A ELES Model-based quantitative analysis of the consumption structure of the Chinese urban residents

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Abstract. This paper studied the consumption structure of urban residents in China based on the Extended linear expenditure system model (ELES) and the data of Chinese household tracking survey in 2010, 2012, 2014, 2016 and 2018. The results were as follows: firstly, the proportion of the survival consumption to the total consumption decreased from 2010 to 2018, indicating that the consumption structure of the urban residents in China has been upgraded in this period. Secondly, the income elasticity of demand for the survival consumption is 0.256, while for the enjoyment consumption and development consumption is 0.468 and 0.317 respectively. Thirdly, the MPC of the survival consumption is 0.112, while that of the enjoyment consumption and development consumption is 0.174, indicating that the increase of income is conducive to the optimization of the consumption structure of the urban residents. In order to promote the optimization of the consumption structure of urban residents, the government should take measures to perfect the income distribution system and improve the income level of urban residents.

1. Introduction

In recent years, the consumption level of the urban residents in China has been continuously improved. However, the consumption structure of the urban residents is still on a low level and has been upgraded slowly. The optimization of consumption structure of the Chinese urban residents is of great significance to the economic growth of China.

The residents’ consumption structure has attracted the attention of many scholars. Stone(1954) proposed a linear expenditure system model (LES) to make a comprehensive analysis of household consumption. Liuch(1974) improved the linear expenditure system model and proposed the extended linear expenditure model (ELES). Deaton and Muellbauer(1980) proposed AIDS model, which was widely used in the analysis of consumption problems later. Catherine(1994) analyzed the consumption behavior of Chinese residents based on AIDS model. Barnett and Brooks(2010) found that the government expenditure can promote the optimization of consumption structure.

Yuan Zhigang et al. (2009), Chen Bo (2013) found that the consumption structure of urban residents had been obviously upgraded, and the improvement of consumption level could promote the optimization of consumption structure. Jiang Miao and He Li (2013) pointed out that although the consumption structure of urban residents was constantly upgrading, the proportion of food expenditure was still high. Chen Zhiguo et al.(2017) pointed out the unreasonable problem of consumption structure of urban residents. Wang Xueqi (2016) found that consumption habits and income had the greatest impact on the consumption structure of urban residents. Ding Zhongmin and Jiang Banghu...
(2016) found that urbanization could also promote the upgrading of consumption structure. Chen Hao and Song Mingyue (2019) pointed out that consumption habits had a certain degree of inhibition on the optimization of consumption structure.

Based on the ELES model, this paper uses the Chinese household tracking survey data to analyze the consumption structure of urban residents in China. This study is helpful to the optimization of urban residents’ consumption structure in the future.

2. Model

Extended linear expenditure system model (ELES) assumes that in a certain period of time, the consumers’ demand for goods or services depends on the income level and the price of goods, and the demand is divided into the basic demand and the non-basic demand. The basic demand has nothing to do with income. Only after the basic demand is satisfied, the remaining income is distributed according to the marginal propensity to consume (MPC) of each type of goods to meet the non-basic demand. Therefore, in order to study the consumption structure of urban residents in China, the model is set as follows:

\[ C_{zt} = p_{zt}q_{zt} + \beta_{zt}(Y_t - C_t) \quad (z = 1,2,3,4,5,6,7,8; t = 2010,2012,2014,2016,2018) \]  \hspace{1cm} (1)

\[ C_t \] is the total expenditure on category \( z \) consumption goods of urban residents in year \( t \). \( p_{zt} \) is the price of the category \( z \) goods in year \( t \). \( q_{zt} \) is the quantity of the basic demand for the category \( z \) goods of the urban residents in year \( t \). \( \beta_{zt} \) is the basic expenditure on the category \( z \) goods in year \( t \) for the urban residents. \( \beta_{zt} \) is the MPC of the category \( z \) goods. \( Y_t \) is the income of the urban residents in year \( t \).

\[ C_t = \sum_{z=1}^{8} p_{zt}q_{zt}, \] which is the total basic consumption expenditure of the urban residents in year \( t \).

\[ \beta_{zt}(Y_t - C_t) \] is the non-basic consumption expenditure on the category \( z \) goods in year \( t \) of the urban residents. The total expenditure of urban residents on category \( z \) goods in year \( t \) is the sum of the basic expenditure on category \( z \) goods and the non-basic expenditure on category \( z \) goods in year \( t \).

The formula (1) is transformed into:

\[ C_{zt} = (p_{zt}q_{zt} - \beta_{zt}C_t) + \beta_{zt}Y_t \] \hspace{1cm} (2)

Let \( \mu_{zt} = p_{zt}q_{zt} - \beta_{zt}C_t \), then

\[ C_{zt} = \mu_{zt} + \beta_{zt}Y_t \] \hspace{1cm} (3)

By estimating the correlation coefficient through formula (3), the total basic expenditure can be calculated by

\[ C_t = \sum_{z=1}^{8} \mu_{zt} \left/ \left(1 - \sum_{z=1}^{8} \beta_{zt}\right) \right. \] \hspace{1cm} (4)

The basic expenditure on category \( z \) goods is:

\[ p_{zt}q_{zt} = \mu_{zt} + \beta_{zt}C_t \] \hspace{1cm} (5)

Let \( Q_{zt} \) represent the total demand for category \( z \) goods in year \( t \). Then \( C_{zt} = p_{zt}Q_{zt} \). With equation (1), we can get \( Q_{zt} = q_{zt} + (Y_t - C_t)\beta_{zt}/p_{zt} \). Thus the income elasticity of demand is:

\[ I_{zt} = \frac{\partial Q_{zt}}{\partial Y_t} \frac{Y_t}{Q_{zt}} = \frac{\beta_{zt}Y_t}{C_{zt}} \] \hspace{1cm} (6)

\[ C_t = \sum_{z=1}^{8} p_{zt}q_{zt}, \] then we can get the cross-price elasticity of demand and self-price elasticity of demand:

\[ P_{abt} = \frac{\partial Q_{at}}{\partial p_{bt}} \frac{p_{bt}}{Q_{at}} = -\frac{\beta_{at}p_{bt}q_{at}}{C_{at}} \quad (a \neq b) \] \hspace{1cm} (7)

\[ P_{aat} = \frac{\partial Q_{at}}{\partial p_{at}} \frac{p_{at}}{Q_{at}} = -\frac{\beta_{at}(Y_t + p_{at}q_{at} - C_t)}{C_{at}} \] \hspace{1cm} (8)
3. Data
The sample data is from Chinese Household Tracking Survey of Peking University. The sample data divides consumption into eight categories: (1) food; (2) clothing, shoes and hats (clothing); (3) housing; (4) household equipment and daily necessities (equipment); (5) transportation and communication (transportation); (6) medical care; (7) culture, education and entertainment (entertainment); (8) other supplies and services (others). In this paper, the survey data of the rural residents are excluded. Based on 2010, the eight categories of the consumption data were transformed to the real value by the classified consumer price index of the National Bureau of Statistics. The amount of available samples for 2010, 2012, 2014, 2016 and 2018 is 6253, 5284, 5610, 6513, 6465 respectively.

According to Table 1, the expenditure on the eight categories of goods has a trend to increase. The consumption increase faster than the income, the proportion of consumption to income increased from 71.5% in 2010 to 93.2% in 2018. In addition, in terms of specific types of consumption, the proportion of clothing, shoes, hats to the total consumption has changed slightly, from 5 percent in 2010 to 5.1 percent in 2018. And the proportion of housing to the total consumption has increased significantly, from 7.8 percent in 2010 to 18.7 percent in 2018.

Table 1. Descriptive statistics.

| Category     | 2010        | 2012        | 2014        | 2016        | 2018        |
|--------------|-------------|-------------|-------------|-------------|-------------|
| Mean         | %           | Mean        | %           | Mean        | %           |
| Food         | 10833.190   | 0.342       | 14373.726   | 0.334       | 16971.253   | 0.281       | 18520.545   | 0.283       |
| Clothing     | 1598.555    | 0.050       | 2323.436    | 0.054       | 2887.177    | 0.048       | 3326.518    | 0.051       |
| Housing      | 2460.116    | 0.078       | 2997.236    | 0.070       | 8168.168    | 0.163       | 9548.927    | 0.158       | 12226.319   | 0.187       |
| Equipment    | 3765.616    | 0.119       | 8316.561    | 0.194       | 7101.784    | 0.142       | 11611.972   | 0.192       | 10613.433   | 0.162       |
| Transportation| 4249.634   | 0.134       | 4017.096    | 0.093       | 4807.732    | 0.096       | 5782.641    | 0.096       | 6312.936    | 0.097       |
| Medical care | 3778.308    | 0.119       | 3906.623    | 0.091       | 4820.244    | 0.096       | 5799.275    | 0.096       | 5212.048    | 0.080       |
| Entertainment| 4273.119    | 0.135       | 4953.816    | 0.115       | 5328.643    | 0.107       | 6463.072    | 0.107       | 7760.824    | 0.119       |
| others       | 723.255     | 0.023       | 2089.343    | 0.049       | 878.108     | 0.018       | 1316.520    | 0.022       | 1430.561    | 0.022       |
| Survival     | 18891.861   | 0.529       | 19694.398   | 0.458       | 27041.652   | 0.541       | 29407.357   | 0.487       | 34073.382   | 0.521       |
| Enjoyment    | 8015.250    | 0.225       | 12333.657   | 0.287       | 11909.516   | 0.238       | 17394.613   | 0.288       | 16926.369   | 0.259       |
| Development  | 8774.682    | 0.246       | 10949.782   | 0.255       | 11026.995   | 0.221       | 13578.867   | 0.225       | 14403.433   | 0.220       |
| Income       | 44313.83    | -           | 50502.43    | -           | 54186.26    | -           | 67111.32    | -           | 70160.21    | -           |

In addition, this paper classifies food, clothing, shoes and hats, housing as the survival consumption (survival). The household equipment and daily necessities, transportation and communication are classified as the enjoyment consumption (enjoyment). The medical care, culture, education and entertainment, other supplies and services are classified as the development consumption (development). When the proportion of the survival consumption to the total consumption increases or the proportion of the enjoyment consumption and development consumption to the total consumption decreases, the consumption structure of the residents is downgraded. On the contrary, when the proportion of the survival consumption to the total consumption decreases or the proportion of enjoyment consumption and development consumption to the total consumption increases, the consumption structure of the residents is upgraded. In general, the proportion of the survival consumption to the total consumption decreased from 52.9% in 2010 to 52.1% in 2018, indicating that the consumption structure of the urban residents in China has upgraded in the past few years.

4. Empirical analysis
### 4.1. Income elasticity of demand

According to Table 2, the demand for the household equipment and daily necessities is the most sensitive to changes in income. When the income increases by 1 percent, the demand of the household equipment and daily necessities increases by 52.9 percent. The demand for the health care is the least sensitive to changes in income. When the income increases by 1 percent, the demand for the health care increases by 11.7 percent. The income elasticity of demand for the food is 0.211. The income elasticity of demand for the survival consumption is 0.256, while that of the enjoyment consumption and development consumption is 0.468 and 0.317 respectively, indicating that the increase in income is conducive to the optimization of the consumption structure of the urban residents.

**Table 2.** ELES parameters.

|                  | Total expenditure | $H$  | MPC  | Basic demand expenditure | Income elasticity of demand |
|------------------|-------------------|------|------|---------------------------|-----------------------------|
| Food             | 15443.081         | 12188.140 | 0.056 | 14875.050                 | 0.211                       |
| Clothing         | 2573.040          | 1589.050 | 0.017 | 2401.320                  | 0.382                       |
| Housing          | 7245.784          | 5003.832 | 0.039 | 6854.532                  | 0.309                       |
| Equipment        | 8351.095          | 3929.422 | 0.077 | 7579.450                  | 0.529                       |
| Transportation   | 5087.009          | 3246.097 | 0.032 | 4765.745                  | 0.362                       |
| Medical care     | 4739.469          | 4186.027 | 0.010 | 4642.886                  | 0.117                       |
| Entertainment    | 5811.027          | 3069.896 | 0.047 | 5332.663                  | 0.472                       |
| Others           | 1271.763          | 803.019  | 0.008 | 1189.960                  | 0.369                       |
| Survival         | 25261.905         | 18781.02 | 0.112 | 24130.902                 | 0.256                       |
| Enjoyment        | 13438.104         | 7175.519 | 0.109 | 12345.195                 | 0.468                       |
| Development      | 11822.258         | 8058.943 | 0.065 | 11165.509                 | 0.317                       |

### 4.2. MPC

The MPC of the household equipment and daily necessities is the largest according to Table 2. When the income increases by 1 yuan, the consumption of household equipment and daily necessities increases by 0.077 yuan. The MPC of both the housing and the culture, education and entertainment is also high, indicating that the urban residents attach importance to the quality of life and education when their income increases. The MPC of the survival consumption is 0.112, which indicates that when income increases by 1 yuan, the survival consumption increases by 0.112 yuan, while the MPC of the enjoyment consumption and development consumption is 0.174, which indicates that the enjoyment consumption and development consumption increase by 0.174 yuan when the income increases by 1 yuan. This implies that it could upgrade the consumption structure to increase the income. From Figure 1, we can see more intuitively the trend of MPC of each kind of expenditure. The MPC of both the food and the clothing, shoes and hats tend to decrease, while the MPC of the housing tend to increase.
4.3. Price elasticity of demand

In Table 3, the data on the diagonal line from the upper left to the lower right are the self-price elasticity of each kind of goods. And the other data are the cross-price elasticity of each kind of goods. Data for each column represent the impact of changes of the price of this commodity on the consumption demand for other types of goods.

Table 3. Self-price elasticity of demand and the cross-price elasticity of demand.

|          | Food   | Clothing | Housing | Equipment | Transportation | Medical care | Entertainment | Others |
|----------|--------|----------|---------|-----------|----------------|--------------|---------------|--------|
| Food     | -0.091 | -0.009   | -0.025  | -0.028    | -0.017         | -0.017       | -0.019        | -0.004 |
| Clothing | -0.099 | -0.083   | -0.045  | -0.050    | -0.032         | -0.031       | -0.035        | -0.008 |
| Housing  | -0.080 | -0.013   | -0.091  | -0.041    | -0.026         | -0.025       | -0.029        | -0.036 |
| Equipment| -0.136 | -0.022   | -0.063  | -0.162    | -0.044         | -0.043       | -0.049        | -0.011 |
| Transportation | -0.093 | -0.015   | -0.043  | -0.048    | -0.093         | -0.029       | -0.033        | -0.007 |
| Medical care | -0.030 | -0.005   | -0.014  | -0.015    | -0.010         | -0.030       | -0.011        | -0.002 |
| Entertainment | -0.122 | -0.020   | -0.056  | -0.062    | -0.039         | -0.002       | -0.126        | -0.010 |
| others   | -0.095 | -0.015   | -0.044  | -0.048    | -0.030         | -0.030       | -0.034        | -0.072 |

As far as the self-price elasticity of demand is concerned, that of the household equipment and daily necessities is the largest. When their price changes by 1%, the demand changes by 16.2%. The demand for the household equipment and daily necessities is very sensitive to the change of its price. The self-price elasticity of demand for the culture, education and entertainment is also high. When their price changes by 1%, the demand changes by 12.6%. The self-price elasticity of demand for the medical care is -0.03, which is the lowest among all the goods and services. This could be due to the fact that the groups in need of the medical care are often in poor physical condition and have rigid
demand for the medical care. Compared with most other types of consumption, the self-price elasticity of the three types of survival consumption is low, because most of the survival consumption is the necessary expenditure to maintain the basic living needs of the residents. As far as the cross-price elasticity is concerned, the price of food, clothing, shoes and hats, and the housing has great influence on the demand for both the household equipment and daily necessities and the culture, education and entertainment. In addition, the price of food has the greatest impact on other types of consumption demand. This means that food expenditure accounts for a large proportion of the total consumption, which implies the consumption structure needs to be upgraded.

5. Conclusions
This paper analyzes the consumption structure of the urban residents in China by using the data of Chinese household tracking survey from 2010 to 2018 to draw up the following conclusions. Firstly, the proportion of the survival consumption to the total consumption decreased from 2010 to 2018, indicating that the consumption structure of the urban residents in China has been upgraded in this period. Secondly, the income elasticity of demand for the survival consumption is 0.256, while that for the enjoyment consumption and development consumption is 0.468 and 0.317 respectively. Thirdly, the MPC of the survival consumption is 0.112, while the MPC of the enjoyment consumption and development consumption is 0.174, indicating that the increase in income is conducive to the optimization of the consumption structure of the urban residents. In order to promote the optimization of the consumption structure of urban residents, the government should take measures to perfect the income distribution system, improve the income level of urban residents, and strengthen market supervision and standardize commodity pricing.

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