Consumer Coupons Effect Evaluation Based on Principal Component Analysis

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Abstract—Due to the impact of the COVID-19, China's economy was affected. Consumer coupons have been issued everywhere to boost consumption. This project uses the principal component analysis method to analyze and evaluate the local distribution policies and related economic indicators. The following conclusions are drawn: consumption coupons have a significant effect on promoting consumption. The role of consumer coupons in underdeveloped regions is more significant. Consumption of some commodities can significantly improve the effect of consumer coupons. Therefore, this paper suggests: To increase the issuance of consumer coupons. Interregional planning. Limit the range of goods used by consumer coupons.

Keywords-component; consumption coupons; principal component analysis; correlation analysis; consumption multiplier; public consumption

1 INTRODUCTION

In 2020, due to the impact of new coronavirus epidemic, the economy around the country has been hit seriously. In the first quarter of 2020, GDP fell 6.8 % year on year, and the total amount of social consumer goods fell 11.7 % year on year. The significant reduction of consumer demand has brought nonnegligible fluctuations to the supply chain. One of the measures taken by the government to boost consumption is to issue consumer coupons. The principle of

consumer coupons stimulating the economy comes from the multiplier effect, that is, each unit of consumer coupons put by the government will promote multiple consumption, thus promoting market demand and promoting production. The local government has adopted plans to issue consumption coupons worth billions of yuan in the past few months to stimulate consumption in restaurants and shopping malls, and even high-end products such as cars[1]. At present, there are still some doubts about the effect of consumer coupons on stimulating economy. Evaluating the effect of consumer coupons in a scientific and reasonable way is guiding significance to the formulation of government policies, which can avoid unnecessary waste of public resources, putting resources in appropriate places to achieve Pareto equilibrium, can expand domestic demand and consumption, open up all links of production and circulation and promote economic recovery.

At present, domestic scholars have also carried out research on the effect of consumer coupons. Guo Kaiyue analyzed the impact of government consumer couponstimulation policy on consumers from a micro-perspective, and analyzes the advantages and disadvantages of consumer coupons as an economic stimulus tool. Taking Nanjing consumer couponpolicy as the research object[2], Yu Ying used fuzzy comprehensive evaluation method to evaluate the effectiveness of Nanjing consumer couponpolicy under the epidemic situation from four aspects of policy utility, economic utility, social utility and spillover utility[3]. Zeng Jing analyzed the effect of China's consumption couponpolicy from the multiplier effect and crowding-out effect of consumption voucher, the sustainability of consumption couponpolicy and the cost-benefit of consumption couponpolicy[4]. Wu Jianping, taking Chun' an County of Hangzhou City as an example, through the practice of issuing tourism electronic consumption coupons on Alipay platform, establishes a structural equation data evaluation model around the multidimensional data of distribution, receipt, cancellation, consumption attributes and consumption types of electronic consumption coupons, and evaluates the consumption coupons from two aspects of tourism consumption and leverage effect of tourism consumption coupons[5]. On the basis of analyzing the difference between consumer coupons and cash subsidies and their mechanism of stimulating consumption, Ma ruoxi found through policy simulation that under the same policy cost, the policy effect of consumer coupons was better [6].

To sum up, at the level of empirical analysis, the domestic research on the effect of consumer coupons is more inclined to micro theoretical analysis, and there is little systematic research using macroeconomic data. In this paper, through the local macroeconomic indicators, the use of principal component analysis on the issuance of consumer coupons in-depth supplement.

2 DATA&METHODS

2.1 Source of Data

Local statistical yearbooks and local finance Bureau news from 2020 and 2019 in Heilongjiang, Jiangxi, Hainan, Tianjin, Jiangsu, Guizhou, Guangxi, Chongqing, Shandong, Shandong, Zhejiang, Beijing, Fuzhou, Zhuhai, Dongguan, Zhongshan, Jiangmen, Shenzhen, Qingyuan, Chengdu, Kunming Jiangmen, Shenzhen, Qingyuan, Chengdu, Kunming, Chifeng, and the newspaper.

2.2 Statistical Method

2.2.1 Principal Component Analysis:

Principal component analysis (PCA) is a multivariate statistical method that selects important variables through linear transformation by using dimension reduction. With the increasing in computing power, PCA has become a popular and powerful tool for analyzing high dimensional data[7]. If Kaiser-Meyer-Olkin statistics > 0.7 and Bartlett's spherical test significance < 0.05, the factor effect is better. Finally, the contribution rate of individual principal components are used as the weight to construct the comprehensive evaluation function. According to the scores, the comprehensive evaluation function is equation (1)

$$Y = \sum_{n}^{i} \alpha_i Y_i \qquad (1)$$

Where Y is the comprehensive score, α_i is the contribution rate of each component, Y_i is the principal component extracted.

2.2.2 Correlation Analysis:

Correlation analysis refers to the analysis of two or more variables with correlation, so as to measure the correlation between the two variables. Correlation between elements need to have a certain relationship or probability can be analyzed.

2.2.3 Data Processing:

In economic research, in order to comprehensively and systematically analyze problems, many economic indicators often need to be considered[8]. After obtaining the corresponding local economic data, the impact of the epidemic is given the corresponding weight, and the negative impact caused by the epidemic is eliminated. The weight calculation formula is as TABLE 1:

TABLE 1. TOTAL VARIANCE OF INTERPRETATION

Component	Initial eigenvalue		
	Total	*Variance %*	*Accumulate %*
1	3.753	75.059	75.059
2	1.013	20.262	95.32
3	0.201	4.015	99.335
4	0.024	0.478	99.813
Component	Extraction of squares and carry in		
	Total	*Variance %*	*Accumulate %*
1	3.753	75.059	75.059
2	1.013	20.262	95.32
Component		**Rotation square and carry in**	

	Total	Variance %	Accumulate %
1	3.748	74.969	74.969
2	1.018	20.351	95.32

After calculating the weight, with the local GDP, total retail sales of social consumer goods and exports multiplied by the weight of their regions to get the TABLE 2 data after eliminating the epidemic factors. Then use IBM SPSS 21 for principal component analysis of the data to obtain.

TABLE 2. DATA AFTER EXCLUDING EPIDEMIC FACTORS

Area	Regional GDP	Total retail sales of social consumer goods	Regional exports	Regional GDP growth over last year
Heilongjiang	159545	4254	6062054	179.4789538
Jiangxi	28151	9379	46117508	1095.729465
Hainan	5639	1936	4092128	205.4927667
Tianjin	14701	3426	46304301	29.43598284
Jiangsu	114955	32668	443490746	4546.111443
Guizhou	18094	7716	6326690	1073.178944
Guangxi	22784	7609	40295633	945.6246424
Chongqing	26543	11061	64257619	1483.053033
Shandong	79853	26559	206416770	2826.51083
Zhejiang	73842	22826	415152193	2458.565774
Beijing	40156	12176	74538847	731
Fuzhou	44227	18489	123305304	1589
Zhuhai	3517	912	16248997	46
Dongguan	9751	3701	12947116	170
Zhongshan	3174	1397	2828071	51
Jiangmen	3209	1160	17461367	54
Shenzhen	28888	8283	274172236	776
Qingyuan	1779	519	68146	79

Chengdu	18012	7983	4175	716
Kunming	6770	3054	7786606	260
Chifeng	1765	583	27	55

TABLE 3. INSPECTION OF KMO&BARTLETT & COMPONENT MATRIX

Sampling adequacy Kaiser-Meyer-Olkin metric.		0.706	
Sphericity test of Bartlett	Approximate chi-square	151.821	
	df	10	
	Sig.	0.000	
		Component	
		1	*2*
The amount of consumer coupons (ten thousand yuan)		.061	.998
Regional GDP		.919	-.075
Total retail sales of social consumer goods (billion yuan)		.982	.040
Regional exports (thousands of USD)		.994	.054
Regional GDP growth over last year (Hundreds of millions of yuan)		.976	-.087

3 ASSUMPTIONS

Due to the impact of the epidemic, the local economy will be affected. In order to eliminate the impact of the epidemic, it is assumed that the cumulative number of infections from the outbreak to the present in each region of the data represents a percentage of the cumulative number of infections from the outbreak to the present in all regions of the data as the weight of the economic impact of the epidemic. Assuming that the consumer coupons issued to the market are completely cancelled. Assuming that the population and area of consumer coupons are fully covered.

4 RESULTS&DISCUSSION

4.1 Principal Component Extraction

It can be seen from Table 3 that Kaiser-Meyer-Olkin measurement is greater than 5 and sig is less than 0.5, so the data can be analyzed by principal component analysis.

The selection of principal components requires that the initial variance is greater than 1, and the cumulative contribution rate should be about 85%. According to the analysis results, two principal components are obtained, which are named as $Y1, Y2$.

Table 3 shows that among the principal components, the proportion of regional GDP, total retail sales of social consumer goods and regional exports reaches more than 90%. In the principal component, the amount of consumer coupons accounted for 99%. Therefore, the principal component can express regional GDP, total retail sales of social consumer goods, regional exports of these three quantities, so the principal component can express the amount of consumer coupons issued.

4.2 Calculation Of Principal Components

$$Y_i = \sum_n^i \frac{\theta_i}{\sqrt{\gamma_i}} \quad (2)$$

In equation (2) , θ coefficients corresponding to i in the component matrix，γ is the eigenvalue corresponding to the principal component.

The calculated principal component $Y1$, $Y2$ are as equation (3) and (4):

$$Y1 = 0.0637 * x1 + 0.5901 * x2 + 0.5810 * x3 + 0.5569 * x4 \quad (3)$$

$$Y2 = 0.9922 * x1 + 0.0110 * x2 - 0.0008 * x3 - 0.1244 * x4 \quad (4)$$

Obtain principal component calculation results and standardize them.

4.3 Calculation Of Comprehensive Scores

$$Y = \sum_n^i \alpha_i Y_i \quad (5)$$

Through equation (5) and (6) , the comprehensive score in TABLE 4 can be obtained and sorted :

$$Y = 0.7048 * Y1 + 0.2505 * Y2 \quad (6)$$

TABLE 4. COMPREHENSIVE SCORE(AFTER SORTING)

Area	Comprehensive score
Jiangsu	-.59471
Zhejiang	-.29725

Shenzhen	-.60943
Shandong	-.29603
Fuzhou	2.65309
Beijing	-.59261
Chongqing	-.34045
Jiangxi	-.16252
Tianjin	.89324
Guangxi	2.44244
Jiangmen	-.07483
Zhuhai	.27599
Dongguan	-.51916
Heilongjiang	-.54359
Guizhou	-.61885
Kunming	-.51025
Hainan	1.39547
Zhongshan	-.63935
Qingyuan	-.63944
Chengdu	-.58192
Chifeng	-.63985

Due to less data, there will be special cases. After excluding the data of Beijing and Chengdu, the comprehensive ranking and the amount of consumer coupons are made into a line chart to reflect the relationship between local economy and the amount of consumer coupons.
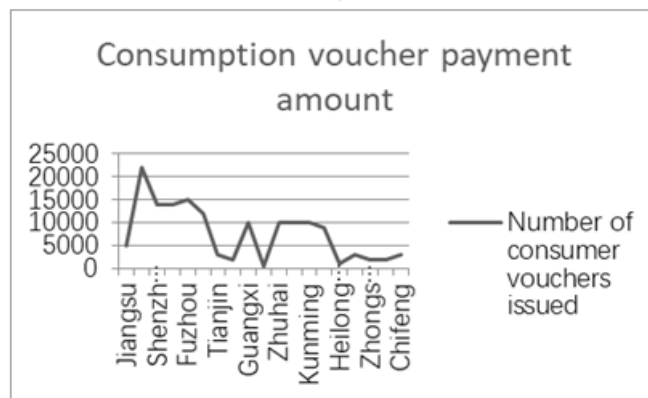

Figure 1. Consumption couponpayment amount

4.4 Correlation Analysis Between Consumption CouponAnd GDP Increment

In order to analyze the relationship between consumer coupons and local economy furtherly, this paper selects two characteristics of GDP growth and consumption couponissuance in 2020 compared with 2019 for correlation analysis.

TABLE 5. CORRELATION ANALYSIS

		Consumption couponpayment amount (ten thousand yuan)	GDP in epidemic areas excluding is higher than that in previous years (billion yuan)
Consumption couponpayment amount(ten thousand yuan)	Pearson correlation	1	-.029
	Significance (bilateral)		.900
	N	21	21
GDP in epidemic areas excluding is higher than that in previous years(billion yuan)	Pearson correlation	-.029	1
	Significance (bilateral)	.900	
	N	21	21

4.5 Income Analysis Of Residents

The relevant data of income and consumption of urban residents in 2020 are selected to calculate the corresponding marginal propensity to consume and the corresponding consumption multiplier.

TABLE 6. COMPREHENSIVE SCORE(AFTER SORTING)

Consumption categories	Aggregate consumption	Consumption increased by % in nominal terms last year	Incremental consume	Marginal propensity to consume	Consumption multiplier
Food, tobacco and wine	7881	1.9	147	0.10	1.11
Closes	1645	-10.2	-187	0.13	1.14
Live	6958	2.6	176	0.12	1.13
Life supplies and services	1640	-2.9	-51	0.03	1.04
Transportation and communication	3474	-5.4	-183	0.12	1.14
Medical care	2172	-4.8	-114	0.08	1.08

Education, Culture and Entertainment	2592	-22.1	-570	0.38	1.63

5 CONCLUSION

Through the above analysis, this paper draws the following conclusions：

A)　　It can be seen from table 4 and figure 1 that comprehensive scores of Jiangsu, Zhejiang, Guangdong, Shandong and Fujian are generally higher than those of other provinces, and the number of consumer couponissuance is positively correlated with its local economy. In the correlation matrix, it could be seen that the number of consumer coupons is positively correlated with GDP growth.　Therefore, through the above analysis, it can be concluded that consumer coupons have a positive effect on regional economic growth during the epidemic period.

B)　For developed regions, the negative Pearson correlation of table 4 shows that the amount of consumer coupons is negatively correlated with GDP increment. Combined with the sorting of table 4, it can be seen that the more the amount of consumer coupons, the lower the GDP increment. Most of the southeast coastal areas have high economic level, and the number of consumer coupons is also large. On the contrary, the number of consumer coupons is small in areas with low economic level.　However, from the results of negative correlation, although the number of high-level regions is large, its effect on GDP increment is not good, while the low-level regions have less distribution, but the effect is good.

C)　Table 6 shows that urban residents' marginal propensity to consume in education and cultural entertainment in 2020 is as high as 0.38, and residents' consumption of more than one yuan in education and cultural entertainment can expand national income by 1.63 times. Education and cultural entertainment industry is a lever to expand national income. In 2020, compared with 2019, residents' consumption in education, culture and entertainment increased negatively, and residents' consumption demand decreased, which will be not conducive to the development of the industry in the long run.

This article will give the following recommendations:

A)　According to the differences in regional economic levels, the issuance of consumer coupons should be reasonably adjusted. Consumer coupons play a real role in stimulating consumption and promoting economic growth. The epidemic has hit businesses, reduced incomes for residents and increased the risk of unemployment. To some extent, increasing the number of digital consumer coupons can support the corresponding industries and populations and promote economic recovery. For areas with high economic level, the number of consumer coupons should be adjusted according to the actual situation to avoid waste of resources. For areas with low economic level, the number of consumer coupons can be appropriately increased, so as to greatly stimulate economic recovery.

B)　Regional overall planning, tilt to low-income areas.　Consumer couponpolicy exists in provinces and cities at all levels of self-war phenomenon, compared with economically developed areas, economically underdeveloped areas to increase the number of consumer

coupons to stimulate economic effect will be better, but economically underdeveloped areas of government finance is weak, the corresponding issuance will be much less, so should be in the national overall planning, increase the number of consumer coupons in low-income areas, so that the allocation of resources to Pareto optimal.

C)   Limit the trial range of consumer coupons to improve the marginal effect of consumer coupons. Such as education and cultural entertainment projects, the residents' marginal propensity to consume is high, and the corresponding economic multiplier is also high. Compared with items wit-h low marginal propensity to consume such as household goods, resources should be invested in items with high marginal propensity to consume to maximize the marginal effect of consumer coupons.

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