new quality productivity influences consumer behavior via these mediating variables. The model's specific pathways are as follows: Independent variables: X1: Agricultural product quality upgrading, X2: Price optimization and accessibility, X3: Product diversification and customization; Mediating variables: X4: Information transparency, X5: Brand value enhancement, X6: Consumption scenario reconstruction; Dependent variable: Y: Consumer behavior as shown in table 14.

4.9Schematic diagram of the structural equation model

Data analysis and result presentation

The model fit indices (χ^2/df=3.395, GFI=0.997, RMSEA=0.069, CFI=0.996) indicate that the model has a good overall fit. The specific results are as follows:

Table 14 Fit Indices of the Structural Equation Model

fitting index	Recommended value	fitted value
χ2	Smaller is better	6.791
χ2/df	< 3.0	3.395
GFI	>0.9	0.997
AGFI	>0.9	0.939
RMSEA	<0.10	0.069

Table 15 Hypothesis Testing

hypothesis	Assumed path	estimated value	standard error	critical ratio	conspicuousness	result
H1a	Agricultural Product Quality Upgrade→Information Transparency	0.421	0.179	0.400	0.689	false
H1b	Agricultural Product Quality Upgrade→Brand Value Reinforcement	-0.823	0.375	-0.690	0.049	found
H1c	Agricultural Product Quality Upgrade→Reconstruction of Consumption Scene	-0.847	0.500	-0.676	0.049	found
H1d	Agricultural Product Quality Upgrade→Consumer Behavior	0.982	0.427	2.031	0.042	found
H2a	Price optimization and accessibility→information transparency	0.094	0.907	0.232	0.008	found
H2b	Price Optimization and Accessibility→Brand Value Reinforcement	-0.067	0.086	-0.143	0.086	false
H2c	Price Optimization and Accessibility→Reconstruction of Consumption Scenarios	-0.113	0.409	-0.193	0.084	false
H2d	Price Optimization and Accessibility→Consumer Behavior	0.103	0.038	0.16	0.037	found
H3a	Product Diversity and Customization→Information Transparency	0.39	0.476	0.939	0.034	found
H3b	Product Diversification and Customization→Brand Value Reinforcement	0.694	0.976	1.01	0.031	found

hypothesis	Assumed path	estimated value	standard error	critical ratio	conspicuousness	result
H3c	Product diversification and customization→reconstruction of consumption scene	0.209	0.179	1.257	0.020	found
H3d	Product Diversification and Customization→Consumer Behavior	-0.840	0.350	-1.969	0.049	found
H4	Information Transparency→Consumer Behavior	-0.369	0.119	-2.217	0.027	found
H5	Brand Value Reinforcement→Consumer Behavior	0.606	0.447	0.943	0.034	found
H6	Reconstruction of consumption scenarios→consumer behavior	0.603	0.101	3.986	0.000	found

This study developed a path analysis model comprising independent variables (new quality productivity), mediating variables (information transparency, brand value enhancement, and consumption scenario reconstruction), and dependent variables (consumer behavior). The results demonstrate that agricultural product quality upgrading (X1) significantly negatively affects brand value enhancement (X5) and consumption scenario reconstruction (X6), while showing no significant impact on information transparency (X4). Price optimization and accessibility (X2) exhibit a significant positive influence on information transparency (X4). Product diversification and customization (X3) demonstrate significant positive effects on information transparency (X4), brand value enhancement (X5), and consumption scenario reconstruction (X6). Among the mediating variables, brand value enhancement (X5) and consumption scenario reconstruction (X6) positively influence consumer behavior (Y), whereas information transparency (X4) has a significant negative effect. Consequently, based on a 5% significance level, the hypotheses H1a, H2b, and H2c proposed in this study are not supported, while the remaining hypotheses are validated as shown in table 15.

5 VERIFY AND RESEARCH THE CONCLUSIONS

5.1 Analysis of the Mediating Effect

The path analysis model is used to test the relationship between new quality productivity and consumer behavior. The results show that information transparency and brand value enhancement and the reconstruction of consumption scene play a mediating role in the relationship between new quality productivity and consumer behavior.

5.1.1 The mediating effect of information transparency

Path 1: Quality upgrading of agricultural products→Information transparency→Consumer behavior

The impact of agricultural product quality upgrading on information transparency is not significant, so the mediating effect of this path is not valid.

Path 2: Price optimization and accessibility→Information transparency→Consumer behavior

Price optimization and accessibility have a significant positive effect on information transparency, and information transparency has a significant negative effect on consumer behavior, which indicates that information transparency plays a partial mediating role between price optimization and accessibility and consumer behavior.

Path 3: Product diversification and customization→information transparency→consumer behavior

The results show that product diversification and customization have a significant positive effect on information transparency, and information transparency has a significant negative effect on consumer behavior, which indicates that information transparency plays a partial mediating role between product diversification and customization and consumer behavior.

The above conclusions show that information transparency plays a significant mediating role in the influence of price optimization and accessibility, product diversification and customization on consumer behavior, but its effect direction is negative, which may be related to consumers' resistance to information overload.

5.1.2 The mediating effect of brand value reinforcement

Path 1: Quality upgrading of agricultural products→Brand value strengthening→Consumer behavior

The results show that the brand value enhancement has a significant negative impact on the quality upgrading of agricultural products, and the brand value enhancement has a significant positive impact on the consumer behavior, which indicates that the brand value enhancement plays a partial mediating role between the quality upgrading of agricultural products and the consumer behavior.

Path 2: Price Optimization and Accessibility→Brand Value Enhancement→Consumer Behavior

The effect of price optimization and accessibility on brand value enhancement is not significant, so the mediating effect of this path is not valid.

Path 3: Product diversification and customization→Brand value enhancement→Consumer behavior

The results show that the brand value enhancement has a significant positive effect on the product diversification and customization, and the brand value enhancement has a significant positive effect on the consumer behavior, which indicates that the brand value enhancement plays a partial mediating role between the product diversification and customization and the consumer behavior.

The above conclusions show that brand value reinforcement plays a significant mediating role in the influence of

agricultural product quality upgrading, product diversification and customization on consumer behavior, and its effect direction is positive, indicating that brand identity is an important factor driving consumer behavior.

5.1.3 The intermediary role of consumption scenario reconstruction

Path 1: Upgrade of agricultural product quality→Reconstruction of consumption scene→Consumer behavior

The results show that the upgrading of agricultural product quality has a significant negative impact on the reconstruction of consumption scene, and the reconstruction of consumption scene has a significant positive impact on consumer behavior, which indicates that the reconstruction of consumption scene plays a partial mediating role between the upgrading of agricultural product quality and consumer behavior.

Path 2: Price Optimization and Accessibility → Reconstructing Consumption Scenarios → Consumer Behavior

Price optimization and accessibility have a significant negative impact on the reconstruction of consumption scenarios, and the reconstruction of consumption scenarios has a significant positive impact on consumer behavior, indicating that the reconstruction of consumption scenarios plays a partial mediating role between the upgrading of agricultural product quality and consumer behavior;

Path 3: Product diversification and customization → Reconstruction of consumption scenarios → Consumer behavior

The results show that the product diversification and customization have a significant positive impact on the reconstruction of consumption scene, and the reconstruction of consumption scene has a significant positive impact on consumer behavior, which indicates that the reconstruction of consumption scene plays a significant intermediary role between the upgrading of agricultural product quality and consumer behavior.

The above conclusions show that the reconstruction of consumption scene plays a significant intermediary role in the influence of the upgrading of agricultural product quality, product optimization and accessibility, product diversification and customization on consumer behavior, and it plays a negative role in the upgrading of agricultural product quality, product optimization and accessibility, and plays an important intermediary role in the product diversification and customization and consumer behavior.

While agricultural product quality enhancement represents a key direction for consumption upgrading, its adverse effects on brand value and consumption scenarios demonstrate that quality improvement alone may not sufficiently drive consumer behavior. This requires complementary strategies such as price optimization and product diversification. Although price optimization and accessibility significantly improve information transparency, excessive transparency could negatively impact consumer behavior, necessitating a balanced approach in information dissemination. Product diversification and customization can simultaneously enhance information transparency, brand value, and consumption scenario restructuring, serving as effective drivers of consumer behavior. Brand value reinforcement and consumption scenario restructuring are critical factors directly influencing consumer behavior, requiring enterprises to prioritize brand building and innovation in consumption scenarios.

5.2 The Model of the Moderating Effect of New Quality Productivity on Consumer Behavior

5.2.1 Theoretical background of the regulation effect theory

Regulatory effect refers to a variable (moderator) altering the influence of an independent variable on a dependent variable by modifying the strength or direction of their relationship. In regression analysis, this effect is typically tested through interaction terms—introducing the product of independent and moderator variables into the model to assess its statistical significance. A significant interaction term indicates that the moderator modifies how the independent variable affects the dependent variable, thereby confirming the regulatory effect. In consumer behavior research, regulatory effects are widely used to examine how different consumer characteristics or external factors influence how market variables shape consumer decisions. The direct impact of new quality productivity on consumer behavior may not be universally applicable, as it could be moderated by individual traits like digital literacy and consumption attitudes, or external factors such as regional economic levels and policy support.

5.2.2 The selection of the regulating variable and the theoretical basis

As indicated by Musa [8], the Technology Acceptance Model (TAM) suggests that consumers with high digital literacy exhibit a greater propensity to adopt and utilize digital products and services. This characteristic may amplify the impact of innovations associated with new quality productivity, such as product customization, on shaping consumer behavior. Regional economics theory [9] suggests that consumers in economically developed regions possess stronger purchasing power and prioritize product quality over price, which may moderate the effects of new quality productivity (e.g., quality upgrades). Institutional theory [10] demonstrates that policy support indirectly influences consumers 'perception and acceptance of new quality productivity through measures like subsidies and publicity. Values theory reveals that environmentally or health-conscious consumption concepts may enhance consumers' preference for green products or customized services, thereby moderating the influence of new quality productivity (e.g., diversified products). Therefore, consumer digital literacy, regional economic levels, and consumption values (e.g., environmental and health-oriented) serve as crucial indicators for studying the moderating effects of new quality productivity on consumer behavior. Consumer digital literacy (X7) measures consumers' proficiency in using digital technologies (Q21, Q22, Q26), with higher levels likely to boost acceptance of new quality productivity. Regional economic status (X8) (Q24) reflects stronger purchasing power in developed areas, where consumers prioritize product quality over price. Policy support (X9) (Q25) indirectly shapes consumer awareness of new quality productivity through subsidies or public campaigns. Environmental and health-conscious consumption patterns (X10) (Q28, Q30) may influence preferences for diverse products[11].

5.2.3 Introduction to ridge regression

Ridge Regression, a method developed by Hoerl and Kennard in 1970, addresses multicollinearity issues. As a variant of linear regression, it incorporates L2 regularization (a penalty term) into the least squares regression framework to reduce coefficient variance, thereby enhancing model stability and generalization.

When there is a high correlation between independent variables (i.e., multicollinearity), the coefficients of ordinary least squares regression may become unstable or even exhibit overfitting. To address this issue, ridge regression incorporates an L2 regularization term into the least squares loss function, penalizing the sum of squared regression coefficients. The equation for ridge regression is:

$$RSS_{ridge}=\sum_{i=1}^{n}(y_0-\beta_0-\sum_{j=1}^{p}\beta_j x_{xj})^2+\lambda\sum_{j=1}^{p}\beta_j^2 \tag{4}$$

Here, λ is the regularization parameter (also known as the ridge parameter $\sum_{j=1}^{p}\beta_j^2$), which controls the magnitude of the penalty term. The L2 norm constrains the size of regression coefficients, thereby reducing the model's variance. When λ=0, ridge regression reduces to ordinary least squares regression. As λ increases, the absolute values of regression coefficients are compressed, making the model more stable, though this may lead to some information loss.

1. Constructing a regression model for adjustment effects

In the methodology section, we established a moderated effect model using multiple regression analysis. The following sections will detail the variable selection and definitions in the model, including the design of new quality productivity, moderating variables, and their interaction terms. Below is the explanation of the moderated effect variables and their interactions as shown in table 16.

Table 16 Selection of Variables and Explanation of Interaction for Adjustment Effect

type of variable	variable symbol	Variable names and definitions	Question item sources	Interaction example
dependent variable	Y	consumer behavior	Q8、D12、Q15、Q16、Q19、Q23	—
New quality productivity	X1	Upgrading the quality of agricultural products	Q7	—
	X2	Price optimization and accessibility	D9、Q10	—
	X3	Product diversification and customization	Q11	—
regulated variable	X7	Consumer digital literacy	Q21、Q22、Q26	—
	X8	Regional economic level	Q24	—
	X9	Policy support	Q25	—
	X10	Consumption concepts (e.g. environmental protection, health-oriented)	Q28、Q30	—
Interaction term	X11	Agricultural Product Quality Upgrade × Consumer Digital Literacy	—	X1*X7
	X12	Agricultural Product Quality Upgrade × Regional Economic Level	—	X1*X8
	X13	Agricultural Product Quality Upgrade × Policy Support	—	X1*X9
	X14	Agricultural Product Quality Upgrade × Consumption Concept	—	X1*X10
	X21	Price Optimization and Accessibility × Consumer Digital Literacy	—	X2*X7
	X22	Price Optimization and Accessibility × Regional Economic Level	—	X2*X8
	X23	Price optimization and accessibility × policy support	—	X2*X9
	X24	Price Optimization and Accessibility × Consumption Concept	—	X2*X10
	X31	Product diversification and customization × consumer digital literacy	—	X3*X7
	X32	Product diversification and customization × regional economic level	—	X3*X8
	X33	Product diversification and customization × policy support	—	X3*X9
	X34	Product diversification and customization × consumption concept	—	X3*X10

After identifying the independent and dependent variables, we established the following multiple linear regression model and calculated the final results based on the model.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_7 + \beta_5 X_8 + \beta_6 X_9 + \beta_7 X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + + \beta_{14} X_{14} + \beta_{21} X_{21} + \beta_{22} X_{22} + + \beta_{23} X_{23} + \beta_{24} X_{24} + \beta_{31} X_{31} + \beta_{32} X_{32} + \beta_{33} X_{33} + \beta_{34} X_{34} + \varepsilon \quad (5)$$

The coefficients β1, β2, β3, β4, β5, β6, β7, β11, β12, β13, β14, β21, β22, β23, β24, β31, β32, β33, β34 correspond to the undetermined coefficients of X1, X2, X3, X7, X8, X9, X10, X11, X12, X13, X14, X21, X22, X23, X24, X31, X32, X33, X34, and ε is the random error term.

6 DATA ANALYSIS AND RESULT PRESENTATION

6.1 Basic Assumption

6.1.1 Residual test

To verify the model's assumptions of linearity and homoskedasticity, we plotted the residual plot.
residuals are randomly distributed around the zero line without any discernible pattern or trend, confirming the validity of the model's linear relationship assumption. Moreover, the consistent dispersion of residuals within the fitted range supports the homoskedasticity assumption, thus validating both the linear relationship and homoskedasticity of the model.

6.1.2 Test of normality

In multiple regression analysis, Shapiro-Wilk test is used to assess the normality of residuals, with the null hypothesis that "the data follow a normal distribution". If the test result is not significant (p> 0.05), the null hypothesis is accepted, and the residuals are considered to be approximately normally distributed as shown in table 17.

Table 17 Results of Normality Test

test of normality			
residual term	statistics	Shapiro-Wilk free degree	conspicuousness
	0.998	500	0.669

The results show that the residual statistic is 0.998, which is very close to 1, and intuitively supports the normality of the residual. Moreover, the p-value is much larger than the conventional threshold of 0.05, indicating that the null hypothesis cannot be rejected, i.e., the residuals follow a normal distribution.

6.1.3 Independence test

The Durbin-Watson statistic is used to test independence. The DW statistic ranges from 0 to 4. A value close to 2 indicates no autocorrelation among residuals. If the DW value deviates significantly from 2, it may indicate positive autocorrelation (DW <2) or negative autocorrelation (DW> 2) as shown in table 18.

Table 18 Results of independence tests

independence test	
model	Debin-Watson
DW price	1.892

In this model, the value of the Durbin-Watson statistic is 1.892. According to the judgment criteria of the Durbin-Watson statistic, it can be preliminarily concluded that there is no significant autocorrelation among the residuals of the model, and the independence assumption is basically satisfied.

6.1.4 Multicollinearity diagnosis

VIF (Variance Inflation Factor) measures the degree of linear correlation between independent variables. A VIF <5 indicates low collinearity, which is acceptable; VIF between 5 and 10 suggests moderate collinearity, requiring attention; while VIF ≥ 10 signifies severe collinearity, necessitating correction. Tolerance, the reciprocal of VIF, reflects how well independent variables can independently explain dependent variables. A tolerance value closer to 0 indicates more severe collinearity as shown in table 19.

Table 19 Results of Multicollinearity Diagnosis

coefficient		
Model independent variables	collinearity statistic	
	tolerance	VIF
X1	0.019	51.377
X2	0.021	47.416
X3	0.021	48.562
X7	0.019	51.573
X8	0.024	41.800
X9	0.022	45.020
X10	0.019	53.035

X11	0.009	107.204
X12	0.014	71.965
X13	0.015	68.958
X14	0.010	98.526
X21	0.007	148.195
X22	0.009	111.491
X23	0.010	100.159
X24	0.013	78.051
X31	0.009	108.919
X32	0.012	81.642
X33	0.011	92.920
X34	0.013	75.839

The results indicate that all variables exhibit VIF values significantly above 10, demonstrating severe multicollinearity in the multiple linear regression model. The interaction terms show particularly pronounced multicollinearity, as they are inherently correlated due to being constructed from the product of original variables. To avoid information loss caused by traditional methods like variable deletion, we adopted a ridge regression model. By introducing L2 regularization to compress coefficients, this approach effectively mitigates the impact of multicollinearity on parameter estimation and enhances model stability.

6.2 Regression Equation

Ridge regression reduces model variance by introducing an L2 regularization penalty to compress regression coefficients, while preserving all independent variables. It enhances model generalization by adjusting the hyperparameter λ to balance bias and variance. The table below displays the standardized coefficients (to three decimal places) of the ridge regression model, including main effect variables (X1-X10) and interaction terms (X11-X34) as show in table 20.

Table 20 Coefficients of Regression Variables

regression coefficient	
Model independent variables	coefficient
constant term	-1.584722471
X1	-0.050321717
X2	0.056539398
X3	-0.010563047
X7	0.112308953
X8	-0.008828191
X9	0.004157013
X10	0.057934179
X11	0.006560514
X12	-0.001476433
X13	0.001343500
X14	0.010690720
X21	0.016356423
X22	0.001664764
X23	0.005634327
X24	0.017188199
X31	0.008676187
X32	0.001784842
X33	0.004228596
X34	0.001679490

Based on the coefficient results, the ridge regression equation is constructed as follows:
$Y=-1.585-0.050X1+0.057X2-0.011X3+0.112X7-0.009X8+0.004X9+0.058X10+0.007X11-0.001X12+0.001X13+0.011X14+0.016X21+0.002X22+0.006X23+0.017X24+0.009X31+0.002X32+0.004X33+0.002X34+\epsilon$

6.3 Significance and Validity Test of Interaction Terms

6.3.1 Regression coefficient test

The analysis of the ridge regression coefficient table reveals the specific impacts of various variables, including interaction terms, on the dependent variable. In terms of main effects, consumer digital literacy (X7) demonstrates the most significant positive influence on the dependent variable, indicating that consumers with higher digital literacy are more susceptible to new quality productivity impacts, thereby exhibiting proactive consumption behaviors. Consumer attitudes (X10) also show a moderate positive effect, while factors such as agricultural product quality upgrading (X1), price optimization and accessibility (X2), and product diversification and customization (X3) have relatively weaker direct impacts. In contrast, regional economic level (X8) indicates they are not decisive factors. Regarding interaction

effects, consumer digital literacy (X7) exhibits mild positive moderating effects in multiple interaction terms, such as enhancing impacts on agricultural product quality upgrading (X11), price optimization and accessibility (X21), and product diversification and customization (X31). Meanwhile, consumer attitudes (X10) play a positive moderating role in some interaction terms, notably promoting agricultural product quality upgrading (X14) and price optimization and accessibility (X24). In comparison, the moderating effects of regional economic level (X8) and policy support intensity (X9) are relatively weak, with most interaction terms showing near-zero impacts as shown in table 21.

6.3.2 Cross-validation to evaluate the model

The predictive performance of models with and without interaction terms was compared using K-fold Cross-Validation. This method evaluates the model's stability on unseen data by repeatedly dividing the dataset into training and validation sets, thereby preventing overfitting or underfitting and objectively reflecting the actual value of interaction terms.

Table 21 Cross-Validation Evaluation of Model Results

Cross-validation is used to evaluate the model results.	
cross validation error with interaction term	cross validation error without interaction
0.2281406	0.2476602

Cross-validation results demonstrate that the introduction of interaction terms reduces model prediction error by 7.9% (MSE=0.2281 vs. 0.2477). While the improvement is modest, it enhances the model's explanatory power for consumer behavior, meeting the practical demands of social science research. By quantifying the synergistic effects between new quality productivity and group characteristics (e.g., digital literacy and consumption attitudes), the interaction terms provide empirical support for differentiated market strategies.

6.4 Interpretation and Discussion of the Effect of the Regulation

This study investigates the moderating effects of new quality productivity on consumer behavior through ridge regression analysis. The regression model incorporates multiple interaction terms to examine how individual consumer characteristics and external environmental factors modulate the impact of new quality productivity on consumer behavior. Results demonstrate that consumer digital literacy (X7) and consumption attitudes (X10) serve as key moderating variables, exhibiting positive moderating effects across multiple interaction terms. For instance, consumer digital literacy enhances the influence of new quality productivity on agricultural product quality upgrading (X11), price optimization and accessibility (X21), and product diversification and customization (X31). This indicates that improved digital literacy enables consumers to more readily accept and adapt to market changes driven by new quality productivity. Additionally, consumption attitudes demonstrate moderate promoting effects in certain interaction terms (e.g., X14 and X24), suggesting that positive consumption attitudes can amplify the moderating impact of new quality productivity on consumer behavior. Regional economic levels (X8) and policy support intensity (X9) show limited direct and moderating effects. Specifically, most interaction terms involving X8 and X9 exhibit regression coefficients approaching zero, such as the interaction term of regional economic levels and agricultural product quality upgrading (X12) and the interaction term of policy support intensity and price optimization and accessibility (X23) These findings suggest that, compared to individual-level factors (e.g., digital literacy and consumption attitudes), macroeconomic and policy factors may not significantly alter the influence patterns of new quality productivity on consumer behavior. The results of cross-validation show that the influence of new quality productivity on consumer behavior is significantly moderated by individual characteristics of consumers, such as digital literacy and consumption concept, and not only direct influence.

6.5 Verify and Research the Conclusions

This chapter examines the moderating effects of new quality productivity on consumer behavior through ridge regression analysis and cross-validation, thereby validating the research hypotheses. The results demonstrate that consumer digital literacy (H7) and consumption attitudes (H10) significantly moderate the impact of new quality productivity on consumer behavior. In contrast, regional economic level (H8) shows no significant moderating effect. Additionally, policy support (H9) demonstrates limited moderating effects, with only modest positive impacts on price optimization and accessibility.

Research indicates that individual consumer characteristics (digital literacy and consumption attitudes) play a crucial moderating role in how new quality productivity influences consumer behavior, demonstrating that enhancing digital skills and optimizing consumption attitudes can effectively drive behavioral changes. In contrast, regional economic levels show weaker moderating effects, suggesting that consumers' acceptance of new quality productivity is primarily determined by individual traits rather than economic conditions. Furthermore, while policy support may stimulate consumer behavior under specific circumstances, its overall impact remains limited. Policy interventions alone cannot significantly alter consumption patterns, necessitating a combination of market mechanisms and consumer education.

7 CONCLUSION

While upgrading agricultural product quality is a key driver of consumption upgrading, its adverse effects on brand

value and consumption scenarios demonstrate that quality enhancement alone may not sufficiently motivate consumer behavior. This requires complementary strategies such as price optimization and product diversification. Although price optimization and accessibility significantly improve information transparency, excessive transparency could negatively impact consumer behavior, necessitating careful balance in information dissemination. Product diversification and customization can simultaneously enhance information transparency, strengthen brand value, and reshape consumption scenarios, serving as effective tools to drive consumer behavior. Notably, brand value reinforcement and consumption scenario restructuring are direct catalysts for consumer behavior.

Gangxi Baise mangoes have demonstrated strong appeal in the younger demographic, with female consumers slightly outnumbering males. When purchasing agricultural products, consumers primarily prioritize price and convenience.

Survey data indicates that the 18-25 age group accounts for 49.8% of the market. In Baise's mango market, young consumers have already secured a significant market share. Regression analysis further reveals that consumers are highly sensitive to price and purchasing convenience. Products with reasonable pricing and easy accessibility are more likely to attract buyers.

With the improvement of living standard, consumers are more and more willing to pay more for the high-quality products.

Although the quality upgrade has a weaker impact than the price factor, it still significantly promotes the consumer behavior, which indicates that consumers pay more attention to the product quality and are willing to pay a premium for the high-quality products, reflecting the trend of consumption upgrading.

Brand value and consumption scenario are important intermediary factors to promote consumer behavior, and the improvement of information transparency may have a negative impact on consumer behavior in some cases.

The consumer digital literacy and consumption concept are the key factors to regulate the impact of new quality productivity on consumer behavior, while the regional economic level and policy support play a relatively weak role.

Consumer individual characteristics (digital literacy and consumption attitudes) play a crucial moderating role in how new quality productivity influences consumer behavior. Enhancing digital skills and refining consumption attitudes can effectively drive behavioral changes. In contrast, regional economic levels show weaker moderating effects, indicating that consumers' acceptance of new quality productivity is primarily determined by individual traits rather than economic conditions. Moreover, while policy support may boost consumer behavior in specific contexts, its overall impact remains limited. Policy interventions alone cannot significantly alter consumption patterns, necessitating a combination of market mechanisms and consumer education.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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