Dynamic Research on Residential Consumption Upgrading and Green Logistics Development Based on PVAR Model

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Abstract. Based on the provincial panel data from 2006 to 2020, this paper uses the PVAR model, impulse response and variance decomposition to analyze the dynamic relationship between residents' consumption upgrading and green logistics development, and conducts research and comparison by economic regions. Research shows that from 2006 to 2020, the development level of green logistics in China has been increasing year by year, but there are significant differences between economic regions. There is a good interactive relationship between consumption upgrading and the development of green logistics. 3. From the perspective of different economic regions, the development of green logistics has a restraining effect on the consumption upgrading of each economic region; The growth of consumption scale has a significant promoting effect on the development of green logistics in various economic regions; The upgrading of consumption structure has a inhibitory effect on the development of green logistics in the eastern region, but its impact on the central, western, and northeastern regions is not significant. Based on the above research, countermeasures and suggestions have been proposed to reasonably promote the upgrading of residents' consumption, promote the development of green logistics, and achieve coordinated and sustainable development between the two.

Keywords: Consumption upgrading · Green logistics · PVAR model · Economic region

1 Introduction

In recent years, with the development of e-commerce platforms, the number of social e-commerce users in China has increased from 418 million in 2016 to 780 million in 2020. Online shopping not only meets the personalized and diversified needs of Chinese residents, but also promotes the upgrading of residents' consumption. The demand for online consumption by residents requires the development of the logistics industry to achieve [13], which has caused a large amount of logistics waste to be generated during

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the implementation process. According to statistics, the increase in express packaging waste in China's mega cities alone accounts for 93% of the increase in household waste, with some mega cities accounting for 85% to 90%. It is urgent to promote logistics transformation. Consumer demand has decisive significance for the existence and development of logistics. Therefore, in the process of upgrading residents' consumption, it is necessary to actively guide the transformation of logistics towards a green logistics industry. Through the upgrading trend of residents' consumption, the logistics industry is forced to eliminate backward technologies and equipment, innovate green operation management processes and operation modes, realize the green and low-carbon carbon cycle development of the logistics industry, and promote the improvement of quality and efficiency of the logistics industry [2]. At the same time, the current development of logistics determines the realization of diversified consumption needs of residents. The logistics industry needs to improve the industry development system, integrate logistics resources, and continuously solve the problems of green logistics development in order to make green logistics a driving force for releasing domestic demand, promote changes in the new consumption structure of residents, and improve their consumption level. Therefore, during the "carbon neutrality" and "carbon peak" work period in China, in-depth research on the dynamic relationship between residents' consumption upgrading and green logistics development will help to improve China's green logistics development level and expand domestic demand, accelerate the development of logistics industry and residents' consumption towards low-carbon direction, thus promoting China's ecological civilization construction and promoting high-quality economic development.

2 Journals Reviewed

In recent years, the topic of logistics and resident consumption has attracted the attention of scholars both domestically and internationally. Among them, in terms of the impact of logistics on residents' consumption, Wang Xiaolong [3], Sun Yuemei [4] found through empirical research that the development of rural logistics industry has a significant promoting effect on rural residents' consumption. Zhang Hong and Wu Shun [5] used the dynamic spatial Durbin model to analyze that the early stage of collaborative aggregation between logistics and manufacturing industries will suppress the growth of residents' consumption. Hu Yu [6] found through research that poor logistics will suppress rural consumption levels. Li Ruofang [7] found that terminal logistics can affect the improvement of residents' consumption level by promoting the increase of residents' income through establishing the mesomeric effect model. Regarding the impact of residents' consumption on logistics, Alagarsamy [8] pointed out that consumers' green attitudes have a positive impact on sustainable logistics. Zhang Guangsheng [9] found through research that the dependence of logistics on consumption has always maintained an upward trend. Zhu Cuijuan and Party Secretary Wen [10] believe that the consumption trend and structure of residents play a decisive role in the development of the logistics industry. Ge Liguo [11] used the grey correlation method to study that upgrading the consumption structure of Chinese residents will promote the development of high-end logistics services. Carbon [12] believes that collaborative consumption can effectively promote the development of the logistics industry.

Throughout the above literature, domestic and foreign scholars have conducted unique research on the relationship between logistics and residents' consumption, but have not conducted relevant research based on green logistics. Meanwhile, existing research only focuses on the one-way relationship between consumption and logistics, and has not studied the interrelationships between the two. The research objects of scholars are mainly based on the national level, and there is no comparative analysis of economic regions. Therefore, based on the panel data of 30 provinces and cities in China from 2006 to 2020, this paper constructs a panel vector autoregression model to study the relationship between green logistics development and consumption upgrading from the perspective of green development, and divides the country into eastern, central, western and northeastern regions for comparative analysis, Based on the actual situation of each economic region, in order to propose feasible suggestions.

3 Model Building

3.1 Green Logistics Indicator System

Under the condition of meeting the requirements of green development, considering the principles of scientificity, operability, desirability and systematicness of indicators, referring to the existing achievements, and due to the lack of data in the logistics industry, this paper uses the data of transportation, warehousing and postal services to replace the data in the logistics industry, combines the concept of sustainable development and "carbon neutrality", and selects forest coverage Constructing an evaluation index system for the development level of green logistics based on 21 indicators such as environmental governance rate [13], see Table 1 and calculate its weights using the entropy method.

3.2 Building Consumption Upgrade Indicators

This article divides the upgrading of residents' consumption into two aspects: the scale of residents' consumption and the upgrading of residents' consumption structure. The upgrading of consumption structure draws inspiration from the research of scholars such as Chen Chong and Wu Weicong [14]. This article takes the increase in the proportion of high-end consumption expenditure and the decrease in the proportion of low-end consumption expenditure as measurement indicators for the upgrading of consumption structure. According to the National Bureau of Statistics, residents' consumption is divided into eight categories: food, tobacco, clothing, housing, daily necessities and services, transportation and communication, education, culture and entertainment, and other goods and services. Residents' consumption is divided into low-end consumption, mid-end consumption, and high-end consumption. At the same time, different levels of consumption are given different weights to calculate the overall consumption structure upgrading index. The calculation process is as follows:

$$Cup_b = \sum_{a=1}^{2} \frac{r_{ab}}{R_b}\left(\frac{lec_{ab}}{C_{ab}} + 2\frac{mec_{ab}}{C_{ab}} + 3\frac{hec_{ab}}{C_{ab}}\right) \tag{1}$$

In Eq. (1), lec_{ab}, mec_{ab} and hec_{ab} respectively represent low-end consumption, mid-end consumption, and high-end consumption, with low-end consumption accounting for

1/6, mid-end consumption accounting for 2/6, and high-end consumption accounting for 3/6[1]. Used to distinguish between towns, when a=1, it represents towns, and when a = 2, it represents rural areas; b represents the year; Represents the total consumption of C_{ab} urban or rural areas; r_{ab} represents the total population of urban or rural areas in the year, and R_b represents the total population in year b; Cup_{ab} represents the upgrading index of consumption structure, which is a positive indicator. The higher the proportion of high-end consumption, the larger this indicator indicates a significant upgrading of consumption structure.

Drawing on the research of Wu Zhenhua [15], the consumption scale is represented by the per capita consumption expenditure of residents, and the indicator is logarithmically processed to eliminate the impact of heteroscedasticity.

3.3 Data Source and Processing

This article selects data from 30 provinces, cities, and autonomous regions in China, excluding Hong Kong, Macao, Taiwan, and Tibet, from 2006 to 2020 as empirical samples. The data mainly comes from the China Statistical Yearbook, CSMAR database, China Energy Statistical Yearbook, and China Science and Technology Statistical Yearbook. The energy consumption and carbon dioxide emissions of the logistics industry and each province are calculated based on the correlation coefficients of the China Energy Statistical Yearbook.

To objectively determine the weight of the indicator system, this article uses the entropy method to calculate the green logistics index. PVAR model.

Holtz [16] proposed the Panel Vector Autoregressive Model (PVAR) based on the Inheritance Vector Autoregressive Model (VAR). PVAR not only inherits the advantages of VAR without the need to set causal relationships between variables, but also fully considers individual and time effects, effectively solving the problem of heterogeneity and reflecting the dynamic relationships between various variables. Based on this, this article takes three variables: consumption scale, consumption structure upgrading, and green logistics development level as endogenous variables, and constructs a PVAR model as follows:

$$Z_{it} = \alpha_0 + \sum_{j=1}^{m} \alpha_1 Z_{i,t-1} + \mu_i + \lambda_i + \varepsilon_{it} \tag{2}$$

Among them, in Eq. (2), z_{it} is an endogenous variable, which includes three endogenous variables: consumption scale (lnS), consumption structure upgrading (Cup), and green logistics development level (G). In order to reduce the absolute value, the consumption scale is logarithmically treated; i represents each sample; t is the year; j is the lagging order; α_0 is the intercept term; α_j is the regression coefficient matrix; $Z_{i,t-j}$ is an endogenous variable with j-order lag; μ_i is an individual fixed effect; μ_i is a fixed time effect; λ_t is a random interference term.

[1] This article divides food, tobacco, alcohol, clothing, and housing into low-end consumption, daily necessities, services, and other consumption into mid-end consumption, and education, culture, entertainment, medical insurance, and transportation and communication into high-end consumption.

4 Empirical Analysis

4.1 Stability Test

In order to prevent the false correlation or regression of variables and the distortion of the structure of panel vector autoregression model, the robustness of the test is considered. This article uses HT and IPS methods for unit root tests to examine the stationarity of variables in samples from various regions, as well as national and economic regions. The structure is shown in Table 1.

Through the unit root test, it can be found that the original sequences *lnS*, *Cup*, and *G* are unstable. After first-order difference, most of the *DlnS*, *DCup*, and *DG* can reject the original hypothesis of "existence of unit roots" at a significance level of 1%, which is a first-order single integer. In order to determine whether there is a long-term equilibrium relationship between various variables, this article conducted cointegration tests on each variable, and the results are shown in Table 2. From the table, it can be seen that the P-values are all less than 0.05, which means rejecting the original hypothesis of "no cointegration relationship" at a significance level of 5%. Therefore, we can believe that although the original variable is unstable, there is a long-term cointegration relationship, which can be analyzed using the PVAR model.

Table 1. Unit Root Test for Variables

		lnS	*Cup*	*G*	*DlnS*	*DCup*	*DG*
Nationwide	HT	2.5364	2.1358	7.5135	18.8383***	2.1179***	18.3503***
	IPS	4.6242	1.1782	9.4248	5.8377***	7.8101***	7.4610***
Eastern region	HT	1.7150	0.4470	4.5622	8.5064***	11.8933***	9.3720***
	IPS	2.4825	0.9140	6.2608	1.7585**	4.0641***	4.0699***
Central region	HT	-0.9726	0.6715	1.8949	10.5817***	11.2974***	8.8727***
	IPS	1.0982	0.1047	2.7118	3.3402***	3.8407***	3.6540***
Western Region	HT	1.3262	0.4433	2.6023	12.4977***	13.9206***	13.9997***
	IPS	2.1684	0.4144	2.4087	4.1463***	5.3319***	4.8462***
Northeast Region	HT	2.2163**	3.2701***	0.2315	6.5415***	7.3255***	3.3634***
	IPS	0.8040	1.3889*	0.1623	2.4992***	2.1881**	-1.5964 **

Note: According to STATA

Table 2. Cointegration Test Results

	Statistic name	Statistical T-value	P-value
Nationwide	PP	-3.0569	0.0011
Eastern region	PP	-4.0916	0.0000
Central region	PP	-5.1178	0.0000
Western Region	PP	-2.4679	0.0068
Northeast Region	PP	-1.6526	0.0492

Note: According to STATA

4.2 Optimal Hysteresis Selection

Because the correlation mechanism between consumption upgrading and the development level of green logistics is complex, panel data may have time effects and individual fixed effects. Therefore, this paper uses forward mean difference method to eliminate possible time effects and individual fixed effects. At the same time, this article uses PVAR2 presented by Lian Yujun to determine the optimal hysteresis period of the PVAR model based on AIC, BIC, and HQIC information criteria. According to Table 3, from the results of the optimal lag period of the samples, it can be seen that the lag order of the samples selected for the national, eastern, central, western, and northeastern regions is 1 period.

4.3 Granger Causality Test

In order to investigate the interrelationships between variables in depth, the Granger causality test was used. In the national sample, consumption scale is a one-way Granger

Table 3. Optimal hysteresis selection

	LAG	AIC	BIC	HQIC
Nationwide	1	-14.641*	-13.634*	-14.242*
	2	-12.190	-11.024	-11.726
Eastern region	1	-13.292*	-12.432*	-12.943*
	2	-7.799	-6.684	-7.346
Central region	1	-15.762*	-14.947*	-15.436*
	2	-12.783	-11.644	-12.329
Western Region	1	-14.619*	-13.749*	-14.266*
	2	-13.059	-11.945	-12.607
Northeast Region	1	-15.427*	-13.749*	-14.266*
	2	-13.059	-11.945	-12.607

Note: * represents the optimal hysteresis period under this criterion; According to STATA

factor in the upgrading of consumption structure, and the development level and consumption scale of green logistics are the results of the interaction of Granger factors. Among them, in the sample of the eastern region, the upgrading of consumption structure is a one-way Granger factor of consumption scale, while the development level of green logistics and consumption scale are mutually influencing Granger factors; The upgrading of consumption structure and scale is a factor for Granger, similar to the central and northeastern regions. The development level of green logistics is a one-way Granger factor in the upgrading of consumption structure.

4.4 Pulse Response Analysis

This article obtains the dynamic relationship between two variables through the impulse response function and characterizes the long-term equilibrium relationship of each variable. In the impulse response function, orthogonal decomposition is more sensitive to the ranking order of each variable. In order to better understand the relationship between consumption scale, consumption structure upgrading, and the development level of green logistics, this article sorts them according to the impact order among the three. Among them, consumption scale will promote the upgrading of consumption structure, thereby stimulating the improvement of green logistics development level and promoting the change of green logistics development structure. Therefore, this article places consumption scale (lnS) at the top, followed by consumption structure upgrading (Cup), and finally the level of green logistics development (G). This question uses the Monte Carlo method for 200 simulations to obtain pulse responses with a lag of 10 periods, as shown in Figs. 1, 2, 3 and 4.

Impact on oneself.

In the samples of the whole country, eastern region, central region, western region, and northeastern region, we can find that when faced with the impact of self standardization on consumption scale, upgrading of consumption structure, and development level of green logistics, the positive impact on oneself in the current period is the greatest, and then continuously decreases, with a trend of approaching zero or even decreasing to less than zero, indicating that consumption scale The upgrading of consumption structure and the development level of green logistics both have a self enhancing effect, which can promote the continuous development of oneself.

The impact of consumption scale.

Faced with a standardized impact on consumption scale, the response value of the national consumption structure upgrade began to show zero, and then continued to grow. The reason may be that with the continuous development of the economy and the expansion of consumption scale, people's consumption concepts will also change, placing more emphasis on the quality of life, promoting the upgrading of consumption structure. From the perspective of various economic regions, the results of the upgrading of consumption structure are not consistent: in the sample of the eastern region, due to a standardized impact of consumption scale, the current period of consumption structure upgrading is zero, followed by a negative impact, showing a "U" shape that first decreases

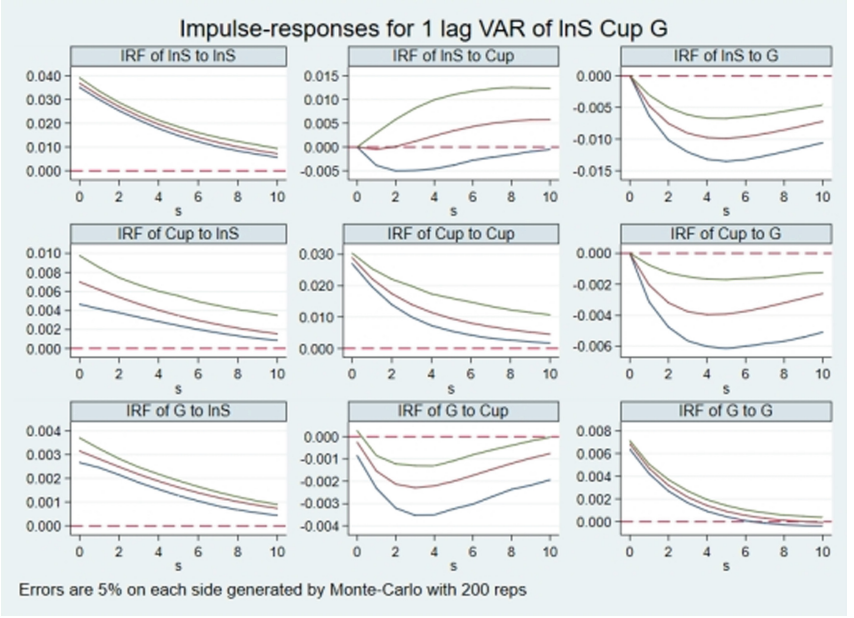

Fig. 1. Pulse Response Map of National Samples

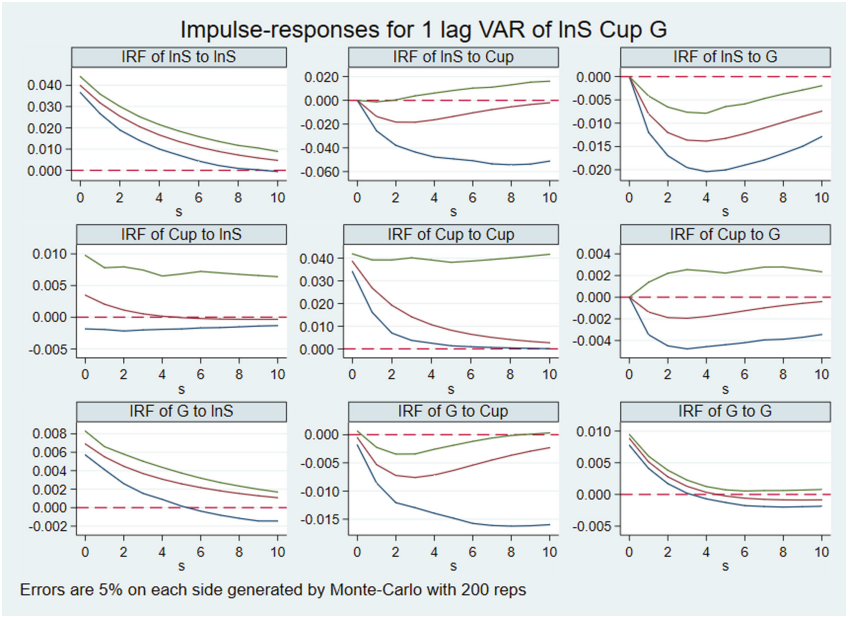

Fig. 2. Eastern Region Samples

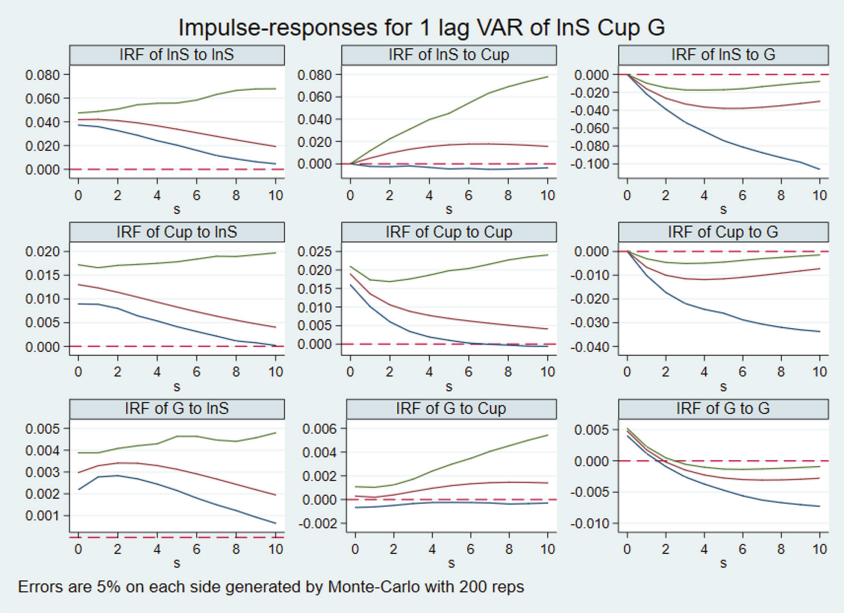

Fig. 3. Central region sample

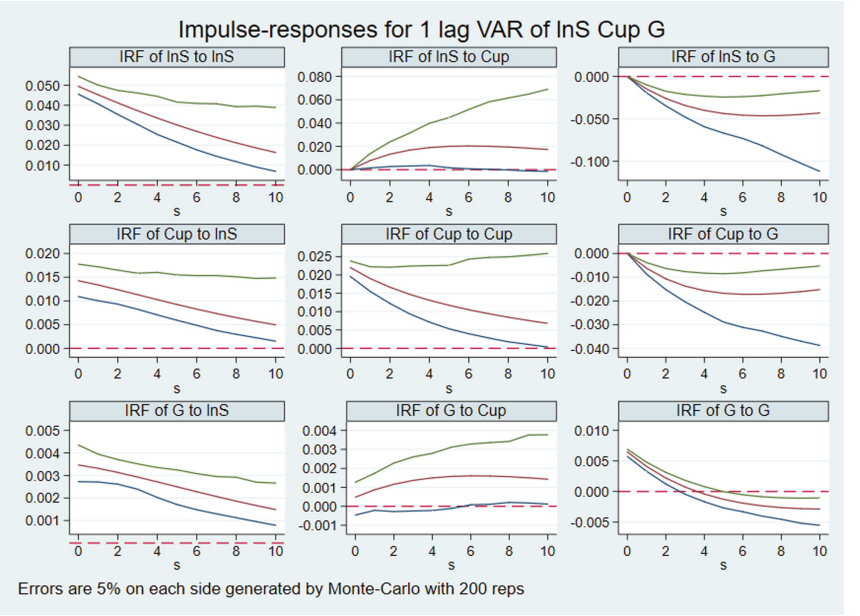

Fig. 4. Western Region Samples

and then rises to zero. The reason may be: firstly, with the acceleration of urbanization, the housing prices in the eastern region have increased significantly, and at the same time, the inflow of population into the eastern region is relatively large, The rapid rise in housing prices will have a squeezing effect on other consumption, leading to a decline in the upgrading of consumption structure. Therefore, it will have a negative impact on the upgrading of consumption structure. However, in the long run, consumption scale will have a positive impact on the upgrading of consumption structure. Secondly, according to Ye Jingjing [17], the upward space for consumption structure upgrading in the eastern region is relatively small, showing a slight downward trend. At the same time, the expansion of consumption scale in the eastern region is mainly due to the consumption growth relying on clothing, food, housing, and transportation, which will have a negative impact on consumption structure upgrading. In the central, western, and northeastern regions, the impact of consumption scale on the upgrading of consumption structure shows an inverted "U" trend of first increasing and then slightly decreasing. This is because the per capita disposable income and consumption expenditure of residents in the central, western, and eastern regions are constantly increasing, and most cities and towns have entered the affluent stage of social development. The price elasticity of low-end consumption is relatively small, and the growth rate of expenditure is slow. The growth rate of mid end and high-end consumption expenditure is relatively fast. With the continuous development of the social economy, the growth rate of mid range and high-end consumer spending will tend to slow down.

Affected by a standardized impact on consumption scale, the development level of green logistics in the whole country, eastern regions, central regions, and western regions has shown consistent responses, with zero impact in the current period. Subsequently, the response value decreases negatively to its peak and then increases, showing a "U" shape, with a continuous trend towards zero. The reason is that the scale of green consumption plays a decisive role in the development level of green logistics. According to the research of Si Linsheng [18], there is a significant gap between the green products provided by China and consumers' expectations. Consumers' satisfaction with green products is low, leading to a lower level of green consumption in China. The lower the level of green consumption, the lower the level of green logistics development, but with the attention of the government and operators, The continuous improvement of green products will enhance the level of green consumption and promote the development of green logistics. In the sample of Northeast China, the trend of the impact of consumption scale on the development level of green logistics is not significant, which may be due to the following reasons: firstly, the sample size in Northeast China is relatively large, resulting in a less obvious trend. Secondly, in recent years, the population loss in Northeast China has been relatively severe, and the level of economic development has been continuously declining, so the trend is not significant.

The impact of upgrading the consumption structure.

Faced with a standardized impact of consumption structure upgrading, the consumption scale of the country and various economic regions immediately had a positive impact, followed by a continuous decline and a trend towards zero. The upgrading of consumption structure can promote the development of consumption scale, because

low-end consumption belongs to rigid demand and has low price elasticity, and low-end consumption expenditure is relatively stable. Therefore, the upgrading of consumption structure is inevitably caused by an increase in mid to high end consumption expenditure, and the upgrading of consumption structure will inevitably promote the expansion of consumption scale.

Due to the standardization impact of the upgrading of consumption structure, the development level of green logistics across the country and various economic regions has shown a consistent response, with zero impact in the current period. Subsequently, the response value has decreased to a negative peak and then increased, showing a "U" shape. The reason for this is: firstly, at present, the green consumption demand concept of Chinese consumers is relatively weak, whether it is low-end consumption expenditure or high-end consumption expenditure, The relatively small proportion of green consumption expenditure leads to a decrease in the development level of green logistics. With the development of society, the proportion of green consumption expenditure will gradually increase, which will promote the improvement of the development level of green logistics. Secondly, the upgrading of consumption structure plays a decisive role in the structure of the development level of green logistics. There are differences in green consumption needs among different professions, industries, ages, income levels, regions, ages, and genders. Therefore, the green consumption structure will also be different. Only by adapting the structure of green logistics development to the green consumption structure can the improvement of the development level of green logistics be promoted. However, due to the current inability of logistics enterprises in China to adjust and change the green logistics structure in a timely manner based on changes in consumption structure, the upgrading of consumption structure has a negative impact on the development level of green logistics [19].

The Impact of Green Logistics Development.

Faced with a standardized impact on the development level of green logistics, the consumption scale of the country and various economic regions immediately had a positive impact. Among them, the consumption scale of the national sample, the eastern region, and the western region was currently the largest, and gradually decreased, approaching zero. The central and northeastern regions are different. Although there is a positive impact in the current period, the positive increase reaches its peak and then decreases and approaches zero. The reason is that consumers must rely on logistics to achieve their consumption needs, and diversified green consumption can be achieved through green logistics as a medium. Therefore, the improvement of the development level of green logistics will promote the improvement of the degree of green consumption realization, thereby expanding the consumption scale.

Affected by the standardization impact of the development level of green logistics, the upgrading of consumption structure across the country and the eastern region reflects a consistent response. The current impact is negative, followed by a peak increase and convergence towards zero when the negative response value decreases. The reason is: firstly, the development level of green logistics has a restrictive effect on the upgrading of consumption structure. Green logistics can guide consumers' consumption direction through the price ratio of goods, thereby inhibiting green consumption and leading to

a decrease in the upgrading of green consumption structure. Secondly, China's logistics infrastructure construction is still in a relatively backward situation, and the current green transformation of the logistics industry is difficult to meet the rapid upgrading of the consumption structure in the eastern region, which has a restraining effect on the upgrading of the consumption structure. When the central, western, and northeastern regions are impacted by the standardization of green logistics development level, the current period has a positive impact, and then the response value increases positively and reaches its peak before decreasing. The reason is that the consumption expenditure on food, tobacco, alcohol, and clothing in the central, western, and northeastern regions respectively accounts for 43.45%, 44.08%, and 42.29% of the total consumption expenditure, which is higher than the national 42.59% and the eastern 40.52%. The upgrading speed of the consumption structure is relatively low, and the current green logistics organizational structure can meet its needs.

5 Conclusion

This article constructs an indicator system for the development level of green logistics, and measures it based on the entropy weight method. It obtains the development level of green logistics in 30 provinces, cities, and autonomous regions in China (excluding Tibet and Hong Kong, Macao, and Taiwan) from 2006 to 2020. The PVAR model is used to empirically analyze the consumption scale, consumption structure upgrading, and green logistics development level, and the following conclusions are drawn:

Firstly, the development level of green logistics in China is constantly improving, but with the development of time, the differences between different economic regions are becoming increasingly significant. The gap between the eastern region and the central, western, and northeastern regions is constantly widening, presenting a situation of "high in the east, low in the central, western, and northeastern regions, and collapse in the northeast".

Secondly, there is a self strengthening mechanism in the consumption scale, upgrading of consumption structure, and development level of green logistics across the country and various economic regions. Overall, the development of green logistics has a significant inhibitory effect on consumption upgrading. The upgrading of consumption structure has a certain negative impact on green logistics, while the growth of consumption scale has a promoting effect on the development of green logistics. To some extent, it reflects the expansion of green consumption demand with the improvement of consumption level, which has promoted the development of green logistics. However, currently, green logistics enterprises are unable to adjust the structure and direction of green logistics development based on changes in consumer demand, which restricts the realization level and upgrading of consumer demand.

Thirdly, from the perspective of economic regions, the development of green logistics in each economic region has a significant inhibitory effect on the expansion of consumption scale, while the expansion of consumption scale has a promoting effect on the development of green logistics, which is consistent with the overall situation; The development of green logistics in the central, western, and northeastern regions has a restraining effect on the upgrading of consumption structure, but has no significant

impact on the eastern region; The upgrading of consumption structure in the eastern region has a certain negative impact on the development of green logistics. This indicates that the development level of green logistics in the eastern region is relatively high, which is in line with the upgrading of consumption structure. However, it cannot fully play the role of green logistics and guide the upgrading of consumption structure.

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