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Original Research

Impacts of the Integrated Development of Agriculture and Tourism on Sustainable Development of Agriculture – Based on Provincial Data of China from 2008 to 2019

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Abstract

The integration of agriculture and tourism heavily depends on agricultural resources, and in turn, it can also contribute to agricultural sustainability. Based on panel data from 30 provinces in China from 2008 to 2019, the relationship between agriculture and tourism integration and sustainable agricultural development is empirically analysed using the fixed effect model, system GMM model and spatial Durbin model. Results are as following: (1) The level of sustainable agricultural development (SADL) and the level of integration of agriculture and tourism (ATL) increase steadily during the study period, presenting obvious spatial agglomeration characteristics. (2) ATL has a positive impact on SADL. So improving the integration of agriculture and tourism can contribute to promoting sustainable agricultural development. (3) SADL of the previous period has a significant influence on the level of SADL of the current period, showing strong path dependence and inertia effects. Even so, the integration of agriculture and tourism is still effective in promoting the sustainable development of agriculture. (4) The effect of ATL on SADL has a spatial spillover effect. That is, the integration of agriculture and tourism in a region can promote sustainable development of agriculture in its neighbouring provinces. Based on the above findings, this paper proposes policy recommendations for the integral development of agriculture and tourism and promotion of the sustainable development of agriculture.

Keywords: integration of agriculture and tourism, sustainable agricultural development, impact, fixed effect model, system GMM model, spatial Durbin model

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Introduction

The United Nations Food and Agriculture Organization (FAO) (2019) released a report titled "The State of Land and Water Resources in the World's Food and Agriculture Systems on the Verge of Collapse", which pointed out that the consumption and pollution of water,soil, and land have increased dramatically in the past 10 years. The traditional agricultural development mode characterized by high input, high consumption and high pollution has brought great pressure to agricultural resources and ecological environment for a long time, which restricts the sustainable development of agriculture [1]. It may by hard to meet 10 billion people's demand for food all over the world in 2050 [2]. Therefore, sustainable agricultural development has aroused great concern worldwide.

China is a big agricultural country which has made remarkable achievements in agriculture. The statistic shows China's total grain production increased from 430.7 million tons in 2003 to 686.53 million tons in 2022, realizing 19 consecutive years of growth [3]. Even so, the sustainable development of agriculture in China still faces serious challenges. Due to the lack of per capita resources in China, the country's per capita land occupancy and water occupancy are only 1/3 and 1/4 of the world average level, respectively [4]. In the process of agricultural production, a large amount of chemical fertilizers and pesticides is applied. In addition, there is an extensive application of agricultural machinery and petroleum fuel as well as the arbitrary discharge of livestock and poultry manure, not only causing a decline in soil quality and environmental pollution but also affecting food safety. So the central government has attached great importance to green and sustainable agricultural development. In 2017, the "No. 1 Document" of the Central Committee proposed "promoting the green production mode and enhancing sustainable agricultural development ability". The report of the 19th National Congress also noted that coordinated regional development should be implemented, the degree of coordination among various factors should be strengthened, and sustainable agricultural development ability should be improved. In 2021, the Ministry of Agriculture and Rural Affairs formulated the 14th Five-Year Plan for National Agricultural Green Development, which clearly calls for speeding up the establishment of a green, low-carbon and circular agricultural industry system, strengthening the treatment of non-point agricultural source pollution, and promoting carbon reduction and sequestration in agriculture and rural areas. Food production and consumption and the balance between supply and demand have always been regarded as important issues closely related to national economic security. Therefore, it is particularly necessary to accurately evaluate the level of sustainable agricultural development (SADL), and to explore the possible influencing factors which can promote sustainable agricultural development.

After entering the new century, to give full play to the multiple functions of agriculture and increase its output efficiency, the central government promulgated a series of policies and actions to support the integrated development of agriculture and other industries in China. As an important form of rural industry integration, the agro-tourism or leisure agriculture industry has expanded in recent years. From 2010 to 2019, the number of registered industrial and commercial enterprises related to leisure agriculture increased from 26,000 to 216,000 [5]. In addition, the scale of the agro-tourism market has been expanding. In 2014, in agro-tourism, there were 1.5 billion tourists, and agro-tourism generated 360 billion Yuan in revenue; In 2019, in agro-tourism, there were 3.2 billion tourists, and agro-tourism generated more than 850 billion Yuan in revenue, with both figures doubling in growth [6]. In 2019, the total number of visitors in agro-tourism accounted for 53.28% of the total number of visitors to the domestic tourism industry, and its operating revenue accounted for 14.83% of the total operating revenue of the domestic tourism industry in China [7]. The agriculture and tourism integration promotes the flow of human resources, capital and information to rural areas, resulting in increased investment in rural infrastructure construction and contributing to improving the rural living environment. Data of 1,000 key rural tourism villages in China shows that in the first quarter of 2022, the average contribution of rural tourism employment was 47.1%, and other indicators of infrastructure construction were also prominent. Therefore, the high-quality development of agriculture and tourism integration provides strong support for sustainable development of agriculture and rural areas. Agro-tourism activities are deeply affected by ecological resources, of which agro-ecological factors are the most critical [8-10]. Agriculture-related tourism activities, such as harvesting local products and gathering fruits, may also affect the environment [11, 12], especially the agricultural environment. The integration of agriculture and tourism promotes the realization of agro-ecological premium, which in turn will encourage agricultural producers to adopt green and sustainable agricultural production models. However, researchers have paid little attention to the impact of agriculture and tourism integration on agricultural sustainable development.

Given the context above, the main purposes of this paper are as follows: (1) to assess the level of sustainable agricultural development (SADL) in China based on 2008-2019 data on 30 provinces; (2) to measure the level of agriculture and tourism integration (ATL) to better reveal the interaction between agriculture and tourism; (3) to demonstrate the impacts of agriculture and tourism integration on sustainable agricultural development and to further analyse its spillover effect; and (4) to propose specific policy recommendations for improving agriculture and tourism integration to promote sustainable agricultural development. The contributions of this study are as follows: First, it demonstrates the impact of the integration of agriculture and tourism on sustainable agricultural development through empirical analysis, providing a new perspective for exploring factors that contribute to agricultural sustainability. Secondly, it can expand research perspective of effects of agriculture and tourism integration while most studies concerning its economic impacts. Additionally, the relationship of agriculture and tourism integration and sustainable agricultural development can be demonstrated more scientifically by using fixed effects model, dynamic model and spatial Durbin model to illustrate the relationship of agriculture and tourism integration and sustainable agricultural development.

Literature Review

Research on Agriculture and Tourism Integration

An industry can cause changes in other industrial structures through inter-industrial linkages, providing possibilities for inter-industrial coupling development [13]. Tourism industry itself is highly comprehensive, involves many industries, and is interwoven with several industries; therefore, there is a possibility of integration between tourism and agriculture or related industries [14]. Tourism consumption creates the demand for agricultural products and promotes the production of agricultural products and food [15]. On the other hand, processes and seasonal characteristics of agricultural production affect the supply of agro-tourism. Given the close links between tourism and agriculture, the agriculture and tourism integration has been receiving more and more attention [16-18]. Based on symbiosis theory, Chen (2014) believes that the integration of tourism and agriculture is the internalization of the inter-industry division of labour and the sharing of products, markets and resources by the two industries based on market demand, economic growth and competition, thus realizing the symbiotic development process of the two industries [19]. Driven by market demand, economic growth and competition, the integrated development of agriculture and tourism is a process of realizing the internalization of inter-industry division of labour, the blurring of boundaries, the sharing of products, markets and resources, and the symbiotic development [20].

Effects of agriculture and tourism integration have also received lots of attention. In terms of its economic effect, scholars believe that establishing effective links between agriculture and tourism can create new market space and consumer demand, as well as promote high-quality development of tourism and agriculture [10, 21]. Although agricultural products needed by tourism only account for a part of the total agricultural products, tourism plays an important role in ensuring the quality and safety of agricultural products and promoting economic development [22]. At the same time, the integrated development of agriculture and tourism is conducive to solving some local problems, such as the shortage of labour in the tourism industry and the lack of market demand for agricultural products [23, 24]. However, there may also be conflicts of interest between local residents and policy-makers [25]. Moreover, many scholars have conducted empirical tests on the impact of agriculture and tourism integration on rural and regional economic growth [26, 27]. In terms of its social effects, scholars believe that the development of agro-tourism can provide economic incentives and stability for farmers and improve the quality of life of rural populations in mountainous areas to meet the challenges of population migration and economic changes [28-30]. Additionally, this development is conducive to strengthening urban-rural linkages and can contribute to the preservation of natural or cultural heritage.

Research on Sustainable Agricultural Development

The concept of sustainable development (SD) has been evolving since it was first proposed at the Paris Biosphere Conference in 1968 [31]. In 1972, the United Nations held the first global conference on humans and the environment in Stockholm, the capital of Sweden. The Declaration on the Human Environment adopted by the conference became an important milestone in seeking harmony between humans and nature, keeping the environment clean and maintaining ecological balance. In 1981, Brown Lester, an American agricultural scientist, systematically elaborated the concept of sustainable agricultural development in his book "Building a Sustainable Society", which laid the foundation for sustainable agricultural development theory. In 1985, the state legislature in California passed the "sustainable agricultural education law", aiming to re-choose the path of agricultural development and to comprehensively solve the major problems of population, resources, the environment, development and food facing humankind [32]. In 1988, the Food and Agriculture Organization defined sustainable agriculture in a systematic and comprehensive way. In 1991, the Tanpa International Conference proposed three strategic objectives of sustainable agricultural development: (1) to actively increase food production, not only considering the basic principles of self-reliance and self-sufficiency but also considering appropriate adjustments and reserves ,a stable food supply, to solve the problem of food for poor people and ensure the safety of food; (2) to promote the comprehensive development of rural areas, carry out a variety of operations, expand employment opportunities for rural labour, increase farmers' income, and especially to eliminate rural poverty; and (3) to protect natural resources and create a good ecological environment to benefit the long-term interests of future generations [33].

There are many approaches to evaluating sustainable development, including the dominance-based rough set approach, the ecological footprint, the driver-pressure-state-impact-response (DPSIR) model, the indicator importance method, and the multi-criteria decision analysis (MCDA) approach [33-35]. Similarly, scholars have combined different methods to measure the level of sustainable development. To evaluate sustainable agricultural development, the entropy method, the standardized Euclidean distance method [36], is commonly used by scholars.

In recent decades, many studies have focused on constructing index systems to evaluate the performance of sustainable development [37-40]. Based on the strategic objectives of sustainable agricultural development, scholars have selected indicators to measure the level of sustainable agricultural development. Due to the differences in the focus of attention and research areas, the evaluation index systems selected by researchers have been different. For example, Sabiha et al. (2022) believed that regional sustainable agricultural development indicators should be discussed from the perspectives of the agricultural development level, development efficiency, development potential and comprehensive development ability [41]. Fu et al. (2022) evaluated the sustainable development of agriculture from the perspectives of agricultural resource endowment, agricultural production, agricultural science and technology level, ecological benefits, economic benefits and social benefits [42].

Materials and Methods

Theoretical Analysis

Influence Mechanism of the Integration of Agriculture and Tourism on Sustainable Agricultural Development

Based on existing studies, influence mechanism of agriculture and tourism integration on sustainable agricultural development can be concluded from the following three aspects, including technological progress, factor allocation, and agricultural industrial structure, as shown in Fig. 1.

On the one hand, the integration of agriculture and tourism promotes progress in agricultural technology. The integration and evolution of agriculture and tourism promote the formation of spatial agglomeration of business units, and promote the flow of talents and technological interaction [43]. At the same time, the advanced technology and management experience of tourism enterprises will spill their knowledge, technology and management skills to related or cooperative agricultural operation subjects, so that the technical level of agricultural production and operation can be improved [20]. In addition, when integrating agricultural resources and expanding the "tourism" function of agricultural products and production activities, such as pastoral agriculture, folk customs, leisure and vacation, science popularization and education, agricultural management subjects will also take the initiative to introduce advanced agricultural technology and equipment and management mode, which plays an important role in improving agricultural technology.

On the other hand, the integration of agriculture and tourism promotes optimal resource allocation. Under the traditional agricultural management mode, the allocation framework of agricultural factors is mainly reflected in the level of limited capital, abundant land and primary labour resources, which makes the allocation efficiency of agricultural production factors relatively low [44]. In the process of agricultural and tourism integration, the capital, technology, talents, information and management elements of the two industries realize market-oriented flow and full interaction, thus promoting the optimal allocation of various production factors at a higher level, and effectively improving the allocation efficiency of agricultural factors [16]. The new business forms and models generated by the agriculture and tourism integration provide lots of non-agricultural jobs and entrepreneurial chances for the rural labour force. And it can promote the appropriate scale and intensive management of agricultural land resources, and then release the appropriate scale economy effect with lower cost and better efficiency [26].

Additionally, the integration of agriculture and tourism promotes the optimization and upgrading of agricultural industrial structure [2]. It has enriched the connotation and extension of the development of rural tourism, and created a larger number of rural tourism products or service formats with rich content [45]. For example, in practice, a variety of new business formats have appeared, such as national agricultural park, leisure farm, rural camp, rural museum, citizen agricultural park, rural homestay and so on. Driven by the demand, the adjustment of the allocation direction and field of agricultural production factors leads to the optimization of agricultural production structure, quality structure and variety structure. This adjustment of agricultural supply structure, which is close to the changes in market demand, helps to improve the efficiency of agricultural production and management [43]. The agriculture and tourism integration has promoted the development of agricultural versatility and satisfied the diversified demands of consumers for agricultural and tourism products or services, and led to the improvement of agricultural technical efficiency and technological progress.

Spillover Effect of the Integration of Agriculture and Tourism on Sustainable Agricultural Development

The cross-regional operation is an important feature of tourism industry when compared with other industry because tourism flow has strong network diffusion.

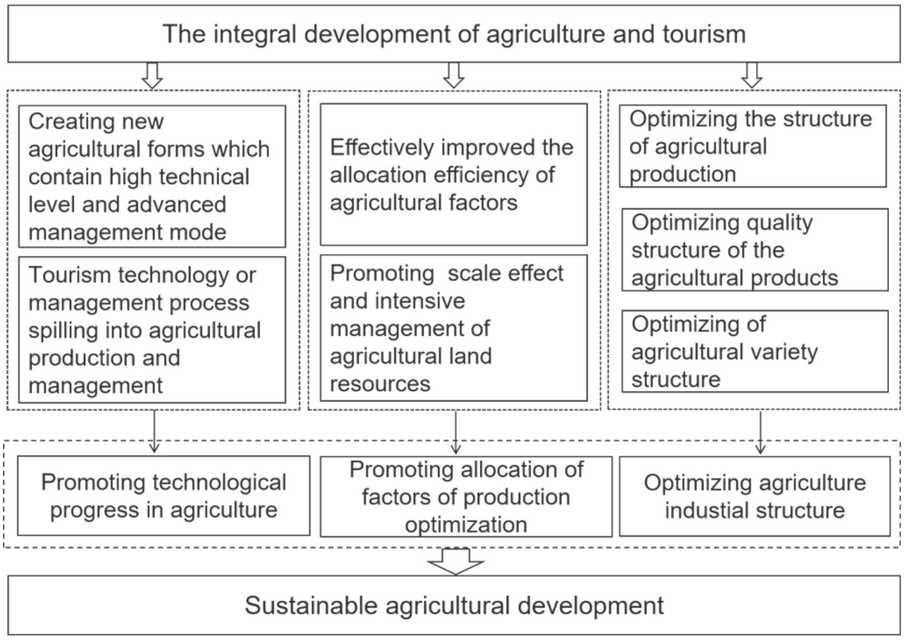

Fig. 1. Influence mechanism of the integration of agriculture and tourism on sustainable development of agriculture.

Due to the vast territory of China and the apparent difference in crop production cycles, cross-regional operation of agro-tourism becomes a possibility. At the same time, cross-regional operation is also helpful to expand the market scale, further deepen the vertical division of labour of the whole agricultural system, and contribute to the realization of scale economies [45]. Besides, the seasonal nature of crop production enhances the mobility of agro-tourism tourists, thus promoting the efficiency of information and technology exchange between regions. Therefore, the integration of agriculture and tourism can influence the allocation of production factors, the structure of agricultural industries and technological progress in neighbouring regions by operating across regions, thereby changing the SADL of the entire agricultural system.

However, few empirical studies have focused on the impact of agriculture and tourism integration on sustainable agricultural development. Given the current situation in China and the above analysis, it was hypothesized that: The agriculture and tourism integration could contribute to promoting sustainable agricultural development, and this effect may have the characteristics of spatial spillover.

Model Elaboration

The Fixed Effect Model

The fixed effects model can control for individual unobservable factors that do not change over time. Therefore, it can effectively solve the error problem caused by missing variables in the model. On this basis, the linear relationship between the integration of agriculture and tourism and the sustainable development of agriculture was tested by the individual fixed effect panel model. The fixed effect model is set as the benchmarking model, and it is written as follows:

$$SADL_{it} = \alpha_0 + \beta ATL_{it} + \sum_{k=1}^{n} \lambda_k C_{it,k} + \mu_i + \xi_{it} \quad (1)$$

In the above formula, $SADL_{it}$ and ATL_{it} represent the explained variable and the core explanatory variable, respectively. The subscripts *i* and *t* denote the province and year, respectively. μ_i represents the individual fixed effect of each province that does not change with time. ε_{it} represents the random error term, which follows a normal distribution. $C_{it,k}$ is a set of control variables.

The Dynamic Panel Model

The sustainable development of agriculture means that the agricultural economy realizes ecologically friendly development and contributes to the protection of the ecological environment of all elements of mountains, forests, rivers, lakes and grasses. Based on the concept of sustainable agricultural development, the rural ecological environment will be greatly improved. Agro-tourism is an industrial carrier based on rural natural landscapes and cultural landscapes [21]. Thus, sustainable agricultural development could also contribute to the integrated development of agriculture and tourism. Therefore, the sustainable development of agriculture and the integration of agriculture and tourism have an endogeneity problem of mutual causation. To reveal the dynamic change process of sustainable agricultural development more objectively and to avoid endogeneity problems, the SADL with a lag of one period ($SADL_{i,t-1}$) is included on the basis of Formula (1), and the dynamic panel model is set as follows:

$$SADL_{it} = \alpha_0 + \rho SADL_{i,t-1} + \beta ATL_{it} + \sum_{k=1}^{n} \lambda_k C_{it,k} + \mu_i + \xi_{it} \quad (2)$$

The explanations of the variables other than $SADL_{i,t-1}$ are the same as those in Formula (1).

The Spatial Durbin Model

Global *Moran's I*

According to the first law of geography, the regional economy is an open system. There are various kinds of material and immaterial connections between regions, which lead to mutual influence and interdependence among regions [46]. The economic growth of a region no longer only depends on its initial conditions. It also depends closely on the economic activities of neighbouring regions [47]. Therefore, an analysis of the impact of agriculture and tourism integration on sustainable agricultural development without considering spatial factors may lead to biased results and even overestimate the impact. Whether spatial effects exist among economic variables can be examined by the global *Moran's I*, which is defined as follows:

$$Moran' I_{global} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{m} W_{ij}} \quad (3)$$

In the above formula, Y_i and Y_j represent the observed value of the level of agriculture and tourism integration (*ATL*) or sustainable agricultural development level (*SADL*) in regions *i* and *j*, respectively. W_{ij} is the spatial weight matrix. The geographical distance spatial weight matrix is used in this paper, which is usually calculated by the reciprocal of the square of the actual geographical distance between the two regions, that is $W_{ij} = 1/d_{ij}^2 (i \neq j)$. d_{ij} is represented by the direct distance between the two provincial capitals.

The Spatial Durbin Model Specification

Spatial models can be divided into the spatial lag model (SLM) and the spatial error model (SEM) [48]. If both the explained variable and explanatory variable are spatially dependent, the spatial Durbin model (SDM) should be constructed. In view of the spatial dependence of the explained variable *SADL* and explanatory variable *ATL*, the following spatial Durbin model is constructed:

$$SADL_{it} = \alpha_0 + \rho WSADL_{it} + \beta ATL_{it} + \gamma C_{it,k} + \theta WATL_{it} + \xi W \sum_{k=1}^{n} C_{it,k} + \mu_i + \upsilon_t + \varepsilon_{it} \quad (4)$$

In the above formula, $SADL_{it}$ and ATL_{it} represent the explained variable and the core explanatory variable, respectively. ρ is the spatial correlation coefficient, and W is the spatial weight matrix. β, γ, θ and ξ are the parameters to be estimated, u_i is the spatial effect, v_t is the time effect, and ε_{it} is the spatial error term.

The Entropy Weight TOPSIS Method

There are many multi-criteria decision-making (MCDM) methods, of which the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method is an effective method for ranking and selecting a number of possible alternatives [49]. For MCDM, the weight of the index is crucial for measuring the importance of the index. The weight is usually divided into two types. One is determined by the knowledge and experience of experts or individuals and is named the subjective weight; the other is based on statistical properties and measurement data and is named the objective weight, which can effectively eliminate the influence of subjective factors, such as the entropy weight (EW) method. In this paper, the entropy weight was defined and constructed based on the information entropy and data. Therefore, the TOPSIS method with the EW is used to determine the level of the evaluation object.

(1) Standardize the evaluation matrix:

If the evaluation index is a positive index:

$$y_{ij} = \frac{x_{ij} - \min x_j}{\max x_j - \min x_j} \quad (5)$$

If the evaluation index is a negative index:

$$y_{ij} = \frac{x_{\max} - x_j}{\max x_j - \min x_j} \quad (6)$$

(2) Calculate the information entropy:

$$H_j = -k \sum_{i=1}^{m} p_{ij} Inp_{ij} \text{ (Where } p_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}}, k = \frac{1}{Inm}) \quad (7)$$

Define the weight of the *jth* indicator as:

$$W_j = \frac{1 - H_j}{\sum_{j=1}^{n}(1 - H_j)} \text{ (Where } W_j \in [0,1], \text{ and } \sum_{j=1}^{n} W_j = 1) \quad (8)$$

(3) Construct the weight normalization matrix:

$$R = (r_{ij})_{m \times n},\ r_{ij} = W_j \cdot y_{ij}\ (i = 1, 2, \ldots, n; j = 1, 2, \ldots, m) \quad (9)$$

(4) Determine the positive and negative ideal solution S_j^+ and S_j^-, respectively:

$$S_J^+ = \max(r_{1j}, r_{2j}, \cdots, r_{nj}) \tag{10}$$

$$S_J^- = \min(r_{1j}, r_{2j}, \cdots, r_{nj}) \tag{11}$$

(5) Calculate the Euclidean distance between each scheme:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (S_i^+ - r_{ij})^2} \tag{12}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (S_i^- - r_{ij})^2} \tag{13}$$

(6) Calculate the degree of closeness to the comprehensive level of sustainable agricultural development LX_i:

$$LX_i = d_i^- \big/ (d_i^- + d_i^+) \tag{14}$$

In the above formula, $LX_i \in (0,1)$. The closer the value of LX_i is to 1, the better the evaluation object is, that is, the higher level of evaluation object is, and vice versa.

The Coupling Coordination Degree Model

In an open industrial system, different industries may lead to industrial coupling due to resource complementarity, which will make the industrial system evolve to an advanced and orderly state [50]. Chen and Cheng (2018) believe that the concepts of industrial coupling and industrial convergence are different. Industrial coupling reflects the dynamic process of gradual integration between industries, while industrial convergence reflects the internal interaction and correlation between industries [51]. However, the two have the same effect, and the deep-level theories are similar. The literature review found that many scholars use a coupling coordination model to evaluate the degree of industrial integration [52-54]. In general, the coupling evaluation method has good applicability, and the coupling coordination model is also used to construct the measurement model of the level of integration of agriculture and tourism.

The construction process of the coupling cooperation degree model of the agriculture and tourism is as follows:

(1) The TOPSIS with EW method is used to measure the development level of agriculture and the tourism industry. $A(x)$ represents the development level of agriculture, and $T(y)$ represents the development level of the tourism industry.

(2) The coupling coordination degree model of agriculture and the tourism industry is established as follows:

$$C = 2\sqrt{\frac{A(x) \cdot T(y)}{(A(x) + T(y))^2}} \tag{15}$$

$$D = \beta \cdot A(x) + \gamma \cdot T(y) \tag{16}$$

$$ATL = U = \sqrt{C \cdot D} \tag{17}$$

In Formula (15), C is the coupling degree, and $C \in [0,1]$. The greater the value of C is, the more ideal the degree of integration of the two industries is, and vice versa. The coupling degree C only reflects the interaction state of agriculture and the tourism industry and cannot accurately reflect the actual integration and development level of the two industries. In order to avoid the biased result of low level of development but high degree of coupling between the two subsystems, the coupling coordination degree U is used to represent the level of agriculture and tourism integration (*ATL*). In general, the greater the value of the coupling coordination degree U is, the higher the degree of integration between industries [52]. In Formula 16, β and γ are undetermined coefficients, and D is the comprehensive coordination index of agriculture and the tourism industry. In view of the interactive relationship between agriculture and the tourism industry system in the process of integration, this paper follows the views of Wang (2018), making $\beta = \gamma = 0.5$ [54].

Measurement of Variable

Explained Variable

The level of sustainable agricultural development ($SADL_{it}$) is the explained variable. Based on the connotation of agricultural sustainable development and previous studies [41, 42], the comprehensive level evaluation index system for sustainable agricultural development is constructed from the following aspects:

The sustainable development of agricultural economy refers to maintaining a relatively high output level or a certain output growth rate in a long period of time to meet the material life needs of the growing social population. Its most basic requirement is to ensure the basic food needs for human life, which is the core of sustainable development. In this study, 5 indicators are selected to evaluate the level of sustainable development of the agricultural economy.

The sustainable development of agricultural resources and environment refers to the sustainable use of natural resources and good agro-ecological environment on which agricultural production and development depend. The sustainability of resources and environment is also needed to improve the living standard and quality of human beings, which is the fundamental guarantee to achieve sustainable agricultural development. In this study, 5 indicators are selected to evaluate the level of sustainable development of resources and another 3 indicators for evaluating the agricultural and rural environment.

The sustainable development of rural social refers to the benign development of rural social environment which is needed to ensure the sustainable development of agricultural production, economy and ecology. This includes the reasonable control of population, the improvement of farmers' family income, the fair distribution of social wealth, etc., which are the ultimate goals of sustainable agricultural development.In this study, 7 indicators are selected to evaluate the level of sustainable development of rural society. All the indicators are shown in Table 1.

Explanatory Variable

The level of sustainable agricultural development (ATL_{it}) is the core explanatory variable. The entropy weight TOPSIS method is used to evaluate the development level of agriculture and the tourism industry. Then the integration level of agriculture and tourism is calculated by the coupling coordination degree model. First of all, appropriate indicators should be selected to evaluate the development level of agriculture and tourism respectively. As discussed in the literature review, the integrated development of agriculture and tourism refers to the process of forming a distinctive brand of agriculture and tourism based on a certain theme or the regional characteristics of agricultural resources in combination with the agricultural resource endowment [20]. Based on research of Yang et al. (2022) [55], Characteristic agricultural tourism brands such as characteristic agricultural tourism towns, key tourism villages, leisure agriculture and rural tourism demonstration counties that have formed around agricultural geographical indication products can best reflect the characteristics and elements of the integrated development of agriculture and tourism. Therefore, 5 indicators are selected to measure the development level of characteristic agriculture, and another 5 indicators are selected to assess the development level of rural tourism. All the indictors are shown in Table 2.

Control Variables

According to the current status of agricultural development in China, control variables selected in this paper are as follows: (1) Fiscal support for agriculture (Fsa) can be measured as the ratio of local expenditures on agriculture, forestry and water affairs to local

Table 1. Indicators to evaluate the level of sustainable agricultural development.

First grade indicator	Second grade indicator	Unit	Attribute	Data sources
Sustainable development of agricultural economy	Per capita agricultural output value	CNY/person	Positive	China Rural Statistical Yearbook
	Investment in agricultural fixed assets	1 Billion CNY	Positive	
	Agricultural output value per unit sown area	CNY/hm^2	Positive	
	Per capita net income for rural residents	CNY /Year	Positive	
	Effective irrigation rate	%	Positive	
Sustainable development of resources	Arable land per capita	hm^2/ person	Positive	
	Total power of arable land machinery per unit	kW/hm^2	Positive	
	Forest coverage rate	%	Positive	China Environmental Statistical Yearbook
	Per capita water resources in rural areas	1 billion m^3/person	Positive	
	Area under control of soil erosion	1000hm^2	Positive	
Sustainable development of environment	Intensity of pesticide use	kg/hm^2	Negative	China Rural Statistical Yearbook
	Fertilizer application intensity	kg/hm^2	Negative	
	Natural disaster rate	%	Negative	
Sustainable development of rural society	Proportion of agricultural population	%	Positive	China Social Statistical Yearbook
	Engel coefficient of rural citizens	%	Negative	
	Regional population density	%	Negative	
	Per capita housing area of rural residents	m^2/person	Positive	China Rural Statistical Yearbook
	Per capita consumption level of rural citizens	CNY /Year	Positive	
	Average life expectancy of rural population	Year	Positive	China Health Statistical Yearbook
	Number of rural medical personnel	Person	Positive	

Table 2. Indicators for measuring the integration level of agriculture and tourism.

Elements	Indicators	Attribute	Data sources
Characteristic agriculture	Number of geographical indications of agricultural products	Positive	Ministry of Agriculture and Rural Affairs
	Number of brands in the "One Brand in One Village "Project	Positive	Ministry of Agriculture and Rural Affairs
	Output value of characteristic agricultural products (1billion CNY)	Positive	Ministry of Agriculture and Rural Affairs
	Number of advantaged agricultural products with local characteristics	Positive	Ministry of Agriculture and Rural Affairs
	Area of fruit orchards (Thousand hectares)	Positive	China Rural Statistical Yearbook
Rural tourism	Number of key villages and towns for rural tourism in China	Positive	Ministry of Culture and Tourism
	Number of famous towns and villages of national characteristic landscape tourism	Positive	Ministry of Housing and Urban-Rural Development
	Number of A-level scenic spots	Positive	China Tourism Year Book
	Number of demonstration counties for leisure agriculture and rural tourism	Positive	Ministry of Culture and Tourism
	Revenue of rural tourism and leisure agriculture	Positive	Ministry of Culture and Tourism

expenditures in the general budget. The development of China's agriculture largely depends on the national fiscal policy of benefiting agriculture and strengthening agriculture. The greater the fiscal support for agriculture, the more beneficial it will be to optimize the external agricultural environment, and thus have an important impact on the sustainable development of agriculture [56]. (2) Level of industrialization (Ins). Relevant studies show that there is an close correlation between the level of industrialization and sustainable agricultural development, so the proportion of added value of the secondary industry in the total output value is selected to measure level of industrialization [57]. (3) Agriculture industrial structure (Ais). The industrial structure of agriculture is the composing proportion of the each industry in agriculture, which is measured by the proportion of the added value of planting industry in the added value of agriculture, forestry, animal husbandry and fishery. Generally speaking, the higher the proportion of planting industry, the higher the degree of agricultural production agglomeration, this may positively affect the sustainable development of agriculture [2]. (4) Human capital (Huc) is reflected by proportion of college students per 100,000 population in rural areas. Generally speaking, the higher the education levels of agricultural producers have the more beneficial to the mastering of production skills and rational use of chemical factors. (5) The urbanization rate (Urb). This study chooses the traditional urbanization rate as the evaluation method of urbanization level, namely, the proportion of urban population in the permanent population of each province. In China, the rapid advancement of urbanization has promoted the transfer of rural labour force to urban areas, resulting in the aging and feminization of agricultural production, and the unbalanced flow of agricultural production factors. In addition, the current agricultural production mode is in the transition period from extensive to intensive. In order to increase production, farmers generally increase inputs such as pesticides and fertilizers in agricultural production. The increase of agricultural carbon emissions has restricted the improvement of sustainable agricultural development. (6) The level of regional economic development (InperGDP) is reflected by the logarithm of per capita GDP. The GDP of constant value based on 2008 is used to measure the economic development level of each region. All relevant variables and their descriptions are presented in Table 3.

Data Sources and Research Areas

The empirical analysis is based on 2008-2019 data of 30 provinces in China (excluding Hong Kong, Macao, Taiwan and Tibet Autonomous Region because data is missing in these areas). The data sources are shown in Table 1, Table 2 and Table 3. In addition, the National Bureau of Statistics, the National Tourism Administration, the Ministry of Agriculture and official provincial websites are used as supplementary sources of data. All data measured in monetary units are deflated based on constant price levels in 2008. R and GeoDa software were used for quantitative analysis and model estimation.

Descriptive Statistics

Using the dataset and the information entropy weight TOPSIS model, the *SADL* of each province from 2008 to 2019 is calculated. The level of agriculture

Table 3. Relevant variables and descriptions.

Variable	Variable name	Unit	Calculation method	Data source
Explained variable	Level of sustainable development (*SADL*)	–	Calculated by entropy weight TOPSIS method	Shown in Table 1.
Core explanatory variable	Integration level of agriculture and tourism (*ADL*)	–	Calculated by coupling coordination degree model	Shown in Table 2.
Control variable	Fiscal support for agriculture (*Fsa*)	%	Represented by the proportion of local expenditures on agriculture, forestry and water affairs to local expenditures in the general budget	China Rural Statistical Yearbook
	Agriculture industrial structure (*Ais*)	%	Represented by the proportion of the added value of planting industry in the added value of agriculture, forestry, animal husbandry and fishery	
	Human capital (*Huc*)	%	Represented by the proportion of college students per 100,000 population in rural areas	China Statistical Yearbook
	Level of industrialization (*Ins*)	%	Represented by the proportion of added value of the secondary industry in the total output value	
	The urbanization rate (*Urb*)	%	Represented by the proportion of urban population in the permanent population of each province	
	Level of regional economic development (*InperGDP*)	–	Represented by the logarithm of per capita GDP	

and tourism integration (*ATL*) is measured by the coupling coordination degree. The basic average levels of *SADL* and *ATL* in the study area from 2008-2019 are shown in Fig. 2 and Fig. 3. Overall, the *SADL* and *ATL* of the 30 provinces continuously improved over time, with average annual growth rates of 3.823% and 2.144%, respectively. In recent years, the central government of China has attached great importance to the sustainable development of agriculture; therefore, *SADL* has improved greatly. The mean level of *SADL* in eastern provinces is higher than that in central and western provinces. The eastern region has a more developed economy and invests more in the development of agricultural ecology; thus, the *SADL* in the region is higher than that in the other regions. The integration of agriculture and tourism is beneficial for promoting rural economic growth and rural revitalization. Thus, the government has issued a series of policies to support the integrated development of agriculture and tourism. The descriptive statistics of the variables in the specification model are displayed in Table 4.

Results and Discussion

Results of the Benchmark Model and Analysis

Results of the Fixed Effect Model

The commonly used fitting models for panel data include the pooled ordinary least squares (POLS), fixed effect model (FE) and random effect model (RE) method. The specific model needs to be further tested. Therefore, the F test and *Hausman* test are conducted in this paper. According to results of the F test, the fixed effect model is better than the POLS method, and the

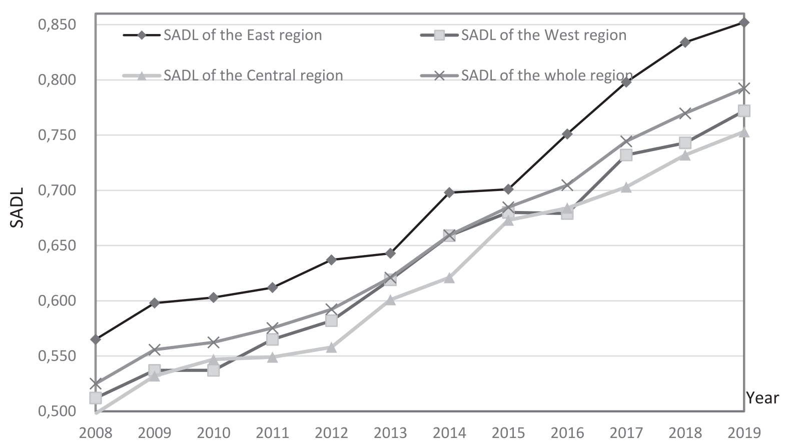

Fig. 2. Average levels of SADL in China from 2008 to 2019.

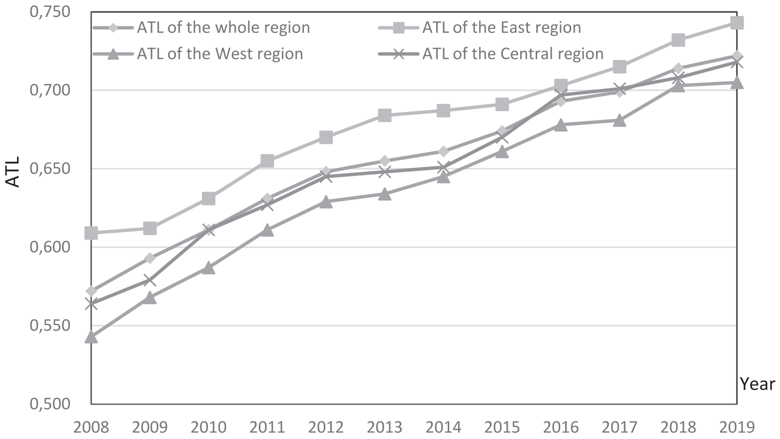

Fig. 3. Average levels of ATL in China from 2008 to 2019.

Table 4. Description of variables in the specification model.

Variables	Observations	Mean	Median	Std.Dev.	Max	Min
*SADL*it	360	0.665	0.692	0.115	0.824	0.468
*ATL*it	360	0.661	0.689	0.121	0.853	0.376
Fsait	360	0.109	0.101	0.065	0.179	0.084
Aisit	360	0.516	0.515	0.083	0.865	0.303
*Huc*it	360	0.028	0.025	0.008	0.064	0.010
Insit	360	0.404	0.398	0.075	0.792	0.254
*Urb*it	360	0.554	0.542	0.139	0.895	0.211
*InperGDP*it	360	1.092	1.116	0.505	2.316	-0.143

modified *Hausman* test results show that the fixed effect model is better than the random effect model. Therefore, the fixed effect model is set as the benchmarking regression model in this paper. The estimated results of the models are shown in Table 5.

As shown in Table 5, the estimated coefficient of the integration of agriculture and tourism is 0.612 ($P<0.05$), indicating that the integration of agriculture and tourism can positively affect the sustainable agricultural development. The integrated development of agriculture and tourism always adheres to the "agriculture-oriented" principle and the ecological development concept, taking agriculture and rural areas as the basic support. The process of integration promotes the intensification, clean production and management of agriculture. Moreover, with the unique natural landscape and cultural landscape resources in rural areas, rural tourism or agro-tourism develop rapidly. In the process of the deep integration of agriculture and tourism, based on the perspective of the whole industrial chain concept of the integration of agriculture and tourism with other industry, a new business form is derived from the deep integration of elements and resources originally belonging to the agricultural field and adjacent industries. For example, agriculture and tourism integration with the sports industry, agriculture and tourism integration with the health care industry, agriculture and tourism integration with the education industry and other models can release the correlation effect of tourism and agriculture, thus promoting the transformation of traditional agriculture into ecological agriculture, modern agriculture and intensive agriculture and accelerating the effective integration and rational allocation of inter-industry resources. This will inject new momentum into rural development, expand agricultural functions, form a new economic growth model, bring new value growth points, and ultimately promote sustainable agricultural development.

Endogeneity and the Solution

To alleviate the endogeneity problem, we used the generalized method of moments (GMM) to estimate the dynamic panel model. The GMM can be divided into difference generalized method of moments estimation (difference GMM) and system generalized method of moments estimation (system GMM). Compared with the difference GMM estimation method, the system GMM estimation method has fewer bias problems and improved efficiency under the condition of finite

Table 5. Estimated results of the whole research areas.

Variable	FE	RE	POLS	SYS-GMM	DIF-GMM
ATL_{it}	0.612** (2.969)	0.206* (2.418)	0.337* (2.315)	0.408** (2.984)	0.324** (3.118)
Fsa_{it}	1.311* (2.165)	1.234** (3.136)	1.128** (2.921)	1.212* (2.419)	1.168** (3.136)
Ins_{it}	0.021** (0.418)	0.017** (3.042)	0.014** (3.139)	0.014** (3.087)	0.020 (0.418)
Huc_{it}	0.148** (3.123)	0.117** (2.854)	0.094** (3.176)	0.107** (2.814)	0.148** (3.136)
$InperGDP_{it}$	0.213* (1.998)	0.206 (0.418)	0.274** (3.143)	0.311*** (4.642)	0.243*** (5.418)
Ais_{it}	0.020*** (4.418)	0.028** (3.136)	0.015* (2.418)	0.013** (3.117)	0.001* (2.089)
Urb_{it}	-0.348*** (-3.649)	-0.198* (-2.143)	-0.144** (-2.842)	-0.198** (-3.230)	-0.246* (-2.185)
$SADL_{i,t-1}$				0.521*** (4.011)	0.108*** (5.871)
AR(1)				0.000	0.001
AR(2)				0.298	0.486
Sargan				0.129	0.127
F Test	12.215***				
Hausman Test	25.435***				

Note: *, **and***represent the significance level of 10%, 5% and 1%, respectively, with T values shown in brackets.

samples. It can address weak instrumental variables and alleviate the bias problem of the results in the difference GMM estimation method, and it can also improve the robustness of model estimation. As the weight of the GMM estimation method in the two-step system relies heavily on parameter estimation and there is downward bias of the standard error, the standard error of the regression coefficient will be seriously underestimated, resulting in overly significant regression results. Therefore, this paper chooses a one-step systematic GMM estimation method for endogeneity processing. In addition, to ensure the robustness of the results, the regression results of the difference GMM estimation method are reported in Table 5.

The system GMM estimation method requires that the instrumental variables are strictly exogenous variables and that there is no first-order autocorrelation for the perturbation term and no second-order autocorrelation for the perturbation term after differencing. Therefore, it is necessary to carry out the Sargan instrumental variable validity test and Arellana-Bond sequence correlation test. According to the results of the system GMM estimation method in Table 5, the P value of the first-order sequence autocorrelation test (AR1) is less than 0.05, and that of the second-order sequence autocorrelation test (AR2) is greater than 0.1. These results indicate that there is no first-order sequence autocorrelation or second-order sequence autocorrelation of the disturbance term. The P value of Sargan's over-identification test is greater than 0.1, which indicates that the instrumental variable selection is effective and that the endogeneity problem is well eliminated. The estimation results show that the sustainable agricultural development level lagged one period has a positive impact on the sustainable agricultural development level of the current period and that this result is significant at the confidence level of 1%. These results indicate that the sustainable agricultural development of the current period is affected by that of the previous period, which can be seen as typical path dependence and inertia effects. The estimated coefficient of agriculture and tourism integration is 0.408(P<0.01), indicating that the promoting effect of agriculture and tourism integration on sustainable agricultural development is still valid after eliminating the endogeneity problem.

Robustness Tests

To ensure the robustness of the benchmarking regression results, the following methods are selected for robustness tests:

1. Using the instrumental variable method (Model 1). To solve the endogeneity problem of the model, we incorporated the lagged terms of the explained variables into the model to build a dynamic panel model; the instrumental variable method can also be used to eliminate this problem. In this paper,

agricultural and tourism integration lagged one period and lagged two periods were selected as instrumental variables for two-stage least squares (2SLS) estimation. Since the number of instrumental variables was larger than the number of endogenous variables, FE transformation was first performed in the first-stage estimation, and then, GMM estimation was performed in the second stage, which could improve the estimation efficiency of the model [53]. In the 2SLS estimation process, the validity of the instrumental variable setting needs to be tested. The results of the under identification test, weak identification test and over-recognition test all show that the two selected instrumental variables are effective and that there is no problem of weak instrumental variables and over-recognition.

2. Obtaining the robust standard error based on the self-help method (Model 2). Panel data usually assume that the disturbance terms among different individuals are independent of each other and that the same individual is not auto-correlated with the disturbance terms of the same period. Based on the consideration of heteroscedasticity and autocorrelation, the robust standard errors clustered at the provincial level are not accurate enough in small samples, but the self-help method can obtain more accurate results. Therefore, this paper replaces clustered robust standard errors with self-help standard errors. In the calculation process, the number of bootstrap iterations is set to 500.
3. Changing the sample size (Model 3). In general, municipalities directly under the central government enjoy greater national policy preferences and stronger autonomy. In this context, municipalities directly under the central government can improve the speed of decision-making in economic construction, promote urban renewal based on local conditions, develop the deeper potential of cities and activate their development potential. From the perspective of the reality of economic development, the four municipalities (Beijing, Shanghai, Tianjin, Chongqing) directly under the central government give full play to their own economic radiation and have formed three important economic growth poles: the Beijing-Tianjin-Hebei region, Yangtze River Delta and the Chengdu-Chongqing twin city economic circle. Therefore, the samples of these four municipalities were removed, and then fixed effect estimation was carried out.

Table 6. Results of robustness test.

Variable	Model 1	Model 2	Model 3
ATL	0.546*** (4.093)	0.417** (2.917)	0.696*** (3.323)
Control Variables	Control	Control	Control

Note: ** and ***represent the significance level of 5% and 1%, respectively, with T values shown in brackets

As shown in the regression results in Table 6, the relationship between the integration of agriculture and tourism and sustainable agricultural development did not change and the significance of these models did not change in all 3 models. Therefore, it can be determined that the benchmarking regression results are robust and that the conclusions are reliable.

Results of the Spatial Panel Model and Analysis

Global Spatial Autocorrelation Analysis

The Global *Moran's I* values of the level of agriculture and tourism integration (*ATL*) and the level of sustainable agricultural development (*SADL*) over the years are positive and significant at the 1% confidence level (Fig. 4), indicating that *ATL* and *SADL* both have significant spatial correlation. From the perspective of the time dimension, the mean value of the global *Moran's I* of *ATL* and *SADL* continues to increase over the years. Thus, it can be seen that the spatial agglomeration trend of agriculture and tourism integration and sustainable agricultural development is constantly strengthening.

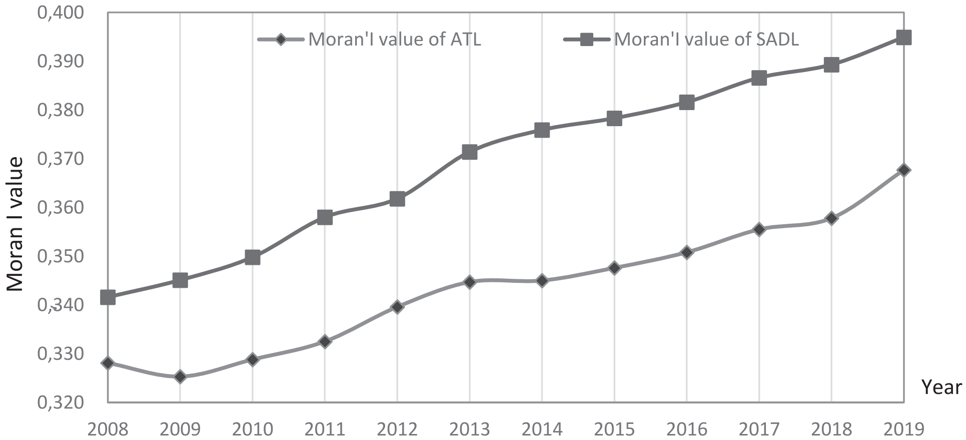

Fig. 4. Average Global Moran' I values of ATL and ASDL from 2008 to 2019.

Identification of Spatial Models

The spatial autocorrelation test above shows that both SADL and ATL have strong spatial correlation characteristics. Thus, spatial factors should be taken into consideration when studying the relationship between them. We follow the two-step method proposed by Elorst (2003) to determine the appropriate spatial econometric model [58]. The first step is to judge whether a non-spatial panel model is applicable. The *LM*, *robust LM* and *robust LM-error* statistics were all significant, indicating that the null hypothesis that SPM and SEM do not exist can be rejected. The *LM* statistics of SEM are not significant, meaning that SLM is superior to SEM. In the second step, the *Wald* and *LR statistics* are combined to determine which spatial econometric model to use. The results show that both the Wald and *LR* statistics are significant, indicating that SDM cannot be simplified into SLM and that it is more reasonable to use SDM model to fit the sample data. The above test results of the econometric model are shown in Table 7. Combined with the results of the *Hausman* test, the statistical value of the *Hausman* test is 25.546 (P<0.000), indicating that the fixed effect model is more suitable.

Results of Spatial Models

According to the above estimation, the spatial Durbin panel with a two-way fixed effects model can be regarded as the optimal model of this study. The estimation results are shown in Table 8. For convenience of comparison, the estimation results of the spatial Durbin panel with time and space fixed effects are also listed in Table 9.

As presented in Table 8, the estimation results show that in the spatial Durbin model, the coefficient of ATL is 0.475. That is, for every unit increase in ATL, SADL will rise by 0.475 units. However, the coefficient of ATL is 0.612 in the fixed effect panel model. Therefore, we see that the effect of ATL on SADL in the fixed effect panel model is greater than that in the spatial panel model. This reflects that the fixed effect panel model may overestimate the positive effect of ATL when ignoring spatial factors. In addition, the spillover coefficient ρ is positive and significant at the 1% level, indicating that the SADL of a region has a positive spatial spillover effect on the SADL of its neighbouring regions.

Due to the spatial spillover effect, the coefficient of ATL can no longer be interpreted as the marginal effect on SADL alone. Therefore, the estimation results need to be decomposed to better reveal the direct (local) and

Table 7. Test results of spatial models.

Spatial correlation test results	*LM-lag*	*Robust LM-lag*	*LM-error*	*Robust LM-error*
	8.464^{***}	15.323^{***}	0.612	6.132^{**}
Wald statistic and LR statistic test results	*Wald-spatial lag*	*LR-spatial lag*	*Wald-spatial error*	*LR-spatial error*
	23.785^{***}	11.094^{***}	14.091^{***}	5.676^{**}

Note: ** and ***represent the significance level of 5% and 1%, respectively.

Table 8. Estimation results of spatial Durbin model.

Variable	Two-ways fixed	Time-fixed	Space-fixed
ATL_{it}	0.475^{**} (2.997)	0.172^{*} (2.315)	0.237^{**} (3.352)
Fsa_{it}	1.245^{**} (3.186)	1.128 (1.191)	1.170 (0.966)
Ins_{it}	0.026^{**} (1.969)	0.025 (0.139)	0.043^{*} (2.118)
Huc_{it}	0.135^{**} (3.326)	0.173^{**} (3.176)	0.209^{**} (2.765)
$InperGDP_{it}$	0.201^{***} (4.180)	0.274^{**} (3.143)	0.243^{*}(2.195)
Ais_{it}	0.014^{*} (2.496)	0.005 (0.989)	-0.001^{*} (-2.383)
Urb_{it}	-0.314^{***} (-3.379)	-0.165^{**} (-2.760)	-0.209^{**} (-2.894)
$W{*}ATL_{it}$	0.175^{**} (3.097)	0.081^{*} (2.035)	0.137^{**} (2.954)
Adj R^2	0.920	0.763	0.587
ρ	0.321^{***} (3.841)	0.206^{***} (3.635)	0.215^{**} (2.819)
Log L	193.143	155.043	119.758

Note: *, ** and ***represent the significance level of 10%, 5% and 1%, respectively, with T values shown in brackets. This table does not report the spatial interaction coefficient of control variables in the SDM model.

indirect (spatial spillover) effects of ATL on SADL. The decomposition results of the spatial effects are shown in Table 9. From the perspective of the direct effects, the direct (local) effect of ATL on SADL is 0.471 ($P<0.05$). This result indicates that the integration level of agriculture and tourism increases by 1% in a region, the sustainable development level of agriculture will increase by 0.471% in the region. From the perspective of the indirect (spillover) effect, the indirect effect of ATL on SADL is 0.245($P<0.05$). This result indicates that a 1 unit increase in the ATL in a region can contribute to a 0.245 unit increase in the SADL in its neighbouring regions.

With the further development of the improvement in agro-tourism infrastructure, the regions that are the first to break through the difficulties and bottlenecks of transformation due to the implementation of differentiated management modes will be the first to be favoured by consumers and will attract more consumers from their own regions and neighbouring regions in the short term. On this basis, a new consumption growth pole and demonstration effect will be formed. On the other hand, under the pressure of competition, neighbouring regions will also make use of local tourism resources to create unique business models. Therefore, the integrated development of agriculture and tourism in a region can not only directly drive the development of rural industries in this region but also drive neighbouring regions to catch up and innovate. In the trend of globalization, regional linkages are becoming increasingly obvious, and the collaborative governance ability among cities is constantly rising, which provides the economic foundation and institutional foundation for the spatial spillover effect of the integration of agriculture and tourism. The integrated development of agriculture and tourism leads to the upgrading of the agricultural structure and the transformation of the economic development mode in a region. This will lead to changes in the labour distribution structure, agricultural industry layout, capital element flow and land transfer mode in neighbouring areas and improve the quality of ecological environment protection and agricultural development in neighbouring areas, which is beneficial for sustainable agricultural development

Table 9. Decomposition results of spatial effects.

Variable	ATL_{it}	Fsa_{it}	Ins_{it}	Huc_{it}	$InperGDP_{it}$	Ais_{it}	Urb_{it}
Direct effect	0.471** (3.056)	1.215* (2.016)	0.016* (2.118)	0.095** (3.187)	0.193** (2.914)	0.021** (2.587)	-0.246** (-2.653)
The indirect effect	0.245** (3.125)	0.055 (1.027)	0.003 (0.735)	0.011* (2.295)	0.016** (3.021)	0.010* (2.769)	-0.021** (-3.191)
The total effect	0.716* (2.159)	1.270* (1.986)	0.019* (1.992)	0.106* (2.131)	0.209** (3.125)	0.031** (2.860)	-0.267** (-2.983)

Note: * and **represent the significance level of 5% and 1%, respectively, with T values shown in brackets.

Table 10. Estimated results of different regions.

Variable	The eastern region	The central region	The western region	Variable	The eastern region	The central region	The western region
ATL_{it}	0.466** (2.738)	0.524** (3.153)	0.480** (3.074)	$W*ATL_{it}$	0.332* (2.154)	0.362* (1.971)	0.277* (2.041)
Fsa_{it}	1.262* (2.003)	1.231* (1.995)	1.339* (2.421)	$W*Fsa_{it}$	0.063 (0.874)	0.043 (1.615)	0.105 (1.241)
Ins_{it}	0.016* (1.984)	0.033* (2.068)	0.036* (2.241)	$W*Ins_{it}$	0.132 (1.030)	0.081 (1.287)	0.039 (1.144)
Huc_{it}	0.181** (3.154)	0.149** (3.086)	0.164 (1.663)	$W*Huc_{it}$	0.281* (2.116)	0.149* (2.089)	0.141 (1.093)
$InperGDP_{it}$	0.232* (2.132)	0.215** (3.221)	0.109** (3.042)	$W*InperGDP_{it}$	0.081* (2.276)	0.073** (2.901)	0.109* (2.324)
Ais_{it}	0.072* (2.415)	0.015** (3.064)	0.009* (2.255)	$W*Ais_{it}$	0.102* (2.098)	0.015* (2.917)	0.009 (0.982)
Urb_{it}	-0.332* (-2.132)	-0.215** (-2.875)	-0.209** (-2.691)	$W*Urb_{it}$	-0.053* (-2.132)	-0.103** (-3.210)	-0.096** (-2.943)
$Adj\ R^2$	0.8984	0.8473	0.8265	ρ	0.221** (2.841)	0.287** (2.605)	0.185** (2.671)
$Log\ L$	163.622	185.732	149.736				

Note: *, **and ***represent the significance level of 10%,5% and 1%,respectively, with T values shown in brackets.

Table 11. Decomposition results of spatial effect in different regions.

Variable	The eastern region	The central region	The western region
Direct effect	0.451**(2.975)	0.513** (2.997)	0.465** (3.091)
Indirect effect	0.335**(3.031)	0.291**(3.115)	0.226**(2.606)
Total effect	0.886**(2.786)	0.804** (3.113)	0.691**(2.867)

Note: **represents the significance level of 5% with T values shown in brackets.

[55]. The development of the agricultural tourism industry promotes the spatial diffusion of tourism flow and production innovation, thus driving the integrated development of agriculture and tourism in surrounding areas.

Results of the Spillover Effect in Different Regions

Considering that there may be regional differences in the impact of ATL on SADL, this study further divides the whole study region into eastern, central and western regions and sets three models accordingly. The model estimation adopts the two-way fixed SDM model, and the results are shown in Table 10. As shown in the analysis results, the estimation results of the eastern, central and western regions are basically consistent with the whole-region samples: the direct (local) effect and the spatial spillover effect are both significant, indicating that the above research results are relatively robust.

At the same time, the direct (local) effect and spatial spillover effect of ATL on SADL are considered to analyse the differences in the spillover effects in different regions. The results of spatial effect decomposition are shown in Table 11. The direct (local) effects of the central and western regions are larger than those of the eastern region, and the central region has the strongest direct (local) effect. This result may be because there is a good resource base for the integrated development of agriculture and tourism in Central China, while its agricultural ecological development level is not as high, as shown in Fig. 2. Therefore, the marginal effect of the integrated development of agriculture and tourism on the sustainable development of agriculture is more prominent. In terms of the spatial spillover effect, the spillover effect of ATL on improving SADL in the eastern region (coefficient = 0.335, $P<0.05$) is greater than that in the central and western regions. Huang (2014) showed that the more developed the economy is, the more significant the economic spillover effect of the tourism industry. In comparative terms, thanks to the economic foundation and infrastructure conditions, the tourism flow, information flow and factor flow in the eastern region can operate conveniently and efficiently. Therefore, the spillover effect in the eastern region is more prominent.

Conclusions

Based on 2008-2019 panel data on 30 Chinese provinces, this paper uses a fixed effect model, system GMM model and spatial Durbin model to verify whether the integration of agriculture and tourism can promote sustainable development of agriculture. The conclusions of this paper are as follows:

(1) Both the level of agriculture and tourism integration (ATL) and the level of sustainable agricultural development (SADL) of the whole research area have continuously improved over time, with average annual growth rates of 3.823% and 2.144%, respectively. Overall, the SADL and ATL in the eastern region are higher than those in the central and western regions.

(2) The integration of agriculture and tourism plays a positive role in promoting the sustainable development of agriculture. The integrated development of agriculture and tourism always adheres to the ecological development concept, taking agriculture and rural areas as the basic support. Therefore, it can promote agricultural intensification and clean production and management, which contributes to the sustainable development of agriculture.

(3) To alleviate endogeneity problems, a dynamic panel model is constructed, and the estimation results based on the GMM estimation method show that SADL lagged one period has a positive impact on the SADL of the current period. This result indicates that SADL is affected by the previous period, which can be seen as typical path dependence and inertia effects. The agriculture and tourism integration is still effective in promoting the sustainable development of agriculture when the dynamic panel model is used to eliminate endogeneity problems.

(4) The impact of agriculture and tourism integration on the sustainable development of agriculture has a spillover effect. The coefficient of ATL on SADL in the fixed effect model is greater than that in the spatial model. This result reflects that ignoring spatial spillover effects may overestimate the effect of agriculture and tourism integration. The estimation results of the eastern, central and western regions are basically consistent with those of the whole research area: the direct (local) effect of agriculture and tourism integration on sustainable agricultural development is significant, and the spatial spillover effect is also

significant. However, the direct (local) effect is greater in the central and western regions than in the eastern region. The spillover effect in Eastern China is greater than that in Central and Western China.

The above conclusions of this study provide implications for promoting agriculture and tourism integration and giving full play to its role in improving the level of sustainable agricultural development as follows:

(1) The government should optimize and improve the top-level design of policies and institutions. It should adhere to the principle of coordination between current and long-term planning, scientifically evaluate the potential of agro-tourism development and the carrying capacity of the natural environment in a region, and establish the rationality and feasibility of project development. Industrial development should rely on the local resource endowment and the industrial development mode of all-factor ecological protection, including mountains, rivers and lakes should be actively explored. The government should adhere to the guiding role of sustainable agriculture and promote the agriculture and tourism integration and the in-depth coordinated development of relevant industries based on local conditions. Measures should be taken to expand the depth and breadth of the agricultural industry chain, striving to build a modern agricultural industrial system.

(2) Considering the positive spatial spillover effect of the integration of agriculture and tourism, it is difficult to maximize the spatial effect of the integration of agriculture and tourism through “departmentalism”. In this regard, we should promote an improvement in the system of coordinated regional governance and the mechanism of coordinated development at an appropriate time and gradually explore a development model consisting of the proper separation of economic zones and administrative regions. It is possible to strengthen regional practical cooperation by means of promoting industrial clusters, and signing of strategic cooperation agreements. It is also possible to facilitate cooperation among administrative regions in platform building, industrial integration, public services and personnel exchange in an effective cross-regional way. We should work hard to address difficulties such as the consolidation of interests, homogeneous competition, lagging administrative control and institutions in trans-regional governance and speed up the formation of a new paradigm of inter-governmental collaborative governance.

(3) The government should strengthen and focus on human capital cultivation. Promoting the integrated development of agriculture and tourism requires the support of high-quality talent. Based on the actual development of agro-tourism and the needs of industrial development, flexible measures and cultivation policies should be adopted for talent introduction, especially for the cultivation and introduction of basic skilled personnel, middle or senior management and operational personnel. At the same time, an improvement in rural vocational and technical education should be promoted to popularize agricultural technology, improve the vocational skills of local workers, and enhance the quality of rural tourism services.

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Author Contributions

Conceptualization, W.J. and C.C.; methodology, Z.F.; resources, Z.Q. and L.X.; formal analysis, Z.F.; writing-original draft, W.J.

Data Availability Statement

The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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