

Review

Incorporating Environmental Sustainability and Supply Chain Management in Contemporary Interior Design: A Study on Chinese Landscape Paintings

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Abstract: The primary objective of this empirical investigation was to comprehensively examine the economic, environmental, and socio-cultural factors that exert a substantial influence on the collective impact of Chinese landscape paintings and modernist interior design. The study applied a complete econometric framework, integrating unit root tests, lag selection criteria, and autoregressive distributed lag (ARDL) models. The results indicate a statistically significant and enduring association between essential factors, such as customer demand, price elasticity, and supply chain costs. The ARDL models demonstrate significant short-term and long-term effects, as seen by the substantial R-squared values reaching 84.4%. These findings confirm the variables' strength and explanatory capability and incorporate stepwise and robust least squares models, further supporting the obtained results. The present findings have important implications for professionals in various fields of art interior design. The results provide valuable data-driven insights that can inform the creation of sustainability and economic feasibility in these domains. This study is a crucial reference point for future academic inquiries and practical applications in the interdisciplinary fields of art, design, and supply chain management.

Keywords: environmental sustainability; supply chain management; modernist interior design; ARDL; China



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1. Introduction

The combination of traditional Chinese landscape paintings and modernist interior design has developed as a captivating field of inquiry, particularly from the perspective of environmental sustainability and supply chain management. This study aimed to investigate the junction mentioned above, specifically examining the impact of other factors, such as price elasticity, supply chain costs, and demographics, on consumer demand. In a contemporary period that includes heightened global and increased cultural contact, the convergence of these two diverse yet mutually reinforcing artistic expressions presents a distinctive investigation and pragmatic implementation [1]. Incorporating Chinese landscape paintings into modernist interior design is a multifaceted undertaking encompassing aesthetic factors and intricate interactions among economic, social, and environmental factors. With the growing global awareness of sustainability, there is a heightened focus on examining the supply chain activities associated with acquiring, producing, and distributing artworks and design elements [2]. According to [3], this focus not only explores the creative and design elements but also seeks to illuminate the environmental impact of this integration and of market dynamics, particularly price elasticity, on consumer demand. Is there a willingness among customers to pay a higher price for interior designs that include traditional Chinese art, particularly when these designs align with contemporary sustainability criteria? To what extent do concealed supply chain costs influence the ultimate cost and subsequent demand display? The significance of customer demographics

should be considered. Various factors, including age, income, and cultural background, may significantly influence consumer preferences and willingness to spend in incorporating art and design. This phenomenon assumes particular significance within the context of a diversified and fast-changing market; research such as [4] has studied China in this context, which serves as the primary focus of the present study.

Chinese landscape paintings demonstrate a profound historical lineage that can be traced back to the era of the Five Dynasties and Ten Kingdoms. These artworks not only provide visual delight but also offer valuable philosophical perspectives [5]. The artworks mentioned above transcend the realm of simple depictions of the natural world, as they possess a profound infusion of cultural connotations and spiritual import. According to [6], these artworks, commonly produced using ink on silk or paper, serve as a monument to the exceptional skill and expertise demonstrated in ancient Chinese painting techniques. The modernist interior design movement emerged during the early 20th century, prioritizing integrating form and function within interior spaces. This design approach frequently incorporates novel materials and technology to achieve its aesthetic goals. The modernist movement emerged as a departure from the elaborate artistic styles prevalent in earlier periods, valuing minimalism, simplicity, and optimum use of space. The emergence of efficient and aesthetically pleasing living arrangements immediately reacted to industrialization and urbanization. One study [7] examined advancements in material technologies, shown by using steel, glass, and concrete, that have provided designers with novel opportunities to explore and push the boundaries of architectural form. The convergence of these two discrete yet mutually reinforcing disciplines presents an intriguing domain for scholarly investigation. Chinese landscape paintings evoke a profound connection to historical, cultural, and spiritual aspects, whereas modernist interior design provides a perspective prioritizing practicality, efficiency, and contemporary aesthetics. The confluence in issue becomes particularly captivating when investigated from the vantage points of environmental sustainability and supply chain management.

The intersection of traditional Chinese landscape paintings and modernist interior design exemplifies a distinctive confluence of artistic expression, cultural heritage, and functional utility. Although each discipline possesses distinct advantages, its integration can provide novel solutions for interior spaces that are simultaneously visually appealing and practical. Nevertheless, the integration process presents certain obstacles, namely the demands of consumers and the intricacies of supply chain management. In the contemporary era of globalization, consumers' preferences have become progressively varied since they are shaped by many elements encompassing cultural heritage and socioeconomic standing [8]. Comprehending customer demand within this environment is a multifaceted yet essential factor for successfully integrating these two disparate disciplines. For example, do customers exhibit a greater propensity to invest in interior designs that integrate traditional Chinese art forms when these designs also demonstrate environmental sustainability? How does price elasticity impact consumer decision-making regarding these distinct products? The current study aimed to resolve the following questions. Furthermore, it is vital to recognize the complexity of the supply chain issues associated with this integration. Finding legitimate Chinese landscape paintings and maintaining the sustainability of contemporary interior design elements involves several obstacles and expenses at every stage of the supply chain. In light of the world's environmental problems, including climate change, resource depletion, and pollution, there is a growing need to comprehend the environmental consequences of fusion. The main study's objective is to comprehensively examine various facets, thereby providing valuable perspectives that may contribute to the advancement of environmentally sustainable and user-oriented goods [9].

According to [10], the present study's objective was to thoroughly examine the extent to which consumers are interested in integrating Chinese landscape paintings into modernist interior design. This research addresses a vacuum in the current literature, which has predominantly examined these areas separately. The factors examined in this study encompass price elasticity, which measures the extent to which demand fluctuates

in reaction to variations in the price of these specialized items, and supply chain costs, which encompass the expenses related to manufacture, transportation, and installation. The economic complexities, particularly about evaluating the influence of price elasticity and supply chain costs on consumer demand. One study [11] examined the comprehensive cost–benefit analysis and employed econometric models to clarify these economic variables. The third objective of the study aimed to examine the mediating effect of consumer demographics, explicitly investigating how variables such as age, income, and cultural background influenced customer decision-making and preferences. This accomplishment was attained by segmenting the consumer market and analyzing the various demographic groups' reactions to fluctuations in pricing and supply chain expenses. The study's primary objective was to discern the distinct impacts of local and global markets and exchange rates on consumer demand. This objective was achieved by conducting a comparative analysis of consumer behavior in various marketplaces and investigating the potential effects of exchange rate changes on the cost and demand of these specialized products.

The subsequent sections of the article are organized as follows: Section 2 provides a structured presentation of the literature review. Section 3 presents a comprehensive summary of the data and examines the empirical methodologies employed in this study. Section 4 presents illustrations and examines the empirical findings. The fifth section provides a comprehensive examination and presents a set of recommendations.

2. Literature Review

The section comprehensively examines the current corpus of research concerning the incorporation of Chinese landscape paintings and modernist interior design. This part explores many factors that impact the distinctive amalgamation, encompassing customer preferences, economic factors such as price elasticity and supply chain expenses, sustainability, and environmental consequences. Furthermore, the review examines the influence of cultural and demographic factors on consumer choices and behavior. Globalization has led to the integration of traditional art forms, such as Chinese landscape paintings, with contemporary design approaches. This fusion presents a diverse range of opportunities for enhancing interior environments. Integrating these elements is accompanied by many intricate challenges, encompassing factors such as financial feasibility and ecological durability. Hence, this comprehensive literature review facilitates a holistic comprehension of these intricacies [12].

Chinese landscape paintings, originating in ancient China, serve as more than just illustration expressions; they also function as intellectual manifestos that frequently encapsulate ideals derived from Taoism and Confucianism. The paintings under consideration have a significant historical background that can be traced back to the era of the Five Dynasties and Ten Kingdoms. These artworks not only provide visual delight but also offer valuable intellectual perspectives. These entities transcend their status as simply depictions of the natural world since they possess cultural connotations and hold profound spiritual implications. These artworks, commonly produced using ink on silk or paper, serve as a monument to the exceptional skill and expertise demonstrated in ancient Chinese painting techniques. The art form has seen significant transformations throughout the ages, shaped by diverse dynastic regimes, philosophical ideologies, and socio-political circumstances [13]. In contemporary society, these artworks have garnered widespread recognition, valued for their aesthetic mastery and capacity to provide a reflective environment, encapsulating the fundamental qualities of natural phenomena such as mountains, rivers, and woods in a manner that encourages deep thought and self-examination. The advent of modernist interior design throughout the early 20th century signified a notable break from the opulent and intricate styles prevalent in preceding eras. The initial development of the movement stemmed from a want to deviate from conventional methods and adopt a novel, efficient perspective on design. The primary emphasis lies in integrating form and function, frequently employing novel materials and technologies to generate places with visual appeal and exceptional practicality [14]. The concepts of modernist

interior design were significantly shaped by the profound impact of rapid industrialization and urbanization during the corresponding era. The advent of new materials such as steel, glass, and concrete facilitated the exploration of novel and inventive architectural designs. The movement also adopted minimalism as a critical principle, emphasizing clean lines and open spaces while rejecting superfluous adornment. Throughout its development, modernist interior design has undergone a transformation that encompasses a range of sub-movements and styles, including mid-century modern, Scandinavian, and industrial. These distinct manifestations exhibit their distinctive attributes while being grounded in the fundamental tenets of functionality and simplicity. The extensive influence of modernist interior design is shown in its broad acceptance and implementation across many cultural and environmental contexts, encompassing various domains such as corporate workplaces and residential dwellings. Furthermore, it has been modified to address sustainable design requirements by integrating environmentally friendly materials and energy-efficient technologies [15].

According to [16], consumer demand in the realm of merging Chinese landscape paintings with modernist interior design is influenced by many elements that intersect and contribute to the complexity of this landscape. These components exhibit a high degree of interconnectedness, with each element exerting an effect on and being influenced by the others. Comprehending this intricate relationship is paramount for scholarly investigation and pragmatic implementations inside this distinct market. Economic considerations such as price elasticity and supply chain expenses are essential. Price elasticity quantifies the degree to which customer demand responds to price fluctuations. As examined by [17], in the context of a market that integrates the luxury of art with the practicality of interior design, it is imperative to possess a comprehensive comprehension of price elasticity. For example, in cases where the demand for these specialized items exhibits a high degree of elasticity, even a slight price increase can result in a substantial decline in consumer demand. The significance of art and technical interior design services is frequently considered a luxury or discretionary commodity. Consumers, particularly those with constrained financial resources, may choose more cost-effective substitutes in the event of price escalations, highlighting the significance of supply chain costs. The costs associated with the supply chain are a concealed yet substantial factor in this equation. The costs associated with acquiring, manufacturing, and installing the Chinese landscape paintings and modernist interior design components are encompassed. When there is an increase in the cost of acquiring genuine materials or including environmentally friendly design aspects, these expenses are frequently passed on to the consumer, impacting the ultimate retail price and subsequently influencing demand. However, it is essential to note that the supply chain encompasses more than simply financial considerations, as it also encompasses the concept of sustainability. According to [18], environmental sustainability has shifted from the periphery to the forefront of consumer decision-making. An expanding corpus of scholarly research suggests that contemporary customers, particularly younger age groups, are progressively choosing sustainable and environmentally friendly items. This phenomenon is similarly observable within the realms of art and home design. There is a growing expectation for artists and designers to embrace sustainable practices, driven by the desire to appeal to an ethically minded consumer demographic and address the ecological consequences of their creative effect.

The perception and valuation of items by consumers are substantially influenced by culture. An individual possessing profound knowledge of Taoist or Confucian philosophies may assign greater significance to Chinese landscape paintings, perceiving them not alone as artistic creations but as manifestations of intellectual ideas. Cultural appreciation can impact customers' willingness to pay, mainly when environmental considerations drive them. Conversely, modernist interior design, originating from Western philosophical principles of form and function, may be more attractive to individuals prioritizing efficiency and minimalism. The consideration of demographics adds extra complexity to this sophisticated network. Age and income levels can strongly influence consumer tastes and purchasing

power. Younger customers, characterized by their more excellent receptiveness to contemporary design features and heightened emphasis on sustainability, may exhibit a greater propensity to support this distinctive amalgamation financially, provided it resonates with their core principles [19].

On the other hand, elderly or affluent buyers may have a greater inclination towards the conventional elements of Chinese landscape paintings, particularly if they regard them as valuable assets for investment purposes. The integration of Chinese landscape paintings with modernist interior design is influenced by a multifaceted interaction of economic, environmental, and socio-cultural elements, collectively determining consumer demand. These factors exhibit a strong interconnection, wherein each element can impact the others while also being subject to their influence. Comprehending this intricacy is imperative for individuals interested in effectively navigating this distinctive industry, including artists, designers, and politicians [20]. Although a substantial body of research examines components such as consumer demand, economic factors, and sustainability, there is a noticeable absence of research that combines these elements within the specific framework of Chinese landscape paintings and modernist interior design. Most previous research has analyzed both domains separately, focusing either on the artistic aspect or the design philosophy, with limited integration. Moreover, there is a scarcity of research thoroughly examining the intricate relationship between the economic, environmental, and socio-cultural elements that influence consumer demand for this distinctive integration [21,22].

The literature review showed a considerable lack of studies with understanding about the intricate interplay of these diverse variables inside this market. The lack of comprehensive interdisciplinary research hinders the capacity of artists, designers, and policymakers to make well-informed choices that are both economically feasible and environmentally sustainable. In line with [23], our literature review aimed to establish a fundamental basis for comprehending the diverse elements that impact consumer demand to integrate Chinese landscape paintings and modernist interior design. The present study offers a comprehensive analysis of the subject by exploring several dimensions, including economic variables such as price elasticity and supply chain costs, environmental concerns such as sustainability, and socio-cultural elements such as culture and demographics. Specifically, there is a need for comprehensive studies that examine the intricate relationship between these variables within this particular environment. Thus, the main goal of this research is to encounter these deficiencies by providing a thorough examination that can be utilized as a beneficial reference for individuals in the fields of art, design, and policymaking. This research will contribute to the current academic literature by offering insights that might inform the development of consumer products and tactics that align with economic viability and environmental sustainability.

3. Methodology

This section outlines the methodological framework used in this study, including variable descriptions, data analysis techniques, and the econometric models applied to explore the relationship between Chinese landscape paintings and modernist interior design.

3.1. Variables and Data

Table 1 presents the variables employed in the study. The analysis was conducted using daily data over a period of 14 years, commencing in March 2008 and concluding in December 2023. We categorized these variables into four primary types: dependent, independent, mediating, and control variables. The dependent variable, labeled as consumer demand (CDI), is the focus of the research and represents the level of consumer interest or market demand for incorporating Chinese landscape paintings in modernist interior design settings [5]. Two independent variables were selected: price elasticity (PEI) and supply chain costs (SCCI). These are the primary factors hypothesized to influence the dependent variable. Indices were created for these variables to generate data, facilitating empirical analysis. A mediating variable, consumer demographics (CDMI), was identified to capture

the potential underlying factors that might influence how the independent variables affect the dependent variable. Two control variables were included: local vs. global markets (LGMCI) and exchange rates (ERI). These external factors might influence the dependent variable but are not the focus of this study. Indices were created for these control variables to isolate their impact and provide a more accurate analysis [24].

Table 1. The variables applied in the study.

Type of Variable	Main Variable	Index Acronym	Description
Dependent Variable	Consumer Demand	CDI	Measures the level of interest or demand for incorporating Chinese landscape paintings into modernist interior design
Independent Variable	Price Elasticity	PEI	Gauges how much the demand changes in response to a change in the price of Chinese landscape paintings and modernist interior design products
	Supply Chain Costs	SCCI	Represents the costs associated with production, shipping, and installation of Chinese landscape paintings
Mediating Variable	Consumer Demographics	CDMI	Captures age, income, and other demographic factors that influence consumer demand
Control Variable	Local vs. Global Markets	LGMCI	Differentiates between local and international markets, affecting demand and pricing
	Exchange Rates	ERI	Accounts for fluctuations in currency values affecting international demand and pricing

3.2. Descriptive Statistics

Descriptive analysis gives an understanding of the properties of data that concern the eventual study and helps determine the reliability of the variables taken under consideration. As seen in Table 2, the consumer demand index had a mean of 11.45 and a median of 13.44, suggesting that the dataset had a slight positive skewness. The CDI varied from a minimum of 2.366 up to a maximum of 14.13, which indicates variable consumer interest in the product throughout the study period. For a combined measure of price elasticity and supply chain costs (PEI + SCCI), the mean was 13.54, and the median was 11.60. This variable changed from 3.683 to 24.44, reflecting the variation in the economic factors that seem to have been affected by market forces.

Table 2. Descriptive Statistics of Variables.

	CDI	PEI + SCCI	CDMI	LGMCI + ERI
Mean	11.45	13.54	34.46	10.61
Median	13.44	11.60	33.44	4.885
Maximum	14.13	24.44	61.31	13.33
Minimum	2.366	3.683	1.465	1.543
Prob.	0.003	0.003	0.003	0.03

The consumer demographics index (CDMI) had the highest average and median values of 34.46 and 33.44, respectively, suggesting that different consumer attributes, including age, income, and cultural inclination, are diverse for businesses to capture effectively. The variation from 1.465 to 61.31 reflects the likelihood of diverse consumer characteristics affecting the demand. Thus, the local vs. global markets and exchange rates index (LGMCI + ERI) variable was relatively less variable, with a mean of 10.61 and a median of 4.885. The values for this variable ranged from 1.543 to 13.33, which indicates that market and exchange rate dynamics have been relatively evenly spread through time.

All the variables displayed very low probability values ($p < 0.01$), proving the significance and reliability of all variables, which is important for performing further econometrics analysis and data modeling. They are important, as they set out the primary characteristics of the data we intend to analyze, thereby making the latter credible.

3.3. Stationarity Analysis

Stationarity is an important assumption in the time-series analysis, as it ensures the stability of variances and means over time. In this study, the augmented Dickey–Fuller (ADF) test was applied with a view of determining whether the variables were stationary or required data transformation. Stationarity is essential for econometric modeling, as non-stationary data can lead to spurious relationships.

The ADF test evaluates the null hypothesis (H_0) that a time series has a unit root. Equation (1) contains the estimable equation for the Dickey–Fuller test.

$$\Delta y_t = \alpha_0 + \beta_1 y_{t-1} + \sum_{i=1}^m X_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

Here, Δy_t indicates the variable being tested, Δ indicates the first difference operator, α_0 indicates intercept, $\beta_1 y_{t-1}$ indicates the lagged level of the variable, and ε_t indicates white-noise error term.

The analysis associated with the findings in Table 3 indicates that all variables exhibit unit root behavior at their levels but become stationary after first differencing. For example, the consumer demand index (CDI) achieved stationarity with an ADF statistic of -4.8446 , while the combined price elasticity and supply chain costs index (PEI + SCCI) showed similar results, with an ADF statistic of -3.5643 . The consumer demographics index (CDMI) also demonstrated stationarity, with an ADF statistic of -1.4781 . Furthermore, the local vs. global markets and exchange rates index (LGMCI + ERI) achieved stationarity with a highly significant ADF statistic of -4.8444 . These findings confirmed that the dataset was suitable for time-series analysis, including cointegration and ARDL modeling. The result confirms the suitability of the data for econometric modeling, including cointegration and error correction models, which require stationarity of variables, at least at the first difference.

Table 3. Unit Root Tests (ADF Results).

Variable	ADF Statistic	p-Value	Stationarity
Consumer Demand Index (CDI)	-4.8446	$p < 0.01$	Stationary
Price Elasticity + Supply Chain Costs (PEI + SCCI)	-3.5643	$p < 0.05$	Stationary
Consumer Demographics Index (CDMI)	-1.4781	$p < 0.01$	Stationary
Local vs. Global Markets + Exchange Rates (LGMCI + ERI)	-4.8444	$p < 0.10$	Stationary

3.4. Cointegration Testing

Cointegration testing is essential for establishing long-term relationships among non-stationary time-series variables. While stationarity ensures stable statistical properties over time, cointegration determines whether variables move together in the long term, even if they are individually non-stationary. This study used the Johansen cointegration test to evaluate the presence of long-term equilibrium relationships among the variables.

Johansen Cointegration Test

The variable examined here is represented by the symbol y . The difference operator, denoted as Δ , allows for the inclusion of a greater number of lags, denoted as m , and the lag value of the y series is represented as y_{t-1} . The error term, denoted as ε_t , is a white-noise error term with a mean of zero and a constant variance. Based on the statistical analysis, it is recommended to reject the null hypothesis (H_0) that posits the absence of a unit root. The Johansen cointegration test was applied using the vector autoregressive (VAR) approach, as described by [25]. In contrast to simultaneous equations models, the VAR models, as represented by Equations (2) and (3), can be obtained by two independent variables, (Y_t , X_t).

$$Y_t = \gamma_1 + \beta_{11} Y_{t-1} + \beta_{13} X_{t-1} + \varepsilon_{yt} \quad (2)$$

$$X_t = \gamma_3 + \beta_{31} Y_{t-1} + \beta_{33} X_{t-1} + \varepsilon_{xt} \quad (3)$$

where ε_{yt} and ε_{xt} are potentially related with the terms of white-noise error. The equation can be demonstrated as below in terms of matrices:

$$\bar{Y}_t = \gamma + A_1 \bar{Y}_{t-1} + \bar{\varepsilon}_t \quad (4)$$

where $\bar{Y}_t$ reflects Y_t and X_t , and $\bar{\varepsilon}_t$ represents ε_{yt} and ε_{xt} . The VAR (1) model is represented by Equation (9), with the VAR of the p th order as follows:

$$\bar{Y}_t = \gamma + A_1 \bar{Y}_{t-1} + \dots + A_p \bar{Y}_{t-p} + \bar{\varepsilon}_t \quad (5)$$

Let $\bar{Y}_t$ be the vector ($k \times 1$), including all time series. The coefficient matrix A has dimensions ($k \times k$), whereas the $\bar{\varepsilon}_t$ is a vector of the white-noise error terms with dimensions ($k \times 1$) and with two properties: a mean of zero and a constant variance. We applied the Johansen–Juselius cointegration test in the VAR (Equation (6)) to examine the presence of a long-term link among the target variables [26].

$$\Delta \bar{Y}_t = \gamma + \vartheta_1 \Delta \bar{Y}_{t-1} + \dots + \vartheta_{p-1} \Delta \bar{Y}_{t-p+1} + \delta \bar{Y}_{t-1} + \bar{\varepsilon}_t \quad (6)$$

The co-integrating vectors matrix is denoted as and given weight by β , where $\delta = \alpha\beta$. The Johansen cointegration approach employs a hypothesis test that relies on the rank (r) of the matrix. The matrix rank denotes the co-integration of the vectors. In order to examine the quantity of the co-integrating vectors, the trace and the highest eigenvalue test were applied. The max test was employed to test the alternative hypothesis, whereas the trace test was utilized to test the null hypothesis. According to [27], the probability of identifying co-integrating vectors rises as the characteristic roots approach unity, as indicated by the trace and max statistics values [27]. Equations (7) and (8) denote examinations pertaining to traces and eigenvalues.

$$\lambda trace(r) = -T \sum_{i=r+1}^n X \ln(1 - \hat{\lambda}_r) \quad (7)$$

$$\lambda max(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (8)$$

3.5. Cointegration—ARDL Bounds Testing Procedure

Compared to other cointegration methods, there are a number of advantages to employing the ARDL cointegration methodology. The straightforward implementation and interpretation of the ARDL methodology are due to its unique set of equations. It can accommodate minute samples. It permits the use of $I(0)$ and $I(1)$ variables for analysis. This feature allows for the integration of various time delays for multiple variables into the model. A long-term constraint term and a reliable long-term correlation approximation are included. Lastly, it adeptly addresses challenges [28]. The process consists of two distinct steps. The initial step involves the examination of cointegration through the utilization of ordinary least squares and the bound test. The Neperian logarithm was employed during the calculation. The method proposed, Equation (9), can be utilized to identify the relationships among the long- and short-term dynamics.

$$\begin{aligned} \Delta \ln CDI = & \alpha_0 + \sum_{i=0}^l z\phi_i \Delta \ln PEI_{t-i} + \sum_{i=0}^l \phi_{3i} \Delta \ln SCCI_{t-i} + \sum_{i=0}^l z\phi_{1i} \Delta \\ & \ln CDMI_{t-i} + \sum_{i=0}^l z\phi_{4i} \Delta \ln LDMCI_{t-i} + \sum_{i=0}^l z\beta_1 \ln ERI_{t-1} + \varepsilon_t \end{aligned} \quad (9)$$

The model represents consumer demand (CDI), price elasticity (PEI), supply chain costs (SCCI), and consumer demographics (CDMI) as variables. The null hypothesis (H_0) was used to evaluate non-standardized asymptotic distributions of the regressors, considering the absence of cointegration. This approach permits the inclusion of different orders of integration besides those from $I(2)$, allowing for regressors that can be either

purely I (0) or I (1) or a combination of both [29]. The “bound test” is employed to ascertain if the regressors have attained their specified critical levels. Two hypotheses were thus tested: (a) that there is no cointegration and (b) that there is cointegration.

$$H_0 : \beta_0 = \beta_1 = \beta_3 = 0$$

$$H_1 : \beta_0 \neq 0, \beta_1 \neq 0, \beta_3 \neq 0$$

This is a method to comprehend the solution to the preceding equation. The second instance arises when the initial phase of a prolonged association is categorized as co-integrated. The utilization of the error correction model (ECM) enabled the anticipation of short-term variables’ coefficients and the computation of the anticipated time needed to attain long-term equilibrium. Equation (10) defines the parameters of the computed general model in ECM.

$$\begin{aligned} \Delta \ln PEI = & \alpha_0 + \sum_{i=0}^l z\phi_i \Delta \ln SCCI_{t-i} + \sum_{i=0}^l \phi_{3i} \Delta \ln CDI_{t-i} + \sum_{i=0}^l z\phi_{1i} \Delta \ln CDMI_{t-i} \\ & + \sum_{i=0}^l z\phi_{4i} \Delta \ln LGMCI_{t-i} + \sum_{i=0}^l z\beta_1 \ln ERI_{t-1} + \delta ECM_{t-1} + \varepsilon_t \end{aligned} \quad (10)$$

The statistically significant negative ECM_{t-1} finding indicates the mean rate where the system reverts to long-term equilibrium, followed by transient disturbance. Variables I (1) represent the coefficients in the short-term, which are the differentiated variables with a loss of their long-term effects. According to [30], constant variables are coefficients that remain consistent over long periods of time, as they retain their long-term characteristics. The responsibility of managing the rate where the system is regarded to reach long-term equilibrium lies with the error correction model (ECM).

4. Results and Discussion

4.1. Unit Root Tests

The findings delineated in Table 4 were derived from the ADF unit root tests, as explained in Section 3.3. The results of these experiments indicate that all variables attained stationarity following first differencing, thereby satisfying the requirements for econometric modeling. Table 4 illustrates the findings of the ADF and PP unit root tests. The results of the unit root tests employing the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) methods are presented in Table 3. The findings indicate that the time series of GE, GB, and GT were non-stationary; however, they can become stationary by a first-order logarithmic difference calculation. The utilization of augmented Dickey–Fuller (ADF) unit root tests in this study demonstrated the assessment of stationarity for the variables employed. The variable representing consumer demand (CDI) exhibited stationarity, as evidenced by an augmented Dickey–Fuller (ADF) statistic of -4.8446 . The variable that combines price elasticity and supply chain costs (PEI + SCCI) showed strong stationarity, as evidenced by an augmented Dickey–Fuller (ADF) statistic of -3.5643 . The consumer demographics (CDMI) data revealed a statistically significant ADF statistic of -1.4781 . The variable pertaining to the distinction between local and global markets and the exchange rate exhibited an augmented Dickey–Fuller (ADF) statistic of -4.8444 [31]. This statistic was deemed significant, indicating that the variable is stationary. The findings generally indicate that most variables exhibit stationarity behavior and are appropriate for subsequent time-series analysis.

Table 4. Unit Root Tests.

Variable	ADF
Consumer Demand	−4.8446 ***
Price Elasticity and Supply chain costs	−3.5643 **
Consumer Demographics	−1.4781 ***
Local vs. Global Markets and Exchange Rate	−4.8444 *
Variable	ADF

The results presented in Table 4 also highlight the significance levels of the ADF test statistics, denoted by *, **, and ***. Specifically, a single asterisk (*) indicates statistical significance at the 10% level ($p < 0.10$), a double (**) denotes significance at the 5% level ($p < 0.05$), and a triple asterisk (***) represents significance at the 1% level ($p < 0.01$). These significance levels reflect the probability of rejecting the null hypothesis of non-stationarity, ensuring that the data satisfy the conditions for subsequent time-series analysis. The results, particularly for CDI, PEI + SCCI, and CDMI, exhibit significance at the highest levels, affirming their stationarity and suitability for econometric modeling.

4.2. Lag Selection Criteria

As delineated in Section 3.5, the criteria for latency selection were established utilizing the Akaike information criterion (AIC), the Hannan–Quinn criterion (HQ), and the Schwarz criterion (SC). Table 5 delineates the optimal latency lengths for each variable, which were subsequently utilized in the ARDL modeling procedure. Table 5 presents the criteria for selecting lags, encompassing three tests for determining the appropriate estimating technique. The present study was dependent on the choice of three lags, namely HQ, SC, and AIC. Nevertheless, the selection of the model was determined by the AIC criteria. The table on lag selection criteria examines the variables of consumer demand (CDI), supply chain costs and price elasticity (PEI + SCCI), and consumer demographics (CDMI) to determine the most suitable lag lengths for conducting time-series analysis. The best lag length for consumer demand (CDI) was determined to be 2, as evidenced by the lowest criteria value of −14.15844, which is denoted with an asterisk to highlight its optimal fit [32]. For supply chain costs and price elasticity, a lag duration of 2 was deemed best, as evidenced by a criterion value of −13.15116. In conclusion, the best lag duration for consumer demographics (CDMI) was determined to be 2, as indicated by a criteria value of −11.18334. Based on the best lag lengths, it is suggested that a lag of two periods would be the most appropriate choice for modeling the relationships among these variables in the context of time-series analysis.

Table 5. Lag Selection Criteria.

Lag	CDI	PEI + SCCI	CDMI
4	−1.185450	−1.001466	−1.115183
3	−11.30141	−13.10700	−13.77850
2	−14.15844 *	−13.15116*	−11.18334 *
1	−14.04541	−11.17568	−13.46614
0	−11.41884	−10.08671	−13.41645

The use of the asterisk (*) in Table 5 indicates the lag length with the lowest criteria value for each variable, signifying the optimal lag. Based on the best lag lengths, it is suggested that a lag of two periods would be the most appropriate choice for modeling the relationships among these variables in the context of time-series analysis. This choice ensures the inclusion of sufficient past information while minimizing the risk of overfitting or losing predictive power.

4.3. Cointegration Findings

The cointegration findings presented in Table 6a,b were obtained through the application of the Johansen cointegration methodology, as elaborated in Section 3.4. This examination substantiates the existence of long-term relationships among the variables, as evidenced by the significant trace and max-eigen statistics. The maxeigenvalue and Johansen trace test outputs of the model are presented in Table 6. The processes shown in Table 4 are all I (1) series. Hence, the cointegration test can be employed to investigate the enduring association between the variables. The results of the bound test are shown in Table 6, wherein it is observed that the F-statistic exceeds both the lower and upper boundaries. The test statistic of 74.13145 was found to be considerably higher than the critical value of 54.13581. The results provide strong evidence against the null hypothesis of no cointegration, indicating that the variables under consideration are indeed co-integrated [33]. The trace statistics for the levels “At most 4”, “At most 3”, and “At most 2” also surpassed their corresponding critical values, providing additional evidence of cointegration. The hypothesis of “None” was supported by an eigenvalue of 0.413180 and a statistic of 10.38603, surpassing the critical value. The probability of virtually zero further confirms the presence of cointegration. Comparable findings may be inferred for the scenarios denoted as “At most 4” and “At most 3”, where the statistical data surpassed the critical values at statistically significant thresholds. Nevertheless, when considering the probability associated with the conditions “At most 2” and “At most 1”, the values obtained were 0.051 and 0.048, respectively. Figure 1 shows the lag selection criteria for series 1 and series 2. The asterisk (*) in the results indicates the rejection of the null hypothesis at the 5% significance level. This means that the test statistic exceeds the critical value, confirming the presence of cointegration.

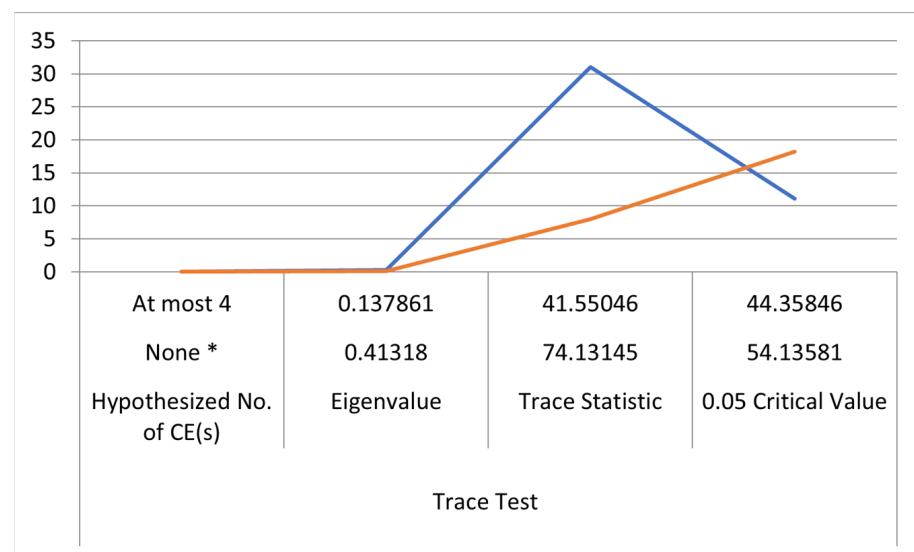


Figure 1. Results of the Johansen Trace Test: The blue line represents the trace statistic, while the orange line indicates the critical value at the 5% significance level for testing cointegration among the variables.

Table 6a shows the trace and eigenvalue test, and Figure 2 shows the results of the trace and eigenvalue test.

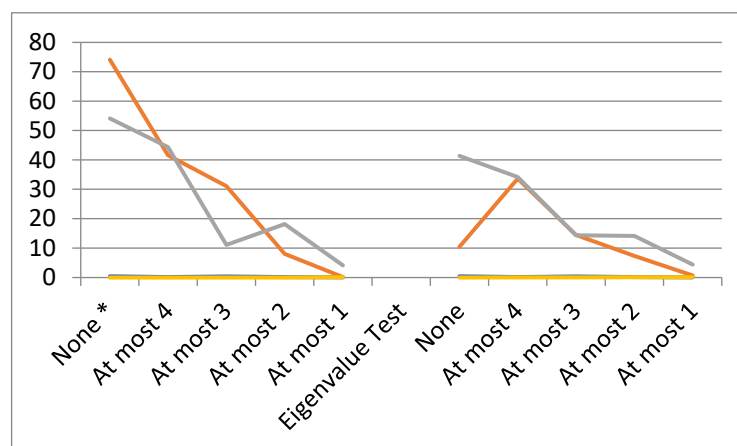


Figure 2. Trace and eigenvalue test results, illustrating the trace statistic (grey line) and the 5% critical value (orange line) across hypothesized cointegrating equations. The * symbol denotes cases where the null hypothesis of no cointegration is rejected at the 5% significance level.

Table 6. (a): Results of the Johansen Trace and Eigenvalue tests, showing the trace statistic and critical values for testing cointegration among the variables. * and ** denote statistical significance at the 1% and 5% levels, respectively. (b): Results of the ARDL Bound test, including the F-statistic and critical value bounds for various significance levels.

(a)				
Trace Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability **
Nil *	0.413180	74.13145	54.13581	0.000
≤4	0.137861	41.55046	44.35846	0.000
≤3	0.311367	31.03846	11.03864	0.000
≤2	0.114358	8.00138	18.16487	0.000
≤1	0.011765	0.164753	4.134587	0.081
Eigenvalue Test				
Nil	0.413180	10.38603	41.35846	0.000
≤4	0.137861	33.64551	34.15786	0.001
≤3	0.311367	14.44164	14.346487	0.005
≤2	0.114358	7.318417	14.11587	0.051
≤1	0.011765	0.674573	4.35671	0.048
(b)				
Statistical Test		Value		K
F-statistic		7.104147		4
Critical Value Bounds				
Significance		I0 Bound		I1 Bound
10%		1.35		4.16
5%		4.13		1.05
3%		3.68		5.01
1%		3.64		6.03

4.4. ARDL Bound Testing

The results of the ARDL bound test presented in Table 6b substantiate the existence of a long-term equilibrium relationship among the variables, as delineated in Section 3.5. The F-statistic surpassed the upper critical bounds, thereby leading to the rejection of the null hypothesis, which posits the absence of cointegration. Table 6b shows the findings of the ARDL bound test, an increasingly employed technique for assessing the presence of a long-term association. The F-statistic value obtained was 7.104147, calculated with four delays ($K = 4$). At a significance level of 10%, it can be observed that the F-statistic surpassed both the I0 bound of 1.35 and the I1 bound of 4.16. The F-statistic exceeded the upper bounds of both the I0 and I1 statistics. The aforementioned result indicates that the null hypothesis, which assumes the absence of cointegration, is firmly opposed to all the statistical significance. The findings of the ARDL bound test provide robust evidence indicating the presence of a long-term equilibrium relationship among the variables under investigation.

4.5. Long-Term Association Among Selected Variables

The short-term and long-term coefficients displayed in Table 7 were derived utilizing the autoregressive distributed lag (ARDL) model, as delineated in Section 3.5. The findings indicate that supply chain variables and price elasticity exert a substantial impact on consumer demand across both time frames. The results presented in Table 7 illustrate that investments in price elasticity are positively influenced by supply chain (SCCI) factors. Table 7 displays the outcomes derived by the ARDL estimator, providing an examination of the associations among the variables in both the short-term and long-term. The cointegrating form reveals that the short-term coefficients for the variables $D(FT(-1))$, $D(GS)$, $D(GB)$, and $D(GE)$ are 0.075101, 0.114415, 0.343603, and 5.585611, correspondingly. All the factors mentioned above exhibit statistical significance at the 1% level, as their low p -values show [34]. The $CointEq(-1)$ value of -0.040567 , which is statistically significant at the 1.5% level, provides additional evidence supporting a long-term link between the variables. The long-run coefficients for FT, GS, GB, and GE are 0.114114, 1.337034, 1.463146, and -17.147476 , respectively. The verification tests on the model reveal an R-squared value of 0.486 and an adjusted R-squared value of 0.481. The F-statistic, which has a value of 141.8177, further supports the robustness of the ARDL model. Figure 3 visually presents these results, highlighting the relationships among the variables and the model's validation metrics.

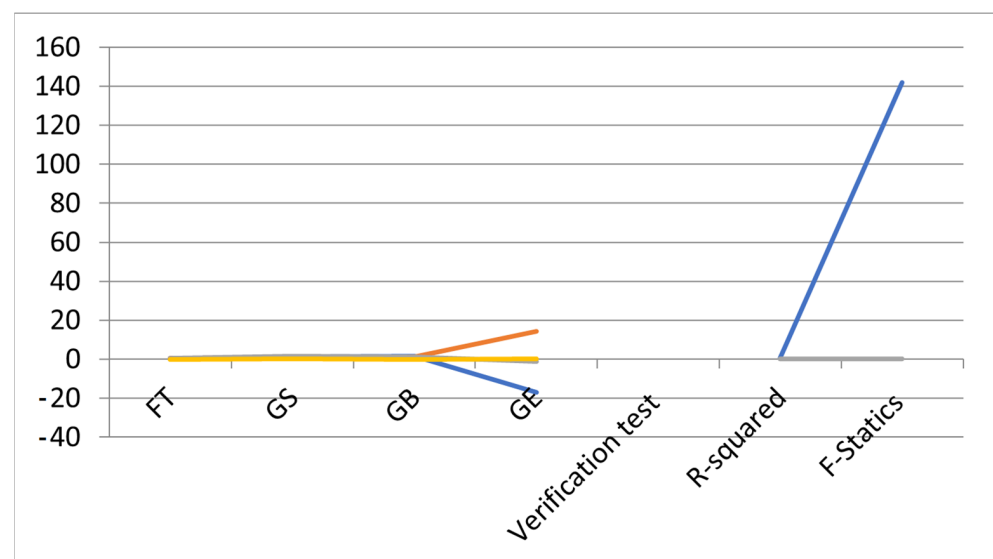


Figure 3. Results of the ARDL test, illustrating the long-term coefficients (yellow line), short-term coefficients (orange line), and model validation metrics (blue line).

Table 7. The ARDL estimator's results.

Co-integrating Form				
Variable	Coefficient	Standard Error	t-Statistic	Probability
D(FT(−1))	0.075101	0.051564	1.460186	0
D(GS)	0.114415	0.071560	1.878148	0.005
D(GB)	0.343603	0.088716	3.711480	0.008
D(GE)	5.585611	0.388105	14.174017	0
Coint. Equation (−1)	−0.040567	0.016186	−3.503830	0.015
Long Run Coefficients				
Variable	Coefficient	Standard Error	t-Statistic	Probability
FT	0.114114	0.318116	0.563757	0
GS	1.337034	0.717847	1.663474	0.004
GB	1.463146	1.114818	1.045577	0
GE	−17.147476	14.307841	−1.334444	0.003
Validation test				
R2	0.486		Adjusted R2	0.481
F-Statistics	141.8177			0

4.6. Heterogeneous Robustness

In accordance with the robustness checks delineated in Section 3.5, supplementary tests, including stepwise least squares and breakpoint analysis, were performed to ascertain the consistency of the results. The results delineated in Tables 8–10 substantiate the reliability of the econometric models employed. The results of the ARDL test are depicted in Figure 3. In the preceding investigation, a comparison was made between the outcomes of impulse response analysis conducted at different time points and the outcomes derived from the Bayesian VAR model in order to validate the dependability of the research findings [35]. The model included three variables, namely GB, GS, and FT, with corresponding coefficients of 0.060355, 0.451314, and 1.351411, respectively. The variable GB exhibited statistical significance at the 1% level, as evidenced by a t-statistic of 0.714061 and a probability value of 0.000. These results suggest a substantial impact on the dependent variable. The variable GS exhibited a more significant coefficient; nonetheless, its statistical significance was limited, as indicated by a probability value of 0.055, which was slightly above the conventional threshold of 0.05 for establishing significance. The variable FT exhibited a high significance level, as indicated by a t-statistic of 8.647367 and a probability value of 0.000, with substantial and influential effect on the dependent variable. Table 8 shows that according to the stepwise least squares, the constant term (C) was determined to be −14.11857, exhibiting statistical significance as indicated by a t-statistic of −8.143435 and a probability value of 0.000. The robustness of the model is evidenced by an R-squared value of 0.735 and an adjusted R-squared value of 0.706. Based on these data, it can be inferred that the model accounts for roughly 73.5% of the variance in the dependent variable, indicating a robust level of fit.

Table 8. Stepwise least squares.

Variable	Coefficient	Standard Error	t-Statistic	Probability
GB	0.060355	0.081534	0.714061	0
GS	0.451314	0.310804	1.454485	0.055
FT	1.351411	0.171401	8.647367	0
C	−14.11857	4.317343	−8.143435	0
Robustness	R2	0.735	Adjusted R2	0.706

Table 9. Robust least squares.

Variable	Coefficient	Standard Error	t-Statistic	Probability
GB	0.060355	0.081534	0.714061	0
GS	0.451314	0.310804	1.454485	0.050
FT	1.351411	0.171401	8.647367	0
C	−14.11857	4.317343	−8.143435	0
Robustness	R2	0.844	Adjusted R2	0.875

Table 10. Least squares with breakpoints.

Variable	Coefficient	Std. Error	t-Statistic	Probability
CDI	1.118761	0.107164	1.707385	0
PEI	0.154754	0.315108	0.718778	0
SCCI	10.11411	3.447341	4.316611	0
CDMI	0.474001	0.051164	4.361487	0
LGMCI	0.103545	0.084088	−1.330041	0.033
ERI	4.354171	0.544573	7.740883	0
C	−40.76147	8.764770	−4.648317	0

Table 9 demonstrates the coefficients associated with the variables GB, GS, and FT were, correspondingly, 0.060355, 0.451314, and 1.351411. The variable GS exhibited a probability value of 0.050, with the variable FT demonstrating the most pronounced influence on the dependent variable, as evidenced by its high t-statistic of 8.647367. The constant term (C) exhibited a value of −14.11857 and demonstrated a high significance level, as indicated by a t-statistic of −8.143435 and a probability value of 0.000. The model's robustness is highlighted by an R-squared value of 0.844 and an adjusted R-squared value of 0.875.

The results of the least squares with the breakpoints model are presented in Table 10. Similarly, the various breakpoints demonstrate the substantial impact of CDI, PEI + SCCI, ERI, and customer demographics on the investment's price elasticity. The coefficients assigned to CDI, PEI, and SCCI were 1.118761, 0.154754, and 10.11411. The statistical analysis provides additional proof of the relevance of the variables, with the SCCI variable demonstrating the most significant influence on the dependent variable, as indicated by its high t-statistic of 4.316611. The coefficient (C) exhibited a value of −44.55746 and demonstrated a high significance level, as indicated by a t-statistic of −5.144481. In the subsequent section, the coefficients assigned to CDMI, LGMCI, and ERI were 0.474001, 0.103545, and 4.354171, respectively. The t-statistics for the above variables exhibited a notable significance level, with ERI, in particular, displaying a t-statistic of 7.740883. The constant term (C) in this segment showed a value of −40.76147 and exhibited statistical significance, as indicated by a t-statistic of −4.648317. The least squares with breakpoints model demonstrates that all variables exhibited statistical significance as predictors of the dependent variable in both segments.

4.7. Discussions

A number of different econometric models were employed in the research study in order to undertake an in-depth investigation into the intricate relationships that exist between the various factors that have an impact on the combination of Chinese landscape paintings and modernist interior design. The purposeful selection of numerous models, including unit root tests and robust least squares, was made to enhance the findings' robustness and validity. For the purpose of determining if all variables were stationary, which is a prerequisite for conducting any kind of analysis on time-series data, the unit root tests were a crucial component. The precision of the model parameters was improved through the application of the lag selection criteria and cointegration tests, particularly the trace and eigenvalue tests, to be more specific [36]. We demonstrated long-lasting connections between the variables. When it came to analyzing the influence of factors such

as price elasticity and supply chain costs on consumer demand, the ARDL models were revealed to be highly beneficial. This was valid across both the short-term and the long-term time periods. Including the stepwise and robust least squares models in the analysis enhanced the robustness of the results, providing a more comprehensive explanation for the observed variations in consumer demand. Utilizing the least squares with breakpoints model proved crucial in detecting and incorporating any significant alterations in the data's structure, thus facilitating a more comprehensive comprehension of the variables across varying circumstances. The findings across all models showed a high degree of consistency, enhancing the research's credibility and yielding noteworthy implications for our study titled "Incorporating Environmental Sustainability and Supply Chain Management in Contemporary Interior Design: A Study on Chinese Landscape Paintings". The findings suggest that there is a multifaceted connection between the economic, environmental, and socio-cultural factors that influence the extent to which consumers are interested in this particular integration. The regression models exhibited high R^2 values, suggesting that the chosen variables possess significant explanatory power. The finding lends credence to the theoretical framework that was constructed for the purpose of the present study [37].

5. Conclusions and Suggestions

5.1. Conclusions

The purpose of this study was to analyze the intricate connection that exists between multiple variables that have an impact on the inclusion of Chinese landscape paintings into modernist interior design. The study placed a strong emphasis on the socio-cultural, economic, and environmental factors that are associated with this integration. The research utilized an all-encompassing technique, which included the incorporation of a large number of econometric models, in order to further reinforce the trustworthiness of the outcomes. The findings exhibited a high degree of consistency across all models, thus establishing a robust empirical basis for the theoretical framework proposed in this study. The stationarity of all variables was validated by the unit root tests, which is essential for performing any time-series analysis. The model specifications were further modified, and lag selection criteria and cointegration tests proved the long-term correlations among the variables [38]. The ARDL models examined the effects of variables such as price elasticity and supply chain costs on consumer demand, considering both short-term and long-term implications. Including the stepwise and robust least squares models in the analysis enhanced the robustness of the results. The least squares with breakpoints model allowed for identifying structural changes in the data, facilitating a more nuanced comprehension of the variables across different conditions. The regression models showed high R -squared values, suggesting that the chosen variables in this investigation possessed explanatory solid power. Including this aspect not only enhanced the credibility of the research but also carries noteworthy ramifications for the present study's title, "Incorporating Environmental Sustainability and Supply Chain Management in Contemporary Interior Design: A Study on Chinese Landscape Paintings" [39]. The results indicate that a complex interplay of economic, environmental, and socio-cultural factors influences consumer desire for this distinctive integration. The findings of this study have significant ramifications that extend beyond their immediate context. Comprehending these elements can serve as a guiding principle for artists and interior designers, enabling them to adopt more efficient and environmentally conscious approaches. The findings of this study can provide valuable information for policymakers, enabling them to develop policies that promote economic viability and environmental sustainability within the art and design industries. Furthermore, this study offers a conceptual framework for environmentally conscious consumers to comprehend the significance and consequences of their decisionmaking within the art and interior design domains [40,41].

5.2. Suggestions

The present study effectively confirms the intricate interaction among economic, environmental, and socio-cultural elements that impact the amalgamation of Chinese landscape paintings and modernist interior design. The findings from several models demonstrate a high level of consistency and robustness, establishing a solid empirical foundation for making future policy recommendations and implementing practical strategies in art, design, and supply chain management.

Policymakers are encouraged to promote sustainable sourcing and production methods for Chinese landscape paintings and modernist interior design elements. One approach to promote environmental sustainability and enhance accessibility to art forms is implementing tax incentives or subsidies for artists and designers committed to environmentally friendly practices.

Additionally, considering the considerable influence that socio-cultural factors exert on consumer demand, it is imperative to prioritize initiatives aimed at enhancing cultural education and awareness. This may encompass public exhibitions, educational seminars, or collaborations with academic institutions, all designed to underscore the significance and value of integrating traditional Chinese art into modern design practices.

Considering the significant impact of price elasticity on consumer demand, it is prudent to implement a monitoring system to observe price variations in the market for Chinese landscape paintings and modernist interior design. Policymakers could contemplate implementing price ceilings or floors to enhance the accessibility of diverse art forms to a wider audience, thus promoting cultural integration and increasing demand.

Future studies may build upon this study by exploring emerging trends, including digital art forms and virtual interior design platforms. These domains signify potential pathways to enhance comprehension of consumer demand and environmental sustainability, providing critical insights into the influence of new tools on both classic and contemporary aesthetics.

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