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СОДЕРЖАНИЕ

Original article

ANALYSIS OF SOCIO-ECONOMIC AND NATURAL FACTORS OF DEVELOPMENT OF THE ANIMAL HUSBANDRY INDUSTRY

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Promoting animal husbandry industry is important to help strengthen the agricultural sector. This study starts from both socio-economic and natural factors perspectives. Based on an exploratory spatial analysis, spatial econometric model, and geographically weighted regression (GWR) model, selecting the 13 Provinces of North China as the study area, this study analyzes the spatio-temporal differences and the driving factors. This study found: 1) Between 2006 and 2017, the spatial and temporal differences of GDP in the 13 provinces were statistically significant, with increased total production values and a slowed growth of the industry. In addition, the study area showed an east-west dichotomy in husbandry industry. 2) GDP had shown obvious spatial agglomeration, of which areas with the high production value were in east of Beijing, and areas with low production value were in western Inner Mongolia, Xinjiang and Gansu. 3) Population, animal husbandry output values, numbers of large livestock, and cultivated areas had greatly influenced the GDP of 13 provinces in north China. 4) The three influencing factors on GDP in the 13 provinces were found to be population, animal husbandry output values, and the sizes of cultivated areas.

Keywords: animal husbandry; socio-economic and natural factors; geographically weighted regression; exploratory spatial analysis; spatial econometric model.

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АНАЛИЗ СОЦИАЛЬНО-ЭКОНОМИЧЕСКИХ И ПРИРОДНЫХ ФАКТОРОВ РАЗВИТИЯ ОТРАСЛИ ЖИВОТНОВОДСТВА

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Развитие животноводства важно для укрепления сельскохозяйственного сектора. Данное исследование основано на социально-экономических и природных факторах. На основе исследовательского пространственного анализа, пространственной эконометрической модели и модели географически взвешенной регрессии с выбором 13 провинций Северного Китая в качестве территории исследования, в этом исследовании анализируются пространственно-временные различия и движущие факторы. Основными результатами исследования стало следующее: 1) В период с 2006 по 2017 год пространственные и временные различия ВВП в 13 провинциях были статистически значимыми, с увеличением совокупной стоимости производства и замедлением роста промышленности. Кроме того, на территории исследования наблюдалась дихотомия востока и запада в животноводстве. 2) ВВП продемонстрировал очевидную пространственную агломерацию: районы с высокой стоимостью производства находились на востоке Пекина, а районы с низкой стоимостью производства – в западной части Внутренней Монголии, Синьцзяне и Ганьсу. 3) Численность населения, объемы продукции животноводства, поголовье крупного скота и посевные площади сильно повлияли на ВВП 13 провинций северного Китая. 4) Установлено, что тремя факторами, влияющими на ВВП в 13 провинциях, являются численность населения, объемы продукции животноводства и размеры посевных площадей.

Ключевые слова: животноводство; социально-экономические и природные факторы; географически взвешенная регрессия; поисковый пространственный анализ; пространственная эконометрическая модель.

Animal husbandry, an important component of agriculture, is also a pillar industry that supports the survival and development of farmers and herdsmen especially in north China. The animal husbandry industry accounts for about half of the global agricultural economy and makes important contributions to global food security. However, global food demands are expected to continue to increase in the coming decades.

This is particularly the case in developing countries, where the consumption of meat, eggs, and milk is expected to increase significantly due to increased population and rising income levels. China has 393 million hectares of grasslands, accounting for 42% of the country's total land area. With the continuing economic development in China and the living standards of her-residents continue to rise, along with the trend that the animal husbandry industry is shifting from traditional household production (self-consumption and local market allocation) to intensive industrial production demands for livestock output in China are projected to continue to increase in the near future.

This growing demand for animal products, such as meat, eggs, and milk has stimulated further development of the animal husbandry economy. As a result, the share of animal husbandry promoted from 14.98% during the early implementation of the Reform and Opening Up Policy in early 1980s to 28.28% in 2016 However, compared to developed countries, this proportion is still relatively low when considering conditions in other developed countries.

For example, the outputs of animal products in the United States, United Kingdom, and France account for 48%, 70%, and 80% of total agricultural output, respectively. Since animal husbandry in China relies mainly on natural and cultivated forage resources and 90% of grasslands has suffered different some degrees of degradation due to overgrazing it is essential to explore the driving factors that influence the development of animal husbandry and their effects on the animal husbandry economy in order to adapt to and mitigate the impact of global changes in economic development.

Developing the animal husbandry economy to drive up GDP growth without sacrificing the ecological environment has become a focus of international research. Approached the subject from the perspective of livestock breeding and proposed that the effectiveness in breeding could be the key to a healthy livestock development and considered that the development of animal husbandry was, to some extent, affected by demographic factors. Influenced by global warming, climate in many regions had changed greatly, which could directly affect vegetation dynamics and biomass. Furthermore, climate changes would also influence the structure and a region's carrying capacity of livestock studied animal husbandry in the hilly areas of northwestern Europe and found that climate changes and production barriers were the primary factors that hindered the production of animal husbandry and economic development in their study areas.

Assessed the vulnerability of animal husbandry toward global climate changes from a macro perspective. Similarly, the Qinghai-Tibet Plateau, an important pastoral area in China, was considered by and that global warming and the shortage of forage are the main reasons for the high vulnerability of the local animal husbandry. At the same time, the rapid growth in animal husbandry has led to further increases in the concentration of global greenhouse gases (GHG) in many regions To that end, suggested that GHG emissions were influenced by animal husbandry industry in China. Scholars have also investigated the effects of grazing on the concentration of soil organic carbon phosphorus in grasslands and carbon emissions.

In the aforementioned studies, although scholars have made certain achievements in research on the animal husbandry economy, the main regions of focus in those studies have been the United States and European countries, both are developed economies. But studies about China, on the other hand, have tended to adopt the perspective of environmental protection. Since China joined the World Trade Organization (WTO) in 2001, the proportion of animal products in exported agricultural products in its total economy has increased. Animal husbandry has gradually become a primary industry of the nation's economy. There is insufficient research on the spatial spillover effects of factors that could affect the animal husbandry economy and their comprehensive impacts from both anthropogenic and natural environmental factors. In addition, the majority of the studies have approached the subject from a provincial and municipal level. However, studies that targeted larger, more generalized regions are few and limited. Moreover, existing research mostly utilized time-series analyses rather than a geospatial perspective to examine the spatial dependency of animal husbandry development at a regional level. Such approaches tend to assume one model fits all regions in a study area, i.e., spatial stationarity, which of course, is usually not the case in reality.

Therefore, in light of the gaps in existing research and limitations of animal husbandry development in China, it is necessary to conduct a comprehensive study to uncover the driving factors

of the development of animal husbandry and its contributions to China's GDP. This study selected 13 provinces, including provincial municipalities and autonomous regions in north China, as the focus of research and 2006 to 2017 as the research period in order to comprehensively investigate the impact of regional animal husbandry on GDP. A spatio-temporal evolutionary perspective was adopted and a spatial analytical method was employed to explore influencing factors; an exploratory analysis method was introduced to measure the spatial differentiation of GDP of the 13 investigated provinces; an econometric model was constructed to verify the existence of a spatial spillover effect; and finally, GWR model was used to quantitatively analyze the different levels of influence by factors that affect the spatial distribution of GDP.

The purpose of the study is to provide a theoretical basis as a reference for decision-making and policies by concerned stakeholders, to facilitate the transformation of traditional animal husbandry to modern animal husbandry, to assist in the alleviation of the imbalance in the forage–animal relationship, and to explore new development models for animal husbandry that are in accordance with the characteristics of pasture areas. And in order to maintain a healthy development in animal husbandry and to create a solid foundation for a sustainable development of the agricultural economy in China.

Spatiotemporal heterogeneity analysis.

China has a large animal husbandry industry. Targeting the main region of animal husbandry production, this study investigated the spatial characteristics of GDP of the provinces and applied GWR model to reveal the spatial heterogeneity of the corresponding drivers.

According to the spatial differences in GDP growth and output values of animal husbandry, the results showed that GDP were higher in the eastern regions but lower in the west of the study area. This agglomerated trend became more apparent as time went on. Moreover, the outputs of animal husbandry were positively correlated with changes in GDP. These trends could be related to the characteristics of different climate zones and land types of the region. Study found that the accelerated expansion of cities in the middle of the study area, and the habitat quality has also declined. Found that regional heterogeneity of water resources severely limits the development of animal husbandry. Specifically, western areas of the study areas mostly suffered from desertification and grassland desertification. Owing to environmental factors (e.g., land desertification and reduced biodiversity), GDP and output of animal husbandry in the western areas of the study areas were lower than that of the eastern areas (Table 1).

Table 1 – Result of research

Variable type	Variable		Indicator
Dependent variable	Y		GDP (1,000 million yuan)
	A	B	
Independent variable	Socio-economic factors	X_1	Output of animal husbandry (100 billion Yuan)
		X_2	Population ($\times 10^4$)
		X_3	Large Livestock ($\times 10^4$)
		X_4	# Cattle ($\times 10^4$)
		X_5	# Sheep ($\times 10^4$)
	Natural factors	X_6	Arable Land (km^2)
		X_7	Grassland (km^2)
		X_8	Surface Temperature (°F)
		X_9	Precipitation (cm)

The spatial error model results shows that promotion of agricultural and animal husbandry development should suit local conditions, such as climate and land use type. Rapid urbanization causes large urban conversions of natural and agricultural land to non-agricultural use. This result

will inevitably affect the animal husbandry industry. Moreover, the results show that GDP growth was not necessarily linked to the number of livestock and poultry units, but rather, it may be associated with the production, processing, and marketing methods for animal products. Thus, the results suggest that concerned parties should control the total number of livestock in each city based on the local conditions of the cities, accelerate the transition from traditional to modern animal husbandry, increase the industrialization of animal husbandry, and improve the protection of livestock against diseases. These practices would help to promote an animal husbandry industry geared towards standardization, scalability, and industrialization. From 2006 to 2017, the factors that have a significant impact on the GDP of the 13 northern provinces of China are the output value of animal husbandry, population, the number of livestock, and the area of arable land. Except for the area of arable land, the regression coefficients of other factors are all east high in spatial distribution. The low west situation indicates that to improve the regional economic development level, it is necessary to promote the growth of animal husbandry output according to local conditions, increase investment in animal husbandry, alleviate the imbalance of grass-livestock relationship, and explore the new model of ecological protection and animal husbandry development suitable for the characteristics of pastoral areas.

Limitations and future directions.

This study still has uncertainties. This study explores the spatio-temporal differences and the spatial heterogeneity of factors influencing the varying animal husbandry development of the 13 provinces in the northern China. Animal husbandry is a major component of agriculture. The development of animal husbandry could help alleviate the poverty of farmers and herders significantly and promote effective social supply The modernization of agriculture through the modernization of animal husbandry would help promote the goal of constructing a strong agricultural sector The influence of human and factors of physical environment on the development of animal husbandry has become increasingly complex. Therefore, concerned parties may want to consider additional influencing factors, make use of relevant favorable policies and government subsidies, and explore new developmental models to facilitate the development of the local economy.

It is noteworthy that, since this study focused on the effect of animal husbandry on GDP, the direct influences of some indicators on GDP were not explored in detail. To further investigate the impact of animal husbandry development on the national economy, we suggest that future studies use the size of the agricultural sector as an independent variable (Figure 1)

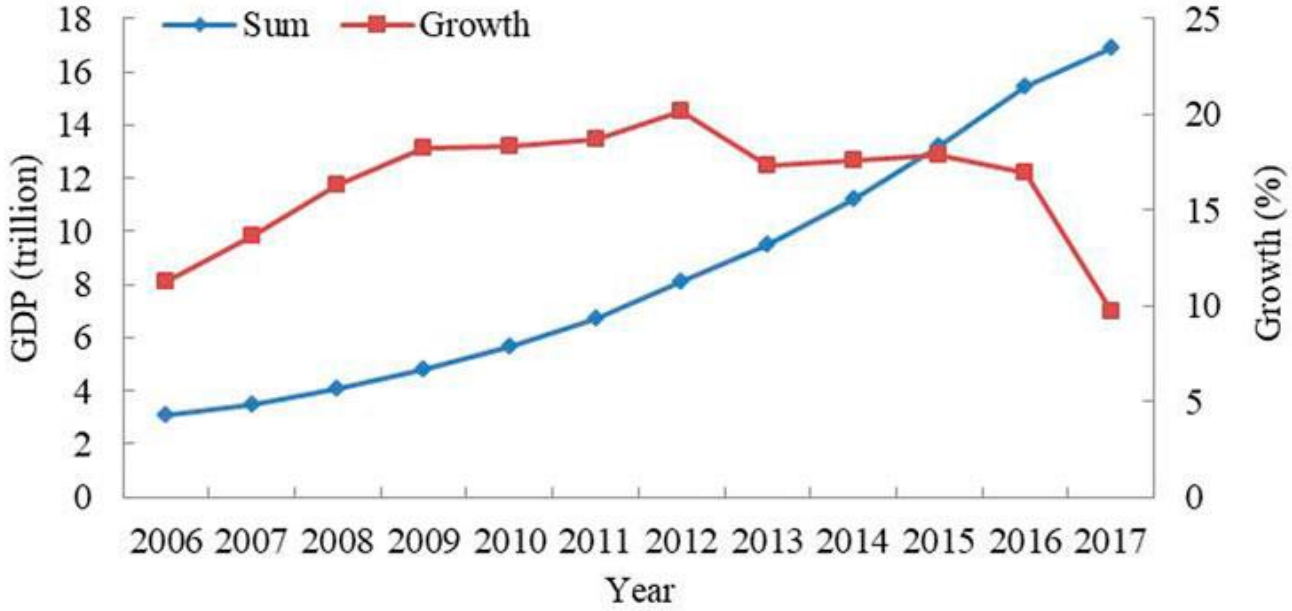

Figure 1 – Effect of animal husbandry on GDP

The Diagram shows that between 2006 and 2017, the GDP of the investigated provinces continued to grow with decreasing fluctuations in the growth rates over time. Specifically, GDP increased from 3.073 trillion yuan (RMB) in 2006 to 16.907 trillion yuan in 2017. Animal husbandry has long been the main driving force for economic development in the study area. Owing to the implementation of key region-wide projects, such as animal protection, improvement in the breeding system of livestock and poultry, and restoring grazing lands to grasslands, the increases of GDP reached a peak value in 2004. Thereafter, affected by the global financial crisis and livestock and poultry diseases in 2012 and 2013, the growth began to slow down. Thus, this study selected 2006 (the first year of the study period), 2009, 2012 (both years with noticeable changes in the growth of GDP), and 2017 (the last year of the study period) to further explore the spatial differences in GDP growth and output values of animal husbandry in the study area.

The results showed that GDP were higher in the eastern regions but lower in the western regions of the study area. This agglomerated trend became more apparent as time went on. Moreover, the outputs of animal husbandry were positively correlated with changes in GDP. These trends could be related to the characteristics of different climate zones and land types of the region. Specifically, western areas of the study areas mostly suffered from desertification and grassland desertification. Owing to environmental factors (e.g., land desertification and reduced biodiversity), GDP and output of animal husbandry in the western areas of the study areas were lower than that of the eastern areas in the study areas.

Conclusion

Exploring the development of animal husbandry is of great significance to stabilizing the people's living standards. This study found, the spatio-temporal differences of GDP were prominent, presenting an increasing trend from west to east. Owing to regional differences in economic development and techniques of livestock and poultry farming, cities with higher GDP tended to concentrate in the east. The impact of the factors (excluding numbers of large livestock units) on GDP, from the largest to the smallest were population, output values of animal husbandry, and areas of arable land. At the early stage of the study period, controlling population (human activities), stimulating the output of animal husbandry, and controlling the numbers of large livestock units (improving techniques for livestock and poultry farming) had a great impact on GDP. At the latter stage of the study period, besides population and animal husbandry output, controlling the areas of arable land gradually became an important driving factor of GDP growth. These results can serve as a scientific reference for accelerating the transformation of animal husbandry in the 13 provinces of north China and for exploring new ways suitable for promoting local animal husbandry development.

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