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The Influence Mechanism and Test of Transformation for Cultivated Land Use on the Economic Resilience of Agricultural Crop Production Industry

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ABSTRACT: Under the current multiple impacts, such as tightening resource and environmental constraints, low agricultural economic benefits and rural labor loss, improving the resilience of the planting economy has become the only way to ensure China's food security and the stable operation of the social economy. As an important way of agricultural production factor, the transformation of cultivated land has a great influence on the development of the agricultural crop production industry. Based on the elaboration of the logical relationship and influence mechanism of the economic resilience of the agricultural crop production industry, the effect and regional differences of the economic resilience of the agricultural crop production industry are empirically tested by a double fixed regression model. It is found that the economic resilience level of the agricultural crop production industry in China is on the rise, but the regional differences are obvious; the transformation for cultivated land use can significantly promote the economic resilience level of agricultural crop production industry and the results are stable; there is regional and dimensional heterogeneity in the impact of cultivated land use transformation on the economic resilience of agricultural crop production industry. Based on this, we can promote the transformation of cultivated land use from three aspects: production, life, and ecology. Especially, attention should be paid to the orderly promotion of the transformation of farmland utilization in the main grain-producing areas and the improvement of the economic resilience of the agricultural crop production industry. Consolidate regional advantages while driving the improvement of economic resilience in the main grain sales areas' agricultural crop production industry to achieve the goal of sustainable and stable development of China's agricultural crop production industry.

Keywords: Economic resilience; Agricultural crop production industry; Cultivated land use transformation; Double fixed effect

1. Introduction

The agricultural crop production industry is an important component of agriculture. In the increasingly complex economic environment and many difficulties such as the global economic downturn, the stable operation and development of the agricultural crop production industry is an important source of driving force for the sustained growth of China's agricultural output value. It is of great significance for achieving strategic goals such as rural revitalization and urban-rural integration development. In the increasingly complex domestic and international situation, as the domestic economy enters a new normal stage of development, the resilience of the agricultural crop production industry economy determines whether the agricultural crop production industry system can dynamically adjust its own structure and resource allocation status to maintain stable operation in the face of risks and turbulence [1]. The transformation for cultivated land use is a systematic adjustment made by the subject of cultivated land rights to adapt to the environmental changes brought about by the evolution of urban-rural relations under the new situation, which will have a certain impact on the improvement of the economic resilience of the agricultural crop production industry.

The concept of resilience has gone through three stages: engineering resilience, ecological resilience, and evolutionary resilience. Engineering resilience and ecological resilience analyze the resilience issues of different systems from the perspective of equilibrium theory. In contrast, evolutionary resilience analyzes how systems adapt to

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environmental changes through dynamic adjustments during shocks and fluctuations from the perspective of evolution theory [2]. Economic resilience is a key factor in the sustained and stable development of the economic system during turbulent or fragile periods [3], and in continuing to meet current needs [4]. It promotes the transformation and upgrading of the social and economic system through continuous adaptation and change in the context of economic environment changes [5,6]. The phenomenon of using resilience to describe the economic field began when Reggiani applied the concept of resilience to the study of spatial economic systems [7]. Research on economic resilience in the agricultural field mainly focused on capital assets [8], learning ability [9], rural population mobility, age structure of agricultural labor force [10], rural industry integration [11], fiscal support for agriculture urbanization construction and diversified development of the agricultural system [12] . The impact of those factors on the economic resilience of the agricultural system is discussed.

The use of cultivated land is an important component of the development of the agricultural crop production industry, and the transformation of cultivated land use will have an undeniable impact on the economic resilience and development of the agricultural crop production industry. Existing research has not yet been conducted on the economic resilience of the agricultural sector from this perspective. Based on defining the concept, characteristics, and influencing factors of the economic resilience of the agricultural crop production industry, this article analyzes the impact mechanism of the transformation for cultivated land use on the economic resilience of the agricultural crop production industry and conducts empirical testing. Based on this, effective strategies and methods to enhance the economic resilience of the agricultural crop production industry are explored, which can provide a useful reference for the improvement of the economic resilience of the agricultural crop production industry and the stable operation and continuous improvement of the agricultural crop production industry economic system.

2. Definition

2.1. The Connotation of Transformation for Cultivated Land Use

The transformation for cultivated land use refers to the dynamic evolution process of multiple attributes such as the form of cultivated land use, property rights relations [13] and production and operation methods in the time dimension. It includes both explicit transformation for cultivated land use mainly based on the transformation for cultivated land use type and the increase or decrease of cultivated land quantity, and implicit transformation mainly based on the evolution of cultivated land property rights relationship, production and operation mode, production technology upgrading, and planting structure adjustment [14]. This evolution process is not only limited by natural factors such as regional resource endowment and terrain but also influenced by social and economic factors such as national policies, characteristics of regional economic development stages, use activities of cultivated land management entities, and interests demands of cultivated land rights entities. In this article, the transformation of cultivated land use refers to an invisible transformation, where the form of land use remains unchanged.

The transformation for cultivated land use includes the transformation of farmland utilization property rights, management methods, production technology, and production efficiency. The transformation for cultivated land use rights mainly refers to the separating cultivated land system from two kinds of rights to three kinds of rights, separating the cultivated land management right from the cultivated land use right, ensuring the parallel realization of the cultivated land production and operation function and the cultivated land social security function, which is the institutional foundation for cultivated land circulation and large-scale use. The transformation of cultivated land production and operation primarily involves the transfer of management rights from farmers to large local planting households, professional cooperative organizations, or industrial and commercial enterprises, through mechanisms such as transfers and shareholding. This facilitates changes in both the scale and the entities responsible for cultivating the land. The transformation for cultivated land production technology can be achieved by changing the business entity. For farmers who still rely on cultivated land cultivation as their main source of income, it can also be achieved by hiring large agricultural machinery to cultivate and harvest cultivated land without changing the ownership of cultivated land management rights, and completing the transformation from traditional farming methods to modern farming methods under the small-scale agricultural economy. The transformation for agricultural crop production efficiency refers to improving the efficiency and quality of agricultural crop production through information technology promotion, production technology innovation, and optimized allocation of production materials.

2.2. The Connotation of Agricultural Crop Production Industry Economic Resilience

The economic resilience of the agricultural crop production industry refers to the ability of the agricultural crop production industry system to respond to risk shocks and environmental fluctuations, including the ability to prevent risks before they occur, the ability to adapt and adjust to suppress risk spread and reduce losses during the risk occurrence process and the ability to improve the risk management system and adjust the system structure base on evaluating the success or failure of risk management. When facing risk shocks and environmental fluctuations, resilience allows the agricultural crop production system to recover to a new stable state through its own adaptation. The economic resilience of the agricultural crop production industry is a kind of evolutionary resilience that can proactively prevent risks, adjust to new environments and continuously improve itself [15]. Therefore, the impact factors of economic resilience include the degree and speed to recover to a stable state of the planting system after risk shocks and environmental fluctuations, as well as the ability to turn challenges into opportunities and continuously adjust one's structure to form a new balanced and stable state.

Firstly, the risk prevention capability of the agricultural crop production industry refers to the ability of the agricultural crop production industry system to anticipate the existence of risk factors before risk shocks and environmental fluctuations occur. This involves eliminating and controlling potential risk factors to either prevent risks from occurring or reduce potential losses.After being affected by shocks and fluctuations, the loss can be controlled within an acceptable range and the stable operating state of the system can be restored as soon as possible. Secondly, the adaptability and adjustment capacity of the agricultural crop production industry refers to the ability to predict risk trends during risk events accurately. At the same time, it involves mobilizing necessary resources quickly to respond to risks, adjusting the system's operations to control the risk's development and preventing the spread of losses. This helps avoid secondary crises and minimize the losses caused by risk shocks and environmental fluctuations. Finally, the innovation and transformation ability of the agricultural crop production industry refers to making correct judgments about the causes and rational control plans after risks occur. Adjust the organizational structure and risk prevention system in response to changes in risk and environment, enhance risk prevention capabilities, and enable the system to achieve balanced and stable operation at a higher level.

Compared with the single equilibrium state of engineering resilience, the economic resilience of the agricultural crop production industry is more similar to ecological resilience, which has the characteristics of complex system structure and dynamically changing equilibrium states [16]. The economic resilience of the agricultural crop production industry is not only influenced by external objective conditions such as natural conditions, institutional policies, social environment, and infrastructure but also impacted by the subjective initiative of relevant stakeholders [17]. The exertion and continuous enhancement of the economic resilience of the agricultural crop production industry are affected directly by factors such as the risk response experience and ability of equity entities, as well as the degree of synergy between them [18]. The ability of risk management depends on the historical information held by the equity subject, the material and financial resources they possess, and the speed and cost of raising emergency funds when risks occur. The coordinated degree among stakeholders is affected by interest consistency. Interest consistency is affected by communicated channels and related policies. The system of farmland property rights, policies for farmland transfer, and the protection system for the rights and interests of each entity determine whether they share common interests in the risk management process. This is the foundation for the formation of the agricultural crop production industry economic system and has a significant impact on the economic resilience of the agricultural crop production industry.

3. The Impact Mechanism and Research Hypothesis of Cultivated Land Use Transformation on the Economic Resilience of Agricultural Crop Production Industry

3.1. The Impact of Transformation for Cultivated Land Use on the Risk Prevention Ability of the Agricultural Crop Production Industry System

The transformation for cultivated land use promotes the diversification of farmland production methods and business entities, increases the complexity of the agricultural crop production industry economic system, and enhances the risk prevention ability of the agricultural crop production industry economic system. In the process of risk shocks and environmental fluctuations, the agricultural crop production industry system with a single production and operation mode, a random planting structure, and a simple supply and marketing chain are more prone to adverse consequences such as agricultural product backlog and industrial chain breakage. The production and operation mode of small farmers with a single main body is difficult to maintain and promote the economic resilience of the agricultural crop production industry [17]. The transformation for cultivated land use is mainly achieved through modernization of production methods and diversification of business entities. Modernization of production methods aims to improve the production efficiency and operating income of farmland by increasing investment in large-scale agricultural machinery and water conservancy facilities. This approach seeks to transform the current situation, where China's agricultural crop production industry is primarily operated by small farmers. Diversification of business entities is mainly achieved through the entry of new agricultural business entities into the field of planting. New agricultural business entities can use modern information technology to grasp agricultural product market information, avoid the impact of cyclical fluctuations and information lag in the agricultural product market on the agricultural crop production industry, and explore a broader product sales market to avoid blind crop selection and agricultural product sales [19], thereby enhancing the economic resilience of the agricultural crop production industry. New agricultural business entities are better at selecting high-quality seedlings, enriching crop planting types, expanding sales channels for agricultural products, and extending the production chain of the agricultural crop production industry. Establishing cooperative relationships with more business entities can make the agricultural crop production industry economic system more diversified and complex, effectively enhancing the risk prevention ability of the agricultural crop production industry economic system.

3.2. The Impact of Transformation for Cultivated Land Use on the Adaptability and Adjustment Ability of the Agricultural Crop Production Industry System

The transformation for cultivated land use reduces losses through risk transfer, risk diversification, and other means. By expanding funding channels and other means, the ability to control risks is enhanced, and the ability of the planting economy system to adapt to risks, control risks, and reduce losses is promoted. Farmers obtain agricultural machinery services by purchasing specialized services or renting large agricultural machinery from specialized companies, avoiding investing too much cost in purchasing large agricultural machinery at once. Obtaining agricultural machinery services through financial leasing reduces production costs and transfers some of the risks to third parties. The transformation for cultivated land use has transformed the main body of farmland production and operation from a single entity to multiple entities, dispersing the risks from a single entity to different entities. Multiple entities jointly bear the potential adverse effects of risks, reducing the losses that a single entity may suffer and playing a role in dispersing risks. In addition, the new agricultural business entities have significant advantages in terms of resource raising ability and risk control ability when risks occur. The new agricultural business entities are mostly specialized agricultural enterprises or local experts who can quickly make judgments on the development trend of risks based on their experience, effectively suppress the spread of risks and the generation of secondary crises, and reduce the direct costs of risk generation. When mobilizing the resources needed to cope with risks, new agricultural business entities not only have advantages in resource mobilization but can also leverage their creditworthiness to minimize resource costs and reduce indirect risk-related expenses. Accurate prediction of risk development trends, rapid resource raising, and accurate selection of risk control measures can effectively enhance the resilience of the agricultural crop production industry economy, enabling the agricultural crop production industry economic system to resume normal operation in the shortest possible time after experiencing risk shocks and environmental fluctuations.

3.3. The Impact of Transformation for Cultivated Land Use on the Innovation Ability of Planting System Transformation

The transformation for cultivated land use promotes the self-recovery and improvement speed of the planting economy system after risks occur by attracting industrial and commercial capital and professional technical talents to go to the countryside, expanding the livelihood fields of farmers, and enhancing the innovation ability of the planting economy system. The transformation of cultivated land use enhances output and income through the scale and industrialization use of cultivated land. It attracts urban professionals to participate in the agricultural production and operation process. Urban professionals entering the field of agricultural production not only bring capital and advanced technology but also new business concepts and management experience. This helps to absorb lessons and summarize experiences in various risk shocks and environmental fluctuations. In order to cope with new risks and adapt to new environments, the transformation and upgrading of the agricultural crop production industry economic system are promoted through agricultural technology research and development promotion, transformation for agricultural scientific and technological achievements [20] and improvement of the management system. The transformation for cultivated land use not only directly provides employment opportunities for farmers but also promotes farmers to actively seek nonagricultural income sources, enrich income structure, and improve income levels. The expansion of income sources and improvement of income levels help farmers broaden their perspectives and accumulate valuable experience. This enables them to adjust their household livelihood strategies and income sources in response to risk shocks and environmental fluctuations. This allows them to maintain or improve their income levels and ensure the stability and continued improvement of their family's production and living conditions. In the process of transformation for cultivated land use, the inflow of industrial and commercial capital provides a material foundation for innovation in the agricultural crop production industry. The addition of professional talents assists innovation in the agricultural crop production industry, and the expansion of farmers' livelihood fields provides a platform for the application of innovative achievements. The reconstruction of the capital-talent-farmer relationship has created a new development model and path for the agricultural crop production industry. This transformation turns the risks arising in the development of the agricultural production system into a driving force for innovation and change. The optimization of the agricultural crop production industry economic system promotes its resilience and forms a new equilibrium state at a higher level.

Based on the above analysis, this article makes the following hypothesizes:

Hypothesis 1 (H1). *Transformation for cultivated land use can promote the economic resilience of the agricultural crop production industry system.*

Hypothesis 2 (H2). *Affected by factors such as urbanization level, household income level, and food production level, there is regional heterogeneity in the promotion effect of transformation for cultivated land use on the economic resilience of the agricultural crop production industry system.*

4. Research Methods, Variable Definitions, and Data Sources

4.1. Research Methods

This article uses a fixed effects model to examine the impact of cultivated land use transformation on the economic resilience of the agricultural crop production industry, as there are individual differences in the sample data and the Hausman test results are significant. The specific model is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 Controls_{i,t} + \mu_i + \omega_t + \varepsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ and $X_{i,t}$ represent the dependent variable and explanatory variable of the i-th province, respectively; $Controls_{i,t}$ refers to other control variables; μ_i and ω_t 1 and 2 are dummy variables for provinces and years, respectively, to control for individual and time effects; $\varepsilon_{i,t}$ is a random perturbation term.

4.2. Variable Definition

(1) Explanatory variable: Economic resilience of the agricultural crop production industry. In response to the analysis of the connotation of the economic resilience of the agricultural crop production industry in the previous text, this article constructs an evaluation index system for the economic resilience of the agricultural crop production industry from three dimensions: risk prevention ability, adaptability adjustment ability, and innovation and transformation ability of agricultural economy resilience [21]. The specific indicator system is detailed in Table 1.

Table 1. The table evaluated index system of the economic resilience of agricultural crop production industry.

Target Layer	Indicator Layer	Unit	Features	Indicator Meaning and Calculation Method
Risk prevention capability	Per capita output value of agricultural crop production industry	Yuan/Per Person	+	Reflect the level of agricultural economic development, total output value of agricultural crop production industry/rural population
	Risk management status	Million yuan	+	Reflecting the level of agricultural risk management and the income from agricultural insurance premiums
	Agricultural Professional Cooperative		+	Scale of anti new agricultural business entities and number of agricultural professional cooperatives
Adapt and adjust capability	Agricultural technicians		+	Reflecting the human resources foundation of agricultural technology innovation, agricultural technicians from public economic enterprises and institutions
	Agricultural credit level	Billion Yuan	+	Reflect the financing constraints of farmers and the balance of agricultural loans
	Scale of agricultural mechanization service organizations		+	Reflect the level of agricultural mechanization services and the number of agricultural mechanization service organizations
Innovation and Transformation Capability	Internet usage status	Ten thousand households	+	Reflect the internet usage status of farmers and the number of broadband access households in rural households
	Income structure of farmers	%	+	Reflecting the expansion level of farmers' livelihoods, nonagricultural income/disposable income of farmers
	Total fiscal expenditure on supporting agriculture	Billion Yuan	+	Reflect the strength of fiscal support for agriculture, and the total amount of fiscal support for agriculture expenditure

Note: "+" indicates that the indicator direction is positive.

When calculating the comprehensive indicator system, the entropy method is used to determine the indicator weight. Since this method has been widely used in academia, this article will not elaborate on its specific calculation method.

(2) Explanatory variable: Transformation for cultivated land use. Referring to the related research results [22,23], the implicit transformation for cultivated land use is characterized by the "three generative" function of farmland. Among them, crop production and planting capacity are the basic functions of cultivated land utilization. This article selects indicators such as the output value of the per capita agricultural crop production industry, the comprehensive utilization rate of crop cultivation income, and the carrying capacity of the per capita labor force to measure. Life function refers to the carrying capacity of living security provided by cultivated land, mainly referring to the ability of cultivated land to maintain farmers' livelihoods, reduce unemployment risks, and provide material supplies such as food, fruits and vegetables for social stability and development. This article selects indicators such as the proportion of agricultural crop production industry output value, per capita food security rate, and the proportion of agricultural crop production industry employees to measure. Ecological function is an important supporting condition for ensuring the sustainable development of farmland production and living functions, reflecting the service capacity of the farmland system. This article selects indicators such as the effective irrigation rate of farmland, total carbon emissions from the agricultural crop production industry, and planting diversity index to measure. Table 2 refers to evaluation index system for cultivated land use transformation.

Table 2. Evaluation index system for cultivated land use transformation.

Target Layer	Indicator Layer	Unit	Features	Indicator Meaning and Calculation Method
Production function	Average production value of land agricultural crop production industry	Yuan/hm^2	+	Reflect the production value of cultivated land, total output value of agricultural crop production industry/cultivated land area
	Comprehensive utilization rate of crop cultivation and harvest	%	+	Weighted average values reflecting the level of agricultural mechanization, machine tillage rate, machine sowing rate, and machine yield
	Average carrying capacity of local labor force	Per person/hm^2	–	Agricultural crop production industry employees/cultivated land area, reflecting the carrying capacity of cultivated land labor force
Livelihood function	Proportion of Agricultural crop production industry Output Valu	%	+	Reflecting the survival guarantee function of cultivated land for farmers, the per capita total planting output value/per capita disposable income of rural residents
	Per capita food security rate	%	+	Reflecting the food security guarantee function of cultivated land, the calculation equation is: grain yield/(permanent population × 400 kg)
	Proportion of employees in the agricultural crop production industry	%	–	Reflecting the employment security function of cultivated land, the total number of employees in the agricultural crop production industry/rural labor force
Ecological function	Effective irrigation rate of farmland	%	+	Reflect the level of farmland water conservancy facilities, effective irrigation area/cultivated land area
	Total carbon emissions from the agricultural crop production industry	Ten thousand ton	–	Reflect the degree of damage to the ecological environment during the production process of the agricultural crop production industry, and refer to relevant literature for calculation
	Planting Diversity Index	/	+	Reflecting the crop planting structure, the proportion of each crop planting area is multiplied by its natural logarithm and summed up (crops are divided into grain crops, oil crops, vegetable and fruit crops, and other crops)

Note: "+" indicates that the indicator direction is positive, "–" indicates that the indicator direction is negative.

(3) Control variables: To control for the impact of other factors on the economic resilience of the agricultural crop production industry, this article selects the following control variables: ① urbanization level, expressed as the proportion of urban population to the total population (%). ② The income level of farmers is expressed as per capita disposable income of rural residents (yuan). The level of grain production is expressed in terms of grain yield (10,000 tons). Grain production foundation isexpressed in terms of grain sown area (in thousands of hectares). The level of population base, expressed in total population (10,000 people). Based on unified dimensions, five indicators are introduced as control variables into the model analysis to control the impact of other factors on the economic resilience of the agricultural crop production industry.

4.3. Data Sources and Descriptive Statistics

This article mainly selects panel data from 30 provinces in China (excluding Tibet, Hong Kong, Macao, and Taiwan) from 2011 to 2020. The sample data is sourced from the "China Statistical Yearbook", "China Rural Statistical Yearbook", "China Agricultural Machinery Industry Yearbook", "China Science and Technology Statistical Yearbook", "China Tertiary Industry Statistical Yearbook", or calculated and organized by the author. The descriptive statistics of each variable are detailed in Table 3.

Table 3. The descriptive statistics of each variable.

Variables	Observations	Average ± SE	Max/Min
Economic resilience of agricultural crop production industry	300	0.268 ± 0.080	0.560/0.111
Transformation for cultivated land use	300	0.228 ± 0.145	0.726/0.023
Urbanization level	300	0.581 ± 0.125	0.896/0.345
Income level of farmer	300	10.31 ± 0.315	11.244/9.615
Grain production level	300	0.208 ± 0.174	0.754/0.003
Fundamentals of grain production	300	7.743 ± 1.275	11.065/3.839
Population base level	300	0.457 ± 0.275	1.260/0.057

To avoid multicollinearity issues that could affect the credibility of the estimation results, a collinearity diagnosis was conducted on each explanatory variable in advance. The collinearity diagnosis results showed that the variance expansion factor (VIF value) of each variable was much less than 10, so it is considered that there is no multicollinearity problem, proving that the sample data has good statistical quality. From the table, the standard deviation of each variable is less than the mean, indicating that the data has good stability. From the perspective of economic resilience indicators of the agricultural crop production industry, the average value from 2011 to 2020 is 0.268, indicating that China's agricultural crop production industry economic system has a poor ability to face risk shocks and generate adaptive adjustments. From the perspective of indicators of cultivated land use transformation, the average value from 2011 to 2020 is 0.228, indicating that the overall development level of China's cultivated land use transformation is still at a relatively low level. At the same time, there is a significant difference between the maximum and minimum values of the two variables, reflecting the significant differences in the economic resilience of the agricultural crop production industry and the transformation level of cultivated land use in various provinces of China.

5. Empirical Testing

5.1. Trends in the Transformation for Cultivated Land Use and the Resilience Level of Planting Economy

The entropy method is used to calculate the transformation of China's cultivated land use and the resilience level of the agricultural crop production industry economy from 2011 to 2020, and to explore its evolutionary characteristics and laws. The specific calculation results are shown in Table 4.

For the transformation for cultivated land use, the index of cultivated land use transformation showed an upward trend during the research period, with an average increase from 0.238 to 0.308, with an average annual growth rate of 2.94%. From the perspective of regional values, the main grain-producing areas, as the concentrated areas of agricultural production and operation activities in China, have a higher transformation index of cultivated land use than the main grain sales areas and the grain production and sales balance areas.

As for the economic resilience level of the agricultural crop production industry, overall, during the research period, the economic resilience level of the agricultural crop production industry showed an upward trend, with an average increase from 0.143 to 0.319, with an average annual growth rate of 12.31%. This indicates that the economic resilience of China's agricultural crop production industry is gradually strengthening and the trend of sustained positive development is obvious. In recent years, China has always placed the issue of agriculture, rural areas, and farmers in a prominent position, accelerating the implementation of strategies such as rural revitalization, high-quality development of the agricultural economy, and modernization of agriculture. This series of favorable policies has significantly promoted the resilience level of the agricultural crop production industry economic system. From the perspective of regional values, the economic resilience advantage of the agricultural crop production industry in the main grain-producing areas is relatively obvious. In contrast, the economic resilience of the agricultural crop production industry in the main grain selling areas and the grain production and sales balance areas is relatively lagging.

Table 4. Trends in the transformation for cultivated land use and resilience of planting economy in China from 2011 to 2020.

Year	Transformation for Cultivated Land Use				The Resilience of Planting Economy			
	Total Sample Mean Value	Average Value of Major Grain Producing Areas	Average Value of Main Grain Sales Areas	Average Value of Production and Sales Integration Zone	Total Sample Mean Value	Average Value of Major Grain Producing Areas	Average Value of Main Grain Sales Areas	Average Value of Production and Sales Integration Zone
2011	0.238	0.274	0.197	0.228	0.143	0.209	0.091	0.095
2012	0.243	0.282	0.201	0.230	0.160	0.233	0.103	0.106
2013	0.248	0.290	0.204	0.230	0.180	0.263	0.115	0.120
2014	0.252	0.296	0.208	0.232	0.194	0.281	0.128	0.124
2015	0.256	0.303	0.211	0.233	0.216	0.316	0.143	0.137
2016	0.272	0.324	0.228	0.241	0.238	0.351	0.159	0.140
2017	0.269	0.322	0.228	0.229	0.254	0.372	0.173	0.149
2018	0.285	0.333	0.240	0.258	0.278	0.405	0.195	0.163
2019	0.307	0.345	0.255	0.309	0.299	0.427	0.214	0.182
2020	0.308	0.350	0.263	0.297	0.319	0.457	0.230	0.189

5.2. Analysis of Benchmark Regression Results

The dual fixed effect OLS regression was conducted on the transformation for cultivated land use and the economic resilience of the agricultural crop production industry, and the results are shown in Table 5.

Table 5. Benchmark regression results.

Variables	Uncontrolled Variables	Adding Control Variables
Transformation for farmland utilization	0.818 ***(6.89)	0.472(4.4) ***
Urbanization level		0.461(5.61) ***
Income level of farmers		0.065(1.18)
Grain production level		0.629(7.5) ***
Fundamentals of Grain Production		0.014(2.42) **
Population base level		0.583(4.71) ***
Constant	−0.051(−1.78)	−1.338(−2.39) **
R^2	0.784	0.857

Note: **, *** are significant at 5%, and 1% levels respectively, and the standard error values are in brackets.

Among them, in the first column, based on controlling for individual and time-fixed effects, a simple regression was conducted using the transformation for cultivated land use to assess the economic resilience of the agricultural crop production industry, and the estimated coefficients were significantly positive at the 1% statistical level; The second column adds other control variables on the basis of simple regression, and the results show that the estimated coefficient of cultivated land use transformation is still significantly positive at the statistical level of 1%. This preliminarily proves that the higher the level of cultivated land use transformation, the stronger the economic resilience of the agricultural crop production industry.

In addition, from the perspective of control variables, the estimated coefficient of urbanization level is significantly positive, indicating that the higher the urbanization rate, the stronger the economic resilience of the agricultural crop production industry. The possible reason is that as the urban population increases, the rural population that needs to be supported by cultivated land decreases, and the economic resilience of the agricultural crop production industry will also increase. The estimated coefficient of grain production level is significantly positive, indicating that an increase in grain production will enhance the economic resilience of the agricultural crop production industry. The possible reason is that the level of grain production is the material foundation for the economic resilience development of the agricultural crop production industry. The higher the level of grain production, the stronger the economic resilience of the agricultural crop production industry. The estimated coefficient of grain production foundation is significantly positive, indicating that the larger the grain planting area, the stronger the economic resilience of the agricultural crop production industry. The possible reason is that the more solid the foundation of grain production is, the better the economic resilience of the agricultural crop production industry will develop. The estimated coefficient of population base level is significantly negative, indicating that population size can also promote the development of economic resilience in the agricultural crop production industry. The possible reason is that population growth can ensure the population base is engaged in planting production during the development process of economic resilience in the agricultural crop production industry in order to promote the enhancement of economic resilience in the agricultural crop production industry. In addition, the estimated coefficient of farmers' income level is positive, indicating that it can also promote the economic resilience of China's agricultural crop production industry to some extent.

5.3. Robust Test

5.3.1. Replacement Model Estimation Method

Considering that the value of the economic resilience index of the agricultural crop production industry measured in this article is 0–1, which meets the conditions of the restricted dependent variable model, the panel Tobit model is used to re-estimate Equation (1) [24]. The results are shown in the first column of Table 6. Comparing the estimation results of the Tobit model and the OLS model, the impact direction of farmland utilization transformation remains unchanged and remains significantly positive at the statistical level of 1%. The estimation results after replacing the model are consistent with the conclusions of the benchmark regression results.

Table 6. Robust test.

Variables	Tobit Test	Tail Reduction Treatment	Excluding Samples from Municipalities Directly under the Central Government
Transformation for farmland utilization	0.203(3.33) ***	0.472(4.4) ***	0.477(3.61) ***
Urbanization level	−0.337(−6.98) ***	0.461(5.61) ***	0.322(3.34) ***
Income level of farmers	0.241(14.13) ***	0.065(1.18)	0.001(0.02)
Grain production level	0.367(10.08) ***	0.629(7.5) ***	0.552(6.4) ***
Fundamentals of Grain Production	0.015(2.78) ***	0.014(2.42) **	0.012(1.96) *
Population base level	0.154(8.35) ***	0.583(4.71) ***	0.509(3.98) ***
Constant	−2.377(−14.34) ***	−1.338(−2.39) **	−0.586(−0.91)
R^2	−1.827	0.857	0.875

Note: *, **, *** are significant at 10%, 5%, and 1% levels respectively, and the standard error values are in brackets.

5.3.2. Tail Reduction Treatment

Shrink the upper and lower 1% of the sample values and perform re-regression. The results are shown in the second column of Table 6. The transformation for cultivated land use is still effectively empowering the economic resilience of the agricultural crop production industry at a significance level of 1%. The estimated coefficients and significance of other control variables are basically consistent with the benchmark regression, indicating that the conclusion of this article is relatively robust.

5.3.3. Remove Some Samples

Considering that the production and operation activities of cultivated land in municipalities are significantly different from other provinces, the sample data of Beijing, Tianjin, Shanghai, and Chongqing were excluded, and the remaining sample data was used to estimate Equation (1). The results are shown in the third column of Table 6, and the estimation coefficient of cultivated land use transformation is still significantly positive at the statistical level of 1%. The research conclusion is still valid.

5.4. Heterogeneity Analysis

5.4.1. Regional Heterogeneity

Due to significant differences in geographical conditions and resource endowments among different provinces in China, there is also significant heterogeneity in the utilization and production status of cultivated land and the development level of the agricultural crop production industry. To further investigate the regional differences in the impact of cultivated land use transformation on the economic resilience of the agricultural crop production industry, this article will conduct regression estimation on the model from three perspectives: the main grain production areas, the main grain sales areas, and the grain production sales balance areas. The specific estimation results are shown in Table 7.

Table 7. Robust test.

Variables	Main Grain Producing Areas	Main Grain Sales Areas	Grain Production and Sales Balance Zone
Transformation for farmland utilization	0.559 **(2.14)	0.127(1.17)	0.838 ***(7.37)
Urbanization level	0.476 ***(2.85)	0.466 ***(3.45)	−0.166 **(−2.2)
Income level of farmers	−0.088(−0.77)	0.013(0.23)	−0.011(−0.19)
Grain production level	0.086(0.72)	−1.878 ***(−4.84)	0.922 **(2.59)
Fundamentals of Grain Production	0.006 (1.1)	0.021 *(1.77)	0.012(0.18)
Population base level	1.129 ***(4.4)	0.525 ***(8.21)	1.133 ***(3.78)
Constant	−0.081(−0.07)	−0.631(−1.01)	−0.412(−0.69)
R^2	0.930	0.955	0.929

Note: *, **, *** are significant at 10%, 5%, and 1% levels respectively, and the standard error values are in brackets.

From the perspective of significance, the regression results of the main grain production areas and the grain production and sales balance areas are significantly positive, while the regression results of the main grain sales areas are positive but not significant. This indicates that the main grain producing areas and grain production and sales balance areas, due to better quality grain production conditions and more complete grain production infrastructure, can better promote the transformation for farmland utilization and enhance the economic resilience of the agricultural crop production industry. However, due to the large population and limited land in the main grain sales areas, the self-sufficiency rate of grain is low, and the transformation for farmland utilization cannot better promote the economic resilience of the agricultural crop production industry. From the estimation coefficient perspective, the estimated coefficient of the grain production and sales balance area is the largest, followed by the main grain production area, and the main grain sales area is the smallest. The possible reason is that the transformation for farmland utilization in the grain production and sales balance area only empowers the economic resilience of the local agricultural crop production industry, ensuring self-sufficiency in grain production in the local area. The farmland utilization in the main grain production area not only ensures the economic resilience of its agricultural crop production industry but also supports the nationwide increase in food demand and the economic resilience of the agricultural crop production industry.

5.4.2. Dimensional Heterogeneity

This article divides the economic resilience of the agricultural crop production industry into three dimensions: risk prevention ability, adaptability and adjustment ability, and innovation and transformation ability. The impact of farmland utilization transformation on each dimension will inevitably vary. Therefore, this article further examines the effect of farmland use transformation on the economic resilience of the agricultural crop production industry from the perspective of dimensional heterogeneity. Table 8 shows the regression results of dimensional heterogeneity.

Table 8. Dimensional heterogeneity.

Variables	Risk Prevention Capability	Adapt and Adjust Capability	Innovation and Transformation Capability
Transformation for farmland utilization	0.187 ***(4.16)	0.081 **(2.15)	0.204 ***(3.62)
Urbanization level	0.226 ***(6.55)	0.06 **(2.08)	0.175 ***(4.07)
Income level of farmers	0.026(1.14)	−0.01(−0.54)	0.048 *(1.68)
Grain production level	0.279 ***(7.91)	0.208 ***(7.11)	0.142 ***(3.23)
Fundamentals of Grain Production	0.005 **(2.24)	0.004 **(1.97)	0.004(1.50)
Population base level	0.061(1.17)	0.108 **(2.51)	0.414 ***(6.37)
Constant	−0.524 **(−2.23)	0.015(0.08)	−0.829 ***(−2.83)
R^2	0.844	0.609	0.808

Note: *, **, *** are significant at 10%, 5%, and 1% levels respectively, and the standard error values are in brackets.

From the regression results of various dimensions of cultivated land use transformation on the economic resilience of the agricultural crop production industry, it can be seen that the estimated coefficients of cultivated land use transformation are significantly positive for the three dimensions of risk prevention ability, adaptability adjustment ability, and innovation transformation ability, indicating that the transformation for cultivated land use has a significant promoting effect on the three dimensions of economic resilience of the agricultural crop production industry. Comparing the estimated coefficients of the three dimensions, the transformation for cultivated land use has the greatest promoting effect on innovation and transformation ability, followed by risk prevention ability, and finally, adaptability and adjustment ability. This indicates that the transformation for cultivated land use in the future should promote and ensure the economic resilience of the agricultural crop production industry, and more attention should be paid to improving the adaptability and adjustment ability of the agricultural crop production industry.

6. Conclusions and Discussion

6.1. Conclusions

This article systematically reviews the impact and mechanism of cultivated land use transformation on the economic resilience of the agricultural crop production industry in theory. Taking 30 provincial panel data of China from 2011 to 2020 as an example, it measures and analyzes the economic resilience level and development trend of the agricultural crop production industry in each province. Based on this, a regression model is constructed for empirical testing. The following conclusion can be drawn: (1) During the sample inspection period, the overall economic resilience level of China's agricultural crop production industry showed an annual optimization trend. Moreover, there are obvious regional differences in the economic resilience of China's agricultural crop production industry, manifested as the resilience level of the main grain-producing areas always being higher than that of the main grain sales areas and the grain production and sales balance areas. (2) The empirical results show that the transformation for cultivated land use can significantly promote the improvement of the economic resilience level of the agricultural crop production industry, and the results are still stable after replacing the regression model, shrinking the tail, and removing some samples. (3) There is heterogeneity in the impact of cultivated land use transformation on the economic resilience of the agricultural crop production industry. Among regional heterogeneity, the impact of major grain-producing areas and grain-producing and selling areas is significantly positive, while the impact of major grain-selling areas is positive but not significant; In terms of dimensional heterogeneity, the transformation for cultivated land utilization has a significant positive impact on the risk prevention ability, adaptive adjustment ability, and innovation transformation ability in the economic resilience of the agricultural crop production industry, with the greatest promoting effect on innovation transformation ability.

6.2. Discussion

The transformation for cultivated land use enhances the economic resilience of the agricultural crop production industry by expanding business entities, enriching system composition, and other means. The economic resilience of the agricultural crop production industry is closely related to its ability to prevent risks, adapt to adjustments, and innovate and transform. It is necessary to promote the orderly transformation of cultivated land use to enhance the economic resilience of the agricultural crop production industry.

On the one hand, it further promotes the resilience level of the planting economy by promoting the optimization and transformation of cultivated land utilization. According to the research results, it can be concluded that the transformation of cultivated land use can effectively improve the economic resilience level of the agricultural crop production industry. Therefore, the optimization and transformation of cultivated land use is a key element to ensure the enhancement of the economic resilience of the agricultural crop production industry. Firstly, maintain the fundamental production function of cultivated land use while improving the marketization level of the agricultural crop production industry. Promoting the economic level of agricultural crop production industry development through increased output value, talent guarantee, and high mechanization. Secondly, ensuring the living function of cultivated land use and maintaining the stable development of the agricultural crop production industry. Promote the stable improvement of the development level of the agricultural crop production industry by integrating income security, food security, and personnel security. Finally, pursuing the ecological function of cultivated land utilization and promoting the sustainable enhancement of the economic resilience of the agricultural crop production industry. To ensure the long-term benefits of cultivated land use through improved facilities, carbon sequestration of farmland, and planting index, and promote the sustainable development of the economic resilience level of the agricultural crop production industry.

On the other hand, it emphasizes the transformation of cultivated land use and strengthens the regional coordinated development of the agricultural crop production industry's economic resilience. The role of cultivated land use transformation in promoting the economic resilience of the agricultural crop production industry is more evident in the main grain producing areas and the grain production and sales balance areas, but not in the main grain production and sales areas. Therefore, for the main grain-producing areas, while developing the economy, attention should be paid to the utilization of cultivated land and the development of agricultural crop production industry in the local area. While providing assistance to the main grain-producing areas, efforts should be made to improve the efficiency of cultivated land use and enhance the level of agricultural crop production. For both major grain-producing areas and those with a balance of grain production and sales, the goal is to unlock the benefits of cultivated land use transformation continuously. This can be achieved by increasing investment in farmland production infrastructure, agricultural mechanization, and other key areas, promoting the healthy integration of modern technology with farmland. These efforts will improve land use efficiency, strengthen the effectiveness of land use transformation, and enhance the economic resilience of the agricultural crop production industry, thus playing a more significant role in its development.

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Declaration of Competing Interest

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