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# An Empirical Study on the Synergistic Impact of the Digital Economy on the Cultural Industry Chain—Taking Cantonese Embroidery as an Example

**Jin Qiu[1,*], Fan Zhang[1]**

*[1]Guangdong University of Science and Technology, Dongguan, China*
**Corresponding author: 610192133@qq.com*

***Abstract:*** *Against the backdrop of accelerated global digitalization and cultural diversification, Cantonese embroidery, a world-class intangible cultural heritage, is facing challenges such as a break in its transmission and limited industrial efficiency. Based on panel data from Guangdong Province from 2021 to 2023, this study employs a two-way fixed effects and threshold model to systematically identify the driving role and stage-specific characteristics of the digital economy in the synergy of the Cantonese embroidery industry chain. The results show that the digital economy significantly improves the synergy level of the Cantonese embroidery industry chain, with increased consumption capacity being the key transmission mechanism, and this impact exhibiting a strengthening threshold effect as digitalization deepens. The study further proposes three paths for international breakthroughs: using digital technology to elevate Cantonese embroidery from a regional craft to a global digital cultural and creative brand; expanding the international influence of Chinese culture through cross-border e-commerce and digital dissemination; and reshaping the intangible cultural heritage industry ecosystem through intelligent production and blockchain, providing a Chinese solution for cultural integration along the "Digital Silk Road." This study provides a replicable path for the modernization and international dissemination of intangible cultural heritage and contributes Eastern wisdom to the digital transformation of global cultural heritage.*

***Keywords:*** *Digital Economy, Cultural Industry Chain, Synergistic Impact, Cantonese Embroidery*

## 1. Introduction

### *1.1 Research Background*

In an era deeply intertwined with globalization and informatization, the cultural industry has become a strategic driving force for economic restructuring and high-quality growth[2]. The continuously improving national intangible cultural heritage protection policy system and the "Cultural Power" strategic layout provide unprecedented institutional support and development opportunities for the revitalization of traditional handicrafts[3]. Simultaneously, the upgrading of residents' consumption and the enhancement of cultural confidence jointly drive the rapid expansion of cultural, aesthetic, and cultural needs, forming a strong demand-side foundation for the expansion and quality improvement of the cultural industry.

Under this macro-favorable environment, Cantonese embroidery, as the essence of Lingnan culture and a world-class intangible cultural heritage, should have leveraged this momentum to achieve breakthroughs in industrialization, branding, and internationalization[5]. However, its actual development trajectory presents a structural paradox of "high potential energy, low kinetic energy," and the industry's sustainable foundation is being systematically eroded. First, production efficiency severely restricts large-scale development. Cantonese embroidery relies heavily on meticulous handcrafting processes; a high-quality piece often takes months to a year to complete, far from meeting the contemporary market's demands for efficient delivery and flexible supply, resulting in limited production capacity and insufficient order fulfillment capacity, further compressing the industry's expansion space. Second, the solidification of dissemination channels weakens intergenerational transmission. Cantonese embroidery has long relied on offline exhibitions and physical sales, limiting its reach to regional markets. The proportion of young consumers is insufficient, and the brand faces a

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significant cognitive gap among digital natives, hindering the effective conversion of cultural influence into market growth. Ultimately, the lack of a value conversion mechanism has led to the degradation of the industrial ecosystem. The lag in both production and dissemination has trapped Cantonese embroidery in a structural dilemma of "high artistic value, low commercial returns," intensifying homogenized competition, compressing profit margins, significantly shrinking the industry's workforce, and threatening the extinction of core techniques. A typical example is the Shunde Fude Embroidery Factory, where the number of embroiderers plummeted from 36,000 in the 1990s to less than 3,000, reflecting a rapid weakening of the industry chain's collaborative capabilities and the foundation for living heritage transmission[9].

In conclusion, the obstacle facing Cantonese embroidery is not a single link, but a structural imbalance across the entire chain of production, dissemination, and value conversion. It urgently needs to leverage the digital economy to reconstruct its industrial ecosystem and achieve sustainable inheritance and international advancement of intangible cultural heritage in a modern context.

### *1.2 Literature Review*

A review of the academic development of Cantonese embroidery and the digital economy reveals that domestic research primarily focuses on three areas: the reconstruction of the digital inheritance system, design innovation and cross-disciplinary integration driven by digital technology, and the industrial chain synergy mechanism promoted by the digital economy[2]. The research paradigm has gradually shifted from early exploration of technological applications to systematic industrial chain analysis.

Regarding the inheritance system, existing research generally agrees that digital technology is reshaping the knowledge transmission path of intangible cultural heritage. Case studies show that the traditional apprenticeship system is no longer sufficient to meet contemporary dissemination needs. E-commerce platforms and digital displays have expanded the audience reach, but the fragmentation of information within the industrial chain still limits overall synergy[9] (Wang Yangyang, 2024). Meanwhile, 3D scanning and AR technologies have shown outstanding performance in the digital recording of needlework techniques, and the combination with online teaching platforms has expanded the coverage of inheritance by approximately 40%, significantly improving the accessibility of Cantonese embroidery skills[8] (Liu Fanjia, 2025).

Regarding design innovation and cross-disciplinary integration, related research indicates that Cantonese embroidery has historically possessed the ability to absorb diverse aesthetics. Historical document analysis shows that Cantonese embroidery actively integrated Western styles during its export period, a pattern that provides important insights for innovation in the digital age—digital consumer demand is becoming a new driving force for design innovation[10] (Yang Qiuhua, 2024). Further field research revealed that digital platforms have facilitated cross-sector collaboration between "Cantonese embroidery + fashion/cultural and creative industries," but the lack of algorithmic collaboration mechanisms between designers and embroiderers limits its large-scale development[5] (Yang Qiuhua et al., 2025).

Regarding supply chain collaboration mechanisms, the study emphasizes the crucial role of the digital economy in reducing transaction costs, improving innovation efficiency, and optimizing resource allocation. Quantitative evidence shows that digital technology significantly enhances the synergistic effect of the cultural industry; taking Cantonese embroidery as an example, for every 1% increase in e-commerce penetration, the synergy increases by 0.7%[2]; however, small and medium-sized embroidery workshops remain at a disadvantage in terms of digital capabilities and resource acquisition (Yu Yafei, 2025). Furthermore, policy text analysis shows that the advantage of the "Intangible Cultural Heritage + AI" model lies in the formation of a collaborative system among government, platforms, and enterprises[3] (Pei Xu, 2025), while the "cloud factory" model shortens the delivery cycle by 50% through real-time data integration, providing a replicable path for industry chain collaboration[6] (Li Yongcai, 2025).

Overall, existing research has laid an important foundation for the digital development of Guangdong embroidery, but there are still problems such as insufficient quantitative evidence at the regional level, a lack of systematic models of the mechanism of action, and insufficient integration of the collaborative logic of production, dissemination, innovation, and branding. Based on this, this study uses panel data from Guangdong Province and employs a two-way fixed effects and threshold model to systematically examine the impact of the digital economy on the collaboration of the Guangdong

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embroidery industry chain, and proposes four collaborative paths: digital production, dissemination, innovation, and brand building, aiming to provide more empirically supported theoretical and policy references for the high-quality development of Guangdong embroidery in the digital economy era.

### *1.3 Research Approach*

As shown in Figure 1, this study constructs a research framework consisting of three analytical stages, including current status analysis, empirical testing, and mechanism examination.

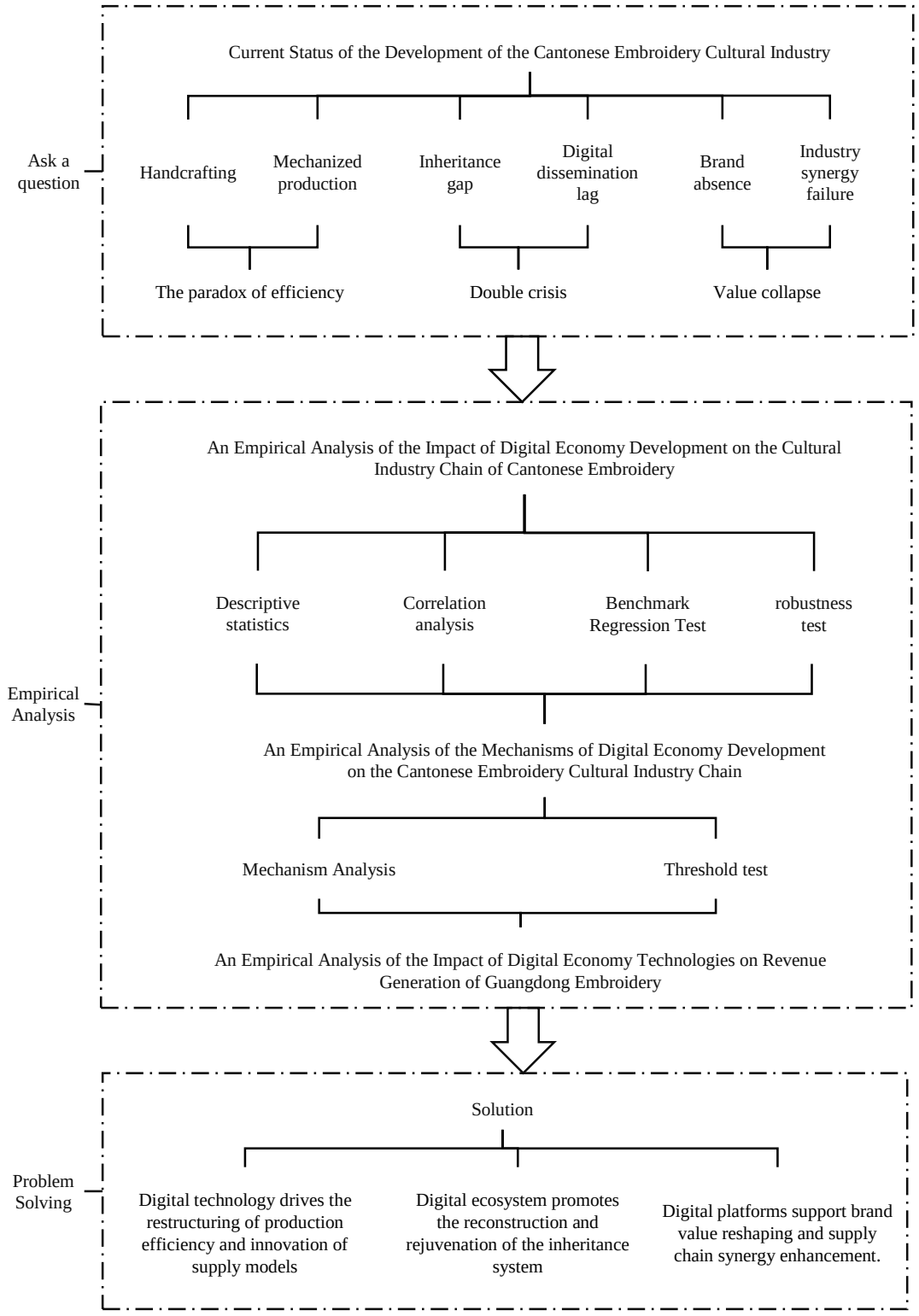


*Figure 1 Research Approach*

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## 2. Current Development Status of the Cantonese Embroidery Cultural Industry

### *2.1 Overview of the Development of Cantonese Embroidery Cultural Industry*

As one of the four major embroidery styles in China, Cantonese embroidery's development trajectory is deeply embedded in the historical context of social and economic changes in Lingnan. According to the "Guangdong Gazetteer" and existing artifacts, the art of Cantonese embroidery originated in the Tang Dynasty. By the Jiajing period of the Ming Dynasty (1522-1566), it had formed a mature craft system centered in Guangzhou and Chaozhou, renowned for its exquisite techniques of "needlework finer than a hair's breadth and meticulous adherence to rules." After the establishment of the Guangdong Customs in the 24th year of the Kangxi reign (1685), Cantonese embroidery entered its heyday as an export art form. The "Guangzhou Prefecture Gazetteer" records that during the Qianlong period (1736-1795), there were over fifty embroidery workshops in Guangzhou, employing over ten thousand people, with an annual output value equivalent to approximately three hundred thousand taels of silver. Products were exported to Europe, America, and Southeast Asia via the Maritime Silk Road, becoming an important cultural trade commodity in the region. During the Republican era (1912-1949), affected by both war and the impact of machine-made embroidery, the number of traditional embroidery workshops sharply decreased to less than ten, and the inheritance system was on the verge of collapse. After the founding of the People's Republic of China, the Guangzhou Embroidery Factory was established in 1957, bringing together veteran artisans to resume production. Following the reform and opening up, the scale of embroidery production expanded rapidly, reaching over 50,000 embroiderers in the province by the 1980s, with an annual output value exceeding 50 million yuan. Cantonese embroidery once again became an important export-oriented industry. In 2006, Cantonese embroidery was included in the first batch of national intangible cultural heritage lists, and in 2018, it was included in the national traditional craft revitalization directory, further improving the policy support system.

Currently, the Cantonese embroidery industry is undergoing a transformation trend of "scale contraction and structural optimization." As of the end of 2022, the four core production areas of Guangzhou, Chaozhou, Foshan, and Zhongshan had a total of 287 enterprises and individual workshops, employing 3,167 people. Among them, inheritors over 60 years old accounted for 43%, while young practitioners under 40 years old accounted for only 15%, indicating a strong generational structure still reflecting the apprenticeship system. From 2021 to 2023, the industry's average annual total output value remained stable between 420 million and 480 million yuan. The product structure was significantly optimized, with the proportion of traditional religious themes decreasing to 28%, while the proportion of cultural and creative derivatives, modern decorative paintings, and high-end customized products increased to 72%, reflecting a clear shift in market demand towards the aesthetics of daily life. The industry integration index reached 0.62, higher than the average level of embroidery-related intangible cultural heritage (0.54), highlighting its advantages in cross-border design and cultural tourism integration. The spatial layout formed a "three-core, multi-point" structure: Guangzhou developing high-end art pieces—Chaozhou promoting the industrialization of Chaozhou embroidery—Foshan exploring the application of intelligent equipment. These three cities combined contributed over 85% of the province's total output value.

Regarding market channels, offline exhibitions and physical stores still accounted for 65% of the market share, but digital channels experienced rapid growth. In 2023, online sales increased by 31% year-on-year, and the proportion of young consumers (18-35 years old) increased from 12% in 2019 to 18%. In the areas of inheritance and innovation, the "Digital Archives Project of Cantonese Embroidery Techniques," launched in 2019, has completed the collection of needlework techniques from 52 provincial-level or above inheritors, constructing a database of 128 traditional needlework techniques. The "Digital Pattern Gene Bank of Cantonese Embroidery," established in 2021, includes 3,670 patterns. On the production side, some enterprises are exploring a "human-machine collaboration" model, shortening production cycles by 40%-60%. Shunde Fude enterprises have seen a threefold increase in efficiency since introducing an AI design system in 2022, with personalized customization orders increasing from 15% to 38%. Regarding talent cultivation, the "Cantonese Embroidery Enters Schools" program covers 47 primary and secondary schools, training over 2,000 people annually. Since Chaozhou Vocational and Technical College established its embroidery major in 2020, it has graduated 89 students, with a 76% employment rate in related fields.

Overall, Cantonese embroidery shows a steady development trend in terms of policy support, product structure, digital applications, and talent systems. However, shrinking scale and generational gaps remain key challenges affecting its sustainable development.

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### *2.2 Development Challenges and Analysis of Cantonese Embroidery Cultural Industry*

#### *2.2.1 The Paradox of Efficiency between Manual Production and Mechanized Production*

The unique artistic value of Cantonese embroidery is sharply contradictory to its production efficiency. Currently, manual production exhibits significant polarization: simple works take over a week, medium-sized and larger works require several months or even half a year, and classic pieces like "White Peacock" require a whole year of meticulous work; some bead embroidery even exceeds a year. In contrast, machine embroidery can be mass-produced in just 40-240 hours, with a decisive cost advantage. In-depth analysis shows that Cantonese embroidery, from design conception and material selection to needlework techniques, relies heavily on individual experience throughout the entire process, and the complexity of the process directly hinders the improvement of industry efficiency. This structural imbalance leads to frequent production capacity bottlenecks for Cantonese embroidery enterprises during peak periods of commercial cooperation, causing them to miss market opportunities and struggle to meet the core demands of modern consumers for personalized and immediate products, ultimately falling into the development trap of "high-end positioning and inefficient supply."

#### *2.2.2 The Dual Crisis of Discontinuity in Inheritance and Lagging Digital Dissemination*

The rapidly shrinking scale of the industry and the solidification of skill dissemination channels form a vicious cycle. Current data shows that the number of embroiderers at Shunde Fude Embroidery Factory has plummeted from 36,000 in the 1990s to 3,000 currently, with a very low proportion of young practitioners. The main inheritors face the risk of "losing their skills as people leave." Meanwhile, dissemination has long been confined to traditional offline exhibitions and physical stores, with young consumers accounting for less than 20%, leading to a continuously shrinking market base. The deeper problems lie in: the lack of a data-driven protection mechanism for core techniques, causing inheritors to have serious concerns about digital transformation; and significant lag in online marketing and social media applications, preventing cultural influence from being translated into market growth. This double lag not only exacerbates the talent gap in skill inheritance but also results in low brand awareness of Cantonese embroidery among the digitally native consumer base, leading to a severe disconnect between dissemination effectiveness and market demand.

#### *2.2.3 Value Collapse due to Brand Absence and Ineffective Supply Chain Collaboration*

The proliferation of OEM manufacturing and the systemic lack of brand awareness constitute a bottleneck for value transformation. Currently, nearly 90% of Cantonese embroidery enterprises do not have brand management departments, and most enterprises in Guangdong Province adopt OEM manufacturing models, resulting in an extreme scarcity of independent brands and a "small, scattered, and weak" industry structure. In-depth analysis reveals that insufficient brand equity accumulation, unclear positioning, and inadequate promotional investment have made it difficult to establish communication power and consumer loyalty. Furthermore, information fragmentation across the design, production, and sales segments of the industrial chain has resulted in a lack of synergy. This systemic deficiency directly weakens brand premium capabilities, while product homogenization and low-price competition erode industry profits, hindering the extension of the industrial chain to higher value-added segments. Ultimately, this has left Cantonese embroidery at a continuous disadvantage in high-end market competition, fundamentally eroding the foundation of the industrial ecosystem.

## 3. An Empirical Analysis of the Impact of the Digital Economy on the Cultural Industry Chain

### *3.1 Research Design*

#### *3.1.1 Research Hypothesis*

This paper proposes the following hypothesis: The development of the digital economy has a significant promoting effect on the economic revenue of the cultural industry chain.

#### *3.1.2 Variable Design*

Variable design is shown in Table 1.

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*Table 1 Empirical Analysis Variable Design*

| | Variable name | variable name | Variable Description |
|---|---|---|---|
| Explanatory variable | Cantonese embroidery economic revenue generation | Y | Regional Cantonese embroidery economy revenue |
| Explanatory variables | Digital Economy | X | Measurement |
| control variables | Regional GDP | Regional GDP | Ln region GDP |
| | Openness to the outside world | Openness to the outside world | Local outbound investment/GDP |
| | Industrial structure | Industrial structure | Tertiary sector output/Secondary sector output |
| | Fiscal support | Fiscal suppor | General budget expenditure/Gross regional GDP |
| | Urbanization level | Urbanization level | Urban population/Total population |
| Mediator variables | spending power | spending power | Ln Consumption capacity |

### *3.2 Research Methods*

#### *3.2.1 Model Setting*

To verify the impact of the digital economy on the economic revenue of Guangdong embroidery in various regions, and to simultaneously examine the mechanisms by which regional GDP, degree of openness to the outside world, industrial structure, fiscal support, and urbanization level play a role, this paper constructs a two-way fixed effects model for empirical analysis. The model setting is as follows:

First, to examine the direct impact of the digital economy on the economic revenue of Guangdong embroidery, the following baseline model is constructed, as shown in Equation (1):

$$Y_{i,t}=\alpha_0+\alpha_1 X_{i,t}+\alpha_4 Controls_{i,t}+\varepsilon_{i,t} \quad (1)$$

Where:

$Y_{i,t}$ is the dependent variable representing the revenue of the Guangdong embroidery industry;

$X_{i,t}$ is the explanatory variable, representing the level of digital economy development;

$Controls_{i,t}$ denotes the set of control variables;

$\alpha_0$ absorbs inherent heterogeneity of individuals;

$\varepsilon_{i,t}$ is the random disturbance term.

Secondly, considering the differences in policy environment and development needs of different cities in different years, in order to control the possible bias of the year effect and city effect on the regression results of the model, a year dummy variable (Year) and a city dummy variable (City) are further introduced. The extended model form is shown in Equation (2):

$$Y_{i,t}=\alpha_0+\alpha_1 X_{i,t}+\alpha_4 Controls_{i,t}+\sum Year+\sum CITY+\varepsilon_{i,t} \quad (2)$$

Equation (2) incorporates both region fixed effects and time fixed effects to eliminate omitted variable bias arising from time-invariant characteristics and common time shocks. The definitions and measurement methods of all variables are consistent with those presented in Table 1.

#### *3.2.2 Sample and Variables*

This study uses cities in Guangdong Province (such as Guangzhou, Shenzhen, Foshan, and Chaozhou) that are major clusters of the Cantonese embroidery industry as its research subjects, spanning from January 1, 2021 to December 31, 2024. Data are sourced from publications such as the Guangdong Provincial Economic Statistical Yearbook and the China Urban Statistical Yearbook.

1) Explained Variable

The quantitative assessment of the revenue-generating capacity of the Guangdong embroidery

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industry is based on a comprehensive calculation result of deep integration of multi-dimensional data. At the data collection level, on the one hand, key financial indicators of Guangdong embroidery enterprises within a specific observation period are precisely identified, including but not limited to core data such as main business sales and net profit. Through systematic review and in-depth analysis of financial statements, the economic activities of enterprises are grasped. On the other hand, market transaction records and sales data of Guangdong embroidery products from mainstream e-commerce platforms are widely collected to comprehensively track the flow and revenue of Guangdong embroidery products in different market channels. In the indicator construction stage, scientific and reasonable statistical methods are used to organically integrate the above-mentioned diverse data, constructing a revenue-generating indicator system that accurately reflects the total economic value created by the Guangdong embroidery industry in market transactions. This comprehensive indicator system not only broadens the breadth of data sources but also enhances the depth of data integration, striving to comprehensively and accurately reflect the overall economic performance of the Guangdong embroidery industry in a complex market environment from both macro and micro perspectives. This provides a solid data foundation and strong quantitative support for further in-depth research into the influencing factors and mechanisms of Guangdong embroidery revenue generation in the context of the digital economy.

2) Explanatory Variables

The detailed construction of explanatory variables is presented in Table 2.

*Table 2 Explanatory Variables*

| Primary Indicator | Secondary Indicator | Tertiary Indicator | Unit | Indicator Attribute |
|---|---|---|---|---|
| Digital Economy Comprehensive Development Index | Internet penetration rate | Number of Internet users per 100 people | person | positive |
| | Number of people employed in internet-related industries | Percentage of employees in computer services and software industries | % | positive |
| | Internet-related output | Total telecommunications business volume per capita | Yuan/person | positive |
| | Mobile internet users | Number of mobile phone users per 100 people | person | positive |
| | Inclusive development of digital finance | China Digital Inclusive Finance Index | - | positive |

3) Mediating Variables

Consumption Capacity: The development of the digital economy can influence consumption capacity through various channels, such as providing more convenient payment methods and richer consumption scenarios. In turn, the improvement of consumption capacity will promote the development of the cultural industry and boost the consumption of cultural products such as Cantonese embroidery.

4) Control Variables

To more effectively measure the impact of the digital economy on the revenue generated by the Cantonese embroidery economy within the cultural industry chain, it is necessary to control for other factors affecting the cultural industry chain. First, the Gross Regional Product (GDP) reflects the economic scale and overall development level of a region. Regions with a strong economic foundation often have a stronger capacity to support the development of the cultural industry and the digital economy. Second, the industrial structure effectively reflects the proportional relationship between industries in a region. A reasonable industrial structure helps the coordinated development of the cultural industry and the digital economy, avoiding synergistic obstacles caused by incoordination between industries. Third, the level of fiscal support indicates the government's financial investment in related industries. Fiscal support can promote infrastructure construction and technological research and development in the cultural industry and the digital economy, influencing their synergistic process. Fourth, the level of urbanization reflects the degree to which regional population, land, and other factors are concentrated in urban areas. Urbanization can gather resources and expand market demand, providing broader space and opportunities for the synergy between the cultural industry and the digital economy.

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### *3.2.3 An Empirical Analysis of the Impact of Digital Economy Development on the Cantonese Embroidery Cultural Industry Chain*

1) Descriptive Statistics

The descriptive statistics of the variables used in the empirical tests are shown in Table 3. From the descriptive statistics of the explained variable (Y), we can see that its minimum value is 3.805, its maximum value is 11.16, and its mean is 8.420. From the descriptive statistics of the explanatory variable (X), its minimum value is 0.002, its maximum value is 0.512, and its mean is 0.153. The standard deviations of all variables are relatively small after being shortened by 1% for continuous variables, proving that the construction and preprocessing of the variables in this paper are reasonable and meet the needs of further empirical testing. From the quantile perspective, the lower quantile of the digital economy indicator (0.0230) corresponds to the lower quantile of Guangdong embroidery sales (7.219), while the higher quantile of the digital economy indicator (0.293) corresponds to the higher quantile of Guangdong embroidery sales (9.926), indicating that the digital economy and Guangdong embroidery sales show a certain positive correlation overall. However, the correlation between the median quantiles (0.0690 and 0.868) and the median quantile of sales of Cantonese embroidery (8.484) is not strong, reflecting that the development of the digital economy can increase the sales of Cantonese embroidery to a certain extent, but this promoting effect is subject to the synergistic effect of other factors, such as market environment, brand building, and cultural awareness. It is necessary to comprehensively consider multiple factors to promote the digital and large-scale development of the Cantonese embroidery industry.

*Table 3 Descriptive Statistics*

| variable | N | min | max | mean | sd | p25 | p50 | p75 |
|---|---|---|---|---|---|---|---|---|
| Y | 36 | 3.805 | 11.16 | 8.420 | 1.938 | 7.219 | 8.484 | 9.926 |
| X | 36 | 0.00200 | 0.512 | 0.153 | 0.161 | 0.0230 | 0.0690 | 0.293 |
| Regional GDP (in yuan) | 36 | 16.02 | 19.53 | 18.07 | 1.161 | 17.19 | 18.40 | 18.86 |
| Openness to the outside world | 36 | 0.166 | 2.117 | 0.660 | 0.564 | 0.279 | 0.448 | 0.822 |
| Industrial structure | 36 | 0.626 | 2.863 | 1.265 | 0.777 | 0.749 | 0.868 | 1.632 |
| Fiscal support | 36 | 0.0740 | 0.198 | 0.111 | 0.0350 | 0.0870 | 0.0970 | 0.131 |
| Urbanization level | 36 | 0.578 | 0.967 | 0.818 | 0.154 | 0.680 | 0.872 | 0.947 |

2) Correlation Analysis

The table above shows the correlation analysis results among multiple economic variables. The correlation coefficient between Y and X is 0.425, significant at the 1% level, indicating a strong positive correlation. This means that changes in the digital economy have a positive impact on the economic revenue of Guangdong embroidery, preliminarily proving the research hypothesis of this paper: the development of the digital economy has a significant promoting effect on the economic revenue of the cultural industry chain.

The correlation coefficient between GDP (yuan) and X is 0.336 (significant at the 5% level), indicating that X is also positively correlated with regional economic development. The correlation coefficient between GDP (yuan) and per capita GDP (yuan) is as high as 0.980, with a significance level of 1%, reflecting a high degree of synchronicity between the two, which is consistent with the general laws of economic development. The correlation coefficients between each control variable and the explained variable are significant at different significance levels, proving that the control variables selected in the model (Table 4) are necessary and reasonable.

However, the correlation coefficients between variables only represent the direct relationship between them and do not take into account other control variables, industry characteristics, time characteristics, and other model issues. Therefore, it is not in line with the requirements of the research design to test the hypotheses proposed in the theoretical analysis based solely on the direct correlation coefficients between variables. This paper will further verify the theoretical analysis through subsequent empirical results analysis.

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*Table 4 Correlation Analysis*

| | Y | X | Regional GDP (in yuan) | Openness to the outside world | Industrial structure | Fiscal support | Urbanization level |
|---|---|---|---|---|---|---|---|
| Y | 1 | | | | | | |
| X | 0.425*** | 1 | | | | | |
| Regional GDP (in yuan) | 0.926*** | 0.336** | 1 | | | | |
| Openness to the outside world | 0.136 | 0.436*** | 0.251 | 1 | | | |
| Industrial structure | 0.701*** | 0.334** | 0.579*** | -0.183 | 1 | | |
| Fiscal support | -0.681*** | -0.297* | -0.788*** | -0.539*** | -0.0350 | 1 | |
| Urbanization level | 0.547*** | 0.288* | 0.724*** | 0.669*** | -0.0890 | -0.938*** | 1 |

3) Benchmark Regression Test

Based on the correlation analysis described above, the benchmark regression test introduced multiple control variables (such as GDP, industrial structure, and fiscal support). Coefficients were estimated using the least squares method, and the significance of variables and the overall explanatory power of the model were determined using t-tests and F-tests. This quantified the marginal effect and direction of the correlation between the digital economy (X) and Guangdong embroidery revenue (Y).

The regression results of the model (Table 1) are shown in Table 5. Table 5 shows that this benchmark regression model aims to explore the impact of each variable on the dependent variable Y. The model included independent variables such as X, GDP (yuan), GDP per capita (yuan), industrial structure, fiscal support, and urbanization level, and controlled for city fixed effects (city FE) and year fixed effects (year FE). The overall goodness of fit R-squared was as high as 0.988, indicating that the model fits the data extremely well.

From the regression coefficients of each variable, X has a significant positive impact on Y, with a coefficient of 5.463 and a corresponding t-value of 4.08. This significantly confirms the research hypothesis of this paper at the 1% significance level, namely, that the development of the digital economy has a significant promoting effect on the economic revenue of the cultural industry chain.

*Table 5 Benchmark Regression Test*

| | (1) |
|---|---|
| VARIABLES | Y |
| X | 2.930* |
| | (1.75) |
| Regional GDP (in yuan) | 14.537*** |
| | (3.56) |
| Openness to the outside world | 1.891 |
| | (1.19) |
| Industrial structure | 2.257 |
| | (1.41) |
| Fiscal support | -28.449** |
| | (-2.29) |
| Urbanization level | -8.595 |
| | (-0.24) |
| Constant | -248.656*** |
| | (-3.69) |
| Observations | 36 |
| R-squared | 0.979 |
| city FE | YES |
| Year FE | YES |

4) Robustness Test

Robustness tests are used to verify the reliability of the baseline regression results. By changing variables, adjusting model settings, changing the sample range, or using different estimation methods, the significance and coefficient stability of the core variables are tested to ensure the robustness of the

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research conclusions.

This test considers that the COVID-19 pandemic, as a major global public health event, has had a profound impact on various aspects of all countries. To avoid the potential negative impact of the 2020 COVID-19 pandemic on the regression results, this paper removes the sample data after 2020. However, the remaining sample still has sufficient representativeness and breadth. The remaining sample is re-regressed, and the regression results are shown in column (1) of Table 6. From the regression results, X (digital economy level index) has a significant positive impact on Y (Guangdong embroidery revenue), with a coefficient of 6.349, which is significant at the 1% significance level (corresponding to a t-value of 3.51). This indicates that the improvement of the digital economy level can effectively promote the growth of Guangdong embroidery revenue, even after excluding sample data that may be significantly affected by the pandemic. The model's R-squared value is as high as 0.988, indicating its strong explanatory power for the income generated by Cantonese embroidery, and the included variables can well explain the fluctuations in Cantonese embroidery income. Furthermore, the model incorporates city fixed effects (city FE) and year fixed effects (year FE) to control for potential influencing factors such as individual city differences and the time dimension, making the regression results more accurate and reliable.

Overall, these robustness test results further verify that the digital economy level index has a significant positive promoting effect on the income generated by Cantonese embroidery, providing strong empirical evidence for the Cantonese embroidery industry to leverage the development of the digital economy to increase income.

*Table 6 Robustness Tests*

| | (1) |
|---|---|
| VARIABLES | Y |
| X | 4.297** |
| | (2.22) |
| Regional GDP (in yuan) | 12.812*** |
| | (3.13) |
| Openness to the outside world | 2.243 |
| | (1.55) |
| Industrial structure | 0.595 |
| | (0.36) |
| Fiscal support | -15.563 |
| | (-1.58) |
| Urbanization level | 26.319 |
| | (0.72) |
| Constant | -245.764*** |
| | (-3.82) |
| Observations | 32 |
| R-squared | 0.981 |
| city FE | YES |
| Year FE | YES |

### *3.2.4 An Empirical Analysis of the Mechanism Factors of Digital Economy Development on the Cantonese Embroidery Cultural Industry Chain*

1) Mechanism Analysis

Mechanism analysis aims to explore the intrinsic path of causal relationships between variables. By introducing mediating variables, it analyzes how independent variables influence dependent variables through mediating variables, thereby revealing the mechanism of action and transmission path.

To test whether consumption capacity is the transmission mechanism of the impact of the digital economy on the sales revenue of Cantonese embroidery, X represents the digital economy level index, Y represents the revenue generated by Cantonese embroidery, and per capita disposable income is used as the key indicator for measuring consumption capacity. This paper tests the model, and the regression

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results are shown in Table 7.

As can be seen from the table, the regression result of the explanatory variable (X) on the transmission mechanism variable (consumption capacity) is positive, significant at the 1% significance level, and significant at the 10% significance level. This proves that with the increase of the digital economy, the sales revenue of Cantonese embroidery will be significantly improved. Therefore, per capita disposable income is the transmission mechanism of the digital economy on the sales revenue of Cantonese embroidery. This conclusion provides empirical evidence for the Guangdong embroidery industry to leverage the development of the digital economy and enhance consumption capacity to achieve revenue growth. It also suggests that policymakers should focus on using digital economic means to increase residents' income levels, thereby stimulating consumption potential and promoting the prosperity of the Guangdong embroidery industry.

*Table 7 Mechanism Analysis 1*

| | (1) | (2) |
|---|---|---|
| VARIABLES | per capita disposable income | Y |
| per capita disposable income | | 0.660** |
| | | (2.13) |
| X | 1.706* | 1.804 |
| | (1.82) | (1.06) |
| Regional GDP (in yuan) | 0.195 | 14.409*** |
| | (0.09) | (3.47) |
| Openness to the outside world | -0.288 | 2.081 |
| | (-0.62) | (1.33) |
| Industrial structure | 0.127 | 2.173 |
| | (0.28) | (1.38) |
| Fiscal support | -4.222 | -25.662** |
| | (-0.73) | (-2.13) |
| Urbanization level | 28.511 | -27.414 |
| | (1.30) | (-0.77) |
| Constant | -15.590 | -238.366*** |
| | (-0.53) | (-3.34) |
| Observations | 36 | 36 |
| R-squared | 0.972 | 0.981 |
| city FE | YES | YES |
| Year FE | YES | YES |

2) Threshold Test

The threshold test is used to analyze the nonlinear characteristics of the relationship between variables. By setting a threshold variable, it tests whether a threshold effect exists, and determines whether the relationship between variables changes with different intervals of the threshold variable, thereby determining the stability and conditionality of the relationship.

To explore whether the influence between the two truly has a nonlinear relationship, this paper intends to use the panel threshold model proposed by Hansen in 1999 to study the relationship between the digital economy and the economic revenue of Guangdong embroidery using actual data. The results of the threshold test are shown in Table 8. The table shows the regression results with scale coordination of the threshold variable. The regression results show that when the threshold variable is scale coordinated, the explanatory variable (X) is positive and significant at the 1% level for the explained variable (Y) regardless of whether it is less than the first threshold value, greater than the first threshold value, less than the second threshold value, greater than the second threshold value but less than the third threshold value, or greater than the third threshold value. This result indicates that the

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influence of the explanatory variable (X) on the explained variable (Y) has obvious stage-specific changes; the higher the level of the digital economy, the greater the marginal utility of Guangdong embroidery sales.

Particularly in the second and third groups, the digital economy demonstrated a significant and strong driving force, while the impact on the first, second, and fourth groups was relatively insignificant or showed signs of diminishing marginal returns. This provides insights for the development of the Cantonese embroidery industry: the construction and development of the digital economy should be emphasized, fully exploring its potential to generate revenue for Cantonese embroidery at different stages of development. Simultaneously, attention should be paid to other related factors such as optimized fiscal support and coordinated urbanization processes to promote a steady increase in the revenue of the Cantonese embroidery industry.

*Table 8 Threshold Test*

| | (1) |
|---|---|
| VARIABLES | Y |
| Regional GDP (in yuan) | -0.532 |
| | (-0.46) |
| Openness to the outside world | 1.140 |
| | (1.14) |
| Industrial structure | -0.384 |
| | (-0.35) |
| Fiscal support | -32.443*** |
| | (-4.27) |
| Urbanization level | 85.924** |
| | (2.49) |
| 0b._cat#c.X | 32.358 |
| | (0.92) |
| 1._cat#c.X | 18.463** |
| | (2.09) |
| 2._cat#c.X | 1.176 |
| | (0.48) |
| 3._cat#c.X | 3.079*** |
| | (2.84) |
| Constant | -49.433** |
| | (-2.13) |
| Observations | 36 |
| Number of id | 4 |
| R-squared | 0.663 |
| city FE | YES |
| Year FE | YES |

### *3.2.5 An Empirical Analysis of the Impact of Digital Economy Technology on the Revenue Generation of Guangdong Embroidery*

In the previous study, we explored the overall impact of the digital economy on the development of the Cantonese embroidery industry. The results showed that the advancement of the digital economy significantly promotes the growth of the Cantonese embroidery industry. Further, to clarify the differences in the roles of specific elements within the digital economy, this study selects artificial intelligence, virtualization, and blockchain technology as three core sub-indicators for detailed analysis.

According to the regression analysis results (Table 9 ), the development of artificial intelligence has a significantly positive impact on the Cantonese embroidery industry, passing the statistical test at the 10% significance level. This indicates that artificial intelligence plays an important role in improving the production efficiency, design innovation, and marketing models of the Cantonese embroidery industry. While the development of virtualization technology also shows a positive relationship, it did not reach statistical significance. This may be related to the fact that the application of this technology

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in the Cantonese embroidery industry is still in the exploratory stage and its acceptance within the industry is insufficient. The development of blockchain technology also has a significant positive impact on the Cantonese embroidery industry, passing the test at the 5% significance level, suggesting that blockchain has strong application potential in improving the traceability management, intellectual property protection, and cross-border transaction security of Cantonese embroidery products.

In conclusion, artificial intelligence and blockchain technologies have a more prominent role in promoting the Cantonese embroidery industry in the current digital economy context. While the potential of virtualization technology has become apparent, its industrialization effects still need further exploration and optimization. Future research can delve deeper into aspects such as the implementation of technology applications, supply chain collaboration, and the dissemination of digital culture to promote the high-quality development of the Cantonese embroidery industry.

*Table 9 Mechanism Analysis 2*

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | Y | Y | Y |
| AI | 0.150* | | |
| | (1.87) | | |
| Regional GDP (in yuan) | 13.825*** | 15.599*** | 12.063*** |
| | (3.90) | (4.34) | (3.51) |
| Openness to the outside world | -3.707* | -4.107* | -3.707* |
| | (-1.82) | (-1.92) | (-2.07) |
| Industrial structure | 4.227*** | 5.021*** | 4.170*** |
| | (5.47) | (6.64) | (5.44) |
| Fiscal support | -26.764** | -23.369** | -30.306** |
| | (-2.45) | (-2.21) | (-2.80) |
| Urbanization level | -126.104*** | -116.616*** | -88.973*** |
| | (-4.07) | (-3.41) | (-3.67) |
| Virtualization | | 0.012 | |
| | | (0.17) | |
| Blockchain | | | 0.157** |
| | | | (2.55) |
| Constant | -64.356 | -97.059 | -62.294 |
| | (-0.89) | (-1.27) | (-0.78) |
| Observations | 36 | 36 | 36 |
| R-squared | 0.980 | 0.977 | 0.982 |
| city FE | YES | YES | YES |
| Year FE | YES | YES | YES |

### *3.3 Research Conclusions*

Empirical analysis verified the significant promoting effect of digital economy development on the economic revenue of the Guangdong embroidery industry. A two-way fixed effects model was adopted, combining panel data from major Guangdong embroidery industry clusters within Guangdong Province. Guangdong embroidery economic revenue (Y) was selected as the dependent variable, and the comprehensive development index of the digital economy (X) as the core explanatory variable. Variables such as GDP and openness to the outside world were controlled for. Consumption capacity was introduced as a mediating variable, and artificial intelligence, virtualization, and blockchain technologies were selected as sub-technical indicators of the digital economy for mechanism analysis. The results show that the impact of the digital economy on the economic revenue of Guangdong embroidery is significantly positive, and the conclusions remain robust after excluding external factors such as the COVID-19 pandemic. Mechanism analysis revealed that increased consumption capacity is the transmission mechanism of the digital economy on Guangdong embroidery revenue. Artificial intelligence and blockchain technologies have a significant promoting effect on the Guangdong embroidery industry, while the potential of virtualization technology needs further exploration. The threshold effect test shows that the impact of digital economy development on Guangdong embroidery revenue has a phased characteristic, and its driving effect becomes more significant with the improvement of the digital economy level.

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## 4. Pathways for Synergistic Breakthroughs in the Digital Economy and the Cantonese Embroidery Cultural Industry

### *4.1 Digital Technology Drives Production Efficiency Restructuring and Supply Model Innovation Empirical*

Research shows that the digital economy has a significant positive impact on the revenue of Cantonese embroidery (benchmark regression coefficient 2.930, $p<0.01$), and its threshold effect exhibits increasing marginal returns in the second and third development stages. This result confirms that digitalization of production is a key path to breaking the dilemma of "high-end positioning, inefficient supply." Currently, Cantonese embroidery still faces a structural efficiency crisis: the classic work "White Peacock" requires a whole year to produce, while machine embroidery only requires 40-240 hours, and the production capacity bottleneck causes enterprises to repeatedly miss market opportunities.

Based on this, paths for reconstructing the production system are proposed from three aspects. Firstly, an artificial intelligence (AI)-driven intelligent design system is constructed. By leveraging machine learning algorithms to conduct in-depth learning on the data of Guangdong embroidery patterns and stitching techniques, a parametric design model is established to automatically generate pattern schemes compatible with weaving equipment. This compresses the design iteration cycle by more than 60% and realizes large-scale customization capabilities. Secondly, a human-machine collaboration model featuring "numerical control precision + manual charm infusion" is explored. Numerical control equipment is introduced into standardized links such as base fabric embroidery, while inheritors focus on manual refinement of key lines and subtle charm details. This shortens the production cycle of a single piece by 40%-60% while safeguarding the core artistic value. Finally, a demand-driven flexible supply chain platform is built. Relying on a consumer big data analytics system to improve demand forecasting accuracy, a cloud-based production scheduling network is established to connect scattered embroidery workshops, forming a virtual production capacity pool. This reduces the supply chain response cycle to 1/3 of that in the traditional model, thereby transforming the consumer capacity transmission mechanism revealed by empirical evidence into precise supply advantages. Through the progressive collaboration of "intelligent design - hierarchical production - agile supply," the aforementioned paths address the dilemma of "high-end positioning paired with inefficient supply."

### *4.2 Digital Ecosystem Promotes the Reconstruction of the Inheritance System and its Rejuvenation Addressing*

The dual crises of a broken inheritance chain and lagging digital dissemination, empirical analysis shows a significant positive correlation between the digital economy and Cantonese embroidery sales (correlation coefficient 0.425, $p<0.01$), indirectly driving industry growth by enhancing consumer spending power. This mechanism provides a fulcrum for breaking the vicious cycle of "a break in the inheritance chain—insufficient youth consumption": the current number of practitioners has plummeted from 36,000 in the last century to just over 3,000, with consumers aged 18-35 accounting for less than 20%, posing a risk of "loss of skills as people leave."

Based on this, a collaborative mechanism for digital inheritance and expansion should be established: First, a systematic digital archive of skills should be created, relying on the "Digital Archive Project of Guangdong Embroidery Skills" launched by the Guangdong Provincial Intangible Cultural Heritage Protection Center in 2019 (which has completed the collection of needlework techniques from 52 provincial inheritors and built a database of 128 traditional needlework techniques) and the "Digital Pattern Gene Bank" in 2021 (which includes 3,670 patterns), to achieve the digital preservation of core techniques[8]; Second, a youth attraction and cultivation plan should be implemented, expanding the coverage of "Guangdong Embroidery Enters Schools" to 47 primary and secondary schools through online courses, virtual workshops, and other means. The existing achievements, such as training more than 2,000 people annually and a 76% professional matching rate at Chaozhou Vocational and Technical College, combined with the digital narrative of short videos and virtual exhibition halls to enhance cultural dissemination, will transform the empirically revealed penetration effect of the digital economy into an increase in the reserve of inheritors[5]. Third, we will open up the conversion channel from digital dissemination to market monetization, rely on e-commerce and live streaming to achieve traffic conversion, and take advantage of the growth momentum of online sales increasing by 31% year-on-year in 2023 and the proportion of young consumers increasing from

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12% to 18%, to form a virtuous cycle of "digital protection - youth participation - consumption growth".

### *4.3 Digital Platforms Support Brand Value Reshaping and Supply Chain Synergistic Efficiency Enhancement Addressing*

The value collapse caused by brand absence and ineffective supply chain synergy, threshold tests show that the digital economy's contribution to Guangdong embroidery revenue generation is significantly enhanced in the second and third timeframes[3]. Furthermore, the technological empowerment effects of artificial intelligence (coefficient 0.150, $p<0.1$) and blockchain (coefficient 0.157, $p<0.05$) are empirically supported. This points the way to solving the problem of nearly 90% of enterprises lacking brand management departments and experiencing information fragmentation within the supply chain under the "small, scattered, and weak" structure.

Specific pathways include: First, promoting the digitalization of brand assets, supporting enterprises to register their own brands and using blockchain traceability technology to give products a unique digital identity, making brand premium capabilities data-driven and trustworthy, and breaking the value lock-in dilemma under the OEM model[7]; Second, implementing a platform-based integration strategy for the industrial chain, with the government or industry associations building a digital supply chain collaboration platform to connect the data flow of the entire chain of design, production, and sales, and drawing on the "cloud factory" model to achieve order synchronization and resource scheduling, thereby enhancing the scale synergy effect[6]; Third, deepening digital marketing and cross-border integration, through precise social media targeting and cooperation with digital art platforms, transforming the industrial integration index advantage (0.62) into high-end market competitiveness, driving Guangdong embroidery to leap from low-value-added OEM to a branded digital cultural and creative ecosystem, and achieving a systematic upgrade of the high-value-added links of the industrial chain.

## 5. Future Prospects

The digital development of the Cantonese embroidery industry still has vast potential for improvement. With the continuous evolution of technologies such as artificial intelligence, blockchain, and virtual reality, its potential in design innovation, process optimization, cross-border dissemination, and brand building will be further unleashed. Future research can examine the universality of the digital economy's impact on the synergy of the intangible cultural heritage industry chain within a larger sample size, longer timeframe, and cross-regional comparative framework[1][4]. It can also deepen the discussion of consumer behavior, digital platform mechanisms, and international dissemination pathways, providing more forward-looking theoretical support and practical insights for the digital transformation of Cantonese embroidery and even the global intangible cultural heritage industry.

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## References

*[1] Yu Fan. A New "Trajectory" Emerges in the Digital Economy [N]. China Culture Daily, 2025-07-23(003).*
*[2] Yu Yafei. The Path of Digital Economy Empowering High-Quality Development of Cultural Industries [J]. Industrial Innovation Research, 2025, (13): 104-106.*
*[3] Pei Xu. Exploring the Path of High-Quality Development of Digital Cultural Industries—Taking Hebei Province as an Example [J]. Social Science Forum, 2025, (04): 150-158.*
*[4] Wang Huan. Research on the Impact of Digital Economy on the High-Quality Development of*

ISSN 2616-5902 Vol. 7, Issue 11: 103-118, DOI: 10.25236/AJBM.2025.071115

*Shanxi Cultural Industries [J]. Shanxi Finance and Taxation, 2025, (06): 28-32.*
*[5] Yang Qiuhua, An Gang, Zeng Shinan. Characteristics and Contributions of Modern and Contemporary Cantonese Embroidery from the Perspective of Sociocultural Studies [J]. Textile Report, 2025, 44(06): 120-124.*
*[6] Li Yongcai. Research on the Reconstruction Logic and Innovation Path of Rural Cultural Industry Economic Ecology in the Digital Age [J]. Business Manager, 2025, (06): 57-59.*
*[7] Zhang Yuanchun. Research on Innovation Strategies of Enterprise Culture in the Digital Economy Era [J]. Modern Business, 2025, (11): 60-63.*
*[8] Liu Fanjia. Research on the Path and Effect of Digital Empowerment of the Living Inheritance of Cantonese Embroidery Intangible Cultural Heritage [J]. Western Leather, 2025, 47 (06): 32-34.*
*[9] Wang Yangyang. Inheritance and Development of Traditional Cantonese Embroidery Craftsmanship in Contemporary Times [J]. Cultural Monthly, 2024, (12): 32-34.*
*[10] Yang Qiuhua. Explanation and Interpretation of the Transformation of Modern Cantonese Embroidery Design Paradigm [J]. Journal of Clothing, 2024, 9 (06): 556-561.*