

New Quality Productivity Empowering Coordinated Development of Agriculture “Ecological-Economic” in Hebei Province: Based on the perspective of National Agricultural Science and Technology Parks

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Abstract

In order to promote the coordinated development of agriculture "ecology-economy" in Hebei Province, and to give full play to the local effect of the National Agricultural Science and Technology Parks(NASPs), this paper considers NASPs as an important part and carrier of agricultural new quality productivity. In this paper, NASPs are regarded as an important part and carrier of the new quality productivity of agriculture, and based on the panel data of 137 districts and counties in Hebei Province from 2007 to 2021, the impact of NASPs on the coordinated development of the agriculture, ecology and economy of Hebei Province is evaluated by using the DID method. The results show that the level of the coordinated development of agriculture ecological-economic in Hebei Province shows an upward trend in the study interval; the construction of the NASPs significantly improve the level of the coordinated development of agriculture ecological-economic in Hebei Province with a lag, a finding that is still robust after a series of tests such as the placebo test; and the analysis of mediating effects shows that the NASPs promote the coordinated development of agriculture ecological-economic in Hebei Province mainly by increasing the level of local innovations and decreasing the chemical. The mediating effect analysis shows that the NASPs mainly the coordinated development of agriculture ecological-economic in Hebei Province by increasing the local innovation level and reducing the intensity of chemical inputs. Therefore, in the future policy formulation, we should promote the development of new agricultural productivity and improve the coordinated development of agriculture ecological-economic in Hebei Province by building NASPs according to local conditions, promoting new agricultural production methods, and broadening the channels of sharing and evaluating information about the NASPs.

Keywords: agricultural new quality productivity; national agricultural science and technology parks; coordinated development of agriculture ecological-economic; DID model; technological innovation

1.0 Introduction

"To strengthen the country, we must first strengthen agriculture." Agriculture is the basic industry of the country, and its level of development directly affects the country's economic strength and social stability. With the rapid increase of China's agricultural economy, resource consumption and ecological and environmental pressures are becoming more and more

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obvious. Error! Reference source not found. As the level of China's agricultural economy rises rapidly, resource consumption and pressure on the ecological environment are becoming more and more obvious. General Secretary Xi Jinping pointed out at the National Conference on Ecological Environmental Protection that high-quality economic development must be synchronised with a high level of ecological environmental protection. So, in the case of rapid development of agricultural economy, agricultural surface pollution and destruction of soil and water arable land resources, how to efficiently promote the coordinated development of agricultural "ecology-economy"? 2024 Political Bureau of the Central Committee of the Communist Party of China explicitly pointed out that the new quality of productive forces with science and technology at the core, and focus on exploring a more efficient and higher quality of the production mode, and advocate a sustainable development path. The new quality productivity is centred on science and technology. Therefore, the development of new quality productivity in agriculture has become an important means of cracking the problem of coordinated development of agro-ecology and economy and promoting high-quality agricultural development. National Agricultural Science and Technology Parks (NASTPs) are comprehensive zones focusing on agricultural science and technology innovation and integrating multi-functional functions such as agricultural research, education, technology promotion and industrialisation, etc. They play a pivotal role in promoting the high-quality and modernised development of agriculture. are not only a part of the new quality productivity of agriculture, but also an important platform for fostering the new quality productivity of agriculture. The development of National Agricultural Science and Technology Parks is in a mature stage, and Hebei Province, as a large agricultural province in China and a large province supplying the vegetable market in Beijing, Tianjin and Hebei, with the output of major agricultural products at the forefront of the country, has a direct impact on the country's agricultural development pattern. Therefore, this paper is based on the perspective of the National Agricultural Science and Technology Park to explore how the new quality of agricultural productivity to promote the coordinated development of agriculture, ecology and economy in Hebei Province, the results of the study not only for the future development of agriculture in Hebei Province to provide a reference, but also for the development of modern agriculture in China to provide the experience of the province and the whole country to protect the agro-ecology, the development of the agricultural economy, and to promote the enhancement of the new quality of agricultural productivity, accelerate the process of modernisation of agriculture is of great importance. It has important theoretical and practical significance.

Throughout the existing literature, there are not many articles directly discussing the coordinated development of agro-ecological economy in agricultural science and technology parks, and most of the existing studies are on the impact of agricultural science and technology parks on the agricultural economy or agro-ecology, etc. The articles on the coordinated development of agro-ecological economy are mainly focused on measuring the level of coordinated development and exploring the influencing factors, which provide theoretical support and methodological guidance for the present study. The impact of agricultural science and technology parks on the agricultural economy mainly focuses on agricultural output value and farmers' income. On the one hand, agricultural science and technology parks significantly increase agricultural output value through the introduction and cultivation of agricultural high and new technology, and become a regional agricultural economic growth pole. Error! Reference source not found. and become a regional agricultural economic growth pole Error! Reference source not found. On the other hand, agricultural science and technology parks have become the growth pole of regional agricultural economy by introducing and cultivating agricultural high-tech. Further investigation reveals that the key factor for agricultural science and technology parks to

increase agricultural output value is agricultural upgrading.^[4] The key factor to increase agricultural output value in agricultural science and technology parks is agricultural upgrading. The sown area of crops, the total power of agricultural machinery and the total value of food production also affect the effect of agricultural science and technology parks in promoting the growth of agricultural output value to a certain extent.^{Error! Reference source not found.} On the other hand, agricultural science and technology parks have significantly contributed to the growth of agricultural output. On the other hand, agricultural science and technology parks significantly promote the growth of farmers' income. Agricultural science and technology parks work closely with local governments and rural communities to promote modern agricultural technology and management methods, which significantly improves the knowledge and technology level of farmers, and effectively promotes regional economic development through industrial agglomeration and economic diffusion to drive the employment of farmers, and promotes the growth of farmers' income.^{Error! Reference source not found.} It also promotes the growth of farmers' incomes.^{Error! Reference source not found.} It has also improved the living standards of farmers in neighbouring rural areas.^{Error! Reference source not found.} The programme has also improved the standard of living of the neighbouring rural farmers.

Research on the impact of agro-technology parks on agro-ecology focuses on technological innovation and chemical input intensity. Innovative measures in agricultural science and technology parks can effectively improve the quality of agroecology, through effective interaction between farmers, researchers and agricultural extension workers.^[9] The innovation measures of agricultural science and technology parks can effectively improve the quality of agroecology through the effective interaction between farmers, researchers and agricultural extension workers, combining with the welfare of government policies, accelerating the transformation of scientific and technological achievements and green transformation.^[10] The researchers' efforts to improve the efficiency of agricultural production and reduce unnecessary production burdens can play a model role in the ecological development of the neighbouring regions.^{Error! Reference source not found.} In addition, the agricultural science and technology parks are based on the understanding of the needs of the surrounding areas. In addition, based on the analysis of production demand, the Agricultural Science and Technology Park accurately calculates the demand for chemicals and controls the level of chemical inputs, so as to promote the growth of agricultural economic benefits and at the same time ensure the sustainable development of agro-ecology.^[12] Through the adoption of green production technologies, such as recycled agriculture, organic agriculture, and^{Error! Reference source not found.} By adopting green production techniques, such as recycling agriculture, organic agriculture and precision agriculture, the parks can reduce chemical inputs and alleviate the burden on agro-ecology.^{Error! Reference source not found.} The agricultural science and technology parks can reduce chemical inputs and reduce the ecological burden on agriculture by adopting green production technologies such as recycling agriculture, organic agriculture and precision agriculture. Therefore, agricultural science and technology parks can address the challenge of declining ecological quality in agricultural production through scientific planning and management, as well as the introduction of smart technologies.^{Error! Reference source not found.} The following is a summary of the findings of the study.

Since Ren Jizhou first proposed the concept of "agro-ecological economic system" in 1999, a large number of scholars have devoted themselves to measuring the level of coordinated development of agro-ecology and economy.^[15] Since Ren Jizhou first put forward the concept of "agroecological economic system" in 1999, a large number of scholars have been devoted to measuring the level of coordinated development of agroecological economy and exploring factors affecting the coordinated development of agroecological economy. In terms of

measuring the level of coordinated development of agroecology and economy, scholars start from the perspective of large-scale agriculture, and believe that large-scale agriculture is a synthesis of agricultural subsystems such as agriculture, forestry and animal husbandry, and that through its optimal integration, it can form an agricultural system that coexists with sustainable development and efficient use.^{Error! Reference source not found.} Under this theoretical framework, a basic and extended model for coupling agroecology and agroecology was developed^{Error! Reference source not found.} that aim to quantitatively measure the degree of interaction and coordination between agroecology and agroecology. Some scholars have also measured the level of coordinated development by the degree of coupling coordination from the perspective of physics^{Error! Reference source not found.}. There are multiple perspectives in scholars' research in studying the factors influencing the coordinated development of agroecology and economy. Generally speaking, agricultural water-saving irrigation efficiency, agricultural output per unit area, labour output and reduction of energy consumption per unit output value are the main factors affecting the coordinated development of agroecology economy^{Error! Reference source not found.}. Technological innovation and resource allocation are the key factors affecting the coordinated development of agroecological economy.^[12] Technological innovation and resource allocation are the key factors affecting the coordinated development of agroecological economy. In addition, green industry development policies and sustainability strategies also play an important role in promoting coordinated agroecological economic development.^{Error! Reference source not found.} The following are some of the key factors affecting the coordinated development of agro-ecological economy.

Agricultural science and technology parks have a certain role in the healthy and stable development of agricultural ecosystems, but the existing literature on agro-ecology research is mainly based on qualitative analyses, and there are certain results in the academic community for the research of agricultural science and technology parks on a single agro-economy or agro-ecology, while there is still room for research on coordinated agro-ecological and economic development. Based on this, this paper intends to do further research and discussion from the following aspects: First, this paper tries to construct a reasonable evaluation index system of Hebei Province agroecological economic coordination according to the characteristics of agricultural production in Hebei Province, taking into full consideration of the agricultural resources and ecological constraints in Hebei Province, and use the coupled coordination degree model to scientifically measure the coordinated development of agroecological economy in Hebei Province. Secondly, this paper considers the national agricultural science and technology park as a quasi-natural experiment, uses the multi-period DID model to accurately identify the impact of the national agricultural science and technology park on the coordinated development of Hebei Province's agricultural ecology and economy, and researches the role of scientific and technological innovation and the intensity of chemical inputs in the mechanism. Third, the regional differences in the national agricultural science and technology parks' promotion of the coordinated development of Hebei Province's agricultural ecology and economy are explored. According to the ecological demand for agricultural production activities in different ecological function zones, the National Agricultural Science and Technology Parks will be guided to function more efficiently

2.0 Theoretical analysis and research hypothesis

Given the characteristics of agricultural production in Hebei Province, the establishment of the National Agricultural Science and Technology Park is particularly important. The National Agricultural Science and Technology Park can not only carry out long-term operations in the local area to ensure the high efficiency and stability of local agricultural production, but also

provide scientific and feasible solutions to the problems of agricultural production, and provide reference examples for the realisation of the dual goals of economic efficiency and ecological environmental protection. For the agricultural economy, advanced science and technology can help agricultural production activities to complete the "quality upgrade", for example, by improving the "breeding" technology to improve the quantity and quality of agricultural products; for agro-ecology, the role of science and technology innovation is reflected in the "efficient maintenance" of the agro-ecological environment. For agro-ecology, the role of science and technology innovation is reflected in the "efficient maintenance" of agro-ecological environment, through the scientific management of water resources, soil, ecological environment and other factors in the production process, to reduce the excessive dependence on natural resources and loss of agricultural production activities, so as to reduce the pressure on the ecological environment. In summary, the establishment of the National Agricultural Science and Technology Park may have a certain effect on the coordinated development of the agricultural ecological and economic system in Hebei Province, based on the above analysis, this paper puts forward hypothesis 1.

Hypothesis 1: The National Agricultural Science and Technology Park can effectively promote the coordinated development of agro-ecological economy in Hebei Province.

Science and technology innovation is both a direct driver of agricultural economic growth and a key factor in promoting agro-ecological development. The National Agricultural Science and Technology Park itself has certain characteristics of aggregation and diffusion, and through the introduction of high and new technology, it drives the improvement of regional agricultural production technology level^{Error! Reference source not found.} and improve the efficiency of agricultural production and product quality to promote the growth of agricultural economy in Hebei Province.^{Error! Reference source not found.} At the same time, as the standard of living continues to improve, the agricultural economy of Hebei Province is growing. At the same time, with the continuous improvement of living standards, the market demand for high-quality green agricultural products increases. National Agricultural Science and Technology Parks screen and optimise new green agricultural production methods, improve product quality and reduce production costs through standardised production, effectively reduce the ecological burden of agricultural production activities, and promote the coordinated development of ecological and economic benefits. Based on the above analysis, this paper puts forward hypothesis 2.

Hypothesis 2: The National Agricultural Science and Technology Park promotes the coordinated development of the agro-ecological economy in Hebei Province mainly by improving the level of innovation.

In modern agricultural production, reducing chemical inputs such as fertilisers and pesticides is essential to safeguarding the agro-ecological environment. The scientific calculation of chemical input intensity in the National Agricultural Science and Technology Park can reduce the negative impact on the agro-ecological environment, thus realising the coordinated development of the agro-ecological economy in Hebei Province. On the one hand, reasonable chemical input intensity can effectively improve agricultural production efficiency. Through scientific calculation of chemical fertilisers, pesticides and other chemicals, the National Agricultural Science and Technology Park can improve the quality and yield of crops while preventing and controlling pests and diseases, effectively improve the efficiency of chemical use, and promote the growth of agricultural economy. On the other hand, reasonable control of chemical input intensity helps protect biodiversity. The reduction of chemical input intensity reduces the potential pollution to the environment and reduces the degree of damage to the

biological living environment, which plays a key role in safeguarding biodiversity and maintaining the agro-ecological environment. This reasonable chemical use strategy promotes the efficient operation of the agricultural economy while helping to restore the ecological environment, thus promoting the coordinated development of agro-ecological economy. Therefore, the establishment of national agricultural science and technology parks can promote the coordinated development of agroecological economy to a certain extent by reasonably controlling the intensity of chemical inputs. Based on the above analysis, this paper proposes hypothesis 3.

Hypothesis 3: The National Agricultural Science and Technology Park promotes coordinated agro-ecological and economic development in Hebei Province mainly by reducing chemical input intensity.

As an important reference for evaluating and guiding ecological environmental protection and rational use of resources, ecological functional zones play a key role in the overall planning and management of national agricultural science and technology parks. The "14th Five-Year Plan" of Hebei Province for the Construction of Beijing-Tianjin-Hebei Ecological Environment Support Zone divides the province into five major ecological functional zones, each of which has different ecological functions and development objectives, and has different functional requirements for agricultural science and technology parks. The Ecological Transition Zone around Beijing and Tianjin focuses on the provision of ecological space security; the Damshang Plateau Ecological Protection Zone focuses on windbreaks, sand fixation and water conservation; the Yanshan-Taipei Ecological Protection Zone and the Low Plains Ecological Restoration Zone focus on soil and water conservation, water conservation and ecological protection of farmland; and the Coastal Ecological Protection Zone is concerned with marine ecological services and ecological security. Different parks can carry out specific planning according to the characteristics of the ecological functional zones to which they belong, cross-fertilising the scientific and technological outputs of agricultural science and technology parks with the functions of the ecological functional zones. For example, the parks in the Low Plains Ecological Restoration Zone are more focused on restoring and constructing agro-ecological environments, including promoting the protection of biodiversity, the remediation of contaminated land and the recycling of agricultural waste. Therefore, due to the differences in natural resources and main functions of each ecological functional zone, as well as the demand for specialised science and technology, the impact of parks in different ecological functional zones on the level of coordinated agroecological and economic development in Hebei Province may differ. Based on the above analysis, this paper proposes hypothesis 4.

Hypothesis 4: The effect of the National Agricultural Science and Technology Park on the coordinated development of Hebei Province's agroecology and economy may differ in different ecological functional areas.

3.0 Modelling, indicator construction and data sources

3.1 The DID model

In this paper, the pilot of the National Agricultural Science and Technology Park in Hebei Province is regarded as a quasi-natural experiment, and a double difference model is constructed. Since the policy is to gradually expand the pilot scope in batches, a multi-temporal double-difference model is constructed to scientifically assess the implementation effect of the

policy and effectively identify the impact of the National Agricultural Science and Technology Park on the coordinated development of Hebei Province's agro-ecological economy:

$$Dac = \alpha_1 + \beta_1 did_{it} + \delta_1 x_{it} + \gamma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

In equation (1), the Dac is the degree of coordination of agro-ecological-economic coupling; did_{it} is the dummy variable; x_{it} is the control variable; β_1 is the double difference statistic capturing the impact of the national agricultural science and technology park on the degree of coupled agro-ecological and economic coordination in Hebei Province. If $\beta_1 > 0$ and significant, it indicates that the establishment of the National Agricultural Science and Technology Park promotes the coordinated development of agro-ecology and agro-economy in Hebei Province; if $\beta_1 < 0$ and significant, it proves that the establishment of national agricultural science and technology parks hinders the coordinated development of agroecology and agricultural economy in Hebei Province; if β_1 not significant, it proves that the establishment of national agricultural science and technology parks has no direct effect on the coordinated development of agroecology and agricultural economy in Hebei Province; γ_i for area fixed effects; γ_t is the time fixed effect; ε_{it} is the random perturbation term.

$$did_{it} = \begin{cases} 1 & \text{Region } i \text{ was first designated as NASPs in year } t \\ 0 & \text{Region } i \text{ has not been recognized as NASPs in year } t \end{cases} \quad (2)$$

Depending on whether a national agricultural science and technology park is established within the region, the did_{it} defined as a binary variable: if the area i is recognised as a national agricultural science and technology park in the first t year a national agricultural science and technology park is recognised, then a value of 1 is assigned for that year and thereafter (i.e., the treatment group), and vice versa for 0 (i.e., the control group). Since there may be regions i There may be more than one national agricultural science and technology parks in the region, so this paper takes the first recognition of national agricultural science and technology parks in the region as the criterion, and assigns values to did_{it} assigning values.

3.2 Construction of the indicator system

This paper attempts to quantitatively analyse the degree of coordinated development of agro-ecological economy in Hebei Province by studying the dynamic data from 2007 to 2021, and measuring the degree of coupling between agro-economic and agro-ecological indicators through the coupled coordination model. At present, the evaluation system of the coordinated development level of agroecology and economy usually includes indicators such as agricultural output value and water resources, but due to the differences in climate and resource endowment in different regions, this paper refers to the practice of Yang et al.^[23] Error! Reference source not found. experts, according to the resource status and data availability of Hebei Province, based on the agro-ecological and economic development of Hebei Province, 14 index parameters were finally determined, and the weights of each index were calculated using StataMP17.0 software, as shown in Table 1.

Tab.1 Evaluation Indicator System for the Level of Coordinated Agricultural "Ecology-Economy" Development in Hebei Province

name	normative layer	indicator layer	Indicator properties	Indicator weights
agro-ecology	Agro-ecological stress	population density	-	0.019
		Fertiliser application rate	-	0.009

	Pesticide application rate	-	0.009
	Agricultural plastic film use	-	0.009
Agricultural production activities	Crop sown area	-	0.009
	Effective irrigated area	-	0.027
Energy efficiency	Energy efficiency	+	0.330
	Electricity for agricultural production	-	0.010
Agricultural economic output	Gross output value of agriculture, forestry, livestock and fisheries	+	0.073
Agricultural economy	grain production	+	0.061
	Per capita disposable income of farmers	+	0.057
Gains from agricultural labour	labour productivity	+	0.105
Productive resource utilisation	Rural electricity consumption	+	0.202
	Gross power of agricultural machinery	+	0.080

The indicator system contains 2 subsystems of agroecology and agroecology, 6 secondary indicator guideline layers, and 14 indicators. The "agroecology" contains three indicators of ecological pressure, agricultural production activities and resource use efficiency. In "agroecology", population, agricultural activities and chemicals may cause ecological pressure on agroecosystems, and agroecological activities such as planting and irrigation, and the efficiency of diesel fuel and electricity use may affect the ecological environment to a certain extent, so these 8 indicators are selected as indicators for evaluating the "agroecology" of . The indicators of "agroecology" . The "agro-economy" consists of three normative indicators: agricultural output, agricultural labour income, and efficiency of production resource use. Specifically, the output value of food and agriculture, forestry, animal husbandry and fishery is the agricultural output brought by agricultural production activities; the agricultural labour income includes the labour income of farmers and agricultural employees in the process of agricultural production, all of which are closely related to the agricultural economy; and the efficiency of the use of resources, such as the rural electricity consumption and the total power of agricultural machinery in the process of agricultural production, directly affects the agricultural productivity, thus affecting the output of the agricultural economy. Therefore, these six indicators have been selected to measure the "agricultural economy".

3.3 Calculation of the degree of coupling coordination

Degree of agro-ecological and economic coupling and coordination: measured by the coupling and coordination model. The concept of coupling originates from physics and is used to measure the closeness of interrelationships between entities, reflecting at once the degree of dependence on interactions and the constraints between them. Therefore, in this study, the coupling degree model of "agro-ecology" and "agro-economy" is established, and its calculation formula is as follows:

$$C = 2 \sqrt{\frac{U_1 U_2}{(U_1 + U_2)^2}} \quad (3)$$

In equation (3), C is the degree of coupling between agroecology and agroecology, and U_1 C is the coupling degree between agroecology and agroecology, agroecological level, agroecological level. U_2 The value of C is [0, 1], the larger the value of C, the higher the degree of coupling between "agro-ecology" and "agro-economy". Although the coupling degree can

show the strength of the coupling effect, it is difficult to analyse the degree of coordination between the system elements in depth. In order to assess the level of coordination between system elements, it is necessary to construct a coupling coordination degree model. The formula for calculating the degree of coupling coordination is as follows:

$$T = \alpha U_1 + \beta U_2 \quad (4)$$

$$Dac = \sqrt{CT} \quad (5)$$

Equation (4) (5): T is the comprehensive reconciliation index between "agroecology" and "agroecology", α and β are the coefficients of agroecology and agroecology to be determined, this paper considers that agroecology and agroecology are equally important, and therefore sets $\alpha = 0.5$; α and β are the coefficients to be determined. $\beta = 0.5$; Dac The coupling coordination degree between agroecology and agroecology.

3.4. Descriptive statistics

This article aims to explore in depth the impact of national agricultural science and technology parks on the coordinated development level of agricultural ecology and economy in Hebei Province. Therefore, the coupling coordination degree of agricultural ecology and agricultural economy is selected as the dependent variable, and the establishment of national agricultural science and technology parks is selected as the core explanatory variable. When studying policy effects, in order to more accurately extract the policy effects of national agricultural science and technology parks, and comprehensively evaluate the contribution of national agricultural science and technology parks to the coordinated development of agricultural ecological economy, drawing on the research of Sun Qingru ^[25] and Li Yuping ^[26], the local mechanization level of agricultural machinery total power is selected. The higher the total power of agricultural machinery, the higher the local mechanization level; Selecting the sowing area of crops to measure the local land use level, the larger the sowing area of crops, the higher the land use level; Select the ratio of the output value of the primary industry to the total output value to measure the level of local industrial structure. The smaller the ratio value, the higher the level of industrial structure; Selecting per capita gross domestic product to measure the living standards of local people, the higher the per capita gross domestic product, the higher the people's living standards; Selecting agricultural practitioners to measure the local agricultural labor force level, which reflects the local employment structure; Selecting the total output value of agriculture, forestry, animal husbandry and fishery as a representative of the local agricultural economic level, the higher the total output value of agriculture, forestry, animal husbandry and fishery, the higher the agricultural economic level; Selecting agricultural carbon emission intensity to measure agricultural ecological level, the higher the agricultural carbon emission intensity, the lower the agricultural ecological level. At the same time, this paper explores the mechanism of the role of national agricultural science and technology parks in the coordinated development of agricultural ecology and economy in Hebei Province from the perspectives of ecological technology and technological innovation. The local ecological technology level is measured by the intensity of chemical input, and the lower the intensity of chemical input, the higher the local ecological technology level; The level of technological innovation is measured by the number of technology patent applications. The higher the number of patent applications, the better the level of technological innovation. The above variables, except for the dependent variable, core explanatory variable, industrial structure and ecological technology level, and chemical input intensity, have all been logarithmically processed. The specific indicator names and meanings are shown in Table 2.

3.5. Data sources

The research sample of this paper is the panel data of 137 districts and counties in Hebei Province from 2007 to 2021. Individual districts and counties cannot reasonably count the relevant variables due to the change of geographic divisions, for which the data exclusion process is carried out. The list of national agricultural science and technology parks and the time of establishment were obtained from the Ministry of Science and Technology of the People's Republic of China. The carbon emission intensity of agriculture is mainly based on the narrow sense of agriculture (plantation) as the research object to measure the carbon emission intensity of agriculture in Hebei Province. The data of other variables are mainly from the Rural Statistical Yearbook of Hebei Province, the Statistical Yearbook of China's Counties, the Statistical Yearbook of China's Population and Employment, and the Statistical Yearbooks of the cities in Hebei Province, and the missing data are supplemented by interpolation method.

Tab.2: Results of descriptive statistics

typology	name	notation	Measurement methods	average value	standard deviation	maximum values	minimum value
explanatory variable	Agricultural "ecology-economy" degree of coupling coordination	Dae	Indicator system composite index Calculation of the degree of coupling coordination	0.130	0.046	0.410	0.000
Core explanatory variables	Establishment of national agricultural science and technology parks	Did	Dummy variables and the National Agricultural Science and Technology Park Interaction Project	0.093	0.290	1.000	0.000
	Level of agricultural economy	Lae	Gross output value of agriculture, forestry, livestock and fisheries	2.535	0.049	2.667	2.361
	mechanisation level	Gam	Gross power of agricultural machinery	2.537	0.198	2.700	0.994
control variable	Level of land use	Csa	Crop sown area	2.378	0.060	2.627	1.875
	Level of industrial structure	Ils	Primary sector output/total output	0.308	0.015	0.370	0.267
	people's standard of living	Eco	GNP per capita	2.321	0.058	2.507	2.136
	Level of agricultural labour force	Laf	Agricultural workers	2.493	0.038	2.565	2.299
	Agro-ecological level	Cin	Carbon intensity of agriculture	4.643	1.046	7.768	0.000
intermediary variable	Chemical input intensity	Aci	(Fertiliser application + pesticide application + agricultural plastic film use)/area sown under crops	8.211	0.594	12.490	4.722
	Level of technological innovation	Tec	Number of science and technology patent applications	2.191	1.242	5.938	0.095

4.0 Empirical results and analyses

4.1 Analysis of the degree of coordination of agro-ecological and economic coupling in Hebei province

As can be seen from Fig. 1, the overall trend of changes in the degree of coordination of agricultural "ecology-economy" coupling in Hebei Province over the years is "up", that is to say, the coordinated development of agricultural ecology and economy in Hebei Province is generally in a good state. Specifically, in Figure 1, there was a certain decline in 2015, and the degree of modern agricultural development in Hebei Province reached 69.2% in 2015, which is a great improvement in the level of agricultural modernisation in order to adapt to the new normal of economic development, actively integrate into the Beijing-Tianjin-Hebei synergistic development pattern, and promote the modernisation of agriculture, and explore the potential of agricultural production. However, according to Lu Dongshan^{Error! Reference source not found.} and Wang Jia^{Error! Reference source not found.}'s study, Hebei Province experienced a certain degree of ecological degradation in 2015, possibly due to the rapid increase in modernisation levels, which led to an increase in the use of agricultural machinery and an increase in the amount of chemical inputs. This not only increases the cost of managing environmental degradation, but also may have led to a slight decrease in the degree of coordination of agricultural "ecology-economy" coupling in Hebei Province in 2015. According to Song Jian^[28]'s study, in 2017, Hebei Province's major pollutant emissions rose sharply, and in order to alleviate the contradiction between economic growth and ecological protection, the state strictly supervised and managed agricultural production, striving to achieve zero growth in chemical fertiliser and pesticide use, so after 2017, the degree of coordination of Hebei Province's agricultural "ecology-economy" coupling had a steady increase. After 2017, the degree of coordination of agricultural "ecology-economy" coupling in Hebei Province has been steadily improved.

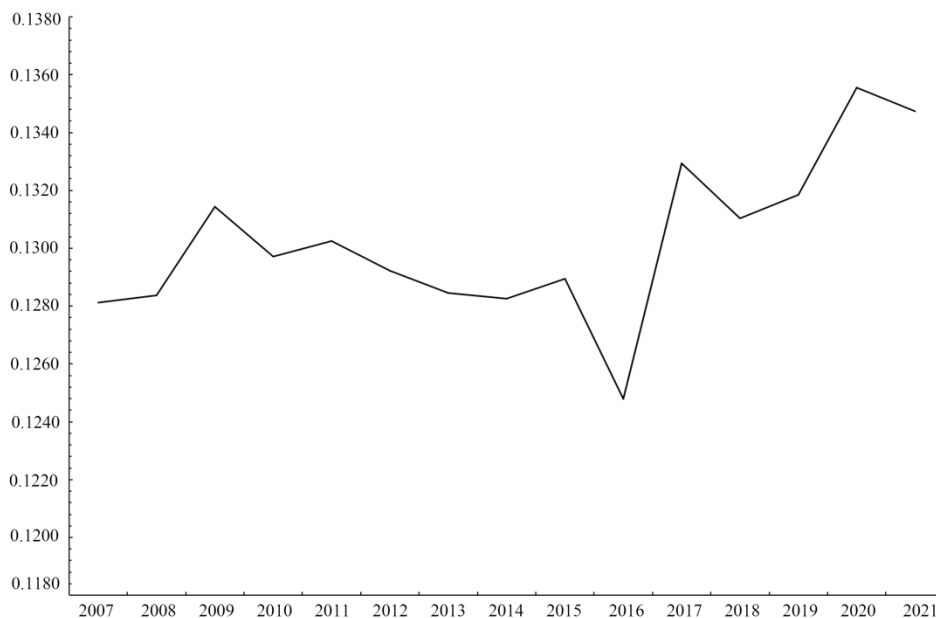


Fig. 1: Trends in the degree of coordination of agricultural "ecology-economy" coupling by region in Hebei Province over the years

4.2 Benchmark regression analysis

In this study, before the benchmark regression, Hausman test was conducted on the sample of articles, through the results of the test, it can be seen that the fixed effect model is more suitable for this study compared to the random effect model, so columns (1) and (2) are further analysed by using the two-way fixed effect model of region and year to analyse the study. It was found that the baseline regression results were significantly positive, with estimated coefficient values of 0.010 and 0.008 for columns (1) and (2) respectively, and the regression results were significant at the 1% and 5% levels, respectively. The result shows that the national agricultural science and technology park can not only significantly promote the level of coordinated development of agricultural ecology and economy in Hebei Province, but also under the full consideration of the level of agricultural economy, mechanization level, land use level, industrial structure level, people's living standard, agricultural labour force level, and the intensity of agricultural carbon emissions, the effect of the national agricultural science and technology park on the level of coordinated development of agricultural ecology and economy in the region of Hebei Province is about 0.80%, so hypothesis 1 is established.

Tab.3: Benchmark regression results

variant	Explanatory variables: degree of coordination of agricultural "ecological-economic" coupling <i>Dae</i>	
	(1) Fixed effects	(2) Fixed effects
Establishment of agricultural science and technology parks Did	0.010*** (0.003)	0.008** (0.003)
Gross output value of agriculture, forestry, livestock and fisheries Lae		-0.301*** (0.037)
Gross power of agricultural machinery Gam		0.045*** (0.012)
Crop sown area Csa		0.176 (0.402)
industrial structure Ils		0.022 (0.182)
economic level Eco		-0.319 (0.228)
Agricultural workers Laf		0.132 (1.902)
Carbon intensity of agriculture Cin		-0.002 (0.001)
Constant	0.128*** (0.002)	1.083 (0.674)
R ²	0.024	0.097
Number of id	137	137
Year fix	YES	YES
idfix	YES	YES

Note: *, **, *** indicate 10, 5 and 1 per cent significance levels, respectively.

4.3. Parallel trend analysis with placebo test

4.3.1. Parallel trend test

The prerequisite for assessment using the multi-period double difference model is to satisfy the parallel trend assumption, i.e. it is assumed that the experimental and control groups had the same trend of change prior to the implementation of the policy, so the event study method was applied to test the data for a parallel trend, as modelled below:

$$Dae = \alpha_2 + \sum_{t=-5}^{t=5} \beta_t did_{it} + \delta_2 x_{it} + \gamma_i + \gamma_t + \varepsilon_{it} \quad (6)$$

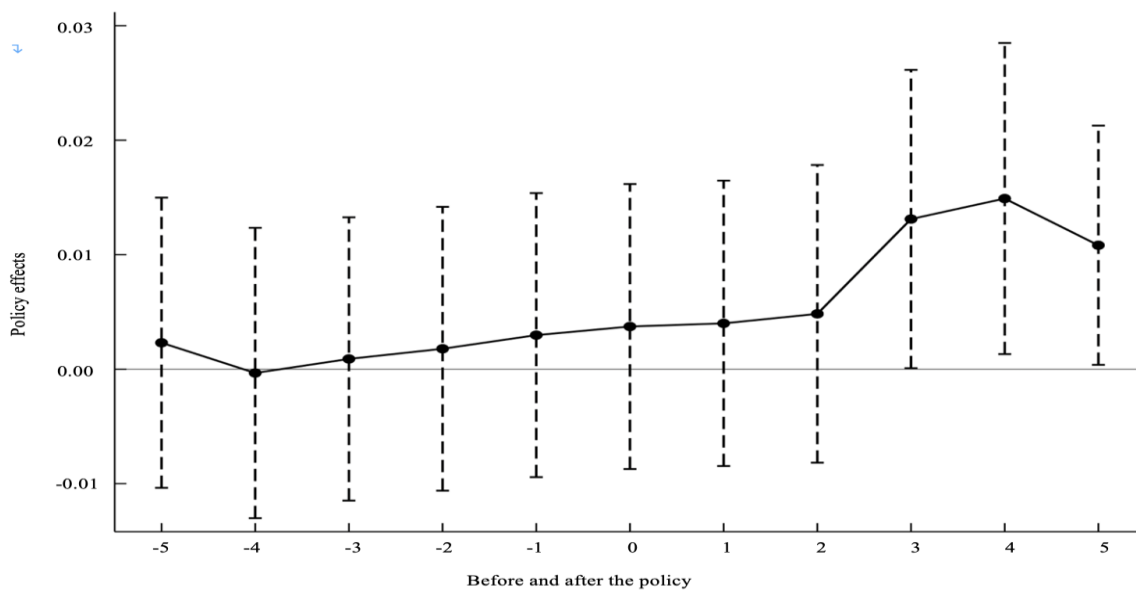
where did_{it} is the interaction term between treatment group and year before and after policy implementation. β_t is the first year of the establishment of the national agricultural science and technology parks t difference in the degree of coordination of agro-ecological-economic coupling between the experimental group and the control group in the year, and the meanings of the rest of the variables are the same as before.

In the model (6) of this study, the parallel trend assumption uses 2010, the year of policy implementation, as the base group, to verify that the experimental group and the control group possess the same trend of change before the establishment of the National Agricultural Science and Technology Park. Figure 2 visualises the trend of the estimated coefficients for the establishment of the National Agricultural Science and Technology Park at 95% confidence interval. From the results, it can be seen that the estimated coefficients before the establishment of the National Agricultural Science and Technology Parks almost always contain zero at the 95% confidence interval, i.e., the estimated coefficients are not significantly different before the implementation of the policy. After the establishment of the National Agricultural Science and Technology Park, the confidence intervals of the estimated coefficients basically do not contain the value of 0 except in the first year, indicating that the estimated coefficients are significantly different after the implementation of the policy, while the coefficients of the National Agricultural Science and Technology Park start to become significant after 2011, indicating that the policy effect starts to appear in the 2nd year of the establishment of the park, which indicates that the establishment of the National Agricultural Science and Technology Park has a certain lag in the coordinated development of the agro-ecology and the economy of Hebei Province. This indicates that there is a certain lag effect in the promotion of the national agricultural science and technology park on the coordination of agroecology and economic development in Hebei Province. This may be due to the fact that the national agricultural science and technology park may have certain problems such as lack of funds, difficulty in introducing talents, and unsound management system at the early stage of establishment, which makes it difficult to exert the policy effect in a timely manner at the early stage of establishment, and with the improvement of the policy, the policy effect of the park is also gradually revealed. As can be seen from Figure 2, the establishment of the National Agricultural Science and Technology Park has gradually promoted the coordinated development of the agro-ecological economy in various regions of Hebei Province.

4.3.2. Placebo test

In order to test that the driving effect of the National Agricultural Science and Technology Park on the coordinated development of Hebei Province's agro-ecological economy is real and reliable rather than influenced by unobserved random factors, this study constructs a counterfactual event for the placebo test. In this paper, 50 regions are randomly selected as experimental groups, and individual policy time points of each experimental group are

randomly screened to generate the interaction term of the pseudo-virtual policy, and then the above process is repeated 500 times to get the coefficient estimation of the random samples, and to construct the kernel density distribution graph. As can be seen from Figure 3, the kernel density distribution plot of random samples is normally distributed with $X=0$ as the symmetry axis, the estimated coefficients of the pseudo-virtual policies are distributed around 0, and the P-value of most of the estimated coefficients lies above 0.1. The vertical dashed line $X=0.1$ in Figure 3 is the true baseline regression estimated coefficient, and there are almost no results where the pseudo-estimated coefficients are larger than the true estimated coefficients, so there is no significant estimation error due to omitted variables, and the regression results are robust and reliable.



Note: The solid dots in the figure are the estimated coefficients of equation (2) β_t , and the short vertical lines are the 95% upper and lower confidence intervals corresponding to the cluster-to-district robust standard errors.

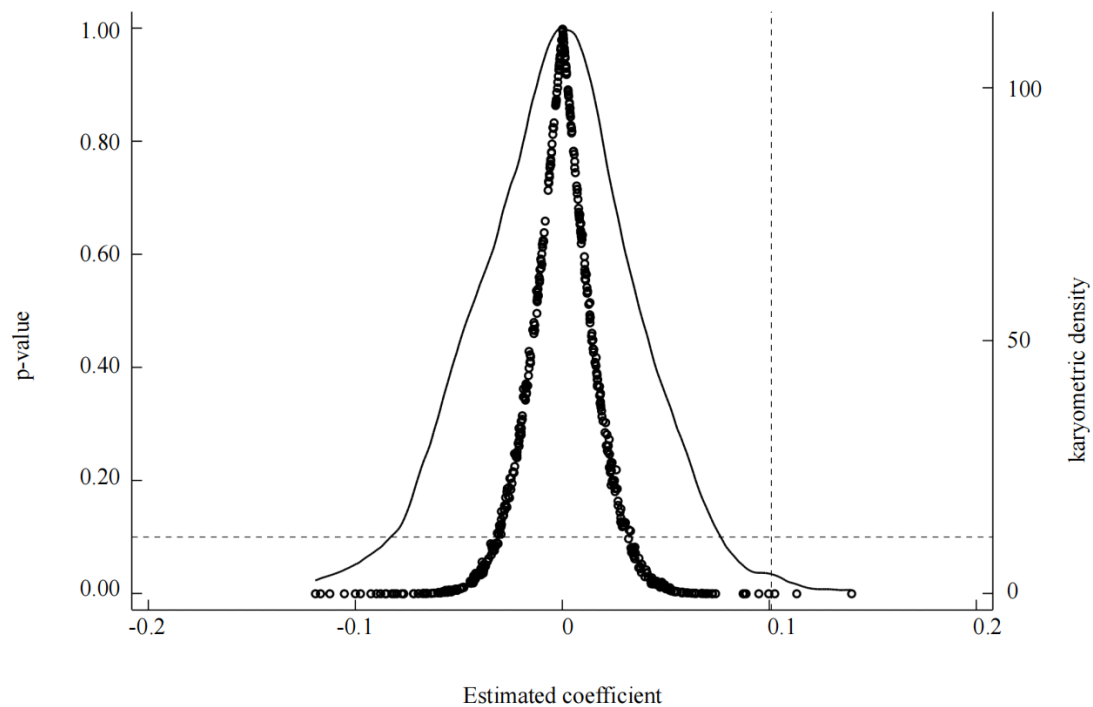


Fig. 3 Placebo test results

4.3.3. PSM-DID Matching

In order to reduce the error of regression results caused by the sample self-selection problem, this study draws on the Hu Zhaolian^{Error! Reference source not found.} et al. PSM-DID to further test the impact of the construction of the National Agricultural Science and Technology Park on the coordinated development of Hebei Province's agricultural ecology and economy. Firstly, all control variables such as gross output value of agriculture, forestry, animal husbandry and fishery, total power of agricultural machinery, sown area of crops, and industrial structure were selected as covariates. Second, a Logit model was used to calculate the trend score for each region. Third, 1:1 nearest-neighbour matching is performed using PSM sample matching method to overcome the effect of sample self-selection bias. Fourth, the matching results were analysed to remove observations that were not in the standard support domain. Finally, regression is performed on the matched samples. The results of propensity score matching are shown in Figures 4 and 5. According to the results in Figure 4, it can be seen that the standardised deviations of most variables are relatively large before matching, while the standardised deviations have become smaller after the samples are matched. As shown in Figure 5, the kernel density functions of the experimental and control groups after satisfying the randomised experiment requirements for matching almost overlap, and the matching results are good.

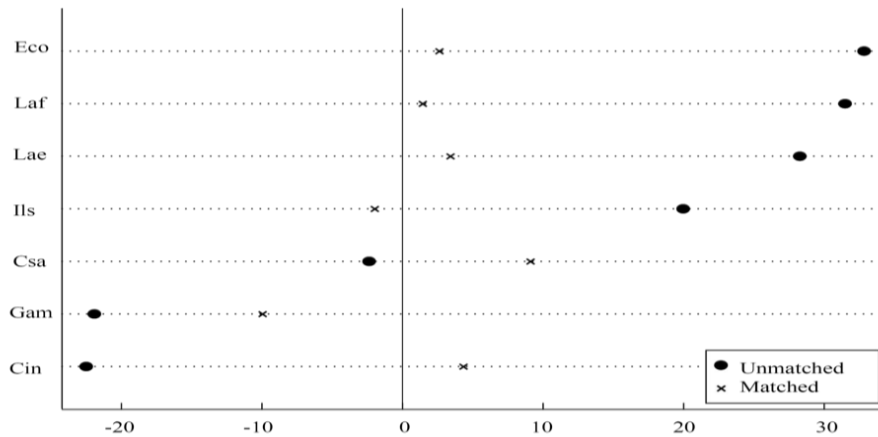


Fig. 4: PSM Matching Scatterplot

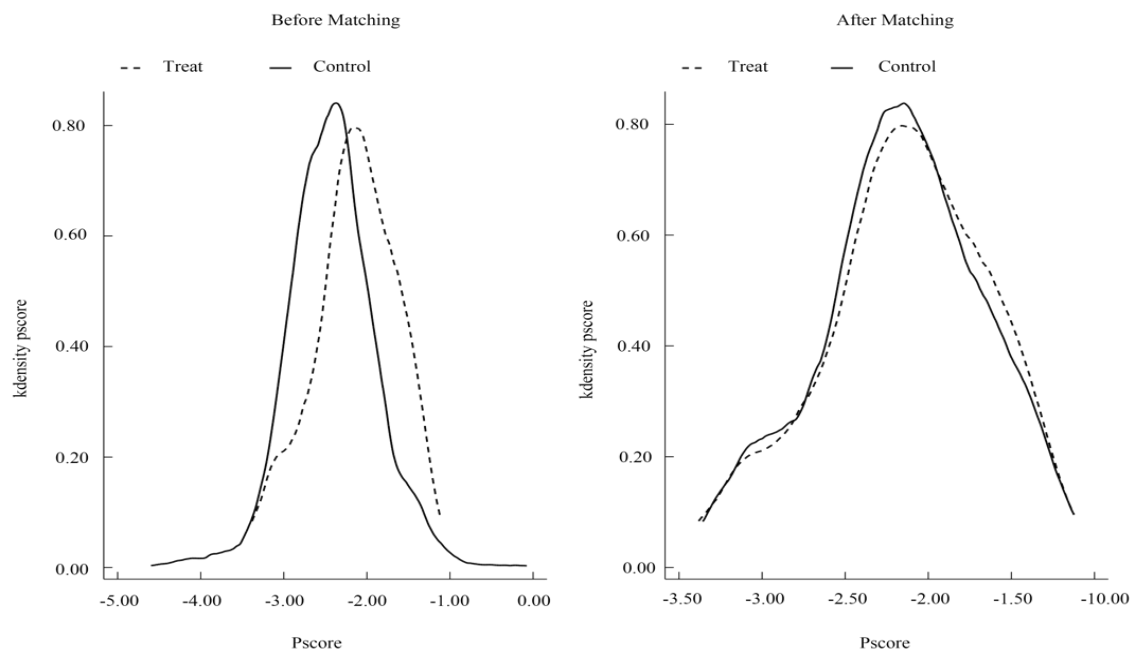


Fig. 5: Kernel density results before and after PSM matching

4.3.4. Robustness Tests

The results of the benchmark regression indicate that the establishment of the National Agricultural Science and Technology Park has a significant promotion effect on the coordinated development of the agro-ecological economy in Hebei Province. In order to ensure the reliability of the benchmark regression results, this paper conducted a robustness test using two methods: k nearest neighbour matching within caliper and sample data screening.

The premise assumption of the double difference model is that the experimental group and the control group have homogeneity, however, in the real situation, the establishment of national agricultural science and technology parks is not random, but is established under the comprehensive consideration of the policy orientation, geographic location, the demand for the development of the agricultural industry, the economic background, and the demand for scientific and technological innovation. Therefore, there may be some differences between the control group and the experimental group, so this paper adopts the PSM-DID method to match

each experimental group with a control group that has similar characteristics to its resource endowment, and further analyses the impact of the National Agricultural Science and Technology Park on the degree of coordination of the agro-ecological-economic coupling in Hebei Province. The results are shown in column (1) of Table 4, and the estimated coefficient values are all significant at the 5% level, indicating that the establishment of the National Agricultural Science and Technology Park indeed has a driving effect on the level of coordinated agro-ecological and economic development in Hebei Province.

Tab.4: Robust type test results

variant	(1) PSM match	(2) Shrinkage 1 per cent	(3) Truncated 1 per cent	(4) Shrinkage of 5 per cent	(5) Truncated 5 per cent
Establishment of agricultural science and technology parks Did	0.008** (0.003)	0.008*** (0.003)	0.008*** (0.002)	0.006*** (0.002)	0.0045** (0.002)
Gross output value of agriculture, forestry, livestock and fisheries Lae	-0.303*** (0.037)	-0.298*** (0.032)	-0.326*** (0.028)	-0.242*** (0.025)	-0.2445*** (0.025)
Gross power of agricultural machinery Gam	0.045*** (0.012)	0.040*** (0.011)	0.146*** (0.019)	0.025*** (0.008)	0.1082*** (0.017)
Crop sown area Csa	0.172 (0.402)	0.133 (0.347)	-0.098 (0.311)	-0.293 (0.270)	-0.7223*** (0.261)
industrial structure Ils	0.025 (0.182)	0.033 (0.157)	0.124 (0.141)	0.204* (0.122)	0.3842*** (0.118)
economic level Eco	-0.318 (0.228)	-0.196 (0.197)	0.047 (0.176)	0.154 (0.154)	0.4400*** (0.149)
Agricultural workers Laf	0.160 (1.902)	0.330 (1.640)	1.431 (1.469)	2.201* (1.279)	4.1931*** (1.236)
Carbon intensity of agriculture Cin	-0.002 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.000 (0.001)	0.0015 (0.001)
Constant	1.082 (0.674)	0.787 (0.581)	-0.042 (0.522)	-0.190 (0.453)	-1.1629*** (0.442)
R ²	0.098	0.116	0.167	0.132	0.169
Observations	2,051	2,051	2,012	2,051	1,848
yearfix	YES	YES	YES	YES	YES
idfix	YES	YES	YES	YES	YES

Note: *, **, *** indicate 10, 5 and 1 per cent significance levels, respectively.

There may be extreme values in the sample data that affect the baseline regression results, in order to prevent the model from overfitting in the tails and to make it better fit the overall data distribution without the interference of outliers, this study deals with the outliers and outliers through the shrinking-tailed and truncated-tailed methods. The results of the study are shown in Table 4, columns (2) to (3), the estimated coefficients are both 0.008 in the case of shrink-tailed 1% and truncated 1%, and the regression results are all significant at 1% level, which indicates that the promotion effect of the National Agricultural Science and Technology Park on the coordinated development of the agro-ecology and economy of Hebei Province is robust in the case of shrink-tailed and truncated treatment of 1% extreme values. Columns (4) and (5) show that the estimated coefficients are 0.008 and 0.006 in the case of shrinking and truncating 5%, and the regression results are significant at the 5% and 1% levels, indicating that the promotion effect of the National Agricultural Science and Technology Parks on the coordinated

development of the agro-ecological economy of Hebei Province is robust under the shrinking and truncation of the 5% extremes.

4.3.5. Analysis of intermediation effects

National agricultural science and technology parks usually have strong technological innovation capacity, focus on the research and development and application of green agricultural technology, reduce the burden on the ecological environment, and promote the coordinated development of the agro-ecological economy of the region under the circumstance of ensuring the bottom line of the ecological environment. On the one hand, national agricultural science and technology parks have a greater capacity for innovation and output, and the improvement of the level of technological innovation can not only improve the efficiency of agricultural production, but also promote the efficient use of resources, and realise the supervision of the agro-ecological environment, so as to promote the coordinated development of agro-ecology and the economy of the region in which the park is located. On the other hand, national agricultural science and technology parks can strictly control the intensity of chemical inputs. The use of chemicals in the process of agricultural production will directly affect the agro-ecological environment, as well as the sustainability of agricultural production, and the reasonable control of chemical input intensity can help to balance the relationship between the economic benefits of agricultural production and environmental protection, so as to improve the degree of coordination of agro-ecological and economic coupling. Therefore, the level of technological innovation and the intensity of chemical inputs may be important mediating variables in the process of national agricultural science and technology parks exerting their comprehensive effect.

The following steps are used to test whether there is a mechanism of mediating variables between the National Agricultural Science and Technology Park and the coordinated development of the agro-ecological economy in Hebei Province. The first step is to test whether the establishment of the national agricultural science and technology park affects the level of technological innovation and chemical input intensity. In the second step, whether the level of technological innovation and the intensity of chemical inputs affect the degree of coordination of agroecological economic coupling. In the third step, the interaction terms of national agricultural science and technology parks with technological innovation level and chemical input intensity were introduced to test the transmission mechanism. The results of the analyses are shown in Tables 5 and 6.

Tab.5: Results of the analysis of the mediating effect of the level of technological innovation

variant	(1) Degree of harmonisation of agricultural "ecology- economy" coupling Dae	(2) Level of technological innovation Tec	(3) Agricultural "eco- Degree of coordination of "economic" coupling Dae
Establishment of national agricultural science and technology parks Did	0.008** (0.003)	0.156** (0.070)	
Level of technological innovation Tec			0.000 (0.001)
National Agricultural Science and Technology Parks x level of technological innovation Did × Tec			0.002** (0.001)

Gross output value of agriculture, forestry, livestock and fisheries Lae	-0.301*** (0.037)	-3.746*** (0.821)	-0.297*** (0.037)
Gross power of agricultural machinery Gam	0.045*** (0.012)	0.859*** (0.270)	0.046*** (0.012)
Crop sown area Csa	0.176 (0.402)	1.876 (8.890)	0.205 (0.403)
industrial structure Ils	0.022 (0.182)	-0.875 (4.020)	0.009 (0.182)
economic level Eco	-0.319 (0.228)	-3.242 (5.051)	-0.340 (0.229)
Agricultural workers Laf	0.132 (1.902)	-9.614 (42.054)	-0.014 (1.906)
Carbon intensity of agriculture Cin	-0.002 (0.001)	-0.068** (0.032)	-0.002 (0.001)
Constant	1.083 (0.674)	17.298 (14.909)	1.130* (0.676)
R ²	0.097	0.830	0.097
Number of id	137	137	137
yearfix	YES	YES	YES
idfix	YES	YES	YES

Note: *, **, *** indicate 10, 5 and 1 per cent significance levels, respectively.

The results in column (2) of Table 5 show that the establishment of national agricultural parks has a significant role in improving the level of technological innovation in Hebei Province, effectively increasing the level of technological innovation by 15.6%, i.e., the establishment of the National Agricultural Science and Technology Parks effectively promotes the level of technological innovation in Hebei Province and improves the efficiency of agricultural production. The estimated coefficients in column (3) show that the increase in the level of technological innovation has a significantly positive impact on the degree of ecological and economic coupling coordination in Hebei Province, i.e., the increase in the level of technological innovation contributes to the coordinated development of the agricultural and ecological economy in Hebei Province. Table 5 shows that the establishment of national agricultural science and technology parks can significantly improve the level of technological innovation, probably because the national agricultural science and technology parks not only introduce advanced production technology, but also have a number of resources, such as equipment, talents and other resources needed for scientific and technological innovation, thus providing a complete guarantee for local scientific and technological innovation, resulting in an increase in the number of scientific and technological patents, which promotes the coordinated development of the agro-ecological economy in Hebei Province, and the empirical results in Table 5 show that hypothesis 2 is valid. The results can be seen that hypothesis 2 is established.

Tab.6 Results of the analysis of the mediating effects of chemical input intensities

variant	(1) Degree of harmonisation of agricultural "ecology- economy" coupling Dae	(2) Chemical input intensity Aci	(3) Degree of harmonisation of agricultural "ecology- economy" coupling Dae
Establishment of national agricultural science and technology parks Did	0.008** (0.003)	-0.224*** (0.052)	
Chemical input intensity Aci			-0.001 (0.001)
National Agricultural Science and Technology Parks x Chemical Input Intensity Did x Aci			0.001** (0.000)
Gross output value of agriculture, forestry, livestock and fisheries Lae	-0.301*** (0.037)	3.148*** (0.608)	-0.298*** (0.037)
Gross power of agricultural machinery Gam	0.045*** (0.012)	0.803*** (0.200)	0.046*** (0.012)
Crop sown area Csa	0.176 (0.402)	20.895*** (6.576)	0.202 (0.403)
industrial structure Ils	0.022 (0.182)	-16.720*** (2.973)	0.002 (0.183)
economic level Eco	-0.319 (0.228)	-10.013*** (3.736)	-0.331 (0.229)
Agricultural workers Laf	0.132 (1.902)	-101.909*** (31.107)	0.008 (1.908)
Carbon intensity of agriculture Cin	-0.002 (0.001)	0.016 (0.024)	-0.002 (0.001)
Constant	1.083 (0.674)	45.906*** (11.028)	1.138* (0.678)
R ²	0.097	0.354	0.097
Number of id	137	137	137
yearfix	YES	YES	YES
idfix	YES	YES	YES

Note: *, **, *** indicate 10, 5 and 1 per cent significance levels, respectively.

Column (2) of Table 6 shows that the establishment of the National Agricultural Park has a significant contributing effect on reducing chemical input intensity in Hebei Province, effectively reducing chemical input intensity by 2.24%, i.e., the establishment of the National Agricultural Science and Technology Park has led to an effective control of chemical inputs and a reduction in the negative impact on the ecological environment. The estimated coefficients in column (3) show that the increase in chemical input intensity has a significantly negative effect on the coupled coordination of the agro-ecological economy in Hebei Province, i.e., the reduction of chemical input intensity contributes to the coordinated development of the agro-ecological economy in Hebei Province. As shown in Table 6, the establishment of the National Agricultural Science and Technology Park effectively reduces the chemical input intensity, probably because the park can bring about a higher level of agricultural management, which reduces the chemical input intensity through scientific calculations, thus playing a positive role in the coordinated development of Hebei Province's agro-ecological economy, and Hypothesis 3 is valid from the empirical results in Table 5.

4.3.6. Heterogeneity analysis

The heterogeneity analysis of this study starts from the perspective of ecological functional zoning in Hebei Province, and examines the differences in the role of national agricultural science and technology parks on the degree of coordination of agro-ecological and economic coupling in Hebei Province. Referring to the "14th Five-Year Plan for the Construction of Beijing-Tianjin-Hebei Ecological Environment Support Zone" and the "Beijing-Tianjin-Hebei Synergistic Development Plan Outline", and taking into account the local natural conditions, ecosystem characteristics, and economic development of Hebei Province, we divided Hebei Province into the Ecological Transitional Belt around Beijing-Tianjin, the Ecological Protection Zone of the dammed plateau, the Ecological Cultivation Zone of Yanshan-Taipei Mountains, the Ecological Restoration Zone of the Low Plains, and the Coastal Ecological and Economic Coupling Zone. Ecological Cultivation Zone, Low Plains Ecological Restoration Zone, and Coastal Ecological Protection Zone, but the National Agricultural Science and Technology Parks in Hebei Province are only distributed in Low Plains Ecological Restoration Zone, Yanshan-Taipei Ecological Cultivation Zone, and the Beijing-Tianjin Ecological Transitional Belt, so heterogeneity analyses are only carried out for the above three ecological functional zones. From model (1) to model (3) in Table 7, it can be seen that for the national agricultural science and technology parks in different ecological functional zones, the national agricultural science and technology parks in the ecological transition zone of Beijing-Tianjin have a more obvious role in promoting the level of coordinated development of the agricultural ecology and economy of Hebei Province, and they have a certain positive effect on the ecological restoration zone of the low plains and the ecological culmination zone of Yanshan-Taipei Mountains, but the regression results are not significant.

The main functions of agricultural science and technology parks in different ecological function zones are different. Compared with the ecological restoration zone of the low plains and the ecological conservation zone of the Yanshan-Taishan Mountains, the national agricultural science and technology parks in the ecological transition zone of the Beijing-Tianjin ring are very crucial in dealing with complex ecological problems, promoting technological innovation, optimising industrial structure, promoting regional synergistic development and effectively using resources. First, the Beijing-Tianjin Ecological Transition Zone may face more complex and severe ecological problems than the Low Plains Ecological Restoration Zone. For example, the Beijing-Tianjin Ecological Transition Zone needs to deal with both the ecological pressures of urbanisation and the ecological impacts of agricultural production. Such dual challenges make the role of the park in this region even more important. Secondly, Hebei Province within the Beijing-Tianjin Rim is characterised by more economic and political activities, with more stringent requirements for technological innovation and ecological protection. Against this background, it is even more important for national agricultural science and technology parks to have a high level of technological innovation capacity to cope with complex ecological and agricultural challenges. Thirdly, the agricultural and ecological development of the Beijing-Tianjin region relies more on the optimisation and upgrading of industrial structure. Here, the National Agricultural Science and Technology Parks should not only promote the transformation of traditional agriculture to modern agriculture, but also promote the development of eco-agriculture in harmony with urbanisation and industrialisation. Fourth, the ecological transition zone around Beijing and Tianjin possesses unique geographical and resource advantages, such as market and technological advantages brought by its proximity to large cities. The National Agricultural Science and Technology Park can make more effective use of these resources to promote the development of eco-agriculture and the green economy, i.e., assumption 4 is valid.

Tab.7: Heterogeneity analysis results

variant	(1) Low Plains Ecological Restoration Area	(2) Yanshan-Taishan Ecological Cultivation Zone	(3) Ecological transition zone around Beijing and Tianjin
Establishment of agricultural science and technology parks Did	0.005 (0.005)	0.001 (0.006)	0.013*** (0.005)
Gross output value of agriculture, forestry, livestock and fisheries Lae	-0.306*** (0.037)	-0.307*** (0.037)	-0.295*** (0.037)
Gross power of agricultural machinery Gam	0.044*** (0.012)	0.043*** (0.012)	0.046*** (0.012)
Crop sown area Csa	0.097 (0.403)	0.132 (0.402)	0.274 (0.405)
industrial structure Ils	0.059 (0.182)	0.045 (0.182)	-0.022 (0.183)
economic level Eco	-0.262 (0.228)	-0.275 (0.228)	-0.368 (0.230)
Agricultural workers Laf	0.540 (1.907)	0.385 (1.902)	-0.351 (1.920)
Carbon intensity of agriculture Cin	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)
Constant	0.923 (0.674)	0.963 (0.674)	1.211* (0.679)
R ²	0.095	0.094	0.097
Number of id	137	137	137
yearfix	YES	YES	YES
idfix	YES	YES	YES

Note: *, **, *** indicate 10, 5 and 1 per cent significance levels, respectively.

5.0 Conclusions and policy recommendations

5.1 Conclusions of the study

Based on the panel data of 137 districts and counties in Hebei Province, this paper reveals the impact benefits and mechanism of the establishment of the National Agricultural Science and Technology Park on the coordinated development of Hebei Province's agro-ecological economy by constructing a multi-period double-difference method (DID) model, and carries out the relevant empirical tests, and draws the following conclusions. First, a series of factual tests such as DID shows that the establishment of national agricultural science and technology parks has a significant positive effect on the coordinated development of Hebei Province's agro-ecological economy, regardless of whether or not conditions such as the level of the agricultural economy, the level of mechanisation, and the level of land use are taken into account. Second, the role of national agricultural science and technology parks on the coordinated development of Hebei Province's agro-ecological economy will be affected to a certain extent by the resource endowment within different ecological function sub-zones. The role of national agricultural science and technology parks in the ecological transition zone

around Beijing and Tianjin in promoting the coordinated development of Hebei Province's agricultural ecology and economy is more prominent. Third, when further analysing the mechanism of the national agricultural science and technology parks on the coordinated development of Hebei's agro-ecological economy, it is found that the establishment of the national agricultural science and technology parks can improve the level of local technological innovation and reduce the intensity of chemical inputs, which significantly promotes the coordinated development of Hebei's agro-ecological economy.

5.2. Policy recommendations

Combined with the above conclusions, the policy revelations of this paper are as follows: first, increase the support of national agricultural science and technology parks, and develop agricultural new quality productivity according to local conditions. National agricultural science and technology parks have a significant role in promoting the coordinated development of Hebei Province's agro-ecological economy, the government should enhance the support for national agricultural science and technology parks, including funds, policies, taxes and other concessions, the government should take into account the characteristics of the ecological function of the zoning in the construction of agricultural science and technology parks, and through the optimisation of the layout of the full play of the new agricultural productivity in the promotion of agro-ecological economy and the coordinated development of the role of the new agricultural productivity. Secondly, promoting new agricultural production methods and accelerating the development of new agricultural productivity. As the frontier of agricultural technological innovation, the National Agricultural Science and Technology Parks, through increasing R&D inputs, introducing advanced technologies, and reducing the intensity of chemical inputs, will enhance the innovation outputs within and around the Agricultural Science and Technology Parks, and utilise highly efficient agricultural technologies and management methods to reduce the ecological burden of agricultural production activities, and to promote the coordinated development of agro-ecological economy. Third, broaden information sharing and assessment channels to promote the sustainable development of new quality agricultural productivity. Through the establishment of information exchange and sharing channels for enterprises in the National Agricultural Science and Technology Parks, we will promote green agricultural technologies and environmentally friendly production methods, and avoid high ecological cost production methods in the agricultural production process. At the same time, a perfect evaluation system for the coordinated development of the agricultural ecology and economy will be established to regularly assess the impact effect of the parks on the coordinated development of the agricultural ecology and economy, so as to identify problems and adjust policies in a timely manner, ensure the coordinated development of the agricultural ecology and economy, and push forward the process of the modernisation and development of agriculture.

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