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Does the Policy of Decoupled Subsidies Improve the Agricultural Economic Resilience?—Evidence from China's Main Corn Producing Regions

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Abstract: Various forms of agricultural subsidy policies often have a significant impact on the development of the agricultural economy and also shape the differentiated spatial pattern of regional agricultural economic resilience, while research on the evolution process of agricultural economic resilience and its influencing mechanisms is still very scarce. This study is based on the impact of China's cancellation of the temporary corn storage policy on corn prices in 2016. By using an economic resilience analysis framework, we selected the indicators of total agricultural output value and disposable income of farmers to measure the agricultural economic resilience of various cities in Jilin Province and analyzed the characteristics and causes of the spatio-temporal change in agricultural economic resilience in Jilin Province from 2008 to 2021. The results show the following: (1) The transition from price and subsidy integration policy to decoupled subsidy policy helps to shape stronger regional agricultural economic resilience, but due to factors such as farmer policy dependence, low international corn prices, severe oversupply in the domestic corn market, and the suddenness of policy changes, there was a short-term decline in agricultural economic resilience in Jilin Province in the early stage of the decoupled subsidy policy (2016–2017), which rapidly increased after 2017. (2) The agricultural economic resilience levels of cities in Jilin Province showed different spatial differentiation characteristics at different stages within the study period, and the central region, as an important corn production area in Jilin Province, had significant changes in agricultural economic resilience. (3) During the execution of the price and subsidy integration policy, the enhancement of agricultural input capacity and agricultural output capacity helped to improve regional agricultural economic resilience; during the execution of the decoupled subsidy policy, the government's support for agriculture and the potential of rural markets had a significant impact on the improvement of agricultural economic resilience. At the same time, the interaction and enhancement effect between influencing factors also had a profound impact on agricultural economic resilience.

Keywords: agricultural economic resilience; policy on the purchasing and stockpiling of corn; spatial-temporal differentiation; influencing mechanism; geographical detector; Jilin Province, China

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1. Introduction

As the foundation of the economy of the country [1,2], agriculture has a direct impact on the increase in farmers' income and rural growth [3], as well as ensuring food security and social stability of the country [4]. The agricultural economy not only reflects the comprehensive agricultural production capacity but also reflects the agricultural structure configuration and supply and demand of the market [5]. Nevertheless, regional agricultural economic development is not only affected by global shocks such as natural disasters [6],

global financial crises [7], international and regional conflicts [8], and global public health events (such as COVID-19) [9], but is also closely related to the adjustments and changes in national and regional agricultural policies [10]. These uncertainties increase the instability and vulnerability of agricultural economic development, leading to stagnation or decline in some regions, while the agricultural economic systems in some areas can actively respond to these uncertainties, minimally impacted, and able to quickly recover and maintain development. The resilience of the agricultural economy is considered an important factor in explaining these differences. It is not only key for the agricultural economic system to respond to uncertainties [11,12] but also an important capability in bearing shocks, identifying risk challenges, and mitigating the impact of shocks [13]. Hence, it is necessary to refine the agricultural economy's resilience to deal with shocks and challenges from various aspects and achieve sustainable development of the economy of agriculture [14]. Agricultural economic resilience is the capacity to withstand various shocks and disturbances (natural disasters, market changes, policy changes, etc.) or recover from them in the process of agricultural economic operation, as well as the capacity to adaptively adjust or restructure its agricultural economic structure and system mechanisms when necessary [15]. The purpose of resilience is to ensure the operation of the core functions of agriculture. Enhancing the resilience of the agricultural economy not only contributes to the competitiveness of regional agricultural products and promotes the modernization of regional agriculture but also helps the regional economy maintain continuous and stable growth.

In the development of agricultural economics, agricultural subsidy policies play a significant role. Traditional theories argue that agricultural subsidies distort market mechanisms [16], reduce productivity [17], hinder the application of new technologies [18], and pose shocks to the market. However, more theories and empirical analyses demonstrate that, in imperfect rural market environments, subsidies could help farmers overcome capital constraints, mitigate risks, and thereby enhance the resilience of regional agricultural economies [19]. Moreover, agricultural subsidy policies exhibit noticeable spatial heterogeneity characteristics across different regions. Some areas experience rapid economic improvement post-implementation, while others witness hindered agricultural production due to these policies. The variations in regional agricultural foundations, international market environments, and agricultural subsidy policies themselves contribute to these divergent policy outcomes [20]. In the debate over agricultural subsidies and agricultural economic resilience, a key distinction is between "coupled" and "decoupled" subsidies [21]. Some studies, taking the Common Agricultural Policy (CAP) of the European Union as an example, analyze the impacts of different types of agricultural subsidy policies on agricultural economics. They believe that the coupled subsidies policy, as an indirect subsidy, means directly intervening in agricultural product prices, which is the root cause of market distortion and hinders the improvement of agricultural economic resilience [22]. Conversely, the decoupled subsidies policy, as a direct subsidy means, does not directly affect farmers' crop choices. While enhancing market vitality, it also ensures farmers' income, improving subsidy efficiency and the adaptability of agricultural economics to the market [23]. The change in the European Union's agricultural productivity also confirms this view. From "coupled subsidies" to "decoupled subsidies", not only has the resilience of the EU's agricultural economy been gradually improving, but its agricultural productivity has also been strengthening [24]. Although the concept of agricultural economic resilience has been gaining more attention in discussions on agricultural subsidy policies across various countries and regions [25], the degree to which coupled subsidies and decoupled subsidies affect regional agricultural economic resilience in developing countries and the factors that can enhance regional agricultural economic resilience under different policy backgrounds, are still rarely studied.

In order to fill this research gap, this study analyzes the resilience of agricultural economics under the adjustment of agricultural subsidy policies. The main contributions are (1) a systematic explanation of the concept, connotation, and analytical framework of

agricultural economic resilience; (2) innovation of the resilience measurement formula, quantifying the impacts of decoupled subsidies and coupled subsidies on the temporal and spatial evolution of regional agricultural economic resilience; (3) exploration and explanation of the factors affecting regional agricultural economic resilience at different stages of policy implementation, identifying the key capabilities to improve regional agricultural economic resilience, and thereby providing a theoretical basis for optimizing agricultural structures and formulating resilient agricultural policies. This study takes Jilin Province, a major corn production area in China, as the subject, analyzing the changes in agricultural economic resilience and its causes over 13 years before and after the cancellation of the temporary corn reserve policy (essentially a coupled subsidies policy implemented from 2008 to 2015; from 2016 onwards, the "market-based procurement + producer subsidy" policy with the nature of decoupled subsidies has been implemented). This paper attempts to answer the following three questions: (1) How do the two forms of agricultural subsidy policies affect Jilin Province's agricultural economic resilience differently? (2) What changes have occurred in the spatial differentiation characteristics of Jilin Province's agricultural economic resilience before and after the cancellation of the maize storage policy? (3) In different stages, which factors or combinations of factors have shaped higher agricultural economic resilience? The structure of this study is as follows: The "Section 1" defines agricultural economic resilience and outlines the purpose and significance of the study. The Section 2 reviews the progress of related research on agricultural policies and agricultural economic resilience, explains the regional overview, and establishes a research framework for agricultural economic resilience. The Section 3 introduces the sources of data and research methods. The Section 4 analyzes the spatial-temporal differentiation characteristics of agricultural economic resilience in Jilin Province and explores the key factors affecting it. The Section 5 summarizes the entire paper and proposes policy suggestions in line with the actual situation of agricultural development in Jilin Province.

2. Conceptualizing the Relationship between Agricultural Policy and Agricultural Economic Resilience

2.1. Public Policy and Resilience

Public policy is a series of interrelated decisions made by government agencies on a particular issue. Howlett [26] believes that public policy consists of policy objectives and policy tools. Policy output is the direct result of the decision-making process of government agencies, usually taking the form of policy proposals, laws, or regulations. Policy objectives are the goals and expectations set by government agencies for a particular issue, while policy tools are the means or techniques used to achieve these objectives (such as rules, bans, subsidies, fines, training, or organizations, etc.). These components of policy interaction with one another are prone to synergies, conflicts, or trade-offs that result in complex configurations of policy with often unclear means-ends relations, which also has the meaning that certain components of policy can enable the resilience of the system in one area while constraining it in another area [27,28]. The challenge for policymakers is then to find out how components of policy can generate synergies and prevent trade-offs so as to deliver support to the resilience of one system. In discussions on public agricultural policy and resilience, there is abundant research using the European Union's Common Agricultural Policy as a case study [29]. Some scholars argue that the rapid development of the EU's agricultural economy owes much to the transition from integrated to decoupled price-subsidy policies, as well as the EU's attention not only to agricultural production subsidy policies but also to rural development subsidy policies, which greatly enhance the sustainable development capabilities of EU agriculture. Other scholars have different views, arguing that the EU's agricultural subsidy policy overemphasizes resistance, neglecting adaptability and transformative capacity, which weakens the agricultural system's ability to cope with long-term challenges [30]. Furthermore, some scholars have analyzed the recovery ability of farms aftershocks under the protection of agricultural subsidy policies and farmers' adaptability to new policies. They not only prove that flexible adjustment of

agricultural subsidy policies improves the level of agricultural economic resilience [31] but also emphasize that ensuring the stable operation of key factors or important functions of the agricultural system (food production, farmer income, ecological environment) is key to enhancing agricultural resilience [32]. Moreover, in regional agricultural production and operation, influenced by long-term natural background conditions, labor and productivity levels, resource allocation conditions, and top-level agricultural planning, the inherent choices formed in the region regarding existing production experience, production methods, and production capabilities often form a "path dependence". This dependence may be further deepened under the intervention of agricultural policies. Walker [33] regards path lock-in as a negative attribute of regional development, believing that the "lock-in effect" under path dependence leads to rigidity in regional industrial structure, restricts the emergence of new technologies, new industries, and new development paths, and thus hinders regional development adaptability. For example, traditional agriculture's excessive reliance on labor input prevents the formation of large-scale production and operation, affecting agricultural productivity and economic benefits. When labor outflows or changes occur in labor structure, traditional agricultural production methods struggle to adapt, easily falling into a trajectory of decline. Hence, the formulation and adjustment of agricultural subsidy policies should focus on the core functions of regional agriculture, improve the layout planning of agricultural structure and the ability to recognize agricultural market risks, and strengthen the government's effective response to short-term shocks faced by the agricultural system [34]. When related policies need to be adjusted, they should fully consider the "path dependence" effect of regional agricultural development and avoid drastic policy changes in the short term as much as possible.

2.2. Study Area and Policy Background

Corn is the most productive grain crop in China. Jilin Province (Figure 1) is a major corn production area in China, with corn output accounting for 11% of the national total, and over 70% of the province's grain output comes from corn. The financial crisis of 2008 led to significant abnormal fluctuations in international grain prices, and the transmission effect to China's grain market was increasingly strengthened. In response to the difficulty faced by farmers in the main corn-producing area of Northeast China in selling their crops, the Chinese government introduced a temporary corn procurement policy in 2008 [35]. Under this policy, new season corn was procured by state-designated storage companies at a temporary procurement price set by the government each year. The essence of this policy is an integrated price-subsidy policy. Its basic principle is to intervene in corn prices through administrative means, promoting a relative balance between price and output and achieving the goal of stable and increased grain production.

Nevertheless, the corn procurement policy, while protecting the interests of farmers, also presented several issues: (1) Imbalance in the supply and demand of corn. From 2008 to 2015, China's corn planting area grew by 29.3%, and yield increased by 47.5%. Nevertheless, due to factors such as the slowdown in economic growth and cyclical fluctuations in pork production, corn consumption remained sluggish. The supply–demand relationship for corn quickly shifted from a shortage to an oversupply, with production exceeding demand by about 50 million tons in 2015. (2) Serious backlog of corn inventory. As the corn yield continued to exceed demand, in order to solve the problem of farmers struggling to sell their grain, the Chinese government increased the amount of corn procured year after year. In 2016, corn procurement exceeded 100 million tons, with a surplus inventory reaching as high as 250 million tons, exceeding China's annual corn output. (3) Increased pressure from imports of corn and its substitutes. With the support of the temporary procurement policy, China's corn prices remained high, while international corn prices fell significantly during the same period. This led to a price inversion between domestic and international corn prices. Simultaneously, the large-scale import of corn and its substitutes directly squeezed the domestic corn market share, exacerbating the oversupply of corn domestically and causing a significant impact on the domestic corn market.

(4) Significant impact on downstream corn industries. The temporary corn procurement policy focused on protecting production without fully considering the sustainable and healthy development of the entire corn industry chain. The continually rising procurement prices and monopolistic purchases led to inflated domestic corn prices, creating a significant crowding-out effect on downstream market entities [36]. As a result, in 2016, the Chinese government abolished the temporary corn procurement policy. The previous policy of "the government setting a minimum procurement price for corn purchases" was adjusted to a "market price procurement for corn + direct subsidies for farmer-producers" policy (i.e., a price-subsidy separation policy). Simultaneously, the entities procuring corn also changed. Corn procurement was no longer mainly conducted by Sinograin on behalf of the state but instead by diversified market entities entering the market independently to purchase. The state no longer carried out temporary procurement. This signified the end of the temporary corn procurement policy that had been in effect for eight years, with corn prices returning to market mechanisms.

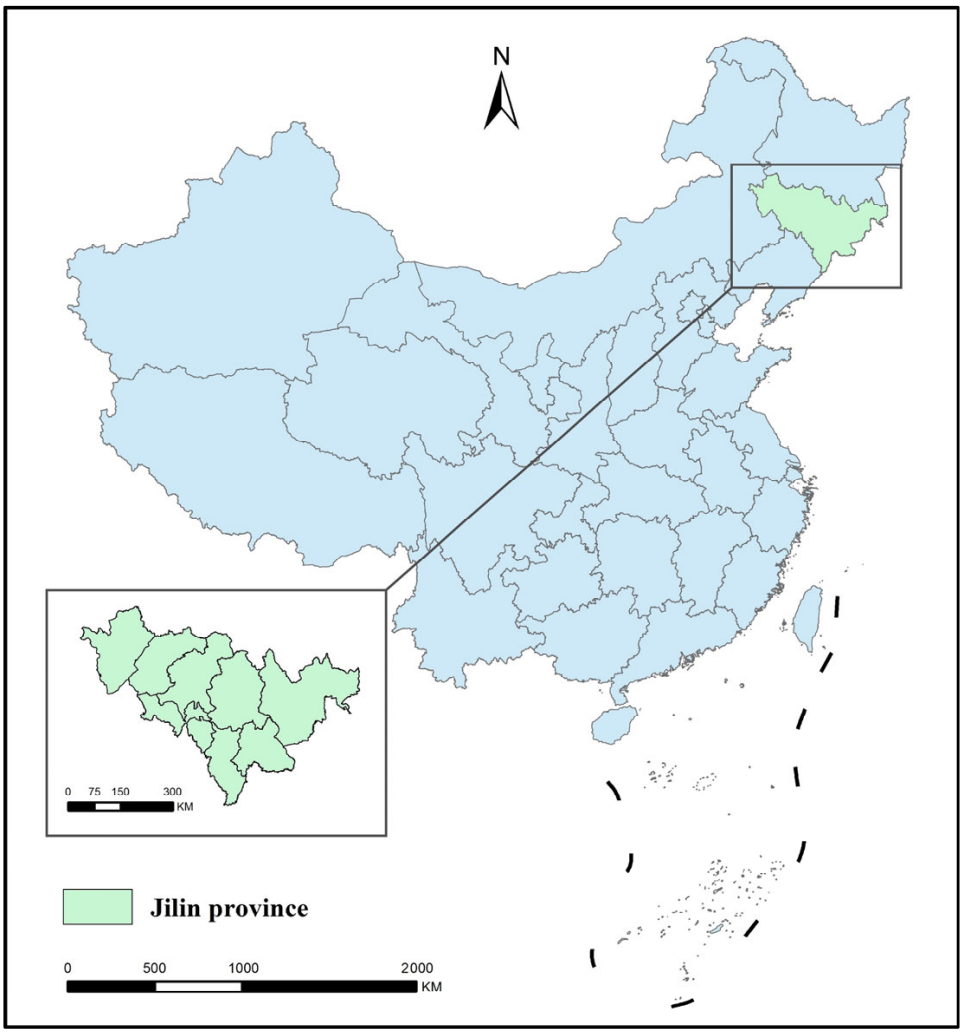

Figure 1. The spatial location of Jilin Province in China.

2.3. Resilience of Agricultural Economy under the Context of Agricultural Policy Adjustment

Resilience means the capacity of a regional economic–social–ecological system to resist or adapt to shocks and disturbances from markets and the environment, quickly restore the primary features of the system, or even transition to a more optimal growing path, thereby achieving sustainable development. Resilience theory takes a regional economic system, unbalanced or unstable, as a complex adaptive cycle system, emphasizing the strengthening of resistance, adaptability, and transformation within the regional economy.

Current resilience theory adopted in the field of agriculture mainly considers ecological and engineering resilience, focusing on the capacity of the system for agriculture to restore its original development path after being impacted by disaster events such as climate change and extreme weather, emphasizing the importance of balance. Nevertheless, evolutionary resilience posits that after a system for agriculture is impacted or disturbed, it often leads to new growth environments and production conditions. The system for agriculture does not need to return to its previous state or enter a new equilibrium state in this new environment, and this change is more evident in the agricultural economic system. Simultaneously, different regional agricultural economic systems show varying degrees of differentiation when responding to shocks, and regional agricultural development disparities (resource endowment, location conditions, economic foundation, etc.) may slow down or amplify the vulnerability of the agricultural economic system to shocks, further affecting the capacity of the regional agricultural economic system to respond to shocks and disturbances. In the agricultural economic system, the nature of risk is considered a key factor affecting resilience [37]. For instance, the crisis source or type (man-made or natural) is relevant to the resilience to what problem [38]? The object of the impact is relevant to the resilience of what entity? The length of the risk (one-off or short-term shock or a slow-burning crisis) confirms the objectives of resilience (the key feature of the system for agriculture) [39]. Current research on the resilience of the agricultural economy mainly considers agricultural market risk [40], agricultural policy adjustment [41], rural development lag [42], and adjustment of key agricultural functions as shocks and disturbances [43]. As shown in Figure 2, Compared to ecological and engineering resilience, evolutionary resilience pays more attention to the resistance, adaptation, and transformation capabilities of the agricultural economic system to shocks and disturbances and provides a more comprehensive explanation of the operating mechanism of the agricultural economic system under the influence of factors such as agricultural policy adjustment, changes in the grain market, and adjustments in agricultural structure.

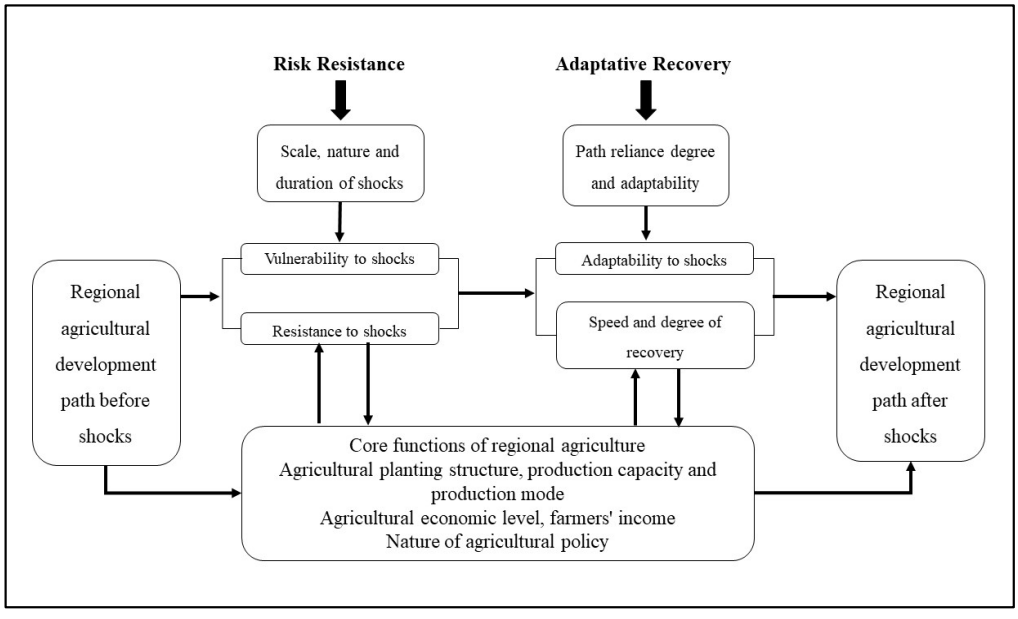

Figure 2. Analysis framework of agricultural economic resilience.

The crisis resistance and recovery adaptability of agricultural economic resilience mainly target two types of shocks in this article: one is the severe interference caused by the corn storage policy on the corn market in the later stage, and the other is the massive adjustment that occurred in the short term due to the corn subsidy policy. In fact, when the new policy of "market-based corn procurement + producer subsidy" was introduced in 2016, it coincided with the high domestic corn stock and low international corn prices. At

the same time, the timing of the new policy was just before the preparation period for corn spring planting. They purchased a large amount of corn production materials before the 2016 spring planting due to the deep policy dependence that farmers had developed from the corn storage policy implemented over eight years. The sudden policy change made it impossible for farmers to change their grain planting structure in the short term, leading to a plummet in corn prices in the northeastern region in 2016. Hence, the evolution of agricultural economic resilience in this article includes crisis resistance and adaptation recovery to the above two shocks, which are two key processes. Crisis resistance mainly refers to the degree of impact on the regional agricultural economic system. Regions with high resistance have less impact on their agricultural economy [44], and the crisis resistance is mainly influenced by the development path before the regional shock [45], including main agricultural functions, agricultural planting structure, agricultural production methods, and agricultural policies. Adaptation recovery means the capacity of the system for agriculture to adjust internally to adapt to shocks during or after the shock [46], mainly manifested in the capacity of the regional agricultural economic system to adjust industrial structure, agricultural technology, agricultural policy, etc., to adapt to shocks. A low level of intensity and short-duration shocks can result in a rebound in the regional economy of agriculture; however, a high level of intensity and long-duration disturbances can result in more transformation [47,48]. In summary, the resilience of the economy of agriculture is a process of co-evolution in agricultural planting structure, grain supply and demand market, and agricultural economic development under the adjustment and change in agricultural policies, continuously shaped by the development path, environment, and regional background. In this process, the two processes of crisis resistance and adaptation recovery exist together and have an impact on each other.

3. Methodology

3.1. Data Source

In 2008, the Chinese government introduced the temporary corn reserve policy, which was canceled in 2016. Therefore, the timeframe of this study was set from 2008 to 2021, aiming to explore the level of agricultural economic resilience in Jilin Province and its influencing factors during the implementation of the temporary corn reserve policy from 2008 to 2015 and after its cancellation from 2016 to 2021. The vector data for the administrative divisions of the research area used in this study come from the standard map service website of the National Geomatics Center of China (http://bzdt.ch.mnr.gov.cn/ (accessed on 12 April 2023)). The agricultural economic data used in this study comes from the Jilin Province Statistical Yearbook from 2009 to 2022 (http://tjj.jl.gov.cn/ (accessed on 12 April 2023)), the statistical yearbooks of various cities in Jilin Province from 2009 to 2022 (Statistics Bureau of various cities in Jilin Province), and the statistical bulletin of the national economy and social development of various cities in Jilin Province from 2008 to 2021 (official websites of various city governments in Jilin Province).

3.2. Research Methodology

The core variable method [49] or the indicator system method [50] is mainly adopted by the current relevant research for the evaluation method of economic resilience, in which the economic resilience and spatial heterogeneity of regions and industries are measured. The impact of different factors on resilience can be comprehensively revealed by the indicator system method, but its strong subjectivity in the selection of indicators and allocation of weights is embodied. Since the agricultural system is in constant change, the importance of some indicators may weaken with the growth of the time scale. The use of the core variable method can help the better reflection of the core functions of the agricultural system, in which the focus can be put more on changes in core functions [51]. However, traditional core variable methods often choose a single macro scale indicator to make the measurement of regional economic resilience (such as the indicators of GDP or added value of sector), in which the changes in micro scale (individuals or enterprises) under the influence of shocks

and disturbances may be neglected by this. The actual development of agriculture in Jilin Province is combined, and the traditional single core variable is not adopted by this research to measure regional economic resilience. Instead, the changes in agricultural economic resilience in Jilin Province are comprehensively analyzed through two core indicators of the level of agricultural economic development (agricultural output value) and the level of farmers' income (disposable income of farmers). As a matter of fact, the key indicators in the development of the regional agricultural economy are reflected in the agricultural economy and farmers' income, which promote each other and work on the resilience of the regional agricultural economy together. In addition to embodying the enhancement of agricultural production capacity, the improvement of agricultural economic benefits can also indicate that the regional agricultural and industrial structure relatively conforms to the market supply and demand structure. When it comes to the increase in farmers' income, it can improve their production enthusiasm and agricultural production capacity on the one hand, which can also promote the improvement of agricultural scale production and organizational management capabilities on the other hand, so a virtuous cycle of regional agricultural systems can be promoted.

Therefore, the multi-core variable method is adopted to carry out the analysis of the resilience of the agricultural economy in Jilin Province, China. By taking the agricultural output value and farmers' income as the core variables to measure the resilience of the agricultural economy, it conducts a comprehensive analysis of the operational status of the agricultural economy in Jilin Province from 2008 to 2021. Moreover, the spatial differences and driving forces of geographical phenomena are detected by using geographical detectors. In this study, agriculture means that in a narrow sense, which is planting, including the activities for the production of food crops, cash crops, feed crops, green manure, and other crops. The output value of products obtained from crop cultivation is the agricultural output value in this thesis, in which the calculation method times the output of agricultural products acquired from the cultivation of crops by their unit product prices, respectively. The total amount of final consumption expenditure and savings that rural households can use refers to the disposable income of farmers; that is, the income can be disposed of freely by rural households. The following is the specific analysis method of the multi-core variable method for regional agricultural economic resilience:

(1) Measure of regional agricultural economic resilience.

This research focuses on the regional resilience measure of Martin for the economy that is widely used [52]; below are related equations:

$$\mathrm{R}_i^t = (\Delta Y_i - \Delta \mathrm{E}) / |\Delta \mathrm{E}| \tag{1}$$

For Equation (1), R_i^t is the resilience level for the economy of agriculture of city i in year t; ΔY_i is the real growth performance for agriculture of city i, for Equation (2); Δ is the predicted growth performance of the city for agriculture economy based on the overall growth performance of the region for agriculture economy where the city is located, for Equation (3).

$$\Delta Y_i = Y_i^t - Y_i^{t-k} \tag{2}$$

$$\Delta \mathrm{E} = ((Y_r^t - Y_r^{t-k}) / Y_r^{t-k}) Y_i^{t-k} \tag{3}$$

where Y_i^t and Y_i^{t-k} are the quantitative indicators of city i at time t and $t-k$, Y_r^t and Y_r^{t-k} are regional quantity indicators (region or country economy as a whole) in which the city is located at time t and $t-k$.

Equations (1)–(3) can be joined as below:

$$\mathrm{R}_i^t = \frac{(Y_i^t - Y_i^{t-k}) / Y_i^{t-k} - (Y_r^t - Y_r^{t-k}) / Y_r^{t-k}}{\left| (Y_r^t - Y_r^{t-k}) / Y_r^{t-k} \right|} \tag{4}$$

R_i is the resilience of economy that shows the level of resilience of agriculture economy of each city. In case $R_i > 0$, the resilience of the agriculture economy of city i is more than the average level of growth performance of the city for agriculture economy, and the larger the value, the better the overall performance of the city's resilience level for agriculture economy in the region; when $R_i < 0$, the resilience of the agriculture economy of city i is lower than the average level of economy in each city, and the smaller the value, the worse the overall performance of the city's agricultural economic resilience level in the region.

(2) Geographical detector.

The geographical detector is a tool to detect the stratified heterogeneity of geographical phenomena and their motivation. The factor detection and interactive detection models could identify the influencing factors of agricultural economic resilience change in all regions of Jilin Province. The calculation formula was as follows:

$$q = 1 - \frac{1}{N\sigma^2} \sum_{h=1}^{L} N_h \sigma_h^2 \quad (5)$$

In the formula, q was the determinant indicator in the change in agricultural economic resilience with the range of [0, 1]; the bigger the q became, the bigger the impact of the influencing factors on the change in agricultural economic resilience; $h = 1, 2, \ldots, L$ is the categorical data; N_h and N is the number of unit number in the city of the No. h type and the total number of cities in the whole region; σ_h^2 and σ^2 are the regional variance of the type h. The bigger the q value was, the higher the interpretive degree of influencing factors on agricultural economic resilience. Detailed variable selection is discussed in Section 4.3.

4. Results

4.1. Stage Features of Agricultural Economic Resilience in Jilin Province

From 2008 to 2021, there was a significant change in the agricultural economic resilience indicator in Jilin Province (Figure 3). Overall, during the implementation of the temporary corn reserve policy from 2008 to 2015, the change in the agricultural economic resilience index was relatively small, changing from 0.11 in 2008 to −0.05 in 2015. The resilience index as a whole fluctuated at a low level, indicating that the corn reserve policy stabilized the development of Jilin's agricultural economy to a certain extent. However, in the later stages of the policy, the negative effects of this price intervention method gradually became apparent. The continually expanding corn planting area rigidified the agricultural planting structure, leading to a severe oversupply in the corn market and gradually deepening the vulnerability of Jilin's agricultural economy. After the cancellation of the corn reserve policy from 2016 to 2021, the previously accumulated supply–demand contradictions were released together. Following a larger corn yield, larger corn inventory, lower domestic and foreign corn market prices, and the sudden policy adjustment, these unfavorable factors collectively caused a noticeable decline in Jilin's agricultural economy in 2016–2017, with the resilience index plummeting to −7.33 in 2017. However, following the continuous adjustment of the planting structure in the main corn production areas in the Northeast region by the Chinese government after 2016 (appropriately reducing the corn planting area in non-advantaged areas) and the continuous reduction in corn inventory, the benefits of the market procurement plus producer subsidy policy began to show. After 2017, domestic corn prices gradually rebounded, the economic benefits of corn in Jilin Province gradually improved, and agricultural economic resilience continued to rise, with the resilience index fluctuating upwards to 1.50 in 2021.

In order to better illustrate the impact of the corn reserve policy on agricultural economic resilience in different stages, this study divides the research period into four stages: 2008–2009 and 2010–2015, respectively, represent the early and late stages of the temporary corn reserve policy (coupled subsidies policy), and 2016–2017 and 2017–2021, respectively, represent the early and late stages of the market procurement plus producer subsidy policy (decoupled subsidies policy). The first stage was 2008–2009. Affected by

the global grain price fluctuations caused by the global economic crisis in 2008 [53] and the reduced grain output caused by the drought in the central corn production area of Jilin Province in 2009 (the drought affected the corn yield in some parts of central Jilin, but did not lead to large-scale corn reduction across the province), coupled with the low corn reserve price and small purchase volume, the effect of the corn reserve policy on stabilizing Jilin's agricultural economy was not significant, and the agricultural economic resilience index of Jilin Province was relatively low during this stage.

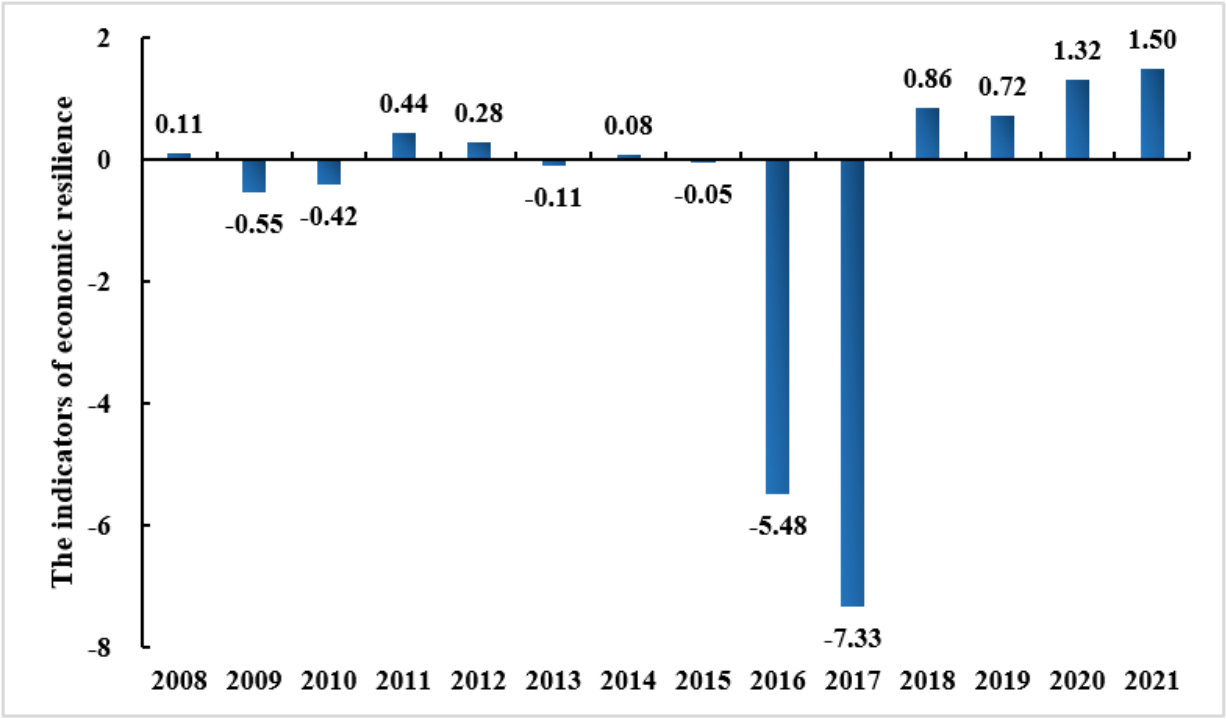

Figure 3. Change in indexes of agricultural economic resilience of Jilin Province from 2008 to 2021.

The second stage was from 2010 to 2015, when the purchasing and stockpiling of corn prices were increasing, and the purchasing and stockpiling amount was growing annually during the period, so the government purchase effect was greatly improved. National purchasing and stockpiling had been the dominant channel for farmers to sell grain. The ability of policy to stabilize the agricultural economy was improved compared with the first stage. In the promotion of the policy on the purchasing and stockpiling of corn, the proportion of corn planting area in the grain planting area of Jilin Province increased from 65.6% in 2008 to 76.9% in 2015, so it resulted in being the main motivation to push the growth of grain planting area. However, the policy intervention in the policy of purchasing and stockpiling caused an oversupply of corn production, so the soaring space for the corn price was very limited. Moreover, the international grain price declined after 2011, so there was a protruding negative price relationship between the domestic grain price and the international one. The agricultural economic vulnerability of Jilin Province was strengthened gradually, and the indexes of agricultural economic resilience were ceaselessly declining after 2011. It showed that the negative effect of the policy intervention in grain prices was gradually prominent in the later implementation period. The stability of policy on the purchasing and stockpiling of corn for the agricultural economy was weakened gradually. The corn yield was increased annually in this stage, but the indexes of agricultural economic resilience unceasingly declined.

The third stage was from 2016 to 2017 and was the turning point of the study. The policy on the purchasing and stockpiling of corn was canceled in 2016. Due to the excessive production of corn and the sliding price of international corn price, the corn price of Jilin Province was greatly decreased, and the corn planting area was slightly reduced; the

agricultural economy showed a higher vulnerability, and the indexes of resilience were in a sharp decline at the same time. Moreover, the inventory pressure of corn was hard to be resolved within a short time because of the long-term oversupply of the corn yield, so the corn price was still low in 2017, and it was not rebounded until the end of 2017. The cancellation of the policy on the purchasing and stockpiling of corn and the "inventory elimination" of corn caused the continuous fall of the corn price, which caused a huge shock to the agricultural economy and a sharp decline in the agricultural economic resilience of Jilin Province from 2016 to 2017.

The fourth stage was from 2018 to 2021, when the growth rate of corn planting area was slowed down because of the corn price returning to the market step by step, the reduction in inventory pressure of corn, the certain achievement gained by the agricultural structure adjustment, and the supply and demand relationship of corn market was relieved, so there was an obvious improvement of the negative price relationship between the domestic corn price and the international one. Moreover, in 2016, the government transformed the original corn price subsidies to be the subsidies for a producer at this stage and adopted the decoupled subsidies instead of the originally coupled subsidies. On the one hand, it ensured the income of farmers so that farmers could choose suitable crops according to their own conditions and business status to reduce the agricultural product cost (including the cost of means of production and labor) and to push the reasonable allocation of agricultural resources. On the other hand, the policy of "decoupled subsidies" enabled a huge growth in the market orientation of the corn price. The agricultural economy was in good running, and there was a higher adaptive recovery in the new policy and new environment; additionally, the indexes of agricultural economic resilience were in a fluctuating upward trend.

4.2. Characteristics of Spatial-Temporal Differentiation in Agricultural Economic Resilience across Cities in Jilin Province

In order to analyze the agricultural economic resilience level of various cities in Jilin Province more accurately, this study calculated the agricultural economic resilience of each city (prefecture-level city) in Jilin Province from 2008 to 2021 according to formula 4, and combined with the four stages proposed earlier, selected 2008 (the year when the corn temporary storage policy started), 2014 (the year when the corn temporary storage price was the highest), 2017 (the year when the corn price decreased the most). The year 2021 (the year with the highest corn market price) is four years, and the toughness index is divided into four grades by using the natural breakpoint method: lower toughness, low toughness, high toughness, and higher toughness. See Figure 4 for the spatial distribution of agricultural economic toughness in Jilin Province.

During the implementation of the policy on the purchasing and stockpiling of corn, the spatial pattern of the agricultural economic resilience of Jilin Province was "high in the east—low in the middle". For the drought in the spring of 2019, the grain yield reduction in the middle and western areas caused a certain shock for the agricultural economy; and the low purchasing price and small purchase amount of corn in 2019 made a stronger vulnerability to the agricultural economy and the lower resilience of agricultural economic resilience. While the eastern area suffered from less drought, the grain yield kept the growth. Simultaneously, Yanbian Prefecture, Baishan City, and other cities in the eastern area had a relatively less proportion of corn planting areas than the main grain planting area, so the agricultural economy suffered less from corn price fluctuation with the relatively higher indexes of economic resilience. In 2014, the resilience indexes in Liaoyuan City and Jilin City in the middle area were positive, while the others were negative; among the western area, Songyuan City had the lowest resilience indexes. In 2014, the corn price was at its peak during the implementation of the policy, and there was a larger scale of government purchases. The corn planting area in Songyuan City rapidly increased, but the increasing inventory pressure made the market have a lower demand for corn in the new harvest, so the corn price in Songyuan City was only maintained at the purchasing price (the lowest purchasing price of third-class corn of Jilin Province was 2240 yuan per ton in 2014); while

the corn planting area in Liaoyuan City and Jilin City in 2014 was almost the same as that in 2013. Though there was a huge inventory pressure, the corn processing ability of the two cities was strong, but there was still a certain gap in corn, and the selling price was slightly higher than the purchasing price (2290 yuan per ton in Liaoyuan City and 2300 yuan per ton in Jilin City). The running status of the agricultural economy was relatively better, and the resilience indexes were also relatively higher. In fact, in the late period of policy on the purchasing and stockpiling of corn, the gap between the selling price and the lowest purchasing corn price in all cities of Jilin Province was smaller and smaller. In Songyuan City, Siping City, and Tonghua City, the corn prices in the new harvest in 2014 were basically equal to the lowest purchasing price. At the same time, the corn yield of Jilin Province had rapid growth during the implementation of the policy, and the land-use cost was higher for the land transfer efficiency and the large-scale operation capability, which greatly affected the effect of the agricultural economy and hindered the growth of agricultural economic resilience. According to the data, the total corn planting cost of Jilin Province had been higher than the average level of the country for a long time during the implementation of the policy, and there was a huge gap with the average level of the whole country in the land cost including the rent of the circulating land and the discount of the self-operated land. It showed that both the use cost and the opportunity cost of cultivated land were relatively higher, and there should be an improvement in the large-scale production and management capacity of corn. The higher land-use cost caused lower profitability [54], and there was an agricultural structure with a heavy proportion of corn, so the multiple factors jointly increased the vulnerability of the agricultural economy of Jilin Province during the implementation of policy on the purchasing and stockpiling of corn. It indicated that the policy on the purchasing and stockpiling of corn not only seriously disturbed the forming mechanism of corn's market price and narrowed the income space of corn, so it was necessary to cancel the policy.

After the cancellation of the policy on the purchasing and stockpiling of corn, the corn price in Jilin Province was in a sharp decline from 2016 to 2017 (the market price of corn was only half of the purchasing price during the implementation of the policy), so the indexes of the agricultural economic resilience in all regions were in a sharp decline with a negative value. The agricultural economy of Jilin City was still highly dependent on the corn business, so its agricultural economic resilience was the worst in 2017. By comparison, in the eastern city of Jilin Province, Tonghua City, and the western city, Baicheng City, the agricultural structure had a low reliance on a single crop. Baicheng City has more cultivated land resources relatively, so the grain crop structure was diverse; it was both an important corn production area and the dominant planting area for oil crops and miscellaneous grains in China. The relatively coordinated agricultural structure not only reasonably distributed the agricultural resources but also greatly reduced sensitivity to the price fluctuation of a single crop in the regional agricultural economy; additionally, it also improved the resistance of the agricultural economy to the price fluctuation of agricultural products. Tonghua City had no advantage in the cultivated land resources compared with the middle and western cities of Jilin Province, but it made full use of terrain and climate resource conditions to add the planting of tobacco, ginseng, fruits and vegetables, and other special agricultural products fitting into the local conditions. Hence, the agricultural structure was more diverse to improve the risk resistance of the agricultural economy. In 2021, the supply and demand relationship of corn in the market was back to balance gradually, and the international corn price increased; the agricultural economic resilience of all sub-regions of Jilin Province exceeded the level before the adjustment of policy. The overall agricultural economic resilience was good. Except for the negative value of the resilience indexes in Siping City and Tonghua City, the resilience indexes in other cities were positive. In fact, after the cancellation of the policy on the purchasing and stockpiling of corn, partially dominant corn areas in China reduced the planting area to some extent. The growth of corn yield was slowed down while the speed of inventory elimination was accelerated, so there was a tight balance in the supply and demand relationship of the corn market. The corn

price was higher, and the pig breeding gradually recovered from the African swine fever, so the soaring feed demand boosted the increase in corn price. In addition, there was a great demand for corn processing alcohol due to COVID-19 [55], and the pandemic also boosted the international corn price and hindered its import [56]. The two factors pushed up the domestic corn price. The overall agricultural economic resilience in all sub-regions of Jilin Province in 2021 was higher, but there was a gap in the agricultural economic resilience in all regions within the province. Changchun City had the highest agricultural economic resilience due to the strength of increasing agricultural economic aggregate. Songyuan City kept enhancing the connection efficiency and processing capacity between the corn processing enterprises and the corn production area after 2016, so the deep processing level of corn was obviously improved. There was a bigger gap in the local corn market in 2021, so the corn price in Songyuan City greatly increased in 2021 with a rapid enhancement of the agricultural economic resilience. Tonghua City had a bigger adjustment in the industrial structure in 2021, so the total planting area of crops in 2021 (including grains, oilseeds, beets, vegetables, tobacco leaves, ginseng, melons and fruits, sunflower seeds, etc.) was 31% less than that of 2019, and the agricultural yield was in a great fall compared with that of 2019, so the resilience indexes dropped down.

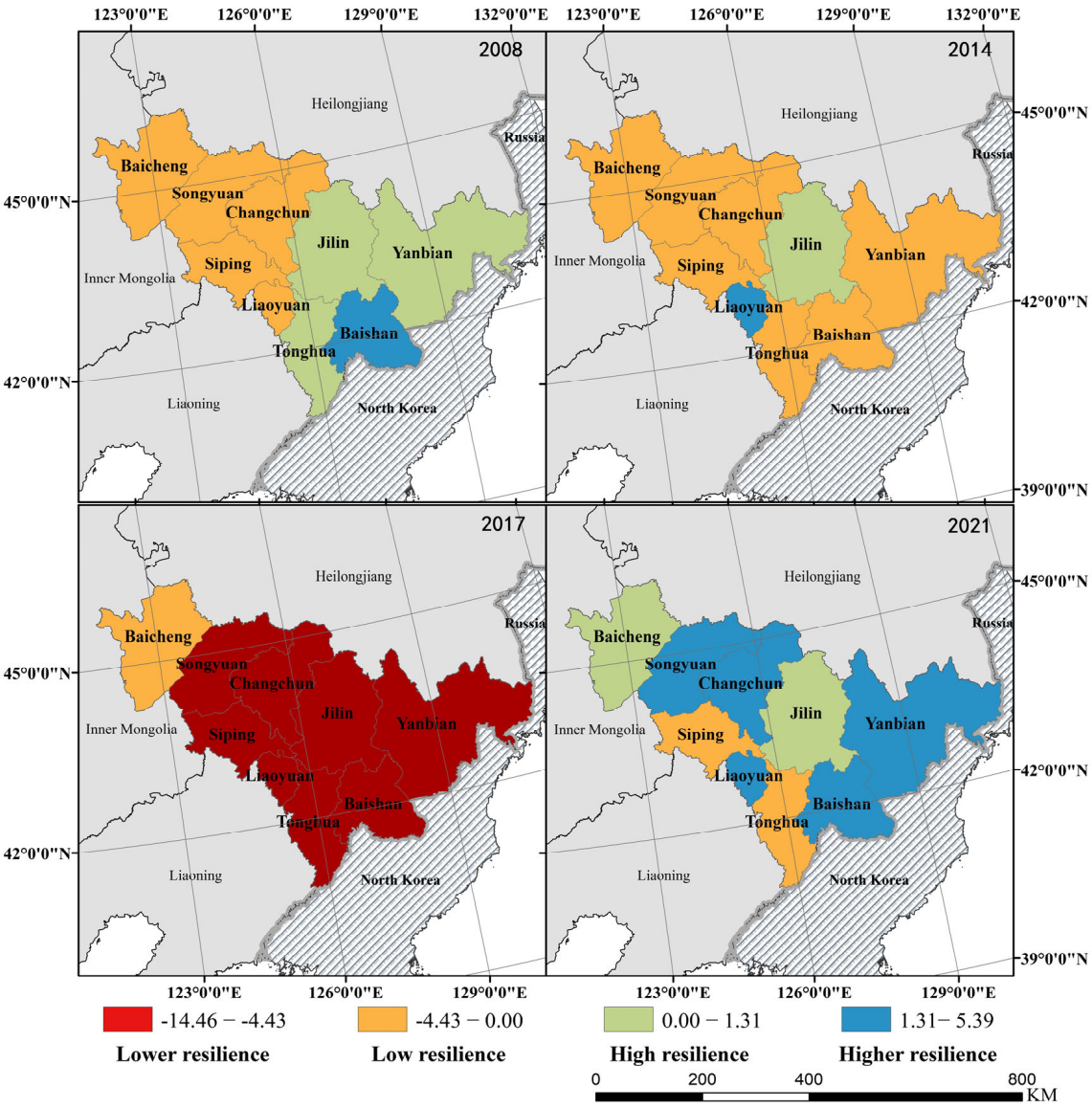

Figure 4. The spatial pattern of agricultural economic resilience of Jilin Province.

4.3. Detection of Influencing Factors

The study selected the four dimensions (government's support for agriculture, agricultural input capacity, agricultural yield capacity, and potential of the rural markets) as the indicators of the influencing factors of agricultural economic resilience. The proportion of agricultural expenditure and per capita agricultural fixed asset investment were the important indicators to measure the government's support for agriculture; the degree of mechanization, proportion of rural labor force, effective irrigation rate of cultivated land, and growth rate of corn planting area were the important indicators to measure the agricultural input capacity; the grain yield per unit area, scale of the agricultural industry, and agricultural labor productivity were the important indicators to measure the agricultural yield capacity; the proportion of rural social consumption, urbanization rate, and Engel's coefficient of rural residents were the important indicators to measure the potential of the rural market. The specific indicators are shown in the following Table 1.

Table 1. Indicators of influencing factors of agricultural economic resilience of Jilin Province.

Type of Variable	Influencing Factor	Calculation Method	Mean	Stdv	Min	Max
Government's Support for Agriculture	Proportion of Agricultural Expenditure	Agriculture, forestry, and water affairs expenditure/Total government financial expenditure	0.144	0.057	0.053	0.275
	Per Capita Agricultural Fixed Asset Investment	Agricultural fixed asset investment/Total agricultural population	1.326	1.414	0.094	6.106
Agricultural Input Capacity	Degree of Mechanization	Total power of agricultural machinery/Cultivated land area at the end of the year	5.084	1.280	2.670	9.130
	Proportion of Rural Agricultural Labor Force	Rural agricultural population/Total rural population	0.423	0.086	0.308	0.655
	Effective Irrigation Rate of Cultivated Land	Effective irrigation area/Cultivated land area at the end of the year	0.236	0.130	0.029	0.489
	Growth Rate of Corn Planting Area	Growth rate of corn planting area in the stage	0.029	0.088	−0.233	0.338
Agricultural Yield Capacity	Grain Yield Per Unit Area	Total grain yield/Cultivated land area at the end of the year	6369.706	1514.816	3333.898	9146.272
	Scale of Agricultural Industry	Planting area of crops/Total agricultural population	1.054	0.362	0.434	1.679
	Agricultural Labor Productivity	Total agricultural output value/Total agricultural population	2.515	0.762	1.317	4.033
Potential of Rural Market	Proportion of Rural Social Consumption	Total retail sales of consumer goods in rural areas/Total retail sales of consumer goods in the whole society	0.118	0.035	0.061	0.205
	Urbanization Rate	Year-end urban population/Year-end total population	0.504	0.125	0.270	0.746
	Engel's coefficient of rural residents	The proportion of total food expenditure of rural residents to total personal consumption expenditure	33.752	6.091	24.800	45.600

4.3.1. Detection Result of Influencing Factors

The study made all cities of Jilin Province as samples and selected 2009, 2014, 2017, and 2021 as a time section according to the stage division in Section 3.1; the indexes of agricultural economic resilience in all sub-regions were dependent variables, and then there was a classification of the continuity influence factors with the ArcGIS 10.2 Jenks to probe into the key driving factors and its interpretive force of the agricultural economic resilience in all cities of Jilin Province in the four years. At the same time, there was an analysis of Pearson correlation coefficients with SPSS to judge the acting director of each factor to study the influencing degree of different factors on the agricultural economic resilience under the shock and disturbances of corn price fluctuation during the agricultural development of Jilin Province (Table 2).

Table 2. Contribution rate of influencing factors of agricultural economic resilience of Jilin Province.

Type of Variable	Serial Number	Influencing Factor	2009	2014	2017	2021	Variation Trend
Government's Support for Agriculture	X1	Proportion of Agricultural Expenditure	0.255	0.793	0.209	0.505	↑
	X2	Per Capita Agricultural Fixed Asset Investment	0.620	0.468	0.071	0.662	↑
Agricultural Input Capacity	X3	Degree of Mechanization	0.655 **	0.558	0.349	0.481 *	↓
	X4	Proportion of Rural Agricultural Labor Force	0.510	0.590	0.614 *	0.651 *	↑
	X5	Effective Irrigation Rate of Cultivated Land	0.509	0.490	0.265	0.068	↓
	X6	Growth Rate of Corn Planting area	0.622 *	0.463	0.214	0.043	↓
Agricultural Yield Capacity	X7	Grain Yield Per Unit Area	0.624 *	0.464	0.471	0.044	↓
	X8	Scale of Agricultural Industry	0.527	0.588	0.175	0.520 *	↑
	X9	Agricultural Labor Productivity	0.078	0.259	0.104	0.441	↑
Potential of Rural Market	X10	Proportion of Rural Social Consumption	0.324	0.554	0.414	0.432 *	↑
	X11	Urbanization Rate	0.780 *	0.153	0.300	0.054	↓
	X12	Engel's coefficient of rural residents	0.426	0.296	0.654 *	0.616	↑

* means the significance under 0.05, ** means the significance under 0.01. "↑" indicates an increasing level of influence; "↓" indicates a decreasing level of influence.

According to the analysis of the dominant influencing factors of agricultural economic resilience in all cities of Jilin Province in 2009, 2014, 2017, and 2021, the following was found: the proportion of agricultural expenditure, per capita agricultural fixed asset investment, the proportion of rural agricultural labor force, the scale of the agricultural industry, agricultural labor productivity, the proportion of rural social consumption, Engel's coefficient of rural residents, and other influencing factors increased the interpretive degree of agricultural economic resilience.

The purchasing and stockpiling price of corn and the corn planting area in Jilin Province in 2009 increased gradually, and the degree of mechanization and grain yield per unit area had a positive correlation on the agricultural economic resilience, which meant the higher the degree of mechanization and grain yield per unit area, the stronger the agricultural economic resilience. The main reason was that the corn yield was the main motivation for agricultural economic growth under the pushing of policy prices, so

the area with the higher degree of mechanization and grain yield per unit area would have a stronger agricultural production capacity [57], and the agricultural economy status was better. The area with the higher urbanization rate would have a relatively developed processing and warehousing ability of corn for the perfect logistics, transportation, and other facilities, and the corn price was also higher. Hence, the urbanization rate was a significant positive pusher for the increase in agricultural economic resilience. While the serious drought would cause the yield reduction in corn, the growth rate of corn planting area worked as a significant negative motivator for the agricultural economic resilience during the drought period (the yield of corn in Jilin Province in 2009 was reduced by 17% due to disasters), which implied that the faster the growth of corn planting area it was, the weaker ability of agricultural economic resilience it was.

The year 2014 was the peak of the corn price after the implementation of agricultural economic resilience. Compared with 2009, the proportion of agricultural expenditure, the proportion of the rural labor force, the scale of the agricultural industry, and agricultural labor productivity greatly increased the interpretive degree of agricultural economic resilience. The main reason was that the purchasing and stockpiling price of corn was soring and the government also kept increasing the financial expenditure on agriculture, and the normal farmers and large-scale planting farmers gradually increased the production input of corn to improve the corn production capacity. During the process, the large-scale planting farmers had bigger strength in the efficiency of agricultural production than the ordinary farmers, and their agricultural yield capacity was also stronger. In some regions with undeveloped agricultural scales, adding the input of the rural labor force was an important approach to increase the agricultural yield capacity [58]. Due to the less occurrence of the natural disaster, the growth rate of corn planting areas on the acting director of agricultural economic resilience was transferred from a negative correlation in 2009 to the positive one. The analysis from 2009 to 2014 shows that pushing the growth of grain yield by adding the agricultural input within the stage was the dominant, decisive factor of agricultural economic resilience; in this time, enhancing agricultural input capacity and agricultural yield capacity had strong support for strengthening the agricultural economic resilience.

In 2017, the shock of the agricultural economy of Jilin Province on the corn price showed the strongest vulnerability. During the period, the proportion of the rural labor force showed a significant negative correlation with agricultural economic resilience, which meant that the bigger the proportion of the rural labor force was, the weaker resistance of the agricultural economy against the fall of corn price. It was because the agricultural large-scale production and management capacity in the area with the relatively dense rural labor force was weaker, the lower labor productivity and the higher production cost caused weak profitability, so it was more sensitive to price shock [59]. In 2017, the areas where farmers had a higher income in Jilin Province were the ones with less proportion of corn in the planting, so they suffered from less impact of the corn price fluctuation, or the areas had a stronger resistance against the corn price shock for having a relatively developed corn processing and consumption ability. The disposable income of farmers worked as a stable supporter of agricultural economic resilience.

In 2021, the degree of mechanization, the scale of the agricultural industry, and the consumption level of rural society had a significant positive correlation with agricultural economic resilience. The agricultural labor productivity and the disposable income of farmers also showed a higher positive pusher. The main reason was that Jilin Province added the investment in agricultural modernization after the cancellation of the policy on the purchasing and stockpiling of corn, while the area with higher mechanization and scale would have higher agricultural modernization accordingly, and then there came the higher agricultural production capacity and the efficiency. The purchasing subject of corn was transformed from the country before 2016 to market entities after 2016. The higher the consumption level of rural society and the disposable income of farmers they were, the better openness of the rural market was in the region [60]; and there were diverse

corn-purchasing subjects. These factors jointly enhanced the adaptive recovery of the agricultural economy after the cancellation of the policy on the purchasing and stockpiling of corn. The proportion of rural labor force showed a significant negative promoter for the agricultural economic resilience, and the reason was that the areas with denser rural labor force had a weaker adaptive recovery of agricultural economy and weaker resilience due to the higher corn production cost and lower corn processing efficiency under the background of the agricultural large-scale production and management. In addition, the government increased the financial expenditures in agricultural fields such as agricultural modernization, rural revitalization, protection of cultivated land resources, and subsidies for grain producers after 2016, so that the proportion of public financial expenditure and per capita agricultural fixed asset investment made a greater contribution for improving agricultural economic resilience during the period. The analysis in 2017 and 2021 shows that with the guidance of the new policy of agricultural subsidies (which was directly subsidized to producers instead of the price subsidy for specific crops) and the adjustment of purchasing subject of corn, the farmers' enthusiasm for growing grain and the potential of the rural market was displayed, so that both the disposable income of farmers and grain yield were increased synchronously. The agricultural economy of Jilin Province showed a higher adaptive recovery, and economic resilience was greatly improved.

4.3.2. Analysis of the Interaction of Influencing Factors

The interaction among different influencing factors was the key mechanism of the agricultural economic resilience in Jilin Province (Figure 5). The interaction among influencing factors was mainly shown to be a nonlinear enhancement and dual-factors enhancement, and it was significantly stronger than the internal interaction of factors. In 2009, the government purchase system came to effect for the policy on the purchasing and stockpiling of corn, which pushed the gradual increase in the corn production capacity, so the two factors, corn planting area and grain yield per unit area, and the coupling interaction between government's support for agriculture and agricultural input capacity imposed synergistic enhancement on the agricultural economic resilience. The interaction between labor productivity and other factors also had a positive promotion for economic resilience. The corn price came to a peak in 2014, and the government kept increasing the subsidy of corn price, so the interaction between the government's support for agriculture and other factors also showed a strong impact. The agricultural water of Northeast China was the key factor in restraining agricultural development. The irrigation utilization rate of cultivated land directly affected the grain yield. The increasing corn planting area also added to the need for irrigation water, so the interaction between the irrigation rate of cultivated land and other factors imposed synergistic enhancement on the agricultural economic resilience from 2009 to 2014. There was a sharp decline in corn prices in 2017, so the coupling effect of the agricultural labor productivity, as a key factor to measure the agricultural input and yield efficiency, and other factors enhanced imposed synergistic enhancement on the agricultural economic resilience. After a series of agricultural reforms and adjustments in 2021, the agricultural modernization level of Jilin Province was enhanced, and the interaction between the degree of mechanization and other factors had a higher interpretive degree with economic resilience. Moreover, the increased subsidies for producers and the gradual opening of market-oriented purchase of corn enabled the coupling relationship between the farmers' income, agricultural yield capacity, and the government's support for agriculture imposed a significant impact on the improvement of agricultural economic resilience.

2009	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	0.26											
X2	0.96	0.62										
X3	0.80	0.73	0.66									
X4	0.91	1.00	0.76	0.49								
X5	0.34	1.00	1.00	1.00	0.15							
X6	1.00	0.96	0.96	0.98	1.00	0.62						
X7	1.00	1.00	0.98	0.98	1.00	0.70	0.62					
X8	0.91	1.00	0.91	0.86	1.00	0.85	0.83	0.41				
X9	1.00	0.73	0.73	1.00	0.72	0.96	1.00	1.00	0.08			
X10	0.58	0.96	1.00	0.88	0.61	0.73	0.71	0.86	1.00	0.32		
X11	0.88	0.95	0.91	0.84	1.00	0.98	0.96	0.86	1.00	0.85	0.78	
X12	0.96	0.96	0.98	0.86	1.00	0.71	0.69	0.72	1.00	0.57	0.82	0.49

2014	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	0.79											
X2	0.96	0.47										
X3	1.00	0.82	0.26									
X4	0.87	0.98	0.71	0.59								
X5	0.98	0.70	0.99	1.00	0.49							
X6	0.99	0.82	0.53	0.71	1.00	0.16						
X7	0.99	1.00	0.86	1.00	1.00	0.96	0.16					
X8	0.82	0.96	0.71	0.69	0.98	0.71	1.00	0.59				
X9	0.96	0.82	0.39	0.71	0.98	0.53	1.00	0.71	0.26			
X10	0.86	1.00	0.65	0.89	1.00	1.00	1.00	0.86	0.65	0.55		
X11	0.99	1.00	0.55	0.71	1.00	0.44	0.82	0.71	0.71	1.00	0.15	
X12	0.89	1.00	0.71	0.65	0.85	0.44	0.96	0.71	0.71	0.89	0.44	0.30

2017	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	0.21											
X2	0.98	0.07										
X3	0.60	0.85	0.35									
X4	0.83	0.91	1.00	0.61								
X5	0.46	0.82	0.62	1.00	0.27							
X6	0.83	0.52	0.95	0.83	1.00	0.21						
X7	0.70	1.00	0.70	0.79	0.70	0.88	0.47					
X8	0.83	0.52	0.84	0.66	1.00	0.35	0.80	0.18				
X9	1.00	0.23	1.00	0.99	1.00	0.52	0.98	0.52	0.10			
X10	0.58	0.85	0.84	0.74	0.76	0.83	0.79	0.60	0.99	0.41		
X11	0.68	0.83	0.55	0.76	0.70	0.71	0.54	0.60	0.99	0.60	0.30	
X12	0.83	0.82	1.00	0.72	0.82	0.71	0.68	0.76	1.00	0.76	0.63	0.55

2021	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	0.50											
X2	0.82	0.66										
X3	0.74	0.75	0.48									
X4	0.92	1.00	0.91	0.65								
X5	0.56	0.78	0.78	1.00	0.07							
X6	1.00	0.86	1.00	1.00	0.25	0.04						
X7	0.94	0.87	0.88	1.00	0.20	0.25	0.04					
X8	0.91	0.86	0.92	0.92	0.79	0.86	1.00	0.52				
X9	0.87	0.99	0.99	0.81	1.00	0.74	1.00	0.99	0.44			
X10	0.87	0.88	1.00	1.00	1.00	0.66	1.00	1.00	0.62	0.43		
X11	0.94	0.81	1.00	0.81	0.20	0.25	0.16	1.00	0.81	1.00	0.05	
X12	1.00	1.00	1.00	0.90	0.80	0.65	1.00	0.80	0.75	0.66	1.00	0.51

Figure 5. The interactive result of different influencing factors of agricultural economic resilience in Jilin Province.

5. Discussion

In our analysis, we found that the continuous deepening of market intervention by the corn price subsidy policy is an important reason for the sharp drop in agricultural economic resilience in Jilin Province from 2016 to 2017. The long-term decoupling of the corn reserve policy from market feedback led to an overly rapid increase in corn planting areas in Jilin Province, rigidifying the agricultural industry structure. In the later stages of the policy, it severely disrupted the corn market, gradually deepening the vulnerability of the agricultural economy. In 2016, when the new policy was introduced, the accumulated supply–demand contradictions from the previous period were released in full, causing a severe shock to the corn market. After 2017, the corn market, which had been decoupled from price subsidies, demonstrated better adaptability. Under the market-based adjustment of agricultural subsidy policies and the continuous optimization of agricultural structure, the resilience of Jilin's agricultural economy gradually increased after 2017. This finding is consistent with some scholars' views on coupled subsidies and decoupled subsidies [10,17,24,25], namely that coupled subsidies can severely distort the market, leading to the loss of agricultural competitiveness and a decrease in agricultural production efficiency, and are not conducive to shaping strong agricultural economic resilience. The results of this study also confirm that the flexibility of agricultural subsidy policies to market feedback is key to policy effectiveness and has a significant impact on

agricultural economic resilience. The formulation and adjustment of agricultural subsidy policies must incorporate market mechanisms and reduce policy price intervention. If grain prices experience significant fluctuations in the future, it should be considered to make use of market regulation as much as possible. When it is necessary to intervene in corn prices, try to take economic measures rather than market-distorting measures such as price subsidies. At the same time, flexibly apply producer subsidy policies to guide farmers in the rational allocation of agricultural resources, further promote the process of corn market procurement, and fully release the vitality of the rural market.

Moreover, we found that the sudden policy adjustments were another major reason for the sharp decline in agricultural economic resilience in Jilin Province from 2016 to 2017. The newly introduced market procurement plus producer subsidy policy happened to coincide with a period of low international corn prices and high domestic corn inventory levels, causing a continuous drop in corn market prices. Moreover, the new policy was introduced in March 2016, when farmers were preparing for spring corn planting. The suddenly announced new policy made it impossible for farmers to adjust their planting structure in a short time. The large corn planting area and output, the large corn inventory, and the low corn market price, these three adverse factors jointly led to a significant decline in agricultural economic resilience in the initial period of the new policy from 2016 to 2017. Therefore, in the process of formulating and adjusting agricultural subsidy policies, it is necessary to avoid major changes in agricultural policies. Due to the persistence and cyclical nature of corn prices being affected by government policies, policy continuity should be considered. Efforts should be made to explore and establish a reasonable range for the cycle of corn price fluctuations, improve the government's ability to monitor and predict trends in the agricultural economy, carry out agricultural policy reforms step by step, establish a long-term stable subsidy mechanism, and formulate response mechanisms for unexpected events.

Thirdly, we found that the adjustment of agricultural subsidy policies is not essentially a direct impact on the agricultural economy. It is first a transformation of government support for agricultural production and agricultural products, aiming to maintain food security and ensure farmers' income. The implementation and adjustment of agricultural subsidy policies will inevitably change the regional agricultural structure, and changes in the regional agricultural structure will greatly influence the form, duration, scope, and targets of agricultural subsidy policies. In conclusion, the resilience of the agricultural economy changes in the process of interaction between agricultural subsidy policies and regional agricultural structures. The underlying cause of changes in agricultural economic resilience is the result of the combined action of government institutions and agricultural structures [42,61]. On the one hand, as the crucial underlying condition for regional agricultural development, the agricultural structure has a profound impact on agricultural economic resilience. A diversified agricultural structure has a clear promotional effect on improving agricultural economic resilience [34]. The gradual increase in the resilience of Jilin's agricultural economy after 2017 is a good testament to this point. In the future, Jilin Province should continue to optimize its agricultural structure. According to the overall demand for agricultural products, the endowment of agricultural resources, and comparative advantages among regions, it should further clarify the regional layout. On the other hand, many scholars believe that compared to the long-term nature and diversity of regional agricultural structural adjustments, the subjectivity and flexibility of government institutions in policy making have a more profound impact on agricultural economic resilience [20,21,32,37]. This perspective is particularly applicable to Jilin Province. When formulating agricultural subsidy policies in the future, the government should fully understand the baseline conditions and actual circumstances of agricultural development in different regions, fully leverage regional agricultural resource advantages, and improve the level of agricultural resilience. In the long run, if Jilin Province continues to overly rely on its corn-based agricultural structure, the resilience of its agricultural economy will depend

on how government institutions use the relative advantages of agricultural structure and resources to enhance their ability to withstand market risks.

6. Conclusions

This study takes Jilin Province as the research object, regards the fluctuations in corn prices caused by policy changes as the source of shocks to agricultural economic resilience, and uses the period of the implementation of temporary corn stockpiling policy from 2008 to 2015 (coupled subsidies policy) and the period of the implementation of market-oriented corn purchase and producer subsidies policy from 2016 to 2021 (decoupled subsidies policy) as one fluctuation cycle. It measures and analyzes the changes in Jilin's agricultural economic resilience from 2008 to 2021 and explores the key factors affecting changes in agricultural economic resilience. The conclusions of the analysis are as follows:

The transition from the coupled subsidies policy to the decoupled subsidies policy helps to shape a stronger regional agricultural economic resilience. During the implementation of the temporary corn stockpiling policy, the corn planting area in Jilin Province increased year by year, and the corn production capacity also gradually strengthened, but the agricultural economic resilience index has always been fluctuating at a low level. This index fluctuated from 0.11 in 2008 to −0.05 in 2015. The cancellation of the corn stockpiling policy in 2016 suddenly released the corn market supply–demand contradiction that had been accumulating for many years. Additionally affected by factors such as farmer policy dependence, low international corn prices, severe oversupply in the domestic corn market, and the abruptness of policy changes, the agricultural economic resilience index of Jilin Province showed a significant decline in the early stage of the decoupled subsidies policy (2016–2017). After 2017, with the gradual digestion of corn inventory and the continuous optimization of agricultural planting structure, the advantages of the decoupled subsidies policy gradually emerged. The agricultural economic resilience index of Jilin Province fluctuated from −5.48 in 2016 to 1.50 in 2021. In fact, the policy combination of producer subsidies and market-oriented procurement has a better effect on improving agricultural economic resilience than the corn stockpiling policy. The direction of the country's reform of the market mechanism for agricultural product prices is correct.

The ability of agricultural economic resilience in different regions of Jilin Province exhibits various spatial-temporal differentiation characteristics. During the temporary corn stockpiling policy period, the resilience capacity of the central region of Jilin Province initially strengthened and then gradually weakened, while the changes in the resilience capacity of the eastern and western regions were relatively small. During the market-oriented procurement and producer subsidy period, the resilience capacity of the central and eastern regions of Jilin Province increased significantly, while the western region showed a smaller increase. During the implementation of the corn stockpiling policy, factors reflecting the level of agricultural input and agricultural output had a high explanatory power for agricultural economic resilience. During the market-oriented procurement and producer subsidy period, factors reflecting the government's support for agriculture and the potential of rural markets had a significant impact on the improvement of agricultural economic resilience. At the same time, the interaction between different influencing factors presents nonlinear enhancement effects and dual-factor enhancement effects, and the explanatory power of the coupling interaction between influencing factors on agricultural economic resilience varies at different stages.

The findings of this study indicate that compared to the coupled subsidies policy, the decoupled subsidies policy, as a form of direct subsidy, causes less distortion to the market, has higher subsidy efficiency, and helps shape greater agricultural economic resilience. At the same time, the structure of agricultural planting has a significant impact on agricultural economic resilience. A diversified agricultural structure can significantly promote the improvement of agricultural economic resilience. Additionally, the continuity of agricultural policy is also an important factor affecting agricultural economic resilience. Therefore, in formulating and adjusting agricultural subsidy policies, priority must be

given to the role of market mechanisms, reducing price intervention, rationally allocating agricultural resources, and constructing a diversified agricultural planting structure. When it is necessary to reform policies, adjustments should be made gradually to avoid sudden policy changes. Due to data acquisition limitations, this study was unable to conduct an in-depth analysis of agricultural economic resilience in county-level units of Jilin Province. In future research, we will continue to track and further analyze the characteristics of changes in Jilin Province's agricultural economic resilience under the decoupled subsidies policy from the perspective of farmer livelihoods and propose better policy suggestions.

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