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RESEARCH ARTICLE

Economic growth and nutrition transition: an empirical analysis comparing demand elasticities for foods in China and Russia

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Abstract

This study provides empirical evidence on the link between economic growth and nutrition transition in two emerging economies, China and Russia. Both countries have experienced rising average incomes, accompanied by an increasing rate of nutrition-related chronic diseases in recent years. Given the regional heterogeneity between these two countries, we analyze the extent to which income growth as a major driver of nutrition transition has a significant effect on the consumption of different food aggregates and how these effects differ between Chinese and Russian consumers. Our results indicate that with increasing household incomes over time the demand for carbohydrates decreases, while the demand for meat and dairy products, as well as fruits increases. This is a development generally known as nutrition transition. Further, we estimate a Quadratic Almost Ideal Demand System (QUAIDS) for nine different food aggregates for China and Russia. Our results indicate that in both countries all food aggregates have positive expenditure elasticities and are thus normal goods. Moreover, our results indicate that in 2008/2009 meat is still a luxury good in China yet a necessity good in Russia. For 2009, the highest own-price elasticities in China are found for non-meat protein sources and dairy products. Within the meat group, beef, poultry and mutton have the highest price elasticities in China. In Russia, the milk and dairy group, together with the vegetable group, is the most price-elastic food group in 2008. In line with the definition of a nutrition transition, our overall results underscore the finding that income growth in China and Russia tends to increase the demand for animal-based products much stronger than, for example, the demand for carbohydrates. Despite being a positive signal for problems of malnutrition in rural China, this trend of increasing meat consumption might further increase the incidence of chronic diseases in urban areas since there is convincing scientific evidence that increasing meat consumption, especially red and processed meat, is associated with an increased risk of chronic diseases.

Keywords: nutrition transition, food demand, QUAIDS, China, Russia

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1. Introduction

Epidemiological experiences in western societies show that with economic growth, dietary patterns shift towards a diet that is high in fat, especially saturated fats, cholesterol, sugar and other refined carbohydrates, but low in unsaturated fats and fiber (Popkin 2002). These major dietary changes, usually referred to as nutrition transition, are often characterized

by an increasing share of animal food products (Popkin 2001). Such a shift in dietary patterns is considered to be a major impact factor of the increasing prevalence of obesity, cardiovascular diseases (Hu *et al.* 2000; Shepard *et al.* 2001; Popkin 2007), type 2 diabetes mellitus (Montonen *et al.* 2005), and various forms of cancer (Beydoun and Wang 2008; Popkin 2008). However, nutrition transition is certainly not exclusively taking place in developed countries. Over the last few decades, many emerging and developing countries have experienced the same trends in dietary patterns and their consequences on public health (Popkin 2001). For example, in China, where policy makers still primarily focus on the alleviation of malnutrition, increases in diet-related, non-communicable diseases such as obesity can be noted (Tian and Yu 2013). In Russia, cardiovascular diseases, diabetes mellitus or chronic respiratory diseases significantly contribute to the country's worrying morbidity and mortality rates (Sedik *et al.* 2003).

According to the World Health Organization (2014), with rising incomes diseases connected to excessive or unbalanced diets like cardiovascular diseases, diabetes or certain kinds of cancer gradually replace undernourishment and hygiene-related factors as major causes of death. This steadily increasing incidence of nutrition-related chronic diseases seems to be caused, at least partially, by rapid shifts in food systems, food pricing and marketing. Thus, for designing and implementing effective public intervention programs, it is important to understand the major drivers of these dynamics (Popkin 2007). As Popkin (2001) points out, epidemiological shifts often differ across countries and regions since an ongoing nutrition transition is closely connected to a country's particular historic and cultural characteristics, which are clearly not transferrable to any other country. Even though an extensive body of literature on food demand and nutrition transition in China exists (e.g., Huang and Rozelle 1998; Gould 2002; Yen *et al.* 2004; Gould and Villarreal 2006; Gale and Huang 2007; Liao and Chern 2007; Huang and Gale 2009; Zheng and Henneberry 2009; Hovhannisyan and Gould 2011; Hovhannisyan and Gould 2014; Wang *et al.* 2014; Zhou *et al.* 2015), only two comparative studies on this topic are available (Monteiro *et al.* 1995; Delgado 2003). However, both studies use rather old data and do not estimate a food demand system. Our research addresses the issue of economic growth and nutrition transition in a comparative way by focusing on two large emerging economies, namely Russia and China.

A comparison of Chinese and Russian food demand controls for a considerably wide range of cultural, economic and geographical differences. Both countries have experi-

enced rather high growth rates of per-capita GDP between 1997 and 2009. Even though the growth rates in 2009 were significantly higher in China (15.4% p.a.) than that in Russia (6.4% p.a.), the per-capita GDP was still twice as high in Russia compared to China (13 616 purchasing power parity (PPP)-USD and 6 207 PPP-USD, respectively; World Bank 2014). In terms of income distribution, the two countries are rather similar, which is reflected in a Gini index of 39.7 for Russia and 42.1 for China in 2010¹. In contrast, the ratio of rural to urban population is significantly different between these two countries. In Russia, 73.7% of the population is living in urban areas, while in China this share amounts to 49.2% (United Nations 2014). In terms of the prevalence of diet-related diseases, the following points are noteworthy. In 2008, the obesity rates in China and Russia were 5.7 and 26.5%, respectively. Thus, the prevalence of obesity is still considerably lower in China than that in Russia. However, higher rates of overweight and obesity in China suggest a certain catching-up effect and increasing problems with chronic diseases in the longer run (Popkin 2001; Du *et al.* 2002; Kelly *et al.* 2008). Given these similarities as well as differences, we analyze in which way expenditure growth as a major driver of nutrition transition has significantly changed the consumption of different food aggregates, as well as how these effects differ between Chinese and Russian consumers. Moreover, considering the strong rural-urban nexus in both countries, we also display results for urban and rural areas separately. Therefore, based on a two-stage budgeting process, we estimate the expenditure elasticities of nine different food aggregates and five different meat aggregates for China and Russia by applying a Quadratic Almost Ideal Demand System (QUAIDS).

The remainder of this paper is structured as follows. In section two, we describe the two employed data sets. Section three includes a descriptive analysis of food consumption trends, with a special emphasis on meat consumption. In section four, we present the estimation procedure and our empirical results. We conclude in section five.

2. Data

For our descriptive and empirical analysis, we use data from the Chinese Health and Nutrition Survey (CHNS 1997–2009) and the Russia Longitudinal Monitoring Survey (RLMS-HSE 1996–2008). Both the CHNS and the RLMS-HSE are primarily organized and coordinated by the Carolina Population Centre, Chapel Hill, USA. Both data sets provide a wide range of information on socioeconomic characteristics, food expenditures, and food production at

¹ <http://data.worldbank.org/indicator/SI.POV.GINI>

the household level, as well as health status indicators and dietary intakes at the individual level. Furthermore, both data sets are representative for the respective country. The RLMS-HSE data set contains information on more than 4 000 households with about 11 000 individuals living in them. The CHNS data set was conducted in nine waves between 1989 and 2011, and gradually increased over that time; by 2011, the sample covered more than 14 000 individuals in over 5 800 households.

In order to use both price and consumption data for each year of our analysis, the time period for the CHNS analysis of the Chinese food consumption patterns is restricted to 1997–2009. For a comparable transition period of 13 years, we employ the RLMS-HSE (Phase II) data from 1996–2008 in the Russian case. Thereby, our calculations are based on both household food consumption data and community price data after the deletion of severe outliers. A comparison of the food consumption data with additional sources, i.e., data from the Russian Government Committee of Statistics (GKS) for 2008 (GKS 2011) or 2009 data from the National Bureau of Statistics China (NBSC 2010) yields comparable average consumption trends and values for both countries across most food items. We only noticed considerable differences between the Russian data set and the GKS data regarding the amounts of consumed potatoes. This difference can be explained by the fact that potatoes are heavily harvested by Russian families, and only the RLMS-HSE directly keeps track of the exact amount of potatoes harvested for family use in the according year². This underscores the representativeness of the RLMS-HSE and CHNS food consumption data. According to Rozelle *et al.* (2006), we based our estimations on community prices instead of unit sales. Missing community prices were imputed first by multiple imputations of chained equations using the bootstrap option. Afterwards, missing prices were imputed by regional medians.

Despite their richness and representativeness, both data sets have certain limitations. First, for the considered time period the CHNS offers only five waves, while the RLMS-HSE offers eleven waves. Hence, the waves of the Chinese and Russian surveys do not always exactly match. However, the length of the observed transition periods, 13 years, is equal for both countries. Second, the RLMS-HSE food consumption data is only collected during winter months and is therefore not seasonally representative. Likewise, CHNS nutrition data are collected between August and December. However, the survey rounds are comparable, which allows us to examine yearly changes during the winter period, as well as population level changes (Jahns *et al.* 2003). Third,

we do not take into account food eaten away from home (FAFH) because of the following reasons. Even though the CHNS provides consumed quantities of FAFH, it does not offer the respective expenditure or price data. CHNS price data available in the Chinese dataset are based on market prices of basic foods but does not reflect restaurant prices, which also include service costs. In the RLMS-HSE data, FAFH expenditures are only provided at an aggregated level of total FAFH expenditures without information on specific food products for FAFH consumption or respective price data. Therefore, in order to provide comparable and unbiased estimation results, our analysis is based on food eaten at home.

3. Nutrition transition in China and Russia

In this section, we provide insights into the traditional eating habits of the Chinese and Russian populations, as well as current trends in consumption patterns, with a focus on meat consumption.

3.1. Chinese trends in food consumption patterns

Throughout Chinese history, nutrition scarcity has been a major issue for the majority of the rural population, and even parts of the urban population. While total energy intake increased after the foundation of the People's Republic of China in 1949, it dropped considerably during a series of political and economic upheavals in the late-1950s and early-1960s (Du *et al.* 2014; Kantha 1990). The subsequent increase in energy intake is generally seen as a direct result of economic reforms and subsequent rise of the general living standard (Tian and Yu 2013). Since 1978, China's remarkable economic development has significantly improved people's living standards, including food consumption and nutritional status (Feng and Shi 2006).

Traditional Chinese meals usually include rice in southern regions and pasta in northern regions, along with vegetables and a small amount of meat (Li 2007). This diet has a low energy density and is high in carbohydrates and dietary fiber. Intake of non-meat proteins is low, as Chinese traditionally rarely consume milk or other dairy products. Although milk consumption has rapidly increased during recent years and is supplemented by the consumption of beans (especially soy beans, included in "other proteins") as an alternative source of proteins, the total consumption of non-meat proteins is still low compared to Russia or western countries such as the United States (Zhai *et al.* 2005).

² GKS per-capita consumption of food items includes food items bought, private consumption of food items within 14 days which are free of cash costs (e.g., presents, household production, wage equivalents), and food items stored on the first and last day of the observation period, but not produced within the year (GKS 2011).

As shown in Table 1, our data indicates significant changes of Chinese households' dietary patterns between 1997 and 2009, especially in rural areas. In the considered time period, the per-capita consumption of carbohydrates remained more or less stable in urban areas, but increased significantly in rural areas (from 71.7 to 95 kg yr⁻¹). The consumption of meat, dairy, fish, and other proteins like beans also steadily increased, again especially in rural areas. Moreover, dairy products (from 2.2 to 9.2 kg in urban areas and from 0.1 to 2.2 kg in rural areas) became a more important part of Chinese diets. As we would expect, the intake of oils and fats also increased (from 12.3 to 13.0 kg in urban areas and from 9.2 to 13.2 kg in rural areas). Fruit intake nearly tripled in urban areas, and we even observe a sevenfold increase of fruit consumption in rural households. Vegetable consumption increased slightly over the considered time period (from 98.6 to 101.7 kg in urban areas and 80.5 to 95.0 kg in rural areas, respectively). For 2009, we

find an annual average per-capita meat consumption of 32.7 kg in urban and 23.2 kg in rural households. Among meat products, pork deserves special attention. With a yearly consumption of 23.9 kg in urban and 18.8 kg in rural households it was the most commonly consumed meat. Moreover, pork consumption increased particularly strongly in rural areas (from 11.3 to 18.8 kg). The second-highest consumption levels are found for poultry, that is, 3.4 kg in rural areas and 6.1 kg in urban areas. Beef and mutton still play only a minor role in Chinese meat consumption patterns.

Fig. 1 further illustrates the development of consumption of processed and unprocessed meat. Processed meat consumption, which includes, among others, the consumption of sausages and smoked meat, rose considerably faster than unprocessed meat consumption. However, the intake of processed meat in China is still extremely low and accounted for only 6.6% (urban areas) and 5.5% (rural areas) of total meat consumed at home. Taking into account meat eaten

Table 1 Chinese average per-capita food consumption by food groups (kg yr⁻¹)¹⁾

	1997	2000	2004	2006	2009
Households of urban settlement type					
Food groups					
Carbohydrates	89.1	93.9	92.3	95.4	90.1
Milk and dairy	2.2	7.5	10.1	10.7	9.2
Meat	30.3	35.1	30.7	32.7	32.7
Fish	9.4	11.1	11.7	13.4	12.7
Other proteins	27.7	31.9	26.9	30.3	31.5
Fruits	9.1	11.2	16.5	21.9	26.9
Vegetables	98.6	102.4	98.5	108.5	101.7
Fats and oils	12.3	12.9	13.8	13.2	13.0
Other foods	15.0	17.4	17.5	18.2	21.1
Meat groups					
Beef	2.4	3.1	2.2	2.8	2.0
Poultry	4.8	5.1	5.6	5.3	6.1
Mutton	0.5	0.8	0.3	0.4	0.6
Pork	22.6	25.9	22.4	24.0	23.9
Other meat	0.1	0.2	0.2	0.1	0.1
Households of rural settlement type					
Food groups					
Carbohydrates	71.7	88.4	96.7	103.8	95.0
Milk and dairy	0.1	0.6	2.1	2.2	2.2
Meat	14.7	18.5	19.4	21.6	23.2
Fish	6.1	6.5	7.3	7.8	8.0
Other proteins	17.1	21.9	23.2	25.8	27.0
Fruits	1.7	4.1	4.9	9.2	12.5
Vegetables	80.5	91.9	102.2	102.0	95.0
Fats and oils	9.2	11.6	12.9	12.6	13.2
Other foods	9.7	13.7	15.3	15.4	17.8
Meat groups					
Beef	0.9	0.9	1.5	1.3	0.8
Poultry	2.3	2.7	2.8	2.7	3.4
Mutton	0.2	0.2	0.4	0.2	0.2
Pork	11.3	14.7	14.7	17.3	18.8
Other meat	0.1	0.1	0.1	0.1	0.0

¹⁾Source: authors' calculations based on Chinese Health and Nutrition Survey (CHNS 1997–2009).

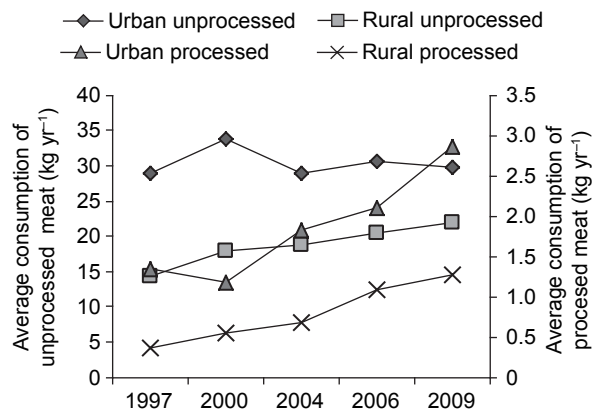


Fig. 1 Per-capita consumption of unprocessed and processed meat in China. Source: authors' calculations based on CHNS (1997–2009).

away from home (57% of processed meat is consumed away from home in the 2009 individual-level survey) lifts this ratio, but only slightly since also the consumption of unprocessed meat increases by adding away-from-home food.

While the changes in dietary patterns in absolute quantities illustrated in Table 1 already indicate an ongoing nutrition transition, we additionally provide Chinese expenditure shares, again separated between rural and urban households. This decomposition of food expenditures by rural and urban households further supports our above mentioned results (Table 2). While carbohydrate consumption in kg increased in both urban and rural areas, the total food expenditure on carbohydrates steadily declined between 1997 and 2009 in both urban and rural areas (from 19.1 to 14.9%, and from 24.3 to 18.7%, respectively). The expenditure share of dairy products is still rather low, but constantly rising in both rural and urban areas. Even though households used a significant share of their food expenditure for meat products, neither rural nor urban residents further increased relative expenses for this item³. Instead, the expenditure for other food products, mainly consisting of convenience foods, sweets, and drinks increased tremendously.

The dynamics between urban and rural areas are especially noteworthy. For many food items, a convergence seems to have taken place during the observed time period. On the one hand, the share of rural household expenditure spent on vegetables and carbohydrates slowly approached the lower urban level. On the other hand, a distinct catch-up development in per-capita consumption can be observed for meat, as well as other protein sources, oils and fats,

and “other foods” (mainly sweets, drinks and convenience foods). For other items like dairy products, consumption rose far slower in rural areas. This indicates that the nutrition transition might consist of two steps in the Chinese case: With economic development, first non-dairy protein such as meat, eggs, soy bean products and fat intake increases, replacing a diet dominated by vegetables and carbohydrates. After having reached a certain welfare level, people seem not to further increase non-dairy protein consumption, but rather enrich their diet with fruit and dairy products, the latter not being part of the traditional diet. Moreover, people increasingly consume convenience foods, snacks and other products, which are usually high in fats and sugar, thus increasing the risk of above-mentioned diet-related diseases.

3.2. Russian trends in food consumption patterns

In general, the base intake level of most food product categories in Russia is completely different from other emerging economies, such as China. During the Soviet Union, the consumption of meat and dairy items was promoted in the official five-year plans by subsidizing these sectors. Furthermore, the Soviet Union's medical and nutritional establishments created dietary standards that called for high levels of protein intake. While these nutrition guidelines ceased being issued in the late-1980s, the practice seems to prevail since no counter-education has been provided yet (Dellava *et al.* 2010). Indeed, we find already relatively high intake levels of animal-based products in 1996, with increasing levels over time (Table 3). This complies with the results of a recent study on eating habits in Russia (Honkanen and Voldnes 2006).

In terms of the dynamics of consumption, Dellava *et al.* (2010) conclude that steep price increases for meat and dairy products in years of economic crisis did not result in long-term dietary shifts. In fact, after a decrease in meat consumption by 27% from 1990–1995 due to the collapse of the managed economy, accompanied by a reduction of the Russian GDP by 40%, Russian households reverted to prior consumption patterns as incomes increased. Hence, after the Russian financial crisis in 1998, average Russian per-capita consumption of meat and meat products increased from 46.91 kg in 2000 to 67.79 kg in 2008, with increasing incomes per capita. Thereby the average per-capita intake of meat products in urban areas is considerably higher (71.88 kg yr⁻¹ in 2008) than in rural areas

³ In this context, it is again important to add that there is empirical evidence that as income increases especially urban households increase their expenditure on meat eaten away from home (Bai *et al.* 2013). In this line, Min *et al.* (2015) reported that especially results for meat consumption might be biased by excluding foods eaten away from home.

Table 2 Chinese mean expenditure shares of food groups (%)¹⁾

	1997	2000	2004	2006	2009
Households of urban settlement type					
Food groups					
Carbohydrates	19.1	17.0	18.7	17.3	14.9
Milk and dairy	2.8	3.2	3.2	5.2	6.8
Meat	32.9	31.1	29.2	25.3	27.1
Fish	7.2	7.6	6.7	7.4	6.2
Other proteins	10.1	8.8	9.1	7.5	7.4
Fruits	10.3	10.4	9.1	9.4	9.3
Vegetables	11.9	11.0	9.5	12.1	12.6
Fats and oils	1.5	4.5	2.1	2.5	1.6
Other foods	3.8	6.2	12.0	11.8	13.0
Meat groups					
Beef	7.9	8.8	7.2	8.6	6.1
Poultry	15.8	14.5	18.2	16.3	18.7
Mutton	1.6	2.3	1.0	1.2	1.8
Pork	74.3	73.8	73.0	73.6	73.1
Other meat	0.3	0.6	0.7	0.3	0.3
Households of rural settlement type					
Food groups					
Carbohydrates	24.3	24.5	23.3	22.2	18.7
Milk and dairy	0.5	1.4	1.0	2.5	3.4
Meat	23.6	22.5	21.7	20.1	22.7
Fish	6.6	5.8	4.6	4.9	4.4
Other proteins	15.5	14.5	12.2	10.0	9.5
Fruits	10.9	11.5	9.7	9.9	10.2
Vegetables	14.0	12.5	11.4	12.8	13.0
Fats and oils	0.2	0.6	0.8	0.8	0.8
Other foods	4.1	6.6	15.2	15.7	16.1
Meat groups					
Beef	6.1	4.8	7.7	6.0	3.4
Poultry	15.5	14.5	14.4	12.5	14.7
Mutton	1.4	1.1	2.1	0.9	0.9
Pork	76.4	79.0	75.4	80.1	81.0
Other meat	0.7	0.5	0.5	0.5	0.0

¹⁾Source: authors' calculations based on CHNS (1997–2009).

(55.00 kg yr⁻¹ in 2008). This is in line with Liefert (2004), who states that Russians consider a heavy intake of livestock products as necessary for a healthy diet.

Furthermore, per-capita consumption of carbohydrates decreased from 230 to 175 kg in urban areas, and from 272 to 230 kg in rural areas from 1996 to 2008. The average intake of fruits and vegetables is higher in urban than in rural areas, which might be due to increased food availability and the fact that even the urban population generally possesses a dacha (private garden plot) to grow their own fruits and vegetables. Over time, fruit intake increased in both rural (from 26.58 to 38.95 kg) and urban (44.31 to 50.75 kg) areas, while the consumption of vegetables decreased from 72.6 to 58.4 kg in urban households, and from 64.1 to 59.9 kg in rural households, respectively. Yet after the financial crisis in 1998, the sum of fruit and vegetable consumption increased both in urban as well as rural areas until 2008. Compared to Chinese per-capita consumption, the average per-capita

consumption of fruits is significantly higher in Russia than in China, while the opposite is true for vegetables. Compared to the United States or many European countries, we find a comparatively low consumption level of fruits and vegetables, which is in line with results of Paalanen *et al.* (2011). This might be due to the difficulty of growing fruits and vegetables in the Russian climate (Brainerd and Cutler 2005).

Average per-capita meat consumption (67.79 kg in 2008) is noticeably higher in Russia than in China (28.29 kg in 2009). The difference between actual meat intakes in China and Russia is also reflected in the difference between officially recommended meat intakes for these two countries. Official Chinese sources suggest a per-capita intake of 18.3–36.5 kg yr⁻¹ (Yang 2005). In contrast, the Ministry of Health and Social Development of the Russian Federation (2010) recommends a per-capita consumption of 70–75 kg meat and meat products per year. The suggested minimum meat consumption for adults lies between 54 and

Table 3 Russian average per-capita food consumption by food groups (kg yr⁻¹)¹⁾

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Households of urban settlement type											
Food groups											
Carbohydrates	230.0	215.8	229.1	234.3	221.9	207.9	209.7	195.1	187.4	186.2	176.9
Milk and dairy	78.5	79.7	80.0	84.3	88.0	89.4	91.3	92.1	92.7	90.5	92.9
Meat	65.2	51.8	51.7	56.0	64.8	65.8	65.5	65.9	67.0	71.8	71.9
Fish	9.6	7.9	8.9	9.7	9.8	10.1	10.7	10.4	10.9	11.3	11.7
Other proteins	18.1	15.5	16.9	17.9	17.2	17.5	16.9	17.3	17.1	17.3	17.3
Fruits	44.3	23.9	47.9	46.7	49.7	56.2	53.3	49.2	51.6	51.5	50.8
Vegetables	72.6	53.5	67.5	71.1	65.3	63.7	64.6	63.2	62.1	55.6	58.4
Fats and oils	17.8	15.8	17.7	17.7	17.2	15.7	15.2	15.1	13.9	14.7	13.8
Other foods	13.2	12.5	17.1	21.2	22.0	23.7	23.2	22.9	25.1	23.5	22.0
Meat groups											
Beef	18.5	17.8	10.6	10.9	12.9	13.9	12.0	11.9	11.5	13.4	12.8
Pork	25.5	22.3	21.7	20.6	27.2	27.0	23.7	25.1	24.1	26.9	24.6
Poultry	15.9	9.0	11.7	15.6	17.3	15.8	19.1	18.3	21.1	22.1	23.6
Other meat	11.9	9.3	9.6	11.4	12.4	14.1	13.7	13.3	13.2	13.4	15.8
Households of rural settlement type											
Food groups											
Carbohydrates	271.6	261.8	252.1	273.3	249.5	245.0	260.1	249.7	235.1	227.6	229.6
Milk and dairy	95.0	94.7	101.3	104.6	103.9	103.5	86.6	86.6	88.6	83.2	84.9
Meat	44.7	31.9	33.8	37.0	40.8	42.4	44.6	45.3	50.5	56.7	55.0
Fish	5.6	4.5	6.0	6.0	6.9	7.7	8.3	9.1	9.2	9.4	11.4
Other proteins	11.6	9.9	11.4	12.4	12.1	11.9	11.4	13.3	12.6	14.1	14.2
Fruits	26.6	17.5	28.7	28.1	28.4	28.6	32.7	34.1	33.7	40.4	39.0
Vegetables	64.1	65.1	59.3	59.2	53.6	55.2	58.3	59.1	54.1	54.8	53.0
Fats and oils	12.9	8.8	13.2	14.8	14.3	14.2	15.2	15.3	13.5	15.0	13.6
Other foods	9.5	10.1	18.1	19.6	18.9	18.6	18.8	19.1	19.9	18.6	19.6
Meat groups											
Beef	8.8	10.1	4.7	4.3	6.0	4.3	4.9	5.1	3.9	6.9	6.6
Pork	26.3	22.5	20.9	20.8	23.3	28.0	23.1	23.6	26.7	30.3	31.5
Poultry	8.3	4.0	6.1	8.5	8.2	8.9	11.3	12.1	16.2	14.8	15.4
Other meat	3.4	3.5	3.5	4.9	4.3	5.0	6.8	6.0	6.8	7.9	8.1

¹⁾ Considering total household consumption data and household production of food items. Source: authors' calculations based on Russia Longitudinal Monitoring Survey (RLMS-HSE 1996–2008).

70.4 kg yr⁻¹, depending on the geographical area in Russia (Government of the Russian Federation 2013). Russian recommendations not only exceed Chinese recommendations, but also nutritional intake recommendations given in the United States or Germany. For comparison, U.S. dietary guidelines recommend a maximum per-capita intake of 62 kg yr⁻¹, while in Germany, an annual maximum meat intake of about 31.3 kg per capita is recommended (German Nutrition Society 2013). The World Cancer Research Fund advises that the consumption of meat, especially processed meat, should not exceed 26 kg yr⁻¹. This recommendation is based on the evidence that high intake levels of processed meat, i.e., meats preserved by smoking, curing, or salting, or through the addition of chemical preservatives, increases the risk of colon cancer (World Cancer Research Fund & American Institute for Cancer Research 2007). Although

the intake of red meat is expected to prevent iron deficiency, frequent meat consumption, especially of processed meat, is assumed to not only be associated with an increased risk for colorectal cancer, but also with cardiovascular diseases, diabetes, and chronic kidney diseases (World Cancer Research Fund & American Institute for Cancer Research 2007; Choi and Kim 2014; Savva and Kafatos 2014; Tárrega López *et al.* 2014; Marckmann *et al.* 2015)⁴.

Fig. 2 illustrates that Russians consume more unprocessed meat than processed meats, with higher consumed amounts of unprocessed and processed meat in urban areas. Considering the groups of unprocessed meat in Table 3, Russian households consume mainly pork and poultry, with higher intake rates of pork in rural areas. Beef intake declined over time in both urban and rural areas, possibly due to the strong decline in beef production in

⁴ Further, evidence suggests that even in diets with little consumption of white or red meat, iron status may not be adversely affected (Savva and Kafatos 2014).

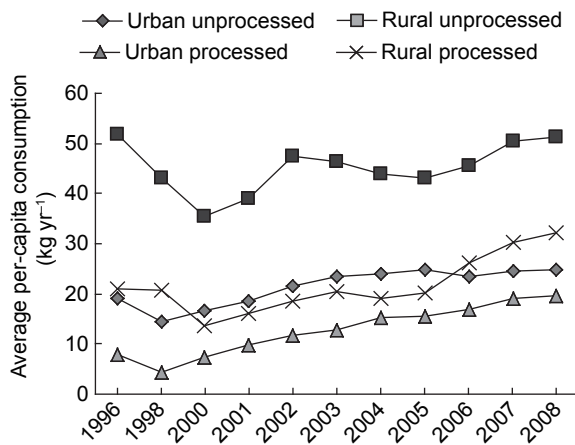


Fig. 2 Per-capita consumption of unprocessed and processed meat in Russia. Source: authors' calculations based on RLMS-HSE (1996–2008).

Russia after the breakdown of the Soviet Union.

Similar to China, the absolute quantitative changes in dietary patterns illustrated in Table 3 indicate an ongoing nutrition transition in Russia. Absolute consumption data is also mirrored in the development of expenditure shares over the observed time period (Table 4). The expenditure shares of animal protein sources increased, while the expenditure shares of carbohydrate consumption decreased over the observed time period.

4. Empirical analysis

To analyze trends in expenditure and price elasticity of food demand, we apply the QUAIDS of Banks *et al.* (1997). The QUAIDS provides more flexibility than the standard Linear Approximation Almost Ideal Demand System (LA/AIDS) of

Table 4 Russian expenditure shares of food groups (%)¹⁾

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Households of urban settlement type											
Food groups											
Carbohydrates	28.5	26.0	28.2	24.6	23.0	22.9	23.1	21.2	21.0	20.7	21.8
Milk and dairy	11.0	11.3	11.1	12.3	12.7	12.8	12.9	13.8	14.3	14.7	14.8
Meat	30.5	29.5	30.2	32.3	34.6	34.3	34.8	37.1	36.7	36.6	36.0
Fish	3.5	3.2	3.2	3.4	3.3	3.4	3.5	3.3	3.4	3.2	2.9
Other proteins	4.1	4.6	4.3	3.9	3.7	3.7	3.8	3.4	3.4	3.9	3.9
Fruits	5.1	4.3	5.0	5.6	5.5	6.8	6.5	6.6	6.8	6.7	7.2
Vegetables	4.4	2.7	3.0	3.3	3.2	2.8	2.7	2.6	2.5	2.1	1.9
Fats and oils	7.2	11.2	7.7	7.0	6.9	6.2	5.7	5.3	4.7	5.8	5.5
Other foods	5.8	7.3	7.3	7.5	7.2	7.2	7.0	6.7	7.2	6.4	5.9
Meat groups											
Beef	26.0	27.9	21.8	21.4	20.9	21.0	20.2	21.4	20.6	22.5	21.3
Pork	43.6	43.3	46.2	43.4	47.0	45.2	43.8	44.3	44.1	44.9	42.9
Poultry	16.7	14.1	17.5	19.1	17.9	18.1	19.6	19.6	19.9	19.4	20.2
Other meat	13.7	14.8	14.5	16.1	14.3	15.8	16.4	14.7	15.4	13.2	15.6
Households of rural settlement type											
Food groups											
Carbohydrates	54.3	52.5	49.4	46.6	40.1	41.5	40.8	35.8	32.9	31.5	32.7
Milk and dairy	5.4	5.0	5.2	5.3	7.0	7.3	7.6	8.6	9.0	9.8	10.0
Meat	18.4	17.1	18.7	21.3	24.0	23.6	25.2	28.2	31.5	31.6	30.8
Fish	3.0	2.6	3.6	3.3	3.9	3.8	3.9	4.1	4.0	3.5	3.6
Other proteins	0.8	1.5	1.8	1.7	1.8	1.8	1.8	2.2	2.3	2.7	2.4
Fruits	1.8	1.7	2.7	3.5	4.3	4.1	4.4	4.8	5.5	5.9	6.3
Vegetables	1.1	0.3	0.7	0.8	1.2	1.0	1.2	1.1	1.0	0.8	0.7
Fats and oils	8.7	10.9	9.2	8.8	9.4	8.7	8.3	7.8	6.5	7.5	7.4
Other foods	6.6	8.5	8.8	8.8	8.4	8.2	6.9	7.5	7.3	6.8	6.2
Meat groups											
Beef	37.0	41.0	29.5	20.9	25.9	15.9	17.9	19.3	10.5	19.6	16.3
Pork	44.5	38.1	48.9	48.3	51.2	60.4	49.8	51.7	57.7	54.5	56.2
Poultry	9.9	7.2	9.1	14.8	11.6	11.3	15.0	15.2	18.5	15.4	15.6
Other meat	8.6	13.7	12.6	15.9	11.3	12.3	17.3	13.9	13.3	10.5	12.0

¹⁾ Considering total of household consumption data and household production of food items. Source: authors' calculations based on RLMS-HSE (1996–2008).

Deaton and Muellbauer (1980). QUAIDS allows expenditure share Engel curves that are quadratic in the logarithm of expenditures. Similar to the LA/AIDS model, the QUAIDS is derived as a generalization of the price-independent generalized logarithmic (PIGLOG) demand system. Demographic scaling used in this study is based on the work of Ray (1985) and Poi (2002, 2012). For more details on the estimation model see Appendix A. Based on the assumption of weak separability of preferences and an aggregation of products based on similar nutrient compositions, we employ a three-stage budgeting model according to Deaton and Muellbauer (1980).

4.1. Estimation procedure and elasticity calculation

Expenditure elasticities are estimated by iterated feasible generalized nonlinear least squares *via* STATA 13. In the first stage, the model reproduces the allocation of total expenditure on foods and non-foods. Due to missing Chinese consumption data of non-foods, we estimate the first stage food elasticities by a single OLS equation. Our first stage regression of food at home demand in Chinese rural and urban areas is based on income data, reduced by savings rate, while our first stage estimation of the Russian demand for food consumed at home is based on total expenditures considering, next to food consumed at home, food away from home (FAFH), housing, utilities, hygiene, education and other non-food goods such as clothes. At the second stage, we distinguish between nine food aggregates of food at home consumption: (i) carbohydrates; (ii) milk and dairy products; (iii) meat and meat products; (iv) fish; (v) eggs and other protein sources; (vi) fruits; (vii) vegetables; (viii) oils and fat; and (ix) other foods⁵. In the third stage, we distinguish between four meat aggregates: (i) beef; (ii) pork; (iii) poultry; and (iv) mutton. The problem of zero observations is controlled for by applying the consistent generalized Heckman procedure (Tauchman 2010)⁶. In order to provide unconditional expenditure and price elasticities for the second stage, we follow Carpentier and Guyomard (2001). For the third stage meat aggregates, we follow Bouamra-Mechemache *et al.* (2008) who extended the above discussed formula of Carpentier and Guyomard for a three-stage budget allocation problem.

We evaluate expenditure, own-price and cross-price elasticities at sample means. Thereby, expenditure elasticities of food and meat aggregates are taken as indicators to measure the effect of expenditure growth on food demand in both China and Russia. Through demographic scaling, we control for five socio-demographic variables: land use, household size, number of children aged 0–14, settlement type, and geographic region. We do not include a time trend variable since we are particularly interested in changes over time.

4.2. Empirical results

We first provide unconditional expenditure elasticities for our nine food aggregates and five meat aggregates. To analyze changes over time, we provide yearly demand elasticities for each of the food and meat aggregates. Subsequently, we present the calculated own-price elasticities, again on a yearly basis. Due to a mixture of different foods in the 'other food' aggregate, we will not discuss the results concerning this food aggregate.

As presented in Tables 5 and 6, our estimates of the Russian and Chinese expenditure elasticities for our food aggregates are all plausible, considering the magnitude, order and relative magnitude among the nine food aggregates with considerably higher food expenditure elasticities in rural areas (Appendix B). All food aggregates in both countries are positive and normal goods, meaning that demand increases (decreases) with increasing (decreasing) expenditure and constant prices. Products of basic demand such as fats and carbohydrates, including cereals and potatoes, or other proteins sources (consisting *inter alia* of soy beans and tofu products) have the lowest expenditure elasticities. In both countries, the highest elasticities can be found for the meat and fish groups. The expenditure elasticities of the different meat products vary considerably, with the lowest elasticity for pork in Russia and for poultry in China. On the other hand, beef and mutton exhibit relatively high expenditure elasticities, especially in rural areas. As mentioned, the 'other meat' group is hardly comparable between the two countries for their different composition.

Compared with the results of other studies on Chinese

⁵ We will not interpret our results of the 'other foods' and the 'other meats' aggregates since these groups' compositions are not consistent across both countries.

⁶ Shonkwiler and Yen (1999) pointed out that the generalized Heckman procedure by Heien and Wessells (1990) is inconsistent and propose an alternative consistent estimation procedure. Tauchmann (2005) compared the performance of Shonkwiler and Yen estimators and Heckman estimators according to their mean squared deviation of the estimated conditional mean from its true counterpart. Tauchmann showed that given certain parameter constellations, the Shonkwiler and Yen estimators perform quite poorly. Based on the critiques of Shonkwiler and Yen (1999) and Tauchmann (2005), Tauchmann (2010) introduced a consistent generalized Heckman estimator.

Table 5 Unconditional expenditure elasticities of Chinese households (1997–2009)¹⁾

	1997	2000	2004	2006	2009
First stage OLS estimation					
Food	0.63	0.75	0.78	0.68	0.73
Second stage QUAIDS estimation					
Carbohydrates	0.50	0.51	0.57	0.42	0.50
Milk and dairy	0.90	1.00	1.15	0.97	1.05
Meat	0.98	1.07	1.10	1.22	1.00
Fish	0.93	1.44	1.12	0.87	1.22
Other proteins	0.40	0.46	0.64	0.54	0.48
Fruits ²⁾			0.59	0.60	0.58
Vegetables	0.46	0.59	0.60	0.53	0.53
Fat and Oils	0.99	1.19	0.80	0.65	0.54
Other foods	0.50	0.51	0.57	0.42	0.50
Third stage QUAIDS estimation					
Beef	0.79	1.03	1.05	1.13	1.04
Pork	0.97	1.07	1.03	0.93	0.88
Mutton	0.56	1.36	1.05	1.14	1.64
Poultry	0.58	0.68	0.72	0.61	0.67
Observations	3 173	3 557	3 334	3 033	3 064

¹⁾ Source: CHNS (1997–2009). The category "other meat" was not included in Chinese analysis due to this food's low consumption share among the meat aggregate (less than 1%). The same as in Table 7.

²⁾ Price data on fruits for 1997 and 2000 are missing in the CHNS. Therefore, we aggregated fruits and vegetables in 1997 and 2000 in the vegetables group. The same as in Table 7.

All numbers significant at the 5%-level are printed in bold letters. The same as below.

Table 6 Unconditional expenditure elasticities of Russian households (1996–2008)¹⁾

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
First stage OLS estimation											
Food	0.99	1.01	0.94	0.95	0.92	0.90	0.83	0.85	0.84	0.85	0.78
Second stage QUAIDS estimation											
Carbohydrates	0.70	0.66	0.79	0.78	0.70	0.70	0.63	0.61	0.68	0.53	0.48
Milk and dairy	0.81	0.67	0.91	0.88	0.79	0.74	0.66	0.69	0.71	0.81	0.79
Meat	1.20	1.30	1.04	1.19	1.17	1.10	1.08	1.10	0.95	1.06	0.95
Fish	1.36	1.51	1.06	1.01	1.13	1.03	1.02	1.03	0.91	1.00	0.95
Other proteins	1.34	1.37	1.12	0.92	0.84	0.87	0.86	0.85	0.82	0.87	0.83
Fruits	1.28	1.33	0.99	1.15	1.06	1.11	0.87	0.90	1.12	1.09	0.89
Vegetables	1.35	1.22	1.20	1.04	0.98	1.03	1.02	1.05	0.96	1.04	0.77
Fats and oils	1.05	1.45	1.08	0.87	0.86	0.84	0.74	0.74	0.85	0.61	0.73
Other foods	1.60	1.32	1.03	0.99	1.05	1.05	0.85	0.84	0.89	0.94	0.93
Third stage QUAIDS estimation											
Beef	1.47	1.82	1.62	1.83	1.76	1.63	1.43	1.85	1.49	1.48	1.33
Pork	1.27	1.10	0.84	1.02	1.11	0.95	0.95	0.97	0.88	0.96	0.88
Poultry	0.98	1.49	1.27	1.25	1.14	1.19	1.15	1.13	0.86	1.07	0.93
Other meat	0.92	1.00	0.86	1.09	0.88	1.05	1.09	0.87	0.90	1.00	0.93
Observations	3 397	3 497	3 723	4 221	4 371	4 400	4 412	4 234	5 119	5 094	4 956

¹⁾ The category "mutton" was not included in Russian analysis due to this food's low consumption share among the meat aggregate (less than 5%). Source: RLMS-HSE (1996–2008). The same as in Table 8.

food demand (Huang and Rozelle 1998; Gould 2002; Yen *et al.* 2004; Gould and Villarreal 2006; Dong and Gould 2007; Gale and Huang 2007; Liao and Chern 2007; Zheng and Henneberry 2009; Zhou *et al.* 2015), we find that meat, fish and dairy products exhibit the highest expenditure elasticities, which is in line with the majority of the comparison studies indicating dairy products as having the highest expenditure elasticities (Table 9 in Appendix B). Our Russian

expenditure elasticities are fairly comparable to the Russian food demand estimations of Elsner (1999) for 1996 and Muhammad *et al.* (2011) for 2005. However, while Elsner (1999) shows unconditional meat expenditure elasticities of 0.77 and unconditional dairy expenditure elasticities of 1.10 for 1996, in our study meat and meat products have higher expenditure elasticity than dairy products. This means that in our study, Russians tend to consider meat

and meat products more luxury than dairy products. This is in line with our expectations and the results of Staudigel and Schröck (2014), who indicate meat as the food product with the highest expenditure elasticity (unconditional meat expenditure elasticity 1.16; dairy 0.80 for 1995–2010). Our results are also in line with the results of other studies on BRIC countries. For example, in their study on food consumption in Brazil (2002/2003), Coelho *et al.* (2010) find expenditure elasticities of beef and pork between 1.13 and 1.00. These authors estimate the expenditure elasticity for fluid milk of 0.83. Further, for Indian food demand between 1983 and 2000, Mittal (2006) estimates expenditure elasticities of 1.30 for meat, fish and eggs, and an expenditure elasticity of 1.19 for fluid milk.

Comparing our Chinese results with the Russian results, we can state that while the relative order for the food aggregates is very similar for both countries, the magnitude of expenditure elasticities is not equivalent. Following Muhammad *et al.* (2011), we expect expenditure elasticities to be higher in countries with lower average income, apart from carbohydrates. Indeed, in 2008 all food aggregates in Russia are necessity goods with unconditional expenditure elasticity below 1. In China, meat, fish and dairy products are still luxury products in 2009. For these three product groups, we derive expenditure elasticities slightly larger than one, meaning that the demand for these food items increases disproportionately with rising household expenditure. In 2008/2009 all meat products have become necessity goods, except for beef in Russia and beef and mutton in China.

Analyzing the trend over the considered period, we can state the following points. First, for Russia, expenditure

elasticities decreased for all groups. Second, in the meat group, expenditure elasticities fell for pork, and increased for poultry, mutton and beef in China. In Russia, meat expenditure elasticities decreased for all meat products. These results underscore the transformation of pork and poultry into a necessity good, whereas beef is still a luxury good in both countries.

Tables 7 and 8 show the uncompensated own-price elasticities, which are calculated as unconditional elasticities. In general, the own-price elasticities in absolute values are lower for China than Russia. Further, overall meat price elasticities do not suggest a trend in Russia, except for beef. Beef price elasticities fell from -2.36 in 1996 to -1.10 in 2007. In China, we can make out a clearer trend: Ignoring insignificant observations, the price elasticity of all meat and dairy products in China fell over the considered time period. The large difference in own-price elasticity for pork between the two countries is striking. While in China pork demand is price-inelastic, pork demand in Russia—same as the other meat aggregates—is highly price-elastic.

For vegetables and carbohydrates, we could not identify a clear up- or downward trend in China. Demand for these two food groups remained rather inelastic in China. For carbohydrates, fruits, fats and oils, and other foods, price elasticities are higher in rural than in urban China. In this line, we also find higher food aggregate price elasticities in absolute values for rural Russian households compared to urban households (Appendix B). Meat products and fats have the highest own-price elasticity in absolute terms in Russia in 2008. Considering the unconditional meat price elasticities in absolute values, all meat products are relatively price elastic, with higher price elasticities for beef

Table 7 Unconditional price elasticities of Chinese households¹⁾

	1997	2000	2004	2006	2009
First stage OLS estimation					
Food	-0.63	-0.65	-0.68	-0.58	-0.63
Second stage QUAIDS estimation					
Carbohydrates	-0.37	-0.11	-0.37	-0.24	-0.35
Milk and dairy	-1.33	-1.18	-0.47	-0.62	-0.69
Meat	-0.63	-0.50	-0.72	-0.20	-0.31
Fish	-0.27	-0.21	-0.10	-0.03	-0.31
Other proteins	-0.46	-0.39	-0.61	-0.47	-0.66
Fruits			-0.10	-0.07	-0.09
Vegetables	-0.34	-0.20	-0.34	-0.22	-0.25
Fat and Oils	-0.02	-0.10	-0.13	-0.02	-0.36
Other foods	-0.10	-0.50	-0.47	-0.63	-0.57
Third stage QUAIDS estimation					
Beef	-1.30	-0.71	-1.57	-0.84	-0.19
Pork	-0.59	-0.09	-0.35	-0.15	-0.22
Mutton	-0.54	-1.71	-1.38	-0.20	-0.95
Poultry	-1.66	-0.72	-0.47	-0.59	-0.97
Observations	3 173	3 557	3 334	3 033	3 064

Table 8 Unconditional price elasticities of Russian households

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
First stage OLS estimation											
Food	-0.72	-0.75	-0.64	-0.64	-0.60	-0.58	-0.53	-0.54	-0.53	-0.52	-0.47
Second stage QUAIDS estimation											
Carbohydrates	-1.10	-1.21	-1.21	-1.10	-1.19	-1.02	-0.93	-0.99	-1.15	-1.07	-1.00
Milk and dairy	-0.96	-1.26	-0.90	-0.77	-1.10	-0.86	-1.17	-0.95	-1.06	-0.93	-1.10
Meat	-1.44	-1.42	-1.51	-1.33	-1.27	-1.19	-1.43	-1.46	-1.43	-1.42	-1.01
Fish	-1.12	-0.84	-1.35	-1.62	-1.14	-0.81	-1.23	-1.13	-1.35	-1.23	-0.83
Other proteins	-0.53	-0.70	-0.38	-0.91	-0.72	-0.90	-0.74	-1.01	-0.94	-0.86	-0.59
Fruits	-1.28	-1.53	-1.32	-0.91	-0.98	-1.29	-0.89	-0.83	-0.90	-1.26	-0.98
Vegetables	-1.26	-1.26	-0.54	-1.10	-0.59	-0.91	-1.00	-1.14	-1.05	-1.30	-1.28
Fats and oils	-0.96	-1.74	-1.21	-1.02	-0.68	-1.01	-0.75	-0.99	-0.90	-1.06	-1.18
Other foods	-1.02	-1.00	-1.03	-1.15	-1.20	-1.27	-1.38	-1.19	-1.15	-1.07	-1.04
Third stage QUAIDS estimation											
Beef	-2.36	-1.89	-0.63	-1.47	-1.45	-1.47	-1.16	-1.37	-1.17	-1.10	-0.56
Pork	-1.97	-1.60	-2.28	-1.84	-1.58	-1.64	-1.69	-2.05	-1.98	-1.89	-1.92
Poultry	-1.75	-2.88	-2.39	-2.11	-1.84	-1.71	-1.84	-1.08	-1.35	-1.79	-1.18
Other meat	-1.41	-2.01	-1.66	-1.74	-1.58	-1.24	-1.07	-1.19	-1.43	-1.58	-1.79
Observations	3397	3497	3723	4221	4371	4400	4412	4234	5119	5094	4956

and poultry in rural areas. Between the financial crisis in 1998 and the food crisis in 2007/2008, our calculated cross-price elasticities are considerably low and often not significantly different from zero. Further, the demand for fruits and vegetables is based on substitutional effects between these two food aggregates. This allows Russian consumers to switch, for example, to vegetables as soon as fruit prices rise. However, it is interesting to note that a complementary association exists between the demand for meats and fats.

Our calculated own-price elasticities for meat in China are similar to the estimates reported by other studies in China (Huang and Rozelle 1998; Gould 2002; Yen *et al.* 2004; Gould and Villarreal 2006; Dong and Gould 2007; Liao and Chern 2007; Zheng and Henneberry 2009; Zhou *et al.* 2015). However, own-price elasticities for other foods are smaller in absolute value compared to those reported by past studies, which might be explained by the open definition of this composite. Considering the first stage, our estimated own-price elasticities in Russia are similar to those of Muhammad *et al.* (2011), but considerably lower than those of Staudigel and Schroeck (2014). Compared to the Russian own price elasticities estimated by Elsner (1999) for the year 1996, our unconditional food aggregates and own price elasticities for the nine food aggregates for 1996 are fairly comparable. However, we indicate vegetables, meat products, and fats to be more price elastic than other food

aggregates. In contrast, Elsner (1999) and Muhammad *et al.* (2011) found dairy products to be more price elastic than meat products in Russia. Further, in their study of Russian food demand, Staudigel and Schroeck (2014) show that between 1995 and 2010, cereals are the most price elastic (-1.27), followed by fats and oils (-0.99)⁷. But comparing our own-price elasticities with results of studies for other BRIC countries, our Russian and Chinese own price elasticities are in line with the estimations of Coelho *et al.* (2010) for Brazil⁸. For a comparison with other studies see Table 10 in Appendix B.

However, we have to assume that our Chinese results are somewhat down-biased in absolute values by the fact that we could not include FAFH consumption. This is in accordance with Zhou *et al.* (2015) who find considerably higher absolute long-run price and expenditure elasticities for FAFH compared to foods consumed at home. Further evidence is given by Bai *et al.* (2013) who report that, especially for meat products, consumption away from home is more responsive to price changes than consumption at home (see also Min *et al.* (2015) for the impact of demographic structure and population aging on meat consumption at home and away from home). For Russia, Staudigel and Schroeck (2014) show that the unconditional expenditure elasticities as well as the unconditional uncompensated own-price elasticities for foods consumed at home and foods consumed away from home are nearly identical.

⁷ However, the studies of Elsner (1999) as well as Staudigel and Schroeck (2014) estimate a LA/AIDS system with unit values, while our estimation procedure, using community price data, denies the LA/AIDS since the quadratic term in each expenditure share equation does not drop out.

⁸ See Tables 3–4 and Tables 7–8 in Appendix B on separate own price elasticities for rural and urban areas.

5. Conclusion

Considering the observed period of economic growth, our data implies a nutrition transition taking place in both China and Russia. While the historical nutrition patterns in these countries influence details of this nutrition transition, the consumption of animal products and fruits increased in both countries, whereas the demand for carbohydrates decreased. From this development we might first deduce that the magnitude and speed of dietary changes is indeed influenced by country-specific nutrition characteristics. Second, some fundamental trends like the decrease of carbohydrates and increase of animal products is a development that is typical for nutrition transition and rather independent from prior dietary patterns. Consequently, the prevalence of overweight and obesity, as well as nutrition-related chronic diseases increased.

Given our results concerning the expenditure and price elasticities, it is possible to suggest some insights into the effects of future economic growth on food consumption patterns. Considering our calculated expenditure elasticities, we assume that with rising household expenditures the demand for meat and fish will increase in Russia and China by relatively larger proportions than the other food aggregates. Furthermore, rising expenditures will also have a relatively strong positive effect on fruit and vegetable consumption in both countries. While rising fruit and meat consumption provides a positive signal for problems of malnutrition, e.g., iron deficiencies in rural China, this trend might also increase the incidence of chronic diseases. Nutrition-related chronic diseases in China are still considerably lower than in Russia. However, higher growth rates of the occurrence of overweight or obesity in China suggest an increasing problem with chronic diseases if we assume similar developments to those in Russia. Even though the demand for meat products in general, and especially for beef, is still quite price elastic, we could find evidence for low price elasticity for specific products like fats and oils in China. For these products, especially products with a higher content of saturated fats, taxing would not efficiently decrease the rather unhealthy demand for them. This implies that beyond the potential influence of governmental intervention strategies on household budgets and food prices, governments have to focus on information strategies by increasing nutritional education due to low nutrition literacy in both countries. Analyzing nutrition transition for rural and urban areas separately showed considerable differences of elasticities between urban and rural areas. Future research also needs to address the role of food eaten away from home in the nutrition transition in both countries.

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Appendix associated with this paper can be available on <http://www.ChinaAgriSci.com/V2/En/appendix.htm>

References

- Bai J, Seale Jr. J, Wahl T, Lohmar B. 2013. Meat demand analysis in urban China: To include or not to include meat away from home? In: *Proceedings of The Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting*. 4–6 August 2013. Washington, D.C., http://ageconsearch.umn.edu/bitstream/150403/2/Missing_Meat_Demand_Junfei.pdf
- Banks J, Blundell R, Lewbel A. 1997. Quadratic Engel curves and consumer demand. *The Review of Economics and Statistics*, **79**, 527–539.
- Beydoun M A, Wang Y. 2008. How do socio-economic status, perceived economic barriers and nutritional benefits affect quality of dietary intake among US adults? *European Journal of Clinical Nutrition*, **62**, 303–313.
- Bouamra-Mechemache Z, Réquillart V, Soregaroli C, Trévisiol A. 2008. Demand for dairy products in the EU. *Food Policy*, **33**, 644–656.
- Brainerd E, Cutler D M. 2005. Autopsy on an empire: understanding mortality in Russia and the former Soviet Union. *Journal of Economic Perspectives*, **19**, 107–130.
- Carpentier A, Guyomard H. 2001. Unconditional elasticities in two-stage demand systems: An approximate solution. *American Journal of Agricultural Economics*, **83**, 222–229.
- CHNS. 1997–2009. China Health and Nutrition Survey. [2013-12-01]. <http://www.cpc.unc.edu/projects/china>
- Choi W J, Kim J. 2014. Dietary factors and the risk of thyroid cancer: A review. *Clinical Nutrition Research*, **3**, 75–88.
- Coelho A B, de Aguiar D R D, Eales J S. 2010. Food demand in Brazil: An application of Shonkwiler & Yen Two-Step estimation method. *Estudos Econômicos*, **40**, 185–211.
- Deaton A, Muellbauer J. 1980. An Almost Ideal Demand System. *The American Economic Review*, **70**, 312–326.
- Delgado C L. 2003. Rising consumption of meat and milk in developing countries has created a new food revolution. *The Journal of Nutrition*, **133**, 3907–3910.
- Dellava J E, Bulik C M, Popkin B M. 2010. Price changes alone are not adequate to produce long-term dietary change. *The Journal of Nutrition*, **140**, 1887–1891.
- Dong D, Gould B W. 2007. Product quality and the demand

- for food: The case of urban China. In: Sheldon I, ed., *China's Agricultural Trade: Issues and Prospects, IATRC Conference Proceedings*. July 8–9, 2007. Beijing, China. pp. 249–279.
- Du S, Lu B, Zhai F, Popkin B M. 2002. A new stage of the nutrition transition in China. *Public Health Nutrition*, **5**, 169–174.
- Du S, Wang H J, Zhang B, Zhai F Y, Popkin B M. 2014. China in the period of transition from scarcity and extensive undernutrition to emerging nutrition-related non-communicable diseases, 1949–1992. *Obesity Reviews*, **15**, 8–15.
- Elsner K. 1999. Analysing Russian food expenditure using micro-data. *IAMO Discussion Paper, No. 23*. [2014-09-05]. <http://www.iamo.de/dok/dp23.pdf>
- Feng Z, Shi D. 2006. Chinese food consumption and nourishment in the last 20 years. *Resources Science*, **28**, 2–8. (in Chinese)
- Gale F, Huang K. 2007. *Demand for Food Quantity and Quality in China*. U.S. Department of Agriculture Economic Research Service Report, No. 32. [2007–01-01]. http://www.ers.usda.gov/media/200564/err32fm_1_.pdf
- German Nutrition Society (Deutsche Gesellschaft für Ernährung). 2013. 10 DGE Rules for whole nutrition. [2013-12-01]. <http://www.dge.de/ernaehrungspraxis/vollwertige-ernaehrung/10-regeln-der-dge/> (in German)
- Goodwin H L, Holcomb R B, Shiptsova R. 2002. An evaluation of East Russian household expenditures for non-dairy animal protein sources. *Journal of Food Distribution Research*, **33**, 11–20.
- Gould B W. 2002. Household composition and food expenditures in China. *Agribusiness*, **18**, 387–407.
- Gould B W, Villarreal H J. 2006. An assessment of the current structure of food demand in urban China. *Agricultural Economics*, **34**, 1–16.
- GKS (Russian Government Committee of Statistics). 2011. Russia in figures. [2013-01-10]. http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/ (in Russian)
- Government of the Russian Federation. 2013. *Statement of Methodical Recommendations for Determining the Consumer Basket of Main Socio-Demographic Population Strata in Subjects of The Russian Federation*. Government Regulation of the Russian Federation dated February 28, 2013 No. 54. [2013-02-28]. <http://base.garant.ru/70308360> (in Russian)
- Heien D M, Wessells C R. 1990. Demand systems estimation with microdata: A censored regression approach. *Journal of Business & Economic Statistics*, **8**, 365–371.
- Honkanen P, Voldnes G. 2006. *Russian Consumers' Food Habits: Results from A Qualitative Study in Moscow*. *Fisheriforskning Report, No. 27/2006*. [2006-11-30]. <http://www.nofima.no/publikasjon/30E275080AE38600C1257233003B7CC9>
- Hovhannisyán V, Gould B W. 2011. Quantifying the structure of food demand in China: An econometric approach. *Agricultural Economics*, **42**(Suppl. 1), 1–17.
- Hovhannisyán V, Gould B W. 2014. Structural change in urban Chinese food preferences. *Agricultural Economics*, **45**, 159–166.
- Hu F B, Stampfer M J, Manson J E, Grodstein F, Colditz G A, Speizer F E, Willett W C. 2000. Trends in the incidence of coronary heart disease and changes in diet and lifestyle in women. *The New England Journal of Medicine*, **343**, 530–537.
- Huang J, Rozelle S. 1998. Market development and food demand in rural China. *China Economic Review*, **9**, 25–45.
- Huang K S, Gale F. 2009. Food demand in China: Income, quality, and nutrient effects. *China Agricultural Economic Review*, **1**, 395–409.
- Jahns L, Baturin A, Popkin B M. 2003. Obesity, diet, and poverty: trends in the Russian transition to market economy. *European Journal of Clinical Nutrition*, **57**, 1295–1302.
- Kantha S S. 1990. Nutrition and health in China, 1949 to 1989. *Progress in Food & Nutrition Science*, **14**, 93–137.
- Kelly T, Yang W, Chen C S, Reynolds K, He J. 2008. Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity*, **32**, 1431–1437.
- Lambert R, Larue B, Yélou C, Criner G. 2006. Fish and meat demand in Canada: Regional differences and weak separability. *Agribusiness*, **22**, 175–199.
- Li Z. 2007. Change of Chinese inhabitant's food consumption and nutrition development in the last 50 years. *Resources Science*, **29**, 27–35. (in Chinese)
- Liao H, Chern W S. 2007. A dynamic analysis of food demand patterns in Urban China. In: *Proceedings of the American Agricultural Economics Association Annual Meeting*. 29 July–1 August 2007. Portland, Oregon, USA. <http://ageconsearch.umn.edu/bitstream/9770/1/sp07li09.pdf>
- Liefert W. 2004. Food security in Russia: Economic growth and rising incomes are reducing insecurity. In: *Food Security Assessment, GFA-15*. ERS USDA. pp. 35–43.
- Marckmann P, Osther P, Pedersen A N, Jespersen B. 2015. High-protein diets and renal health. *Journal of Renal Nutrition*, **25**, 1–5.
- Min S, Bai J, Seale Jr. J, Wahl T. 2015. Demographics, societal aging, and meat consumption in China. *Journal of Integrative Agriculture*, **14**, 995–1007.
- Ministry of Health and Social Development of the Russian Federation. 2010. *Decree dated August 2, 2010 No. 593n: On approval of recommendations of regional norms of food consumption, meeting the modern requirements of healthy nutrition*. [2010-08-01]. <http://www.rg.ru/2010/10/15/pitanie-dok.html> (in Russian)
- Mittal S. 2006. Structural shift in demand for food—Projections for 2020. Indian council for research on international economic relations working paper, no. 184. [2010-08-01]. <http://www.eaber.org/node/22223>
- Monteiro C, Mondini L, de Souza A L, Popkin B M. 1995. The nutrition transition in Brazil. *European Journal of Clinical Nutrition*, **49**, 105–113.
- Montonen J, Järvinen R, Heliövaara M, Reunanen A, Aromaa A, Knekt P. 2005. Food consumption and the incidence of type II diabetes mellitus. *European Journal of Clinical*

- Nutrition*, **59**, 441–448.
- Muhammad A, Seale Jr. J L, Meade B, Regmi A. 2011. International evidence on food consumption patterns: an update using 2005 international comparison program data. TB-1929. U.S. Dept. of Agriculture, Econ. Res. Serv. March 2011. [2013-02-27]. <http://www.ers.usda.gov/publications/tb-technical-bulletin/tb1904.aspx#.UukwgrTBNCU>
- NBSC (National Bureau of Statistics of China). 2010. *Rural Households Survey Yearbook of China*. China Statistics Press, Beijing. (in Chinese)
- Paalanen L, Prättälä R, Palosuo H, Laatikainen T. 2011. Socio-economic differences in the consumption of vegetables, fruit and berries in Russian and Finnish Karelia: 1992–2007. *The European Journal of Public Health*, **21**, 35–42.
- Poi B P. 2002. Three essays in applied econometrics. Ph D thesis, Department of Econometrics, University of Michigan, Ann Arbor, USA.
- Poi B P. 2012. Easy demand-system estimation with quads. *Stata Journal*, **12**, 433–446.
- Popkin B M. 2001. The nutrition transition and obesity in the developing world. *The Journal of Nutrition*, **131**, 871–873.
- Popkin B M. 2002. The shift in stages of the nutrition transition in the developing world differs from past experience. *Public Health Nutrition*, **5**, 205–214.
- Popkin B M. 2007. Understanding global nutrition dynamics as a step towards controlling cancer incidence. *Nature Reviews Cancer*, **7**, 61–67.
- Popkin B M. 2008. Will China's nutrition transition overwhelm its health care system and slow economic growth? *Health Affairs*, **27**, 1064–1076.
- Ray R. 1985. Specification and time series estimation of dynamic Gorman polar form demand systems. *European Economic Review*, **27**, 357–374.
- RLMS-HSE. 1996–2008. Russia longitudinal monitoring survey, conducted by Higher School of Economics and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS. [2013-06-04]. <http://www.cpc.unc.edu/projects/rlms-hse>, <http://www.hse.ru/org/hse/rlms>
- Rozelle S, Gibson J, Olivia S. 2006. Evaluating the use of unit values and community prices in demand and food policy analysis. Working paper. [2013-6-1]. http://iis-db.stanford.edu/pubs/21679/Which_are_better_community_prices_or_unit_values.pdf
- Savva S C, Kafatos A. 2014. Is red meat required for the prevention of iron deficiency among children and adolescents? *Current Pediatric Reviews*, **10**, 177–183.
- Sedik D J, Sotnikov S, Wiesmann D. 2003. *Food Security in the Russian Federation*. Food and Agriculture Organization of the United Nations. Rome.
- Shepard T Y, Weil K M, Sharp T A, Grunwald G K, Bell M L, Hill J O, Eckel R H. 2001. Occasional physical inactivity combined with a high-fat diet may be important in the development and maintenance of obesity in human subjects. *The American Journal of Clinical Nutrition*, **73**, 703–708.
- Shonkwiler J S, Yen S T. 1999. Two-step estimation of a censored system of equations. *American Journal of Agricultural Economics*, **81**, 972–982.
- Staudigel M, Schröck R. 2014. Food demand in Russia: heterogeneous consumer segments over time. *Journal of Agricultural Economics*. doi: 10.1111/1477-9552.12102.
- Tárraga López P J, Albero J S, Rodríguez-Montes J A. 2014. Primary and secondary prevention of colorectal cancer. *Clinical Medicine Insights: Gastroenterology*, **7**, 33–46.
- Tauchmann H. 2005. Efficiency of two-step estimators for censored systems of equations: Shonkwiler and Yen reconsidered. *Applied Economics*, **37**, 367–374.
- Tauchmann H. 2010. Consistency of Heckman-type two-step estimators for the multivariate sample-selection model. *Applied Economics*, **42**, 3895–3902.
- Tian X, Yu X. 2013. The demand for nutrients in China. *Frontiers of Economics in China*, **8**, 186–206.
- United Nations. 2014. *World Urbanization Prospects: The 2014 Revision*. United Nations Publications. New York.
- Wang J, Chen Y, Zheng Z, Si W. 2014. Determinants of pork demand by income class in urban western China. *China Agricultural Economic Review*, **6**, 452–469.
- World Bank. 2014. *World DataBank*. [2014-11-20]. <http://databank.worldbank.org/data/home.aspx>
- World Cancer Research Fund & American Institute for Cancer Research. 2007. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global Perspective*. AICR, Washington, D.C.
- World Health Organization. 2014. WHO fact sheet 310: The top ten causes of death. [2014-05-01]. <http://www.who.int/mediacentre/factsheets/fs310/en/>
- Yang Y. 2005. *China Food Composition Table (2004)*. Beijing Medical University Press, Beijing. (in Chinese)
- Yen S T, Fang C, Su S-J. 2004. Household food demand in urban China: A censored system approach. *Journal of Comparative Economics*, **32**, 564–585.
- Zhai F, He Y, Ma G, Li Y, Wang Z, Hu Y, Zhao L, Cui Z, Li Y, Yang X. 2005. Study on the current status and trend of food consumption among Chinese population. *Chinese Journal of Epidemiology*, **26**, 485–488. (in Chinese)
- Zheng Z, Henneberry S R. 2009. An analysis of food demand in China: A case study of urban households in Jiangsu Province. *Review of Agricultural Economics*, **31**, 873–893.
- Zhou D, Yu X, Herzfeld T. 2015. Dynamic food demand in urban China. *China Agricultural Economic Review*, **7**, 27–44.