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Exploring and Evaluating the Impact of ICTs on Culture and Tourism Industries' Convergence: Evidence from China

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Abstract: Information and communications technologies (ICTs) have been driving the digital revolution of all industries worldwide. Industrial convergence constitutes a new feature and trend of contemporary industrial development and has received extensive attention from the media and public. However, the interrelationship between the two concepts—industrial convergence and ICTs—remains under-researched. This paper aims to explore and evaluate the ICTs' impact on industrial convergence by focusing on the interrelationship between culture and tourism. The study takes an industrial economics perspective with a specific focus on the multi-dimensional (direct, moderated, and threshold) effects. A research framework was suggested synthesizing three econometric models and encompassing three hypotheses. The research model was then empirically tested and validated through quantitative research using China's provincial panel data from 2004 to 2018. The study's findings indicate a positive influence/relationship between ICTs and market-oriented reforms in the culture and tourism industries' convergence. Moreover, a positive labor-convergence relationship was found, while the negative government-convergence relationship was uncovered in control variables. Regarding the moderating effect, the interaction of ICTs and market-oriented reforms is positively correlated with industrial convergence. In addition, there is a single-threshold effect of consumer demand on the ICTs-convergence relationship. This article extends our knowledge in two ways by addressing the knowledge gap regarding the interrelationship between culture and tourism and by providing new insights into the influence of ICTs on this industrial convergence that has theoretical and practical implications.



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Keywords: industrial economics; cultural tourism; information and communication technologies; market-oriented reforms; dynamic panel data estimation; threshold effect

1. Introduction

Tourism and culture industries are both regarded as promising pathways for economic development worldwide [1]. The symbiotic relationship between tourism and culture and their interdependence was highlighted by UN-WTO [2]. It was also indicated that cultural tourism is of great importance to the global tourism industry. [2]. Recent developments and new forms of creativity and technological innovation promote the synergetic action of the two industries.

On the other hand, information and communication technologies (ICTs), such as the internet and big data, have gradually been applied in all fields and industries, including culture and tourism [3]. Smart technologies, such as mobile devices and applications, virtual reality, augmented reality, and wearable devices [4], are reconstructing the value chains of culture and tourism industries in various aspects. By implementing smart infrastructure and services, suppliers of cultural and tourism services are providing new and additional value to customers and visitors. This paper argues that digitalization and smartness have gradually penetrated the value chains of culture and tourism industries and promoted the intersection and restructuring of their links, resulting in an integration.

Academic research on the digitalization of culture and tourism industries is in its infancy. Studies have been conducted to examine related issues that could be classified into two main fields. The first is the close interaction between culture and tourism [5–8], documenting that (i) culture is at the core of attractions of the tourism industry and (ii) tourism supports cultural and creative activities. The second field is the ICT's role in the tourism industry. Extant literature indicates that ICTs in general and the internet in particular have transformed the interaction between tourism suppliers and consumers, positively impacting the tourism industry [9,10]. More particularly, on the supply side, digitalization has encouraged travel trade and hotel suppliers to optimize their business processes [11], explore new opportunities and business models to improve profitability [12], promote and market their services [13], and increase customers' added value and their satisfaction. On the demand side, digitization has changed the way tourists plan their trips and holidays, purchase products/services, and experience destinations [14,15]. Online reviews on interactive travel websites have become an essential source of information for tourists [16], providing them with helpful information in making travel decisions.

A digital landscape for culture and tourism industries has been formed. Business reports and intelligence indicate that we are witnessing the digital era of the two industries with the adoption of new business processes and models [9,10,17,18]. The World Economic Forum predicted that digitalization in aviation, travel, and tourism will create more than 300 USD billion extra value during 2016 to 2025 [19]. It is worth pointing out that culture and tourism play a leading role in China; the national cultural and creative industry generated about 4436.3 CNY billion (642 USD billion) in economic added value in 2019, accounting for 4.5% of national GDP [20]. Furthermore, China is one of the top 10 international destinations; in 2018, the country received 63 million international tourist arrivals (ranked 4th) and earned 40 USD billion in tourism receipts (ranked 10th) [21].

In this context and background, there is an imperative need to explore in-depth the topic of culture and the tourism industries' convergence and interaction with it. Scholars have investigated some issues and aspects of industrial convergence, including the definition, types, characteristics, and drivers of industrial convergence [22–30]. A comprehensive review of cultural tourism by Richards [3] revealed that some studies have focused on cultural consumption, heritage conservation, and cultural tourism economics. However, most of these studies were case studies or other qualitative analyses from a theoretical perspective. Moreover, there is a lack of studies on developing countries in transition. It is, therefore, necessary to conduct more empirical studies.

Academic research on factors influencing factors for the culture and tourism industries' convergence and the role of ICTs is minimal. The study aims to address this knowledge gap. It is set to examine the driving forces for integrating the culture industry into tourism with a specific focus on China. The study's research question is stated as follows: "What is the effect/impact of ICTs on culture and tourism industries' convergence in a developing country whose economy is undergoing transition?" The approach to addressing this question is based on an industrial economics perspective, applying the following methodology: (i) A research framework synthesizing three econometric models and encompassing three hypotheses was elaborated. (ii) A measurement of the degree of culture and tourism industries' convergence was established using the coupling evaluation model and entropy weighting method. (iii) Econometric analysis of the multi-dimensional—direct, moderated, and threshold—effects of ICTs on culture and tourism industries' convergence, using China's provincial panel data covering the period 2004 to 2018. Overall, the study proposes a novel empirical assessment and quantitative evaluation/estimation of the degree of industrial convergence between culture and tourism.

Moreover, it constitutes a contribution to the knowledge body about the critical drivers for the culture–tourism industrial convergence by considering the influence of ICTs and the role of institutional and demand factors. The remainder of the article is structured as follows. In the next section, a literature review is performed, along with the suggested research hypotheses. Section 3 is dedicated to developing the methodology used for the

empirical investigation of the research model. Section 4 presents the analysis of results and the related discussion of the main findings. The paper is completed by outlining the conclusions and implications.

2. Literature Review and Research Hypotheses

2.1. Industrial Convergence

The term ‘convergence’ originated from Rosenberg’s [31] research on technological changes in the US machine tool industry. He proposed that when a new technology can be applied in different industries, their technological platforms may merge. Hacklin et al. [26] divides the convergence process into four stages, namely knowledge, technology, application, and industrial convergence, under the framework of evolutionary economics. ‘Industrial convergence’ refers to the blurring of boundaries between formerly distinct industries through the integration of elements, such as value propositions, technologies, and markets [24,32]. Industrial convergence can be classified into two types [22,33]: (i) The first type occurs when two formerly distinct industries merge to form a new industry segment that replaces the previous market segments; that is, substitutive convergence ($1 + 1 = 1$). (ii) The second type is when the fusion of formerly distinct industries leads to form a new inter-industry market segment, that is, complementary convergence ($1 + 1 = 3$). Greenstein and Khanna [22] proposed that most cases of convergence are ‘complementary’ rather than ‘substitutive convergence’. Hence, the result of convergence is the emergence of a new inter-industry segment [24]. Therefore, industrial convergence occurs through two interrelated processes, namely, functional convergence from the demand side and/or institutional convergence from the supply side.

Regarding the drivers of industrial convergence, Duysters and Hagedoorn [34] and Borés et al. [35] analyzed technological convergence based on the case of the information technology industry and suggested that it constitutes the preceding stage of industrial convergence. Pennings and Puranam [23] proposed market-driven convergence; that is, two independent industries have formed similar demand structures as products begin to substitute each another. In addition, industry convergence can also occur via institutional or policy changes [24,25].

Scholars have investigated the interactive relationship between the two industries, i.e., culture and tourism [3], covering destination cultural planning and creative tourism products [36,37]; increasing integration of creativity into tourism [6]; creativity, tourism, and economic development in the rural context [38]; and the government policy for the creative economy in the tourism industry [39].

It is suggested that there are many forms of value generation in the culture industry, and positive externalities can be exerted in the process of interaction with tourism [40]. The culture industry encompasses media productions and creative performances and activities. Events, festivals, and other similar activities are typical forms of creative tourism [6], which can strengthen local identity and improve tourism experience [7]. The core of the culture industry lies in heritage and creativity, which could guide a destination to shape/reshape its image and enhance its appeal/attractiveness [41]. Through the development of creative activities, culture and tourism industries have naturally merged in many fields [37]. This kind of cross-integration can innovate the traditional development paradigm and its output and create business models [40].

2.2. The Impact of ICTs on Tourism and Culture

ICTs interact closely with culture, creative industries, and tourism [42]. Academic research has documented the close link between tourism and technology [9]. The extant literature focuses on three areas/topics: consumer demand, technological innovation, industry, and business functions. The impact of ICTs mainly comes from websites, social media, and mobile technology [43]. ICTs have transformed the tourism industry by strengthening the interactivity between tourism suppliers and consumers, restructur-

ing distribution channels, promoting process, competition, and increasing input–output efficiency [44,45].

Richards [3] also argues that the extensive implementation of ICTs is also evident in the creative industries. Some studies have been performed on the ICTs' impact on culture and creative industry. The main findings of these studies are outlined hereafter. Florida [46] pointed out that talent, technology, and tolerance contribute to building a local creative environment and to improving economic performance. To empirically verify the viewpoint of Florida, a study by Marrocu and Paci [47] conducted a spatial error model and found that the creative social class, technological capital, and cultural diversity enhance regional productivity. Based on the theoretical hypothesis of creative cities, Scott [48] discussed the connection between technological changes and agglomeration of creative economy. A study by Batabyal and Nijkamp [49] examined the mechanism of how digital technology influences creative economic growth by utilizing mathematical economic models. The main finding was that the application of digital technology exerts an incomplete knowledge spillover effect on the creative region. Another study by Zhao et al. [50] incorporated ICTs and creative human capital into an extended production function and constructed a dynamic GMM model, using data from 142 regions in ten European countries covering the period from 1995 to 2007. The empirical results showed that creative professionals/employees and ICTs are positively correlated, resulting in an increase in gross value added (GVA).

Additionally, the academic research on the ICTs' influence in the hotel and tourism industries mainly takes a marketing perspective [43]. There are a very few studies on the relationship between ICTs and tourism from the economics perspective. Hereafter are outlined some studies that conducted econometric analysis, using panel data from different countries. Kumar and Kumar [51] implemented an AutoRegressive Distributed Lag (ARDL) model to identify the relationship between ICTs, tourism, and economic growth in Fiji. The results indicated that the long-term contribution of tourism was approximately 0.23%, and the short-term contribution was about 0.19%. It was also found that the long- and short-term contributions of ICTs were 1.07% and 0.89%, respectively. Likewise, the study by Jayaraman and Makun [14], using the panel data of five selected Pacific Island Countries (PICs) with a cointegration technique and an error correction model, concluded that tourism and ICTs contributed to economic growth around 0.25% and 0.02%, respectively, in the long term, and around 0.14% and 0.07%, respectively, in the short term. More specifically, tourism and ICTs were found to act in a complementary manner. A study by Petrović et al. [52] provided an understanding of the relationship between the level of ICTs and destination competitiveness by implying the Pearson correlation test, using the cross-sectional data of eleven EU transition countries. A study by Shehzad et al. [53] aimed to explore how ICTs and Silk Road infrastructure affect tourism development, using an ARDL model with quarterly data from China. It was indicated that the adoption of ICTs boosted tourism development, and consequently, economic growth. The study by Seetanah [54] employed the international tourism demand function and ARDL-ECM estimation to test the impact of telecommunications on tourism development in Mauritius. A positive correlation was found between them in both the short and long term. Implementing the ARDL model and PMG estimation, Kumar and Kumar [55] examined the impact of ICTs on international tourist arrivals, using annual data from nine major tourist destinations. The empirical results provided evidence that ICTs create tourism demand and supported the hypothesis of technology-led growth in major tourist destinations. Another study by Adeola and Evans [56] investigated the relationship between ICTs, infrastructure, and tourism development by implementing a dynamic panel gravity model and GMM estimation. The study used annual data from a sample of forty African countries and showed a significantly positive correlation between ICTs and tourism. A study by Lorente-Bayona et al. [13] aimed to explore how internet penetration influences outbound tourism expenditure, applying OLS and FE regression models based on panel data from 95 economies. Their study's findings indicated the positive interrelation between the two factors. Gholipour et al. [57],

with annual data from 46 developing countries, proposed dynamic panel models and GMM estimation to analyze the relationship between telecommunications infrastructure investment and international tourist arrivals. The empirical results showed that ICTs were a determining factor for tourism performance in developing countries.

It is believed that the above-outlined studies made a valuable contribution to the body of knowledge and provide evidence for the potential of and benefits/influence of ICTs on culture and tourism industries. However, there is a research gap in terms of quantitative estimation of the influence of ICTs on culture–tourism convergence from an economics perspective. Our study aims to address the knowledge gap in this field. This study argues that ICTs constitute a key determinant in the process of culture–tourism convergence. In this convergence process, ICTs' influence is mediated by institutional factor (namely, market-oriented reforms) and has a threshold effect under the condition of different scales of consumer demand. These arguments are reflected in the research hypotheses postulated.

2.3. Research Hypotheses

With the development of science and technology, industrial convergence is an increasingly empirical and relevant phenomenon [29]. Prior to the advent of industrial convergence, there were significant differences in technological competence and efficiency among industries. This situation may change if there are new areas for cross-industry technological applications. If new technologies can provide value for different applications, then the adoption by various industries, as well as the integration of different technological platforms, is possible [29]. Gambardella and Torrisi [58] indicated that ICTs are generic technologies that can be applied to a variety of products in different industries. ICTs reorganize existing technologies into a new technology with new functionality or improved efficiency, leading to the development of common technological platforms in different industries [24,30]. Eventually, the existing value chains of two previously distinct industries are disrupted, leading to the blurring of industry boundaries and industry convergence [26]. Academic research based on a theoretical approach and quantitative analysis has demonstrated that technology convergence, which is usually caused by new technological developments, has become the main driving force for industry convergence [23,26,27,59]. The emergence of new technologies, such as ICTs, has changed the existing industrial structure to a certain extent, thereby modifying products, processes, and business models [29]. Based on the above studies, this article suggests that the widespread application of ICTs in culture and tourism has enabled the two industries to gradually form a common technological foundation, which promotes the integration of their products, processes, and business models. Therefore, the following research hypothesis was postulated:

Hypothesis 1 (H1). *ICTs have a positive effect on culture and tourism industries' convergence.*

Additionally, the process of industrial convergence can also be driven by market-level development [26,28]. In the process of culture and tourism industries' convergence in China, it is supposed to be inevitably affected by market-oriented reforms in the macro environment and institutional framework [60]. Market-oriented reforms lead to deregulation and cross-industrial competition and to lower barriers for new entrants that bring alternative technologies or business models into a specific market segment [25]. These reforms contribute to stimulating the business innovation capacity/potential of cultural and tourism suppliers and create opportunities for convergence [61]. Moreover, highly intense market competition often results in an oversupply of products and services, which saturates the demand market for distinct tourism and cultural services. To tackle this challenge, cultural and tourism suppliers attempt to integrate each other's product features into existing products/services to remain competitive in the market and ensure profitability and financial sustainability [28]. In this process, the two industries mutually expand their demand market boundaries and then intersect, which eventually leads to the overlap of corresponding market segments [26,27]. Moreover, market-oriented reforms are undertaken in China with the aim to establish a business-based and market-oriented

technological innovation system that accelerates the penetration and application of ICTs in the culture and tourism industries. This enhances the impact of ICTs on the integration of the two industries. The next hypothesis is therefore advanced:

Hypothesis 2 (H2). *Market-oriented reforms enhance the driving effect of ICTs on the convergence of culture and tourism industries.*

With the widespread implementation and usage of ICTs, the diversification of consumer needs is accelerating the integration process between different technologies and industries [30]. In this regard, Pennings and Puranam [23] argued that “the growing similarity of needs across groups of consumers” constitutes the main catalyst driving the development of the integrated market. With the expansion of culture and tourism demand markets, consumers expect diversified, customized, and innovative products and services. This demand has led suppliers to seek various sources for innovation, including ideas from related industries [59]. This is regarded as a trend of consumers’ preference for convenience and one-stop shopping. Consumers attempt to meet different needs in one transaction and no longer strictly distinguish products from different industries [23,24,32]. If consumers expect a combination of different product functions, cultural and tourism products/services that did not compete to each another begin to become substitutes, and the industrial boundaries are dissolved [27,28]. In other words, the convergence of culture and tourism industries can be induced by the integration of the demand structure between them and by the combination of previously different product features into mixed products/services [24,25,30]. Therefore, industrial convergence does not only depend on technological feasibility. Demand-induced incentives provide an additional framework facilitating the coordinated adoption of compatible technological platforms [61]. This article assumes that there is a threshold of consumer demand in this process. After this threshold is exceeded, the driving effect of ICTs on culture and tourism industries’ convergence will increase. Therefore, a third and last research hypothesis is proposed:

Hypothesis 3 (H3). *The positive interrelation of ICTs and culture and tourism industries’ convergence is improved when the level of consumer demand rises above the threshold level.*

The research framework/model is proposed based on the discussion of above three hypotheses (see Figure 1). The rule of arrows direction is from key explanatory variables to dependent variable via three effects.

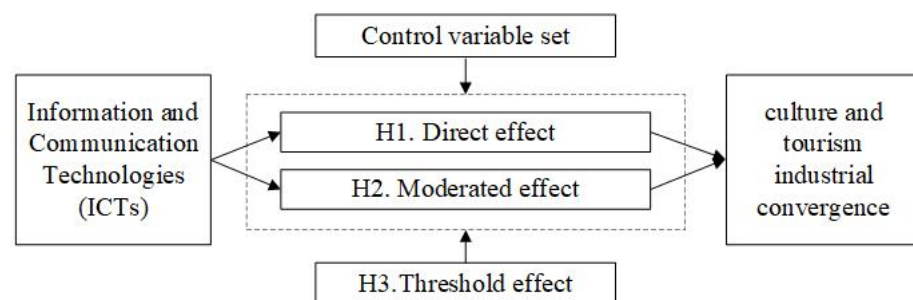


Figure 1. Research framework.

3. Materials and Methods

3.1. Study Design and Data

This study has selected 31 provinces in Mainland China as a research study, a volume that is sufficient to demonstrate the current situation in China. The time period covered by the study is 15 years (from 2004 to 2018); this choice was made based on two elements: comparability and availability. First, statistical data on culture industry are comparable (in terms of time series) since the first year of this period (i.e., 2004). The second element is that the latest available data are related to 2018.

Two official sources of annual data were used; namely, the China Statistics Yearbook Series and the Provincial statistical bulletins. The former covers China Statistical Yearbook (2005–2019), Chinese Cultural Relics Statistical Yearbook (2005–2019), and China Tourism Statistical Yearbook (2005–2019), conducted by the China Bureau of Statistics and the Ministry of Culture and Tourism of China, respectively. The later covers statistical bulletins of 31 Chinese provinces during the period 2004–2018, retrieved from the official website of each provincial Bureau of Statistics.

3.2. Model Specification

In this study, the first main purpose was to empirically explore the impact of ICTs on the convergence of culture and tourism industries. Based on the extant literature, the benchmark econometric specification was employed:

$$CONVERG_{it} = \alpha_0 + \alpha_1 ICT_{it} + \alpha_2 MARKET_{it} + \lambda_k Controls_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where i denotes province and t denotes year. α_0 is a constant term, α_1 , α_2 , and λ_k are the regression parameters to be estimated. μ_i is unobserved individual effect, which might be correlated with the regressors, while ε_{it} , the random disturbance term, denotes those effects that are not accounted for by the main variables of the model. The dependent variable is $CONVERG_{it}$, which represents the degree of culture and tourism industries' convergence. $Controls_{it}$ are a bunch of control variables covering $LABOUR_{it}$, $OPEN_{it}$, and $GOVERN_{it}$. In addition, we included the lagged $CONVERG_{it}$ (L. $CONVERG$) in dynamic panel data models to account for the dynamic nature of industrial convergence since $CONVERG_{it}$ is likely to be persistent in the literature of industrial economics.

Second, to test the moderating effect of market-oriented reform on ICTs' influence on the culture and tourism industries' convergence, this article decentralized variable ICT_{it} and $MARKET_{it}$ to introduce an interaction term $ICT_{it} \times MARKET_{it}$, to explore whether there is a moderating effect by testing the significance of coefficient β of the interaction term. The moderating effect econometric specification was as follows:

$$CONVERG_{it} = \alpha_0 + \alpha_1 ICT_{it} + \alpha_2 MARKET_{it} + \beta ICT_{it} \times MARKET_{it} + \lambda_k Controls_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

The third step was to test the threshold effect of ICTs' influence on the convergence of culture and tourism industries. In order to do so, we adopted the theoretical model suggested by Hansen [62], as indicated by most valuable empirical studies on threshold effect. Consumer demand, denoted as DE_{it} , is incorporated as a threshold variable into the model to explore the non-linear characteristics. $I(\cdot)$ is an indicative function; when the condition in parentheses is met, e.g., $DE_{it} \leq \delta$, the value is one; otherwise, the value is zero. Assuming a single threshold effect, presented by coefficient γ_1 and γ_2 , the panel threshold model is specified as:

$$CONVERG_{it} = \alpha_0 + \gamma_1 ICT_{it} \cdot I(DE_{it} \leq \delta) + \gamma_2 ICT_{it} \cdot I(DE_{it} > \delta) + \alpha_2 MARKET_{it} + \lambda_k Controls_{it} + \mu_i + \varepsilon_{it} \quad (3)$$

3.3. Variable Measure

$CONVERG_{it}$, representing the degree of culture and tourism industries' convergence, is a multidimensional concept that could not be denoted by a single index. Based on the studies conducted by Bryce and Winter [63], Tang et al. [64], and Cao et al. [65] regarding industrial convergence, the measurement of $CONVERG_{it}$ was established employing the combination of coupling evaluation model and entropy weighting method. The coupling evaluation model has been widely utilized to measure the correlation between two systems and was adapted to evaluate the level of integration of two industries. The entropy weighting method mainly assesses the importance of a certain index based on the degree of dispersion and can relatively avoid the deviation caused by subjective factors. Hence, in this study, the measurement of $CONVERG_{it}$ was carried into four steps, as follows.

First step, a comprehensive evaluation index system of culture and tourism industries from aspects of industrial structure and performance was elaborated based on extant literature. Table 1 depicts the specific indicators. The second step was the calculation of indicator weight. This article employed the range method to obtain the standardized value of the indicator x_{ij} , where the subscripts i and j denote the province and indicator, respectively. Based on the entropy weighting method, the specific calculation of indicator weight w_j includes (i) calculating indicator proportion $s_{ij} = x_{ij}/\sum x_{ij}$; (ii) calculating entropy value $h_j = -1/\ln 31 \sum s_{ij} \ln s_{ij}$; and (iii) calculating indicator weight $w_j = (1-h_j)/\sum(1-h_j)$.

Table 1. Comprehensive evaluation index system of culture and tourism industries.

Culture Industry		Tourism Industry	
Primary indicators	Secondary indicators	Primary indicators	Secondary indicators
Industrial structure	Number of companies in the cultural market	Industrial structure	Number of travel agencies
	Number of art performance venues		Number of star-rated hotels
	Number of mass cultural institutions		Number of scenic spots above 4A rating
	Number of employees in the cultural industry		Number of employees in the tourism industry
Industrial performance	Total operating income of cultural market	Industrial performance	Domestic tourism income
	Financial expenditures for cultural undertakings		International tourism income
	Number of museum visitors		Number of domestic tourists
	Number of audience for art group performances		Number of International tourists

The third step was to calculate comprehensive evaluation values of two industries. This paper multiplied the standardized value of each indicator of two industries with the corresponding weight to sum up and to obtain the comprehensive evaluation value of the two industries, which is shown in formulas $U_i = \sum w_j x_{ij}$ and $V_i = \sum w_j x_{ij}$, respectively. The fourth and last step was to estimate the degree of culture and tourism industries' convergence. Based on the coupling evaluation model, the specific calculation is shown in formula:

$$CONVERG_i = \left[\sqrt{U_i \times V_i} / (U_i + V_i) \times (aU_i + bV_i) \right]^{1/2} \quad (4)$$

where a and b are the contributions of culture industry and tourism industry, respectively, whose values are usually taken to be equal.

Our analysis included a set of explanatory variables that are considered to be related to CONVERG_{it}. The first variable, information and communication technology (ICT_{it}), is seen as the fundamental factor driving the convergence between two industries [24,25,59]. Authors (i.e., Naudé and Saayman [66], Seetanah [54], Adeola and Evans [56], and Lorente-Bayona et al. [13]) tended to use internet penetration rate as a proxy for ICTs, which is the proportion of internet users to the total population of each province/region. The internet penetration rate not only reflects the level of informatization/digitalization to a certain extent but also effectively addresses the deviation of results caused by alternative price-related indicators. Likewise, this proxy indicator is used by the present article.

China is a typical country that is undergoing the transition to a market economy, and, at the same time, its culture and tourism industries are under institutional transition. Institutional transformation manifests the fact that private sector firms are entering the market, along with the exit of state-owned enterprises. There is no doubt that the culture and tourism industries' convergence is affected by the process of marketization in a transition economy. To account for the institutional characteristics of services industry in a transition economy, we included the variable MARKET_{it} to represent the economic performance of market-oriented reforms. MARKET_{it} is represented by the proportion of the number of private sector firms and self-employed persons in the total number of employed persons in each province of China.

In order to accurately estimate the ICTs' effect on industrial convergence, this paper also incorporated in the econometric model some important factors affecting industrial convergence as control variables. Since the improvement of the educational level of regional human resources is beneficial for exerting knowledge spillover effects, it is supposed

that this factor is positively related to industrial convergence. Drawing on the research conducted by Liu et al. [67], Croes et al. [68], and Liu et al. [69], this article adopted the human resources/labor force (LABOURit) as a control variable, taking the number of education years per capita as a proxy variable. The calculation method was as follows: (Sample population with primary school education \times 6 + population with junior high school education \times 9 + population with high school education \times 12 + population with college degree and above \times 16) \div total sample population of six years old and more.

Second, taking into account that foreign trade expands the consumer markets for culture and tourism products/services and improves the technical level of culture and tourism industries due to the advanced business models, it is expected to be positively correlated to industrial convergence. According to the studies by Liu et al. [67], Cannonier and Burke [70], and Liu et al. [69], this article incorporated the variable of foreign trade (OPENit), which is expressed by the ratio of the total export value of each province to the regional gross domestic product (GDP). Third, previous studies (see, for instance, Liu et al. [67]; Cannonier and Burke [70]; Liu et al. [69].) have documented the important role of local government/authorities in the development of culture and tourism industries. This article adopted this argument/suggestion and incorporated government consumption (GOVERNit) into the econometric model. GOVERNit is indicated by the proportion of provincial fiscal expenditures in regional GDP, reflecting government ability to regulate and influence regional industries. An additional factor is the demand characteristics of culture and tourism industries. We therefore included the consumer demand (DEit) as a threshold variable. According to the measurement of consumer demand in industrial economics (Liu et al. [67]), this article used the per household annual provincial data of consumption expenditure in the industries of culture, education, and entertainment. The data then was adjusted to constant prices (using year 2000 as basis), according to the relevant CPI index, and was taken to be the natural logarithm due to alleviating the problem of heteroscedasticity.

Table 2 presents the definition and summary statistics for the variables used in this study. The hypothesized relationships of independent variables associated with CONVERG are also provided based on the above discussion.

Table 2. Definitions of the variables and summary statistics.

Variables	Definition and Measurement	Expected Signs	Mean	SD	Min	Max
CONVERG	the degree of cultural and tourism industries' convergence		0.249	0.092	0.061	0.594
ICT	internet penetration rate	+	0.351	0.199	0.025	0.78
MARKET	the number of private enterprises and self-employed persons divide by the number of all types of employment	+	0.441	0.108	0.182	0.732
LABOUR	years of education per capita	+	8.611	1.221	3.738	12.56
OPEN	export value divide by regional GDP	+	0.161	0.186	0.011	0.93
GOVERN	fiscal expenditures divide by regional GDP	−	0.244	0.187	0.079	1.379
DE	logarithm of household consumption expenditure per capita		9.277	0.369	8.525	10.33

Note: All variables are measured annually. Expected signs are the expected relationship between the dependent variable CONVERG and the variable on the row, except threshold variable DE.

3.4. Estimation Method

When it comes to econometric analysis of panel data, static econometric models are the most widely accepted and applied by scholars, including the pooled ordinary least squares (OLS), the fixed effects model, and the random effects model [71]. The pooled OLS is a fair benchmark model, but its regression results may be biased if there is heterogeneity among provinces. In order to tackle this problem, fixed-effects models and random-effects models were proposed, both of which consider individual effects among provinces. The former assumes that the individual effect μ_i is related to a certain explanatory variable, while

the latter assumes that the individual effect μ_i is not related to all explanatory variables. In order to select the most appropriate method, the F test and Hausman test [72] were performed in the static econometric models. The former as used to select between the pooled OLS and the fixed effects technique, whose null hypothesis is that the individual effect μ_i equals to zero. The latter is conducted to select between random effects and fixed effects technique, whose original hypothesis is that the individual effect μ_i has nothing to do with explanatory variables.

Considering an endogeneity problem that may be caused by possible mutual causation between the independent variable ICTit and the dependent variable CONVERG_{it}, dynamic econometric models have been employed to address this problem and to reinforce the reliability of results. The generalized method of moments (GMM), covering difference GMM [73] and system GMM [74], is the essence of estimation techniques of the dynamic models. Difference GMM technique, also known as Arellano–Bond estimation, performs first-order difference on the dynamic panel equation and then implements GMM estimation, using lagged regressors as tool variables. The system GMM technique takes difference equation and level equation as an equation system for GMM estimation, improving the validity of estimated results by increasing lagging and differencing variables as instrumental variables [74]. In order to test the applicability of two GMM estimation techniques, the Arellano–Bond test and Sargan test were adopted to guarantee the estimators to be unbiased and consistent. Null hypothesis of the Arellano–Bond test is zero autocorrelation in first-differenced disturbance term $\Delta\epsilon_{it}$, while original hypothesis of Sargan test is that overidentifying restrictions of moment conditions of instrumental variables are valid. In addition, a two-step GMM estimation procedure was constructed to ensure that the estimators are more efficient than those of 2SLS estimation.

4. Results: Data Analysis and Findings

4.1. Static and Dynamic Panel Data Analysis of Direct Effects

The software Stata 15 used to perform the econometric analyses [71]. Table 3 depicts the results of quantitative estimations for culture and tourism industries' convergence in Equation (1). While the first, second, and third columns display the estimation results of static econometric models (pooled OLS, fixed effects, and random effects), the fourth and fifth columns (difference and system GMM) present the results from the dynamic panel models for comparison and robustness check.

The satisfactory results of specification tests should now be discussed. In terms of static models, results of F test and Hausman test both reject the null hypothesis, implying that FE estimation is more appropriate than pooled OLS and RE estimation. The mean value of the pooled OLS model's variance inflation factor was 2.53 (within the required range of less than 10), which indicates that the model does not have serious multicollinearity [71]. As for the dynamic models, the Arellano–Bond test results do not reject the presence of first-order autocorrelation of first-differenced errors but reject second-order autocorrelation. Sargan test results supported the null hypothesis. This means that the estimation results of dynamic models were robust. In general, the values of F statistic or/and Wald statistic of each model, representing the overall significance of the regression, were statistically significant, and the reported coefficient of determination (R-squared) ranged from 57% to 76%. It indicates that the econometric model fits well and a large portion of variance of influence is explained by explanatory variables. The estimation results are highlighted hereafter.

Regarding the key explanatory variable (ICT); this is positively related (significant at the 1% level) to the CONVERG in all model specifications. This result is in line with the extant literature on industrial economics, indicating that the new technology constitutes an important incentive for the industrial convergence [23,26,27,59]. The regression coefficient of ICT had a value range between 0.024 and 0.291. In terms of its economic significance, that means that every increase by one unit of the internet penetration rate will promote the degree of culture and tourism industries' convergence by 0.024 to 0.291 units. Moreover, the coefficient signs and significance of ICT in the dynamic models are consistent with those

of the static models, indicating that the estimation results are reliable, and the ICTs-led convergence hypothesis is supported in the fields of culture and tourism. Furthermore, in dynamic models, there was a significant (at the 1% level) positive correlation between the lagged CONVERG (L.CONVERG) and itself. The reason for this significance lies in the fact that the fusion of culture and tourism industries in China has strong positive inertia or persistence. The estimated coefficients (Model4: 0.517; Model5: 0.694) were less than one, indicating that there is a trend of convergence in the process of the industrial fusion.

Table 3. Panel data estimation results of direct effects based on different methods.

Variables	Model1 Pooled OLS	Model2 Fixed Effects	Model3 Random Effects	Model4 DIFF GMM	Model5 SYS GMM
ICT	0.291 *** (0.028)	0.105 *** (0.011)	0.111 *** (0.012)	0.048 *** (0.004)	0.024 *** (0.005)
MARKET	0.154 *** (0.035)	0.078 *** (0.016)	0.081 *** (0.017)	0.069 *** (0.008)	0.094 *** (0.010)
LABOUR	−0.040 *** (0.005)	0.015 *** (0.003)	0.014 *** (0.003)	−0.007 ** (0.004)	0.003 *** (0.001)
OPEN	0.097 *** (0.015)	−0.011 (0.013)	−0.003 (0.013)	0.014 *** (0.004)	−0.009 ** (0.004)
GOVERN	−0.396 *** (0.027)	−0.090 *** (0.016)	−0.102 *** (0.015)	−0.093 *** (0.010)	−0.116 *** (0.014)
L.CONVERG				0.517 *** (0.032)	0.694 *** (0.030)
CONSTANT	0.501 *** (0.043)	0.071 *** (0.024)	0.078 *** (0.026)	0.036 *** (0.005)	0.033 *** (0.004)
F statistic	100.2 ***	273.72 ***			
Wald statistic			1314.95 ***	33489.09 ***	30446.37 ***
R-squared	0.576	0.761	0.761		
F test		200.86 ***			
Hausman test		28.43 ***			
AR(1)				0.007 ***	0.007 ***
AR(2)				0.597	0.479
Sargan test				1	1

Note: The standard errors are presented in parentheses for the models under the estimated coefficients. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively. The values in the rows of the Arellano–Bond tests and Sargan tests stand for p-values.

4.2. Static and Dynamic Econometric Analysis of Moderated Effect

According to the results of the moderated effect estimation (depicted in Table 4, columns 1 to 4), the estimated coefficients of MARKET, the other key explanatory variable, were all significant at the 1% statistical level. When the proportion of individual and private economy increases by 1%, the degree of culture and tourism industries' convergence will increase by 0.061% to 0.148%, which indicates that market-oriented reforms have significantly promoted the industrial convergence. Moreover, the coefficients of the interaction term ICT×MARKET varied between 0.103 and 0.275, and most of them were significant at the 1% or 5% statistical level, indicating that ICTs and market-oriented reforms are synergistic in the process of promoting the integration of these two industries in China. The market-oriented reforms have strengthened the positive impact of ICTs on culture and tourism industries' convergence, and Hypothesis 2 was supported. This result reinforces the opinion and argument that China has released a new industrial development process through market-oriented reforms.

Regarding the control variables, 'labor resources' (LABOUR) was positively (significant at the 5% level in most models) associated with CONVERG, while government consumption (GOVERN) had a significantly negative effect on CONVERG. It indicates that the factor 'labor resources', not government consumption, plays a determining role in the process of culture and tourism industries' convergence. It is worth noticing that the coefficient signs and significance of foreign trade (OPEN) among the models were

inconsistent. This may be due to the fact that culture and tourism industries are not export-oriented industries in the traditional/conventional sense, and the proportion of direct foreign investments in these two industries is also low in China.

Table 4. Panel data estimation results of moderated and threshold effects based on different methods.

Variables	Model6 Pooled OLS	Model7 Fixed Effects	Model8 DIFF GMM	Model9 SYS GMM	Model10 TRM FE
ICT	0.295 *** (0.027)	0.114 *** (0.012)	0.073 *** (0.006)	0.047 *** (0.007)	
MARKET	0.148 *** (0.034)	0.073 *** (0.016)	0.042 *** (0.012)	0.069 *** (0.012)	0.069 *** (0.016)
LABOUR	−0.039 *** (0.004)	0.014 *** (0.003)	0.006 *** (0.001)	0.002 ** (0.001)	0.013 *** (0.003)
OPEN	0.098 *** (0.016)	−0.002 (0.013)	0.014 *** (0.004)	−0.007 ** (0.004)	0.031 ** (0.014)
GOVERN	−0.390 *** (0.022)	−0.092 *** (0.016)	−0.086 *** (0.010)	−0.125 *** (0.022)	−0.089 *** (0.015)
L.CONVERG			0.478 *** (0.036)	0.664 *** (0.026)	
ICT×MARKET	0.275 * (0.147)	0.103 ** (0.045)	0.189 *** (0.020)	0.149 *** (0.018)	
ICT· I(DE ≤ 9.822)					0.112 *** (0.011)
ICT· I(DE > 9.822)					0.149 *** (0.013)
CONSTANT	0.493 *** (0.041)	0.078 *** (0.024)	0.052 *** (0.007)	0.057 *** (0.008)	0.081 *** (0.023)
F statistic	100.2 ***	231.23 ***			252.09 ***
Wald statistic			17022.74 ***	21200.19 ***	
R-squared	0.579	0.764			0.779
F test		201.38 ***			
Hausman test		27.26 ***			
AR(1)			0.008 ***	0.007 ***	
AR(2)			0.677	0.494	
Sargan test			1	1	

Note: The standard errors are presented in parentheses for the models under the estimated coefficients. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively. The values in the rows of the AR and Sargan tests stand for p-values.

4.3. Econometric Analysis of Threshold Effect

Finally, before performing threshold regression analysis, it was necessary to test whether there was a threshold effect in the econometric model, and if so, the number of thresholds should be further determined. For this purpose, the traditional approach is to determine the number of thresholds based on research experience. However, this method is highly subjective as it is not possible to perform statistical tests on significance, and this kind of threshold set is not reliable. Thus, Hansen [62] proposed a parameter estimation and hypothesis test of thresholds based on the principle of “minimizing the residual sum of squares”, which is helpful to overcome the result bias caused by subjectively setting thresholds. In the present study, the method suggested by Hansen [62] was implemented for the threshold effect test and threshold regression analysis using the Stata15 software. In terms of threshold effect testing, an interesting result was the single-threshold effect of consumer demand (DE) on the ICT–convergence relationship (see Table 5). This result shows that the single-threshold model with threshold variable DE passed the test at the 5% significance level, while the double threshold effects failed the significance test. The reported threshold estimate was 9.822, which corresponds to a 95% confidence interval between 9.795 and 9.826.

Table 5. Threshold effect test.

Threshold Model	Critical Value				
	F-Statistics	p-Value	1%	5%	10%
Single-threshold	36.92	0.023	43.263	28.905	25.058
Double-threshold	12.49	0.303	24.795	20.235	17.308

The results of threshold regression results are shown in Table 4, Column 5. In the first interval, when the value of consumer demand (DE) was lower than the threshold value 9.822, the coefficient of $ICT \cdot I(DE \leq 9.822)$ was 0.112, which is significant at the 1% level. It indicates that for every unit of increase in the internet penetration rate, the degree of culture and tourism industries' convergence increases by 0.112%. In the second interval, under the condition that the value of DE is higher than the threshold value 9.822, ICT was also positively related (significant at the 1% level) with the CONVERG. When the penetration rate of the internet increases by 1%, the convergence degree increases by 0.149%. This shows that after the consumer demand reaches a certain scale, namely the per capita consumption expenditure reaches 18,435 CNY (equivalent to 2846 USD), the driving effect of ICTs on the convergence of culture and tourism industries tends to increase by 33%. Consequently, Hypothesis 3 is supported.

The main aim of this study was to examine the influence of ICTs on the convergence of culture and tourism industries. This influence was considered and analyzed in terms of three effects, i.e., direct effect, moderated effect, and threshold effect. Capitalizing on current knowledge, our study postulated three hypotheses related to three effects. Then, analyses were conducted using static, dynamic, and threshold econometric models using provincial panel data from China, covering the period from 2004 to 2018. The above-discussed results support the research model, suggesting that ICTs exert a significant influence on the culture–tourism convergence. All three hypotheses were supported by the study's findings. The results from two-stage GMM estimates demonstrated that the convergence seems to have a significant persistence over time, from one year to another.

5. Discussion of Main Findings, Conclusions, and Implications

It is worth indicating that academic research in this specific field is rare; thus, there are only very few similar studies to which we could compare and contrast the present study's findings. Although recent studies (i.e., Shehzad et al. [53]; Seetanah [54]; Kumar and Kumar [55]; Adeola and Evans [56]; Lorente-Bayona et al. [13]; Gholipour et al. [57]) performed empirical examinations to explain ICT's influence on tourism economy from various perspectives, their focus was on ICTs' effect on international tourism arrivals or international tourism expenditure, not on the cultural and tourism industries' convergence. In other words, their findings demonstrated that ICTs have a positive influence on international tourism demand. However, they did not consider the topic of tourism–culture convergence in terms of econometric models. More importantly, multi-dimensional ICT effects were not investigated. Our study explored forces/factors underlying the convergence of culture and tourism industries, with the aim of understanding industrial convergence and, from the perspective of cultural tourism policy, how to achieve a better pairing and synergetic partnership between the two industries [75].

In terms of direct effect, the present study provides evidence for a positive relationship between ITCs and market-oriented reforms and the convergence of culture and tourism industries. The noteworthy finding is that ICTs and market-oriented reforms constitute key factors in boosting the culture–tourism convergence in China. More specifically, the study's results indicated that every increase by 1 unit in the internet penetration rate will promote the degree of cultural and tourism industries' convergence by 0.024 to 0.291 units. Likewise, when the proportion of individual and private economy increases by 1%, the convergence degree will increase by 0.061% to 0.148%. Moreover, regarding the

control variables, a positive labor–convergence relationship was found, while a negative government–convergence relationship was revealed.

As for the moderating effect, the interaction of ICTs and market-oriented reforms was positively correlated with the explanatory variable, which indicates that market-oriented reforms strengthen the driving effect of ICTs on cultural and tourism industries' convergence. In addition, there exists a single-threshold effect of consumer demand on the ICTs–convergence relationship. This shows that after the consumer demand reaches a certain level—the indicator is per capita consumption expenditure—the volume of 18,435 CNY (2846 USD), the driving effect of ICTs on the convergence of culture and tourism industries tends to increase by 33%.

It is believed that the study's findings make a significant contribution to this field of knowledge.

5.1. Theoretical Contribution

This paper contributes to the knowledge in the field of culture and tourism's industrial convergence from a theoretical perspective. First, most of the studies on industrial convergence have been conducted in the context of the manufacturing industry or productive service industry of developed countries, such as computing and communications, nanotechnology, consumer electronics, media, and functional food, to name a few (Geum et al. [59]; Sick et al. [29]). This paper constitutes one of the first studies focusing on the topic of cultural and tourism industries' convergence examined within the context of a developing country that is undergoing economic transition. This endeavor enriches our knowledge on industrial convergence.

Second, the study proposed a novel empirical assessment/estimation of the degree of industrial convergence by quantifying the convergence between the culture industry and tourism industry. Thus, it can be regarded as a supplement of measurement of inter-industry convergence in a culture tourism setting [3]. Finally, this study explored the interaction between ICTs, market-oriented reforms, and culture–tourism convergence into a comprehensive research framework in an integrated manner [9]. Furthermore, the direct and moderated effects of ICTs on the convergence of culture and tourism industries have been explored and demonstrated. The threshold effect of consumer demand on the ICTs–convergence relationship has also been investigated. The related findings extend our knowledge about and understanding of industrial convergence.

5.2. Policy Implications

It is believed that the study's findings are also beneficial to policy makers, industry practitioners, and other stakeholders involved in culture and tourism industries. First, the empirical results showed that ICTs have a significant driving effect on the convergence of the Chinese culture and tourism industry. This means that the value of smart technologies, such as the internet, big data, artificial intelligence, and mobile applications, should be recognized, appreciated, and put into implementation, providing related infrastructure and services, with an emphasis on their cross-border diffusion and innovation evolution in the segments of two industries. In this regard, it is recommended to promote the digitalization and networking of the industrial chain links, such as content production, display and communication, and interactive consumption, with the aim of attaining a creative transformation of traditional culture and the integration of online and offline communication, interaction, and engagement. Moreover, the production technology characteristics of the products and services of the two industries should be improved to optimize the allocation of production resources and achieve economies of scale.

Second, the importance and key role of institutional framework and reforms should be highlighted. It has been revealed that market-oriented reforms not only contribute to the convergence but also act as catalysts to reinforce the ICT's driving effect. On one hand, it is necessary to develop a non-state-owned economy and ensure fair competition in the markets, with the aim of overcoming information asymmetry in product transactions. The

market mechanism has a fundamental role to play in achieving this aim. On the other hand, the synergy between technological innovation and market mechanisms should be taken seriously into account. There is an imperative to accelerate the efficiency and effectiveness of supply and value chains, to reinforce the product and factor markets, improving factors mobility and resource utilization efficiency of two industries. The final outcome should be the improvement of industrial convergence.

Third, in light of the threshold role of consumer demand in the relationship between ICTs and industrial convergence, it is also important to properly meet the needs, expectations, and requirements of consumers. Therefore, the marketing communications should have the following objectives: (i) to fully understand the current characteristics and trends as well as the developments in consumer markets, (ii) to improve the creativity and digital content of cultural tourism products/services and expand the high-quality incremental supply of cultural tourism creativity, and (iii) to optimize the multi-channel supply and value chain of cross-platform display and integrated communications.

5.3. Limitations and Future Research

Despite the above-outlined contribution, this study encompasses limitations, and their acknowledgement could be beneficial for future research direction. First, the proposed econometric model encompassed six main explanatory variables and did not include other factors that might affect the convergence of culture and tourism industries. This issue could be addressed by incorporating additional variables in future research endeavors. Second, the study was based on econometric analyses, without any combination with qualitative research (mixed research methodology), which could be extended to employ semi-structured interviews, a grounded theory approach, or content analysis. The study's context is the third limitation. The research hypotheses were empirically investigated in the context of a single country. Although China is a typical developing country under the status of transition, findings may not be generalized to all developing countries whose economies are undergoing transition. Similar studies could be conducted in the context of other countries to confirm or contradict research findings. Considerable attention could be paid to empirical and comparative analyses between multiple countries to ensure more solid and robust findings. In addition, future research endeavors could further investigate the effect of different types of ICTs on industrial convergence.

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