Research on Influencing Factors of Illegal Wildlife Trade Based on Multiple Linear Regression Model

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Abstract. This study aims to explore the influencing factors of illegal wildlife trade and assess the role of key indicators such as technology, law, and international cooperation in reducing this type of trade. By integrating Spearman's correlation analysis and multiple linear regression models, we conducted an in-depth analysis of China's wildlife trade data. Initially, Spearman's correlation analysis revealed significant positive correlations between education, public awareness, technology, law, and international cooperation with the reduction of illegal wildlife trade. Subsequently, we constructed a multiple linear regression model to quantify the specific impact of these indicators on the reduction of illegal wildlife trade. The model results indicated that technology and law are the main drivers in promoting the reduction of illegal trade, while international cooperation also plays an important role. Furthermore, we conducted sensitivity analysis to evaluate the impact of changes in model parameters on the predictive outcomes, ensuring the robustness of the model. This research provides a scientific basis for policymakers, emphasizing the importance of increasing technological investment, improving legal regulations, and deepening international cooperation in combating illegal wildlife trade. The findings not only contribute to the protection of biodiversity but also offer strategic guidance for achieving harmonious coexistence between humans and nature.

Keywords: Illegal wildlife trade, Spearman's correlation analysis, Multiple linear regression model, big data analysis, Policy impact, international cooperation.

1. Introduction

The illegal trade of wildlife poses a significant threat to global biodiversity, disrupts ecosystems, and potentially leads to the spread of zoonotic diseases, which can have severe implications for public health and safety. This trade, which often operates in the shadows, is a complex issue that requires a multifaceted approach to effectively combat its proliferation. The Chinese government, in line with international commitments and domestic legislation, has been actively working to curb illegal wildlife trade, recognizing its detrimental effects on the environment and society [1].

The advent of big data analytics has revolutionized the way we can approach and address such challenges. By leveraging the power of data, we can identify patterns, trends, and correlations that were previously obscured, providing a clearer picture of the factors contributing to illegal wildlife trade. This, in turn, enables the development of more targeted and effective strategies to mitigate these activities.

This paper introduces a comprehensive research study that utilizes big data analytics, specifically Spearman's correlation analysis and multiple linear regression models, to investigate the factors influencing illegal wildlife trade in China. The study is designed to align with the goals of the State Forestry and Grassland Administration of China, which seeks to protect biodiversity and maintain ecological balance through the enforcement of wildlife protection laws and the promotion of public awareness.

2. Data Analysis

2.1. Client's connection to the Project

2.1.1. Alignment of the Project with the Client's Goals

Humans and the ecosystem are a unity that interacts and influences each other. Illegal hunting and trading of wild animals will destroy the biodiversity and the numerical balance between species, causing an imbalance in the ecosystem. Wild animals are carriers of a large number of viruses, and the illegal trade and consumption of wild animals will lead to food safety risks and even lead to the occurrence of disease transmission [2]. The Chinese government adheres to the principles of prioritizing protection, standardizing utilization and strengthening supervision, and improves preventive and punitive measures for wildlife protection. In China, wildlife crimes are punishable by different penalties depending on the circumstances of the crime, and those with particularly serious cases are sentenced to more than ten years of imprisonment or life imprisonment, and fined.

The deputy director of the wildlife protection department of the National Forestry and Grassland Administration said: "With the rapid updating and iteration of Internet technology, the forms of illegal wildlife trade online are becoming more complex and changeable." In the face of the serious crime situation, in order to use science and technology to better fight crime, China's forestry law enforcement authorities and relevant enterprises have carried out a series of illegal and criminal activities involving precious and endangered wild animals.

This project shares the goals of the State Forestry and Grassland Administration of China and is committed to using science and technology to combat illegal wildlife trade, help stabilize natural ecosystems, and create a harmonious Internet ecological environment. The project establishes a reporting platform for illegal wildlife trade, quickly handles reported information, assists law enforcement agencies in effectively combating criminal behavior, effectively resists the spread of illegal wildlife trade, and adheres to the concept of harmonious coexistence between human beings and nature.

2.1.2. The Project Conforms to the Actual Situation of the Customer

China has been actively implementing CITES and various bilateral and multilateral agreements to punish illegal wildlife trade. In November 2017, China established the "Internet Enterprise Alliance to Combat Illegal Trade in Wildlife Online", which, through online guidance, early warning and monitoring, collaborates with competent authorities to combat illegal trade in wildlife and its products through the Internet [3]. In 2018, the National Forestry and Grassland Administration of China and some world-renowned ecological conservation public welfare organizations launched the initiative of "Creating a better connection between man and Nature" to jointly explore solutions for using digital technology to help ecological and wildlife protection and combat illegal wildlife trafficking [4].

In 2020, Tencent, in conjunction with academic institutions and relevant enterprises, officially released the group standard "Requirements for the Control of Illegal Wildlife and Plant Transactions on Online Platforms" on the platform of the Internet Society of China (ISOC), which provides Chinese Internet enterprises with implementation standards and reference norms for combating illegal wildlife and plant transactions on the Internet. At the same time, the Chinese government requires Internet enterprises to assume social responsibility, actively cooperate with the government in combating wildlife crimes, and provide continuous and effective publicity and education to their users. Moreover, all provincial and municipal governments have set up monitoring platforms to encourage the public to actively report illegal wildlife trade.

2.2. Personal Analysis

CNNIC released the 52nd Statistical Report on the Development of the Internet in China, which shows that as of June 2023, the number of Internet users in China reached 1.079 billion, an increase of 11.09 million compared with December 2022, and the Internet penetration rate reached 76.4% [5,6].

For the moment, data has become a significant factor of production, and the big data industry, as a strategic emerging industry focusing on data collection, storage, and analysis, is the pivotal support to activate the potential of data factors. China attaches great importance to the development of the big data industry, promotes the implementation of the national big data strategy, cultivates an independent, controllable, open, and cooperative industrial ecology, and creates new advantages in the development of the digital economy. In recent years, China's big data industry has started rapidly, and the scale of China's big data industry has reached 1,422.4 billion yuan in 2022.

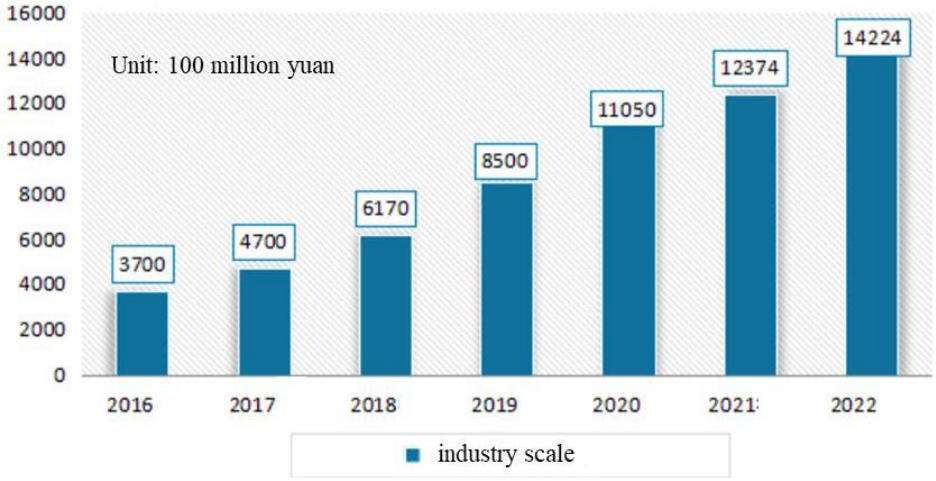


Figure 1. China's big data industry scale statistic

2.3. Data-driven Analysis

2.3.1. Implementation of CITES

CITES is essentially a legally binding international wildlife trade agreement that aims to protect species of wild animals and plants, prevent over exploitation due to international trade, and ensure the sustainability and diversity of wildlife populations. CITES lists different species in three appendices, depending on the level of protection required, and controls international trade in these species and their products through a licensing system, thus making the Convention an effective means to combat illegal trade and limit overuse. Active use of CITES will help countries join hands to combat illegal trade, rationally use wildlife resources, protect biodiversity, and achieve sustainable development of people and nature [7].

Since joining CITES in 1981, China has consistently attached great importance to the protection of wild fauna and flora and the implementation of its obligations under the Convention, and has made remarkable achievements in the protection of endangered wild fauna and flora, international compliance and cooperation, and combating illegal trade, thus contributing positively to the realization of the harmonious coexistence of human beings and nature, and to the promotion of the building of a community of shared destiny for mankind

According to the CITES website, from 2019 to 2023, China is the largest exporter of wildlife trade with nearly 200 million animals and plants, and China is the fifth largest importer of wildlife trade with about 46 million animals and plants.

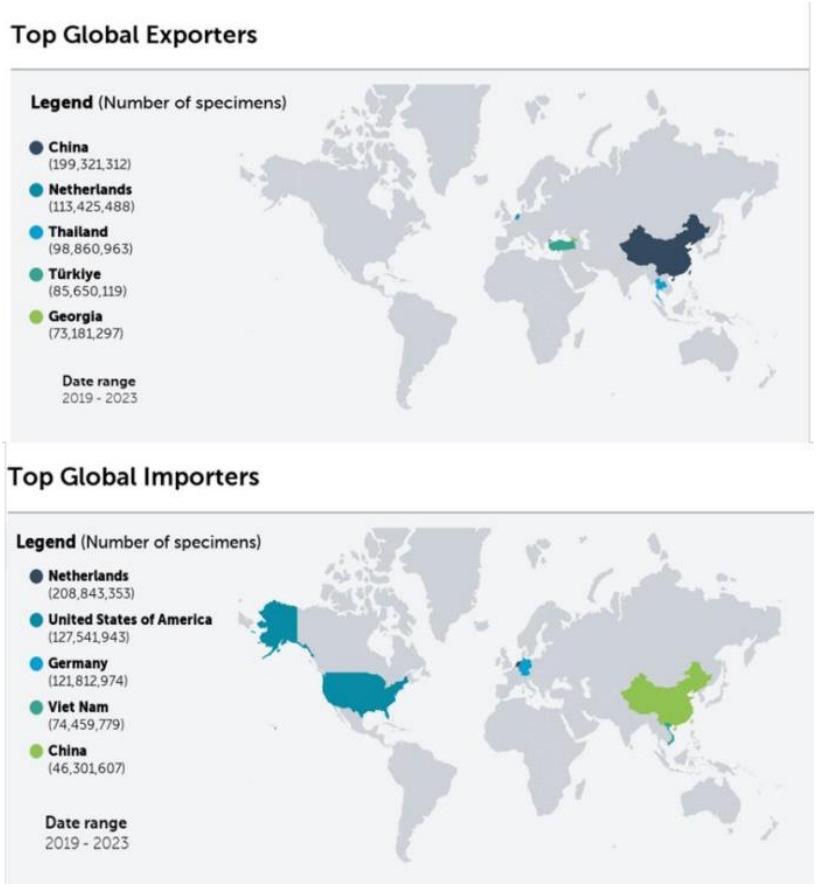


Figure 2. Imports and exports of wildlife trade from 2019 to 2023

According to the above data, it can be concluded that the import and export quantity of wildlife trade in China is high, and the situation is more serious. The project of this paper helps the relevant departments in China to carry out network supervision, cooperate with law enforcement agencies and relevant departments to combat illegal trade in wildlife and protect biodiversity.

2.3.2. Correlation Analysis

The National Forestry and Grassland Administration's current mission to reduce illegal wildlife trade is reflected in the following data indicators: education, public awareness, technology, and laws and regulations. This paper analyzes the correlation between the reduction of illegal wildlife trade and the above four indicators by the Spearman coefficient and concludes that there is a significant positive correlation between the reduction of illegal wildlife trade and technology, laws, and regulations. The correlation coefficient between reducing illegal wildlife trade and technology is 0.789, which is high. This project is based on big data analysis and has a high scientific and technological content, which is conducive to promoting the reduction of illegal wildlife trade. It can carry out scientific and technological cooperation with the National Forestry and Grassland Administration of China to jointly crack down on illegal wildlife trade through security technology and capabilities.

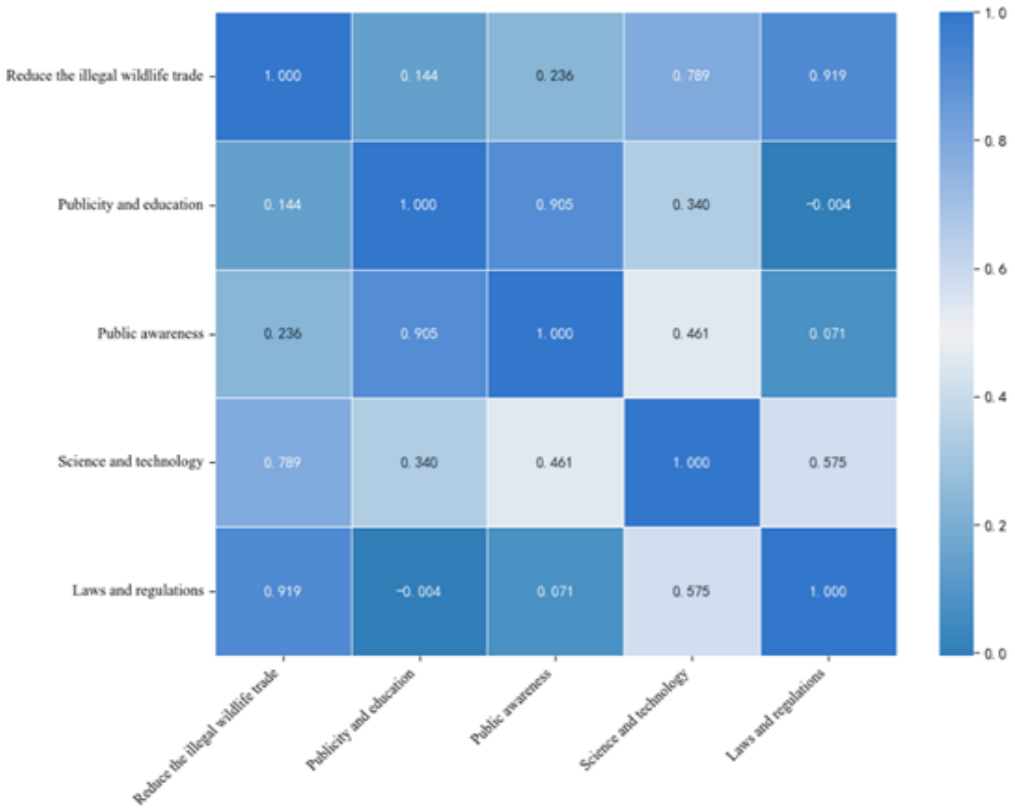


Figure 3. Spearman's coefficient correlation analysis heat map

3. Multiple Linear Regression Model

3.1. Visualization Analysis

On the basis of the previous analysis, two additional project indicators have been added to the project: professional staff and international cooperation. The project is being implemented as expected, with each project indicator increasing by 5% per year, and visualizing the results, it can be concluded that, if the project is implemented, publicity and education, public awareness, and science and technology will increase year by year, and laws and regulations, professional staff, and international cooperation will maintain the trend of growth.

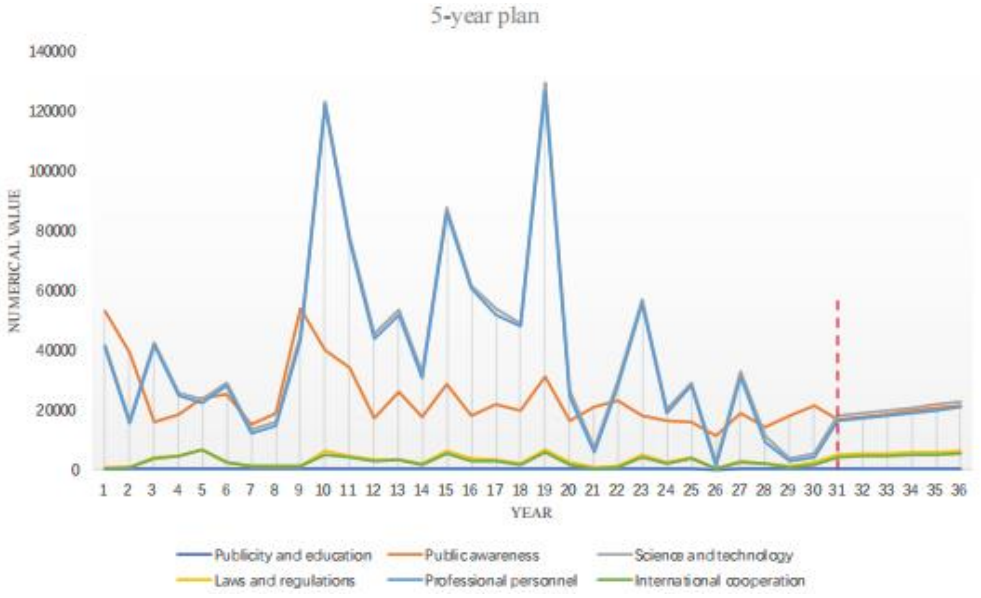


Figure 4. Five-year plan implementation project indicators line chart

3.2. Correlation Analysis

Based on the second chapter, Spearman correlation analysis is conducted between reducing illegal wildlife trade and the above six indicators, and it is concluded that reducing illegal wildlife trade is significantly positively correlated with science and technology, laws and regulations, professionals, and international cooperation. The correlation coefficient between international cooperation and reducing illegal wildlife trade is the largest, which is 0.925. Available: If the project is implemented, the reduction of illegal wildlife trade will increase with the enhancement of technology, and the reduction of illegal wildlife trade will increase with the increase of laws and regulations, professionals, and international cooperation, and international cooperation will be the most effective.

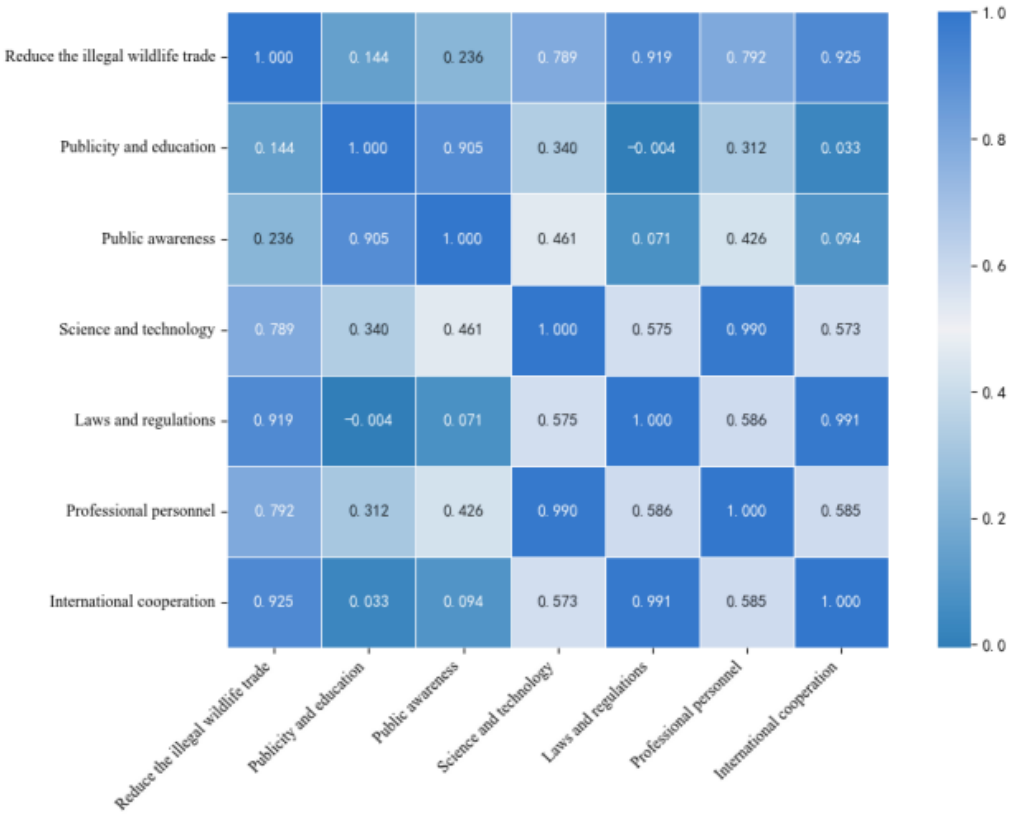


Figure 5. Spearman coefficient correlation analysis heat map

3.3. Establishment of Multiple Linear Regression Model

Based on the data of reducing illegal wildlife trade and the above six project indicators over the years, a multiple linear regression model was established, with "reducing illegal wildlife trade" as the dependent variable y, and the six project indicators as independent variables x1 to x6 in turn, and then the model was constructed and analyzed. See the table 1.

Table 1. Coefficient table of multiple linear regression mode

Variables	Variable Name	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std.Error	Beta		
Constant	Constant	34.808	2.297	-	15.157	0.775
x_1	Constant Publicity and education	-1.379	0.210	-0.541	-6.556	0.955
x_2	Public awareness	0.410	0.134	0.242	3.052	0.991
x_3	Science and technology	0.369	0.118	0.244	3.130	0.853
x_4	Laws and regulations	0.017	0.018	0.080	0.924	0.202
x_5	Professional personnel	0.666	0.156	0.281	4.281	0.955
x_6	International cooperation	-0.118	0.119	-0.105	-0.995	0.943

As shown in the table above, the P value of the independent variable x_2 is greater than 0.05 and the largest, which is not statistically significant, so x_2 is eliminated first, and the construction of the model continues, and so on. Because of space reasons, not much to show, the final results are shown in table 2.

Table 2. Multiple linear regression model ANOVA table

	Sum of Squares	df	Mean Square	F	Sig.
Regression	116889751.3	2	58444875.66	245.706	<0.001
Residual	6660222.870	28	237865.102	-	
Total	123549974.2	30	-	-	

The final multiple linear regression model P value is less than 0.001, the model is extremely significant, and the model is well constructed.

Table 3. The final multiple linear regression model coefficient table

Variables	Variable Name	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	St. Error	Beta		
Constant	Constant	-179.910	2.297	-	15.157	0.278
x_3	Science and technology	0.035	0.210	-0.541	-6.556	<0.001
x_4	Laws and regulations	0.565	0.134	0.242	3.052	<0.001

The P values of independent variables x_3 and x_4 are both less than 0.05, so the final multiple linear regression formula is as (1).

$$y = 0.035x_3 + 0.565x_4 - 179.910. \quad (1)$$

3.4. Solution of multiple linear regression model

According to the formula, substituting the data of science and technology and laws and regulations, we can get the data of "reducing illegal wildlife trade" in the next 5 years after the implementation of the project, and the result is shown in the figure below, which can be obtained: if the project is implemented, the reduction of illegal wildlife trade will increase year by year.

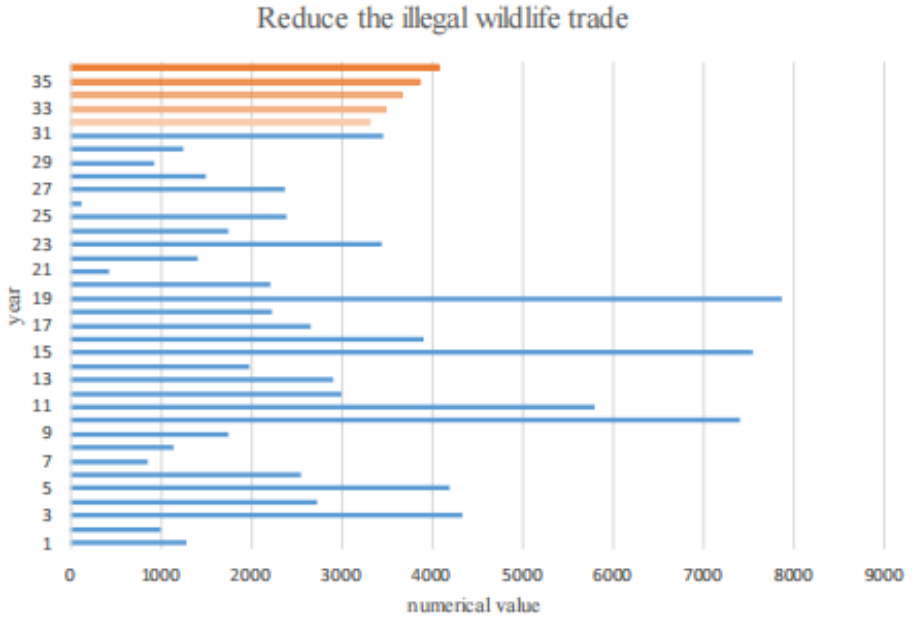


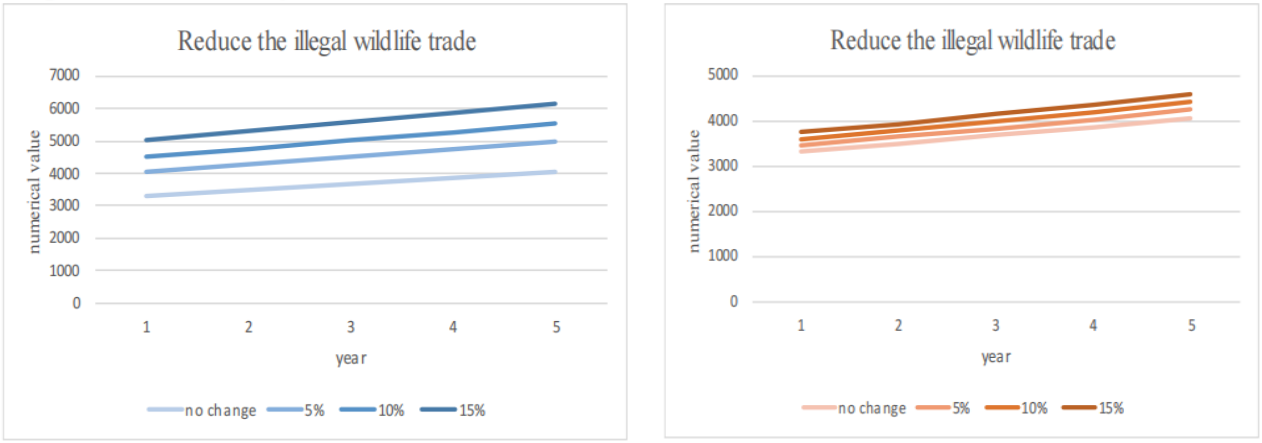
Figure 6. Clustered bar chart

In summary, the measurable impacts on illegal wildlife trade are science and technology, laws and regulations, professionals, and international cooperation, with science and technology and laws and regulations having a greater impact on illegal wildlife trade.

4. Sensitivity Analysis

When the main parameters change, for example, in the multiple linear regression model, the laws and regulations data change, or the scientific and technological data change, the model results are affected to some extent, and there will be relative changes. In addition, in the actual situation, there will be a certain error in the data, which will also lead to changes in the results. Therefore, sensitivity analysis is used to assess the stability of multiple linear regression models.

To simulate different levels of data fluctuation, we add 5%, 10%, and 15% impact data to the original data of science and technology and laws and regulations, and then these impact data are substituted into the model for calculation. The results of the final perturbed data compare with the original results as shown in Fig. 7.



(a) Varying degrees of scientific and technical data (b) Varying degrees of legal data

Figure 7. Sensitivity analysis chart

From the two graphs above, it can be seen that the impact data changed the original results and the direction of change is consistent, verifying the stability of the model.

5. Conclusion

This research has delved into the intricate dynamics of illegal wildlife trade in China by employing both Spearman's correlation analysis and multiple linear regression models. The study's strengths are rooted in its methodological rigor, which integrates quantitative evaluation indicators and balances subjective with objective approaches to weight calculation, ensuring the scientific and comprehensive nature of the model. The use of data from authoritative sources further bolsters the reliability of the analysis. Additionally, the simplicity of the model construction facilitates ease of calculation and correction, making the research process more manageable.

However, the study acknowledges certain limitations. While representative evaluation indicators have been selected, they may not fully capture the capabilities and influence of the target entities engaged in combating illegal wildlife trade. There is also an inherent subjectivity in the modeling trends used for predicting the future implementation of projects. To enhance the research, future studies should consider a more diverse data collection approach and conduct a comprehensive analysis. Incorporating a stochastic variable into the predictive model could also be beneficial, as it would account for potential future uncertainties and their impact on the project's effectiveness.

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