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An Empirical Analysis on Food Expenditure of Chinese Urban Residents Considering the Changes in Population Structure

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ABSTRACT

Currently, the food consumption of Chinese urban residents is characterized by the huge number of consumers, multiple levels of consumption, fast changing consumption mode and clearly defined consumer orientation. In light of these, this paper introduces the concept and variables (e.g. the age structure) of adult equivalent scales method to the food consumption function, establishes a model to estimate the effects of demographic factors, and applies the model to predict the impacts of household income, family structure and other factors on food expenditure. The research results show that the food consumption of Chinese urban households is greatly affected by household disposable income and the family structure.

1. INTRODUCTION

Over the past three decades, the sustained rapid growth of the Chinese economy has bolstered the per-capita income and food consumption of urban residents in China. From 1990 to 2014, the per-capita food expenditure of Chinese urban households grew all the way from RMB 693.8 yuan to RMB 4,493.9 yuan, at an annual rate of 8.1%. Currently, the food consumption of Chinese urban residents is characterized by the huge number of consumers, multiple levels of consumption, fast changing consumption mode and clearly defined consumer orientation.

The growing trend of food expenditure is in sync with the expansion of urban population. In 2014, the total number of rural migrant workers, who have limited spending power, in Chinese cities reached the staggering figure of 274 million [1]. The influx of these special urban residents increases the heterogeneity of urban residents in food consumption, which in turn affects the development of the food industry [2]. To ensure food safety, it is meaningful to examine the influencing factors of food expenditure and identify the pattern of food consumption among urban residents.

The existing studies on these influencing factors mainly focus on such factors as income and family structure [3]. Following is a brief review of the representative research on the effect of income on the food expenditure of urban residents. Based on the urban household survey data of eastern China's Jiangsu Province, Zheng and Henneberry [4] discovers that the income elasticity of demand of low-income groups is high for poultry meat (0.474) and low for grains (0.139), and that of middle- and high-income groups is high for aquatic products and low for edible oil. Referring to the *China City Statistical Yearbook*, Dong and Hu [5] found that low-income households have a weak income elasticity of demand (2.27) for milk, although the income elasticity of demand for edible oil, eggs and vegetables is less than one in all income groups. Using the data of urban household surveys, Han and Chen [6] explored the effects of income on food consumption of rural migrant workers, revealing that the income elasticity of demand is flexible for livestock products (1.081) and high for edible oil (0.787). To sum up, the income elasticity of demand of different income groups varies with the types of data and research models.

With the continuous demographic transition (e.g. population ageing and low birth rate) in urban areas, single-child families now take up a good proportion in China's urban households [7, 8]. The effect of family structure, including the gender and age of family members in different age groups, on food expenditure of urban residents has attracted much attention. For instance, Gould [9] designs variables that characterize the age structure of urban families by adult equivalent scales method, and analyzes the impact of the age structure on the food expenditure of Chinese urban residents. In fact, the adult equivalent scales have been widely adopted to study the relationship between age structure and food consumption [10-13]. However, the relevant studies have two problems. For one thing, the population is generally divided based on life development into children, adults and the elderlies, which cannot fully reflect the variation in food consumption between different ages. For another, the children-adults consumption coefficient and elderlies-adults consumption coefficient are hypothetical.

Considering the growth in per-capita income, the shift in food consumption pattern and the constant changes of population structure, this paper sets up an adult equivalent scales model according to the actual data on urban household consumption and the unique features of China's population growth, explores the influencing factors of food expenditure among urban residents, and carries out microscale data analysis on the relationship between income, population structure and food consumption.

2. FOOD CONSUMPTION OF CHINESE URBAN RESIDENTS

Based on the food consumption data released by National Bureau of Statistics of China, this section analyzes the changes in food consumption of Chinese urban residents, laying the basis for subsequent empirical analysis.

Over the years, the total food consumption in China has grown continuously, but at a decreasing growth rate. The structure of food consumption also undergoes constant changes, marking an era of transformation and upgrading. Since 2000, the food expenditure of Chinese urban residents has increased rapidly, while the proportion of food expenditure to total consumption expenditure first declined and then stabilized. Compared with the past, Chinese urban residents now attach importance to food quality, enjoy convenient access to food products, and boast a great potential of food consumption. These changes are mainly induced by two factors: the urban residents earn more money thanks to economic growth; the fast urbanization has brought a huge influx of migrants to cities.

2.1 Per-capita food expenditure

To begin with, the per-capita food expenditure and Engel coefficient of urban and rural residents were compared in details. As shown in Table 1, the gap between Chinese urban and rural residents in food expenditure has been widened continuously. From 2000 to 2016, the per-capita food expenditure of Chinese urban residents increased from RMB 1,958.3 yuan to RMB 6,762.4 yuan, putting the mean annual rate at RMB 300.3 yuan. Meanwhile, the per-capita food expenditure of Chinese rural residents only grew at a mean annual rate of RMB 152.85 yuan from RMB 820.5 yuan to RMB 3,266.1 yuan.

The significant growth in food consumption of urban residents is accompanied by the deep plunge of Engel coefficient across the country, that is, the improvement of living standards. From 2000 to 2012, the Engel coefficient dropped by 9.88% from 39.18% to 29.3% for urban residents, and by 16.89% from 49.13% to 32.24% for rural residents. Obviously, urban residents have a lower Engel coefficient than their rural counterparts, but the gap is gradually narrowing.

Table 1. Per-capita food expenditure and Engel coefficient of urban and rural residents

Years	Urban residents		Rural residents		The gap between urban and rural food consumption
	Per capita food consumption expenditure	Engel's Coefficient	Per capita food consumption expenditure	Engel's Coefficient	
2000	1947.31	39.22	820.52	49.13	1137.79
2005	2926.39	36.68	1162.16	45.48	1752.23
2010	4812.71	35.67	1800.67	41.09	3004.04
2011	5523.34	36.32	2107.34	40.36	3398.99
2012	6060.85	36.23	2323.89	39.33	3716.96
2013	5576.88	30.13	2495.50	37.67	3075.20
2014	6011.01	30.05	2814.00	33.57	3186.00
2015	6334.70	29.73	3048.00	33.05	3311.70
2016	6756.41	29.30	3266.10	32.24	3496.30

2.2 Food categories

The categories of food (e.g. animal food and plant food) consumed by Chinese urban and rural residents are listed in Table 2 below. From which, it can be seen that the per-capita food consumption of urban residents has remained largely stable, while the proportion of animal and plant food being consumed has changed. In 2016, urban residents on average consumed 343.8kg of food, basically the same as the 340.9kg in 2003. From 2000 to 2016, the per-capita consumption of plant food among urban residents remained basically the same, despite a slight growth from 262.7kg to 266.9kg. As for animal food, the per-capita consumption of urban residents grew rapidly from 58.2kg in 2000 to 76.1kg in 2003 and then slowly reached 76.9kg in 2016.

For rural residents, the total food consumption and plant food consumption has both declined, while the consumption of animal food exhibited an upward trend. Specifically, the total food consumption of rural residents dropped from 407.7kg in 2000 to 332.9kg in 2016. In the same period, the per-capita consumptions of animal food and plant food among rural residents respectively increased from 27kg to 51.2kg, and decreased from 380.7kg to 281.7kg.

For urban residents, the share of animal food in the consumption structure has been steadily expanding. In 1981, the urban residents on average consumed 37.1kg of animal food, accounting for 10.28% of all food products being consumed. The proportion was widened to 15.45% in 1993, 22.32% in 2013 and 22.37% in 2016.

Table 2. The categories of food consumed by Chinese urban and rural residents

Years	Main food consumption (kg)		The proportion of animal food		The proportion of plant food	
	Urban residents	Rural residents	Urban residents	Rural residents	Urban residents	Rural residents
2000	320.9	407.7	18.14	6.62	81.86	93.38
2005	335.4	366.4	22.00	9.06	78.00	90.94
2010	334.5	333.7	22.09	10.16	77.91	89.84
2011	330.2	324.8	22.29	11.33	77.71	88.67
2012	331.7	316.1	22.73	11.83	77.27	88.17
2013	341.1	342.9	21.20	13.44	78.80	86.56
2014	340.9	332.8	22.18	14.36	77.82	85.64
2015	338.7	329.5	22.53	15.20	77.47	84.80
2016	343.8	332.9	22.37	15.38	77.63	84.62

2.3 Consumption of animal products

(1) Consumption of meat products

Figure 1 shows the per-capita consumption of different meat products among Chinese urban residents.

As shown in Figure 1, pork is the most popular meat product among Chinese urban residents, followed by poultry meat, and beef and mutton. More and more pork has been consumed over the years. On average, each urban resident consumed 16.9kg of pork in 1981, 17.7kg in 1992 and 20.4kg in 2016. Now, pork products contribute half of the total meat consumption. However, the share of pork in the total amount of meat being consumed has been shrinking from 82.44% in 1981, 66.79% in 1992 and 58.45% in 2016.

For urban residents, both the consumption of poultry meat and its proportion to the total consumption of meat have been increasing. The annual consumption of poultry meat per urban resident was merely 1.9kg in 1981, taking up 9.27% of all meat products being consumed. In 1992, each urban resident consumed 5.1kg of poultry meat. By 2016, the annual consumption has grown to 10.2kg, and its proportion to the total consumption of meat to 29.23%.

The consumption of beef and mutton remains low among Chinese urban residents, taking up about 10% of the total meat consumption. The per-capita consumption has been growing rather slowly, from 3.3kg in 2000 to 4.3kg in 2016.

(2) Consumption of other animal products

Figure 2 shows the per-capita consumption of other animal products (e.g. eggs, fish and dairy products) among Chinese urban residents.

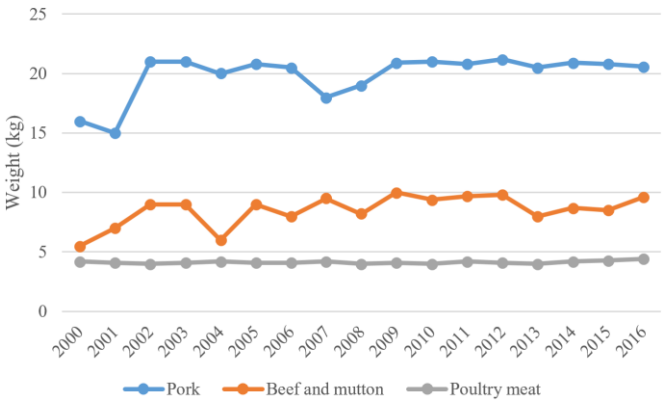

Figure 1. Per-capita consumption of different meat products among Chinese urban residents

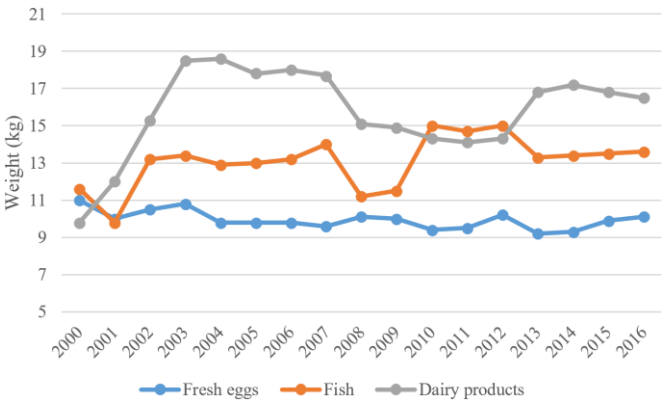

Figure 2. Per-capita consumption of other animal products among Chinese urban residents

As shown in Figure 2, the development of dairy products consumption can be divided into four phases for Chinese urban residents. The annual per-capita consumption grew rapidly from 4.8kg in 1996 to 19.6kg in 2003, remained stable between 17kg and 19kg from 2003 to 2007, decreased from 17.8kg in 2007 to 13.7kg in 2011 due to the melamine incident, and rebounded thereafter to 17.1kg in 2016.

For Chinese urban residents, the annual mean consumption of fish increased all the way to 14.8kg in 2016, and that of fresh eggs grew from 5.1kg in 1981 to 11.1kg in 1997 and remained at about 10kg ever since.

2.4 Consumption of plant products

The per-capita consumption of plant products among Chinese urban residents is illustrated in Figure 3 below. Note that the term “Grains” also covers beans and potatoes after 2012, due to a revision by the National Bureau of Statistics in 2013.

In general, the annual plant food consumption per urban resident has remained basically stable. From 1993 to 2016, the per-capita plant food consumption increased slightly from 264.4kg to 266.9kg. In the same period, the proportion of plant food consumption in total food consumption dropped from 84.55% to 77.63%. Obviously, plant food continuous to dominate the food consumption of Chinese urban residents.

On the categories of plant food, great changes have taken place in the consumption of grains, fresh vegetables and fresh melons since the reform and opening-up in 1978. The annual consumption of grains per urban resident decreased by nearly half from 145.4kg in 1981 to 79.7kg in 2001, and remained stable around 80kg from 2002 to 2012. The annual consumption of fresh vegetables per urban resident dropped from 152.3kg in 1981 to 116.5kg in 1995, and remained stable ever since. The annual consumption of fresh melons per urban resident was stabilized after increasing from 21.2kg in 1981 to 57.5kg in 2000. The per-capita consumption of edible oils remained at a low level, growing from 8.2kg in 2000 to10.6kg in 2016.

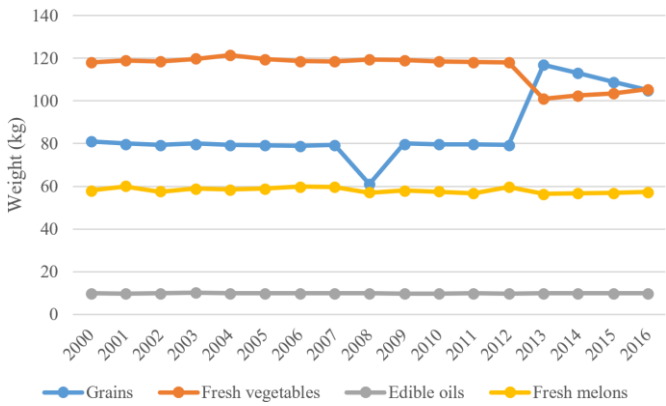

Figure 3. The per-capita consumption of plant products among Chinese urban residents

3. URBAN DEMOGRAPHIC TRANSITION IN CHINA

Figure 4 describes the variation in the number of Chinese urban residents of each gender and in different age groups from 2000 to 2016.

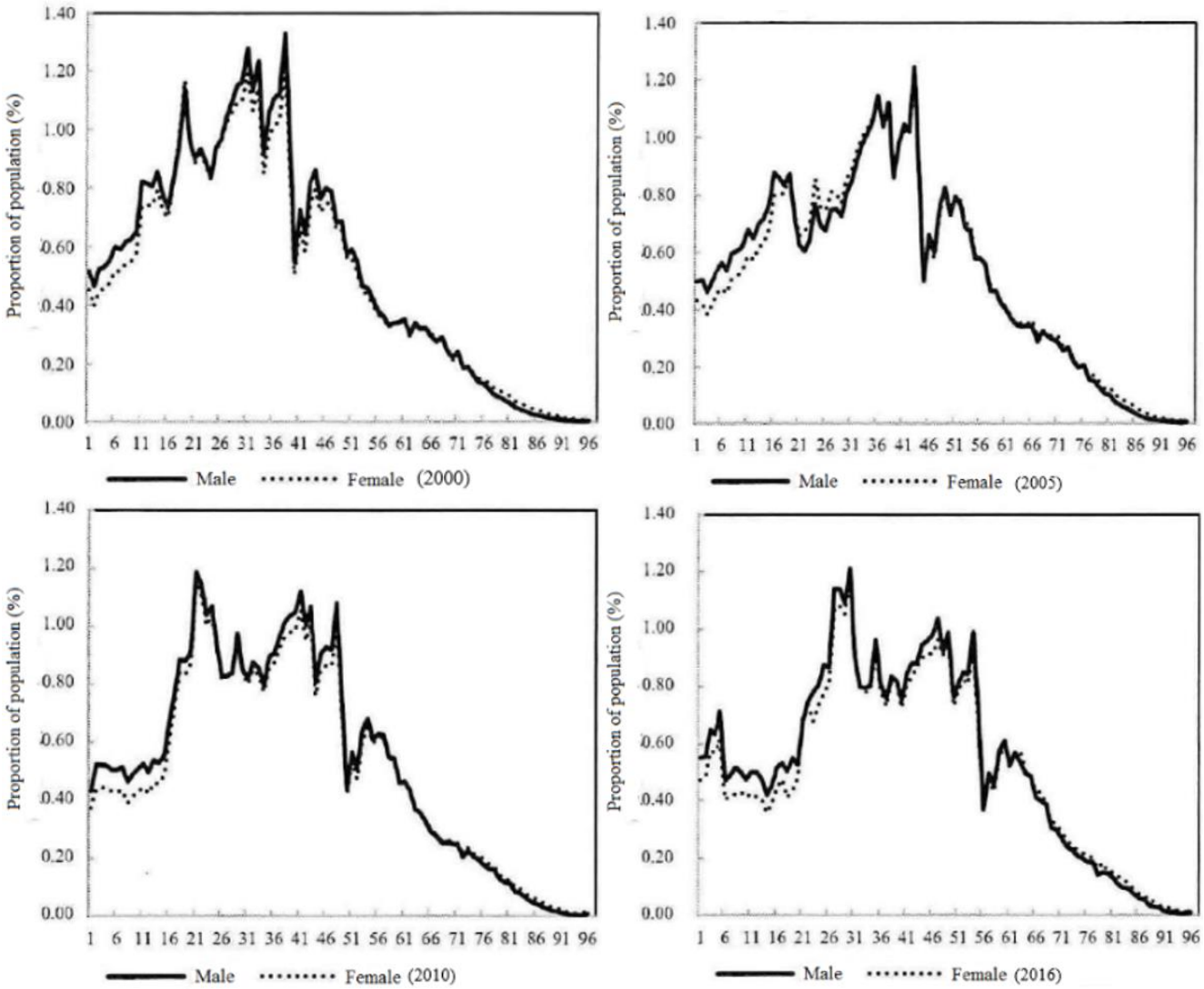

Figure 4. Gender and age structure of Chinese urban population in 2000~2016

Obviously, aging and low birth rate have been the two dominant features of Chinese urban population since 2000. The proportion of urban residents aged 0~14 has dropped from 18.42% in 2000 to 14.68% in 2016, while that of those aged above 65 has rose from 6.42% in 2000 to 8.49% in 2005, surpassing the threshold for an ageing society, and further to 9.6% in 2016.

Tables 3 and 4 respectively display the dependency ratio and sex ratio of Chinese urban population in different age groups. Note that the dependency ratio refers to the age-population ratio of those typically not in the labor force (the dependent part) and those typically in the labor force (the productive part), while the sex ratio means the ratio of males to females in a population.

It can be seen that the proportion of urban working population fluctuated constantly from the level of 75.16% in 2000, and eventually returned to 75.72%, thanks to the influx of numerous rural laborers. On the sex ratio, the proportion of females in urban residents increases with age. This could be attributed to the fact that males have more abnormal deaths while females enjoy a longer life expectancy. In the age group 0~14, the sex ratio of urban population remained above 100 in 2000~2016, indicating that there are more males than females aged 0~14. In the same period, the sex ratio was about 104 for urban residents between 15~64. The sex ratio of those over 65 was always below 100: 91.61 in 2000 and 90.44 in 2016.

The changes in urban population structure are mainly the result of the growth in life expectancy and the decline in fertility rate. On the one hand, the life expectancy of China's population has been growing steadily with the improving living and medical standards. According to the National Bureau of Statistics, the mean life expectancy of China's population increased from 71.4 in 2000 to 76.34 in 2015. The growth in mean life expectancy of males (69.63~73.64) is smaller than that of females (73.33~79.64). On the other hand, the China's population growth is characterized by low birth rate, low mortality rate and low natural growth rate. Since 2001, the birth rate remained below 13%, and the mortality rate stayed at around 7%, leading to a relatively low fertility rate.

More complex changes are expected for Chinese urban population under the combined effects of the existing family planning policies and the newly introduced second-child policy. All these changes will have an impact on food consumption and safety among the urban residents (Table 5).

Table 3. Variation in the dependency ratio of Chinese urban population in different age groups

Years	Total population	0-14 years old		15-64 years old		65 years old or older		The proportion of elderly people to children	Ratio of children being raised	Ratio of elderly people being raised
		Population	ratio	Population	ratio	Population	ratio			
2000	45906	8456	18.42	34501	75.16	2948	6.42	34.87	24.51	8.55
2005	56212	9333	16.60	42107	74.91	4772	8.49	51.13	55.16	44.33
2010	66978	9428	14.08	52327	78.12	5224	7.80	55.41	18.02	9.98
2016	79298	11640	14.68	60047	75.72	7611	9.60	65.39	19.38	12.68

Table 4. Variation in the sex ratio of Chinese urban population in different age groups

Years	0-14 years old			15-64 years old			65 years old or older		
	Male	Female	Sex ratio	Male	Female	Sex ratio	Male	Female	Sex ratio
2000	4481.24	3975.08	112.73	17650.39	16850.91	104.74	1409.66	1538.72	91.61
2005	5020.34	4312.52	116.41	20916.66	21190.71	98.71	2272.62	2499.10	90.94
2010	5097.83	4329.96	117.73	26683.98	25642.56	104.06	2510.72	2712.94	92.55
2016	6267.55	5372.37	116.66	30718.97	29327.67	104.74	3614.61	3996.83	90.44

Table 5. Birth rate, mortality rate and natural growth rate of china's population

Index	Birth rate (‰)	Mortality rate (‰)	Natural growth rate (‰)
2000	14.03	6.45	7.58
2003	12.41	6.40	6.01
2006	12.09	6.81	5.28
2009	11.95	7.08	4.87
2012	12.10	7.15	4.95
2015	12.07	7.11	4.96
2016	12.95	7.09	5.86

4. EMPIRICAL ANALYSIS

4.1 Conceptual framework and model setting

The food expenditure of each urban household can be expressed as:

$$E = f(Y, P, D, Z) + u \tag{1}$$

where, E is the household food expenditure; Y is the household income; P is the price index of various food products; D is the family structure variable; Z is the other influencing factors (i.e. residence, family education level, the number of family members working in state-owned enterprises, the size of the local city, and the region variable) on household food consumption; u is a random error term. The food expenditure function can be rewritten as:

$$\begin{aligned} \ln E = {} & \beta_0 + \beta_1 \ln I + \beta_2 (\ln I)^2 \\ & + \beta_3 \ln P + \beta_4 FAES + \beta_5 Z + \mu \end{aligned} \tag{2}$$

where, $FAES$ is the age structure index of each household; $\beta_0, \ldots, \beta_5$ are unknown parameters. The meaning of the other parameters is the same as that in Eq. (1). Eq. (2) can be solved by the least squares method. The $FAES$ can be expressed as:

$$\begin{aligned} FAES = {} & c_1 \times VA + c_2 \times VB + c_3 \times VC + c_4 \times VD \\ & + c_5 \times VE + c_6 \times VF + c_7 \times VG \\ & + c_8 \times VH + c_9 \times VI + e_{11} \times VJ \\ & + e_{21} \times VK + e_{31} \times VL + e_{41} \times VM \\ & + e_{12} \times VN + e_{22} \times VO + e_{32} \times VP \\ & + e_{42} \times VQ \end{aligned}$$

where, VA, VB…, VQ are family structure variables about the number and age of family members. In each family, males between 35 and 40 were taken as the standard members and assigned the adult equivalent value of 1, i.e. $VC\ c_3$=1. Then, each of the other family members was converted to standard members, and assigned a corresponding adult equivalent value. This method is called the adult equivalent scales method (Model 1).

4.2 Data analysis

Our research uses the 2009 urban household survey data released by the National Bureau of Statistics [14-16]. Six provincial administrative regions (hereinafter referred to as provinces), namely, Hebei, Guangdong, Henan, Jilin, Sichuan and Xinjiang, were selected to represent the northern, southern, central, north-eastern, southwestern and northwestern regions of China, respectively. In total, 10,462 urban households were randomly selected from these provinces, including 1,935 from Hebei, 2,371 from Guangdong, 1,602 from Henan, 1,222 from Jilin, 2,246 from Sichuan, and 1,086 from Xinjiang.

All these households meet the definition of "urban households" in Chinese laws and regulations: non-agricultural households with permanent residence in urban districts or neighborhood committees. Here, the samples also cover the agricultural households with permanent residence in these areas, as well as the agricultural or non-agricultural households without permanent residence but having lived in urban districts or neighborhood committees for more than half a year.

In general, 15.3% of the sample households are from Henan, 18.5% from Hebei, 11.7% from Jilin, 22.7% from Guangdong, 21.5% from Sichuan and 10.4% from Xinjiang. The proportion of each province is above 10%, an evidence for the rationality of sample selection. For comparison, Xinjiang was taken as the reference province in our research.

The food products consumed by urban households were divided into ten main categories: cereals (rice and flour), edible oils (animal oil and vegetable oil), meat (pork, beef, mutton, other meats and meat products), poultry meat (chicken, duck meat, other poultry meats and poultry meat products), eggs (fresh eggs and egg products), aquatic products (fish and shrimp), dairy products (fresh dairy products, milk powder, yogurt and other dairy products), vegetables (fresh vegetables, dried vegetables and vegetable products), fruits (fresh fruits,

fresh melons, dried fruits and dried melons), grains (starch, potato, dried beans and pastries).

4.2.1 Expenditure on each food type

Table 6 shows the per-capita food expenditure of the sample households in 2009. It can be observed that the urban households in Guangdong on average spent the most (RMB 9,755.37 yuan) on food products, while those in Henan spent the least (RMB 45,896.695 yuan). The expenditures of urban households in different provinces were compared on each type of food.

The urban households in Guangdong on average spent RMB 1,248.980 yuan on cereals, more than those in any other province, while those in Hebei spent RMB 790.532 yuan on cereals, fewer than those in any other province. The urban households in Guangdong also dwarfed those in other provinces in the per-capita expenditure on meat, poultry meat, aquatic products, vegetables, fruits and grains. Specifically, the meat expenditure of Guangdong urban households was RMB 3,412.079 yuan, RMB 920.926 yuan higher than that of the second-ranking Sichuan urban households; the poultry meat expenditure of Guangdong urban households was RMB 1,486.778 yuan, RMB 739.724 yuan higher than that of the second-ranking Sichuan urban households; the aquatic products expenditure of Guangdong urban households was RMB 1,680.986 yuan, RMB 1,192.759 yuan higher than that of the second-ranking Hebei urban households.

On edible oils, Sichuan and Jilin were respectively at the top and bottom in the ranking of expenditure per urban resident. The per-capita expenditure of Sichuan urban households stood at RMB 4,87546 yuan, while that of Jilin urban households was only RMB 302.085 yuan. On eggs, Hebei urban households spent an average of RMB 302.085 yuan, more than that of urban households in any other province.

Table 6. Urban household expenditure on different types of food

Food	Total sample	Hebei	Jilin	Henan	Guangdong	Sichuan	Xinjiang
cereals	965.744	790.532	911.019	949.049	1248.980	861.731	960.875
rice	444.463	279.294	483.471	211.068	727.708	511.136	282.87
flour	129.844	230.339	193.238	166.213	14.762	28.766	286.098
starch and potato	85.363	64.467	56.511	105.97	94.551	91.082	92.773
dried beans	136.995	110.674	159.92	158.6	168.197	115.182	103.217
oil	400.952	400.948	304.697	321.440	437.107	487.546	368.532
vegetable oil	389.955	398.266	297.369	320.913	427.133	454.021	367.501
animal oil	10.997	2.681	7.328	0.528	9.974	33.525	1.031
meat	1966.918	1242.282	1523.311	1285.450	3142.079	2221.153	1671.017
pork	1260.362	686.104	822.706	724.959	2331.551	1663.143	394.141
beef	236.047	200.754	369.27	122.936	273.176	200.304	308.733
lamb	165.758	162.009	123.215	128.651	63.658	31.697	775.212
poultry	675.523	274.422	296.113	355.708	1486.778	747.054	369.780
chicken	391.787	126.522	181.697	168.952	940.26	382.241	215.837
duck	92.308	21.14	27.538	20.121	184.972	177.828	19.31
eggs	258.623	203.085	278.884	286.820	235.365	252.821	179.564
fresh eggs	239.076	282.395	253.317	267.42	217.311	233.084	163.97
aquatic products	658.075	392.136	488.197	237.328	1680.956	390.565	263.780
fish	429.314	199.455	294.86	149.124	1114.966	294.68	184.979
shrimp	90.845	128.005	93.397	45.876	174.516	25.534	40.497
vegetables	1294.435	1092.351	1250.046	1104.161	1591.295	1488.296	936.079
fresh vegetables	1188.656	982.883	1167.412	1030.651	1419.729	1395.452	880.109
fruits	876.735	678.799	1016.609	719.672	1132.067	783.834	938.371
fresh fruits	572.204	423.437	714.824	397.723	808.792	545.249	473.396
fresh melon	101.706	116.474	187.169	107.603	81.701	59.221	102.064
pastries	230.66	205.994	182.435	219.691	325.238	186.507	229.883
dairy products	518.579	470.497	421.309	456.456	625.313	582.044	441.057
fresh dairy products	26.451	260.788	180.515	257.793	230.806	344.782	282.565
milk powder	119.153	57.062	80.76	65.445	253.937	128.544	28.524
yogurt	79.397	117.709	100.372	78.06	60.628	60.157	70.271
Total food expenditure	6522.346	4954.799	5817.404	4589.695	9755.37	6846.953	5245.763
Number of samples	10462	1935	1222	1602	2371	2246	1086

4.2.2 Provincial food consumption

As shown in Table 7, the provincial food consumption carries the following features:

(1) On the total consumption, the food consumption of all sample households averaged at 969.431kg. The urban households in Jilin on average consumed 1,000.321kg of food, more than those in any other province, while those in Xinjiang on average consumed 929.967kg, fewer than those in any other province.

(2) By the per-capita consumption, the different types of food can be ranked in descending order as follows: vegetables (365.869kg), cereals (159.613kg), fruits (???kg), meat (73.793kg), dairy products (58.102kg), edible oils (30.915kg), fresh eggs (30.890kg), aquatic products (30. 536kg), grains (28.239kg) and poultry meat (26.003kg).

(3) Under each category of food, the consumption of specific food products per urban resident demonstrates the regional features and consumption habits of the Chinese people.

On cereals, the sample households on average consumed 115.104kg of rice and 44.509kg of flour. By consumption per urban resident, Guangdong and Xinjiang were the greatest and the smallest consumers of rice, respectively (170.493kg vs. 57.150kg). The two provinces switched their places in the ranking of per-capita consumption of four (96.764kg vs. 3.392kg).

Table 7. Consumption of different types of food in each province

Food	Total sample	Hebei	Jilin	Henan	Guangdong	Sichuan	Xinjiang
cereals	259.613	160.240	193.026	121.503	173.885	146.727	172.607
rice	115.104	76.693	135.937	57.150	170.493	138.709	75.843
flour	44.509	93.547	57.089	64.353	3.392	8.018	96.764
starch and potato	28.239	24.370	23.016	36.617	21.936	31.592	35.473
oil	30.915	29.740	30.429	24.167	28.769	38.092	33.361
vegetable oil	30.069	29.483	29.664	24.105	27.874	35.818	33.274
animal oil	0.846	0.257	0.765	0.062	0.895	2.274	0.087
meat	73.793	49.419	59.791	45.551	105.513	95.895	59.673
pork	60.426	36.146	43.229	36.854	96.023	88.075	22.908
beef	7.849	7.494	12.365	4.379	7.640	6.799	11.150
lamb	5.518	5.779	4.197	4.318	1.850	1.021	25.615
poultry	26.003	10.140	14.578	14.279	52.751	29.573	18.636
chicken	20.545	8.881	12.700	12.532	42.865	18.670	17.121
duck	5.458	1.259	1.878	1.747	9.886	10.903	1.515
fresh eggs	30.890	42.133	38.586	40.100	21.673	24.380	22.197
aquatic products	30.536	21.485	28.175	14.544	65.441	21.264	15.888
fish	27.698	17.156	25.323	12.878	60.321	20.564	14.549
shrimp	2.838	4.329	2.852	1.666	5.120	0.700	1.339
vegetables	365.869	359.204	363.864	406.279	344.589	400.021	296.214
fruits	151.540	153.593	185.295	173.847	130.341	122.712	182.938
fresh fruits	107.325	102.457	133.432	106.645	107.136	104.220	94.462
fresh melon	44.215	51.136	51.827	67.202	23.205	18.492	88.476
pastries	13.930	15.547	14.775	16.288	13.112	12.234	11.913
dairy products	58.102	77.095	48.820	57.639	33.842	61.626	81.068
fresh dairy products	44.522	53.768	33.022	43.559	25.211	51.923	69.265
milk powder	1.397	1.231	1.239	0.921	2.132	1.524	0.703
yogurt	12.183	22.096	14.559	13.159	6.500	8.179	11.100
Total food expenditure	969.431	942.966	1000.321	950.815	991.852	984.116	929.967
Number of samples	10462	1935	1222	1602	2371	2246	1086

On edible oils, the sample households on average consumed 30.069kg of vegetable oils, with Sichuan and Henan being the largest and smallest consumers, respectively (35.818kg vs. 24.105kg).

On meat, Guangdong ranked the first in terms of the per-capita consumption (105.513kg), followed by Sichuan (95.95kg). The other four provinces consumed less than 60kg of meat per urban resident. Specifically, Guangdong and Sichuan were the top two consumers of pork, with per-capita consumptions of 96.023kg and 88.075kg, respectively, while Xinjiang was the least pork consuming province (22.908kg). Jilin and Xinjiang consumed more beef per urban resident than any other province (12.365kg vs. 11.15kg). In addition, Xinjiang was the largest consumer of mutton, with per-capita consumption of 25.615kg.

On poultry meat, the leading consumers per urban resident were Guangdong and Sichuan (52.751kg vs. 29.573kg). The per-capita consumption of the other four provinces was merely 20kg. Specifically, Guangdong consumed 42.865kg per urban resident, more than any other province. The same occurred to Sichuan in terms of duck meat (10.903kg).

On eggs, Hebei and Henan were the leading consumers, with per-capita consumptions of 42.133kg and 40.100kg respectively.

On aquatic products, Guangdong took a huge lead in per-capita consumption (65.441kg). For example, this province consumed an average of 60.321kg of fish, much more than any other province. On dairy products, Xinjiang was the leading consumer, with a per-capita consumption of 81.068kg.

On vegetables, Henan and Guangdong occupied the top two spots in the ranking of per-capita consumption (406.279kg vs. 400.021kg), while Xinjiang came at the bottom (296.214kg). On fruits, Jilin had the highest per-capita consumption (185.259kg), followed by Xinjiang (182.938kg), while Sichuan had the lowest per-capita consumption (122.712kg).

4.2.3 Age structure analysis

According to the family life cycle theory, the evolution of each family can be divided into the following phases: formation, expansion, stabilization, contraction, empty-nesting and disintegration. These phases are closely related to the age structure of family members. Thus, this sub-section explores the relationship between the age structure and the food consumption of the sample households (Table 8).

Table 8. Per-capita food expenditure of sample urban households with different age structures

Type of family	Number of samples	Per capita food consumption expenditure
Couple, 24-29 years old	50	2988.71
Boy, Six years old and below	40	2427.64
Girl, Six years old and below	36	2735.24
Couple, 30-34 years old	54	3864.11
Boy, 7-11years old	63	2338.27
Girl, 7-11years old	55	2355.54
Couple, 35-39 years old	34	3818.55
Boy, 12-16years old	143	2533.23
Girl, 12-16years old	112	2318.35
Couple, 40-44 years old	55	3041.93
Boy, 17-21years old	158	2579.63
Girl, 17-21years old	108	2534.38
Couple, 45-49 years old	200	3177.06
Couple, 50-54 years old	252	3376.20
Couple, 55-59 years old	272	3632.92
Couple, 60-64 years old	163	3684.00
Couple, 65-69 years old	80	3186.30
Couple, Over 70 years old	114	2520.60

It can be seen from Table 8 that the per-capital food expenditure of each urban household depends on the number of family members and on the age structure. For instance, the couples aged 30~34 have the largest per-capita food expenditure, while those aged 40~64 increases with age. Males aged 11 and below spent less on average than females in the same age group, while males aged 12~21 spent more on average than their female counterparts. These results confirm the impact of demographic changes on food consumption in urban households, and the importance of adult equivalent scales to the empirical analysis.

4.2.4 Food price analysis

As mentioned before, this paper investigates the food consumption in Chinese urban households against such influencing factors as residence, family education level and the number of family members working in state-owned enterprises. The residence has an impact on household food consumption, because the locals are more likely to have good job opportunities and social security. The education level directly bears on which food the residents choose to consume, and thus affects food expenditure. Here, the family education level is split into eight categories, namely, illiteracy, elementary school, junior high school, senior high school, vocational school, specialist school, undergraduate school and graduate school, and each level is given a rating against a 1~8 scale. On average, the family education level of the sample households was 4.708. The number of family members working in state-owned enterprises was considered because it determines the economic stability of the household.

Table 9 shows the consumption and expenditure of each urban household on the ten types of food. Note that the food price stands for the value per unit of food. It can be seen that meat is the most expensive type of food, with a price of RMB 22.941 yuan/kg, while vegetables are the cheapest type of food, with a price of RMB 3.496 yuan/kg.

Table 9. Statistical description of variables in the sample households

Variable	Total sample	
	Average value	Standard deviation
Household disposable income (yuan)	44435.27	26063.39
Family members' education level	4.708	1.981
Number of working people in the state sector	0.771	0.850
registered residence (1= Local household registration, 0= Other)	0.966	0.182
city (1= Small city, 0= Other)	0.183	0.386
Price(yuan/Kg)		
cereals	4.195	1.110
meat	22.941	3.675
poultry	19.195	4.523
eggs	8.366	1.987
aquatic products	15.616	4.523
dairy products	9.981	7.994
vegetables	3.496	0.997
fruits	6.244	2.639
region		
Henan	0.153	0.360
Hebei	0.185	0.388
Guangdong	0.227	0.419
Sichuan	0.215	0.411
Jilin	0.117	0.321
Xinjiang	0.104	0.420
Number of samples	10462	

4.2.5 Income group analysis

As shown in Table 9, the mean disposable income of Chinese urban households is RMB 44,435.27 yuan. In light of this, the sample households can be divided into low-income ones, middle-income ones and high-income ones. The mean disposable income of the high-income group is RMB 68,417.63 yuan, 1.7 times that of middle-income group and 2.8 times that of low-income group.

Table 10 depicts the relationship between food consumption and income group. It can be seen that the food consumption is positively correlated with the household disposable income. The high-income households contribute 21.9% of the food expenditures, twice that of low-income households.

Besides, the household owners in the high-income group are more educated than those in low-income group: 59.4% of high-income household owners are graduates from specialist school or above, while only 23.2% of low-income household owners have the same education background. 22.1% of high-income households live in small cities, so do 15.7% of low-income households.

Many family members in high-income household have local residence, while only a few in middle- and low-income households. Guangdong has the highest percentage of high-income households (33.4%), and Xinjiang has the lowest percentage (6.9%). Meanwhile, Sichuan and Jilin respectively have the highest and lowest percentages of low-income households (26.1% vs. 12%).

The sample households also differ greatly in the proportion of working family members, the expenditure on durable goods and the number of other properties. Table 11 statistically describes the variables of the family structure $VA, VB, \ldots, VQ$. It can be seen that the mean value of these variables ranges 0.101 to 0.667, that of VQ is 0.101, and that of VG is 0.607.

4.2.6 Estimated food expenditures

Three models were constructed based on Model 1 and used to estimate the food expenditure of the sample households (Table 12). Specifically, Model 2 was created by introducing the square and logarithm of household disposal income to Model 1, Model 3 was designed by introducing family structure variables to Model 1, and Model 4 was constructed by introducing both the square and logarithm of household disposal income and family structure variables to Model 1. The square of household disposal income in Model 4 was proved as significant at the level of 1%, revealing the rationality of the addition of the squared term. The multicollinearity test shows that the variance inflation factors (VIFs) of all variables other than the square and logarithm of household disposal income were smaller than 5, eliminating the possibility of multicollinearity problems.

Comparing the estimation results of Models 3 and 4, it is learned that the variables were similar in coefficient estimates and significance, except for household disposable income and its squared term, indicating the good stability of the models. The estimation results of Model 4 show that the values of 14 out of the 17 family structure variables were below the significance level of 10%. This means Model 4 enjoys better estimation performance than Model 3. Thus, the estimation results of this model were further analyzed below.

The estimates of Model 4 show that the food expenditure of a household is greatly suppressed by the number of family members working in state-owned enterprises, and significantly boosted by the local residence and the scale of the local city. In other words, an urban household tends to spend

more on food if its members are permanent registered residents and the local city is relatively large. Meanwhile, the family education level does not have a significant impact on the household food expenditure. In addition, the prices of the main types of food, which still mean the value per unit of food, were estimated to be significant at the 1% level, indicating the major impact of food price on household food expenditure.

Furthermore, the estimation results of the regional variable show that Henan and Hebei have significantly negative variables, while Guangdong and Sichuan have significantly positive variables. All these provinces differ greatly from the reference province of Xinjiang in household food expenditure.

Table 10. Statistical description of variables in different income groups

Variable	Low income group		Middle income group		High income group	
	Average value	Standard deviation	Average value	Standard deviation	Average value	Standard deviation
Household disposable income (yuan)	24311.02	9605.842	40582.92	12261.88	68417.63	28292.25
Family members' education level	4.782	2.057	4.807	1.980	4.534	1.894
Number of working people in the state sector	0.492	0.707	0.875	0.866	0.947	0.895
registered residence (1= Local household registration, 0= Other)	0.978	0.146	0.970	0.172	0.950	0.218
city (1= Small city, 0= Other)	0.157	0.363	0.171	0.376	0.221	0.415
Price(yuan/Kg)						
cereals	3.888	0.779	4.053	0.953	4.644	1.365
meat	22.219	3.700	22.790	3.503	23.815	3.640
poultry	18.522	4.482	18.820	4.372	20.244	4.527
eggs	8.273	1.962	8.150	1.911	8.674	2.049
aquatic products	14.476	4.085	15.398	4.360	16.975	4.744
dairy products	9.540	7.904	9.291	7.631	11.112	8.314
vegetables	3.278	0.883	3.408	0.934	3.801	1.088
fruits	5.739	2.465	5.959	2.457	7.035	2.796
region						
Henan	0.146	0.353	0.168	0.374	0.145	0.353
Hebei	0.169	0.375	0.219	0.414	0.167	0.373
Guangdong	0.171	0.377	0.175	0.380	0.334	0.472
Sichuan	0.261	0.439	0.202	0.401	0.182	0.386
Jilin	0.120	0.325	0.127	0.333	0.104	0.305
Xinjiang	0.134	0.411	0.109	0.396	0.069	0.424
Number of samples	3488		3487		3487	

Table 11. Statistical description of variables in the FASE

Variable	Average value	Standard deviation	Minimum	Maximum
VA	0.2219	0.341	0	2.006
VB	0.341	0.441	0	3000
VC	0.557	0.412	0	2.987
VD	0.388	0.409	0	2.000
VE	0.104	0.285	0	2.352
VF	0.335	0.439	0	3.453
VG	0.607	0.396	0	3.000
VH	0.396	0.412	0	2.000
VI	0.104	0.286	0	2.000
VJ	0.378	0.786	0	5.024
VK	0.224	0.540	0	3.811
VL	0.581	0.836	0	3.004
VM	0.102	0.335	0	1.470
VN	0.331	0.745	0	5.003
VO	0.279	0.592	0	5.089
VP	0.588	0.834	0	4.320
VQ	0.101	0.332	0	1.470

Table 12. Estimation results on food expenditures of the sample households

Variable	Model 1	Model 2	Model 3	Model 4
The logarithm of the income that the family can control	0.34***	2.547***	0.294***	2.666***
	(0.007)	(0.147)	(0.007)	(0.141)
The square of the logarithm of the income that the household can control		-0.106***		-0.114***
		(0.007)		(0.007)
Family members' education level	0.010***	0.009***	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Number of working people in the state sector	-0.025***	-0.025***	-0.015***	-0.014***
	(0.005)	(0.004)	(0.005)	(0.004)

registered residence	0.095***	0.094***	0.066***	0.064***
	(0.020)	(0.020)	(0.019)	(0.019)
Small city	0.040***	0.045***	0.042***	0.047***
	(0.010)	(0.010)	(0.009)	(0.009)
Food price	Yes	Yes	Yes	Yes
Regional variable	Yes	Yes	Yes	Yes
Demographic variable				
VA			0.166 ***	0.170***
			(0.024)	(0.024)
VB			0.106***	0.104***
			(0.010)	(0.010)
VC			0.121***	0.123***
			(0.014)	(0.014)
VD			0.152***	0.145***
			(0.015)	(0.015)
VE			0.092***	0.096***
			(0.016)	(0.016)
VF			0.082***	0.083***
			(0.010)	(0.009)
VG			0.111***	0.119***
			(0.015)	(0.015)
VH			0.170***	0.183***
			(0.016)	(0.015)
VI			0.095***	0.105***
			(0.014)	(0.014)
VJ			-0.026***	-0.027***
			(0.009)	(0.009)
VK			-0.012***	-0.009
			(0.008)	(0.008)
VL			0.007	0.005
			(0.006)	(0.006)
VM			0.032***	0.031***
			(0.012)	(0.012)
VN			-0.026***	-0.026***
			(0.009)	(0.009)
VO			-0.028***	-0.025***
			(0.007)	(0.007)
VP			-0.018***	-0.015***
			(0.006)	(0.006)
VQ			0.017	0.015
			(0.013)	(0.012)
Constant term	4.134***	-7.365***	4.279***	-8.099***
	(0.116)	(0.772)	(0.113)	(0.746)
Number of samples	10462	10462	10462	10462
Adjusted coefficient of determination	0.456	0.468	0.496	0.509

***, **, * indicate 1%, 5%, 10%, respectively

5. CONCLUSIONS

Focusing the food expenditure of Chinese urban residents, this paper introduces the concept and variables (e.g. the age structure) of adult equivalent scales method to the food consumption function, establishes a model to estimate the effects of demographic factors, and applies the model to predict the impacts of household income, family structure and other factors on food expenditure. Through detailed analysis, the main conclusions were drawn on the food expenditure of Chinese urban residents:

(1) The elasticity of food expenditure to the family structure index, which represents the age and gender conditions of a household, was estimated as 0.066 at the significance level below 1%, indicating that the gender-age structure, i.e. the family structure, directly affects the household food expenditure. The result reflects the importance of demographic factors in the evaluation of food consumption.

(2) The elasticity of food expenditure to household disposable income was estimated as 0.321 without considering the family structure, and as 0.269 when the family structure was taken into account. Thus, the income elasticity will be exaggerated if demographic factors are not considered in the analysis of food consumption.

(3) The elasticity of food expenditure to household disposable incomes of low-, middle- and high-income groups were estimated as 0.411, 0.307, and 0.098, respectively, at the significance level below 5% This means the income elasticity of food expenditure is negatively correlated with the income level. The food consumption of high-income urban residents is more sensitive to the changes in the age structure than that of residents in other income groups.

To sum up, the food consumption of Chinese urban households is greatly affected by household disposable income and the family structure.

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