Nutrition transition in two emerging countries: A comparison between China and Russia

Christine Burggraf [1], Lena Kuhn [1], Qiran Zhao [1, 2], Ramona Teuber [1], Thomas Glauben [1]

[1] Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 06120, Halle, Germany
[2] College of Economics and Management, China Agricultural University, Beijing 100083, P.R. China

Abstract: This study provides empirical evidence on the link between economic growth, nutrition, and health 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. Thereby, the higher growth rate of the occurrence of obesity in China suggests a certain catching-up effect and tremendously increasing problems with chronic diseases in the longer run, especially in urban areas of China. Further, 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. Finally, our estimation results of a Quadratic Almost Ideal Demand System (QUAIDS) underscore the finding that income growth in China and Russia tends to increase the demand for animal-based products much stronger than the demand for carbohydrates.

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

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; Popkin 2007; Shepard et al. 2001), 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; Liao and Chern 2007; Gale and Huang 2007; Huang and Gale 2009; Zheng and Henneberry 2009; Hovhannisyan and Gould 2011; Hovhannisyan and Gould 2014; Zhou et al. 2015; Wang et al. 2014), 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 experienced 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 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 40.1 for Russia and 42.1 for China in 2009.[1] 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). 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. Therefore, 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). Moreover, considering the strong rural-urban nexus in both countries, we also display results for urban and rural areas separately.

The remainder of this paper is structured as follows. In section two, we describe the two employed data sets. Section three discusses recent trends in nutrition-related health outcomes. Section four includes a descriptive analysis of food consumption trends. In section five we present the estimation procedure and our empirical results. We conclude in section six.

[1] http://data.worldbank.org/indicator/SI.POV.GINI.

2 Data

For our descriptive and empirical analysis, we use data from the Chinese Health and Nutrition Survey (CHNS; see CHNS 1989–2009) and the Russia Longitudinal Monitoring Survey (RLMS-HSE; see RLMS-HSE 1996–2008). Both the CHNS and the RLMS-HSE are primarily organized and coordinated by the Carolina Population Centre. Both data sets provide a wide range of information on socioeconomic characteristics, food expenditures, and food production at 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 (Government Committee of Statistics 2011) or 2009 data from the National Bureau of Statistics China (NBS; National Bureau of Statistics 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 year.[2] This underscores the representativeness of the RLMS-HSE and CHNS food consumption data. According to Rozelle et al. (2006), we base our estimations on community prices instead of unit vales. 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 is collected between August and December. However, the survey rounds

[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).

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 is 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 Health and health expenditures

Although parts of the Chinese society are still affected by malnutrition (see e.g., Wang 2005), in this study we focus on the growing prevalence of obesity and chronic diseases during nutrition transition.[3] Several studies attest an increasing prevalence of obesity and chronic diseases in both countries (Kalichman et al. 2006; Wu 2006; Wang et al. 2007; Abegunde and Stanciole 2008; Nugent 2008; Yang et al. 2008). According to the WHO (2015), obesity is expected to rise at an alarming rate, which is described as one of the greatest public health challenges of the 21st century. Therefore, this section gives an overall view of the current situation and trends regarding obesity and other diet-related chronic diseases in China and Russia, considering differences between rural and urban areas.

In Russia, more than 50% of the population can be considered overweight or obese, with obesity prevalence rising from 19.67 % in 1996 to 21.93 % in 2008 (see Figure 1). Furthermore, Figure 1 shows that in 2000/2001, i.e. shortly after the year of a stark economic crisis in 1998, the prevalence of overweight or obesity was lower compared to the time periods before and thereafter. During this period of tremendous economic stress, a large reduction in the energy density of the average Russian diet occurred (Wang et al. 2002). This reduced energy density of the average Russian diet resulted in a lagged lowering of overweight and obesity occurrence. These findings are in accordance with the results of Stillman and Thomas (2008), who state that transitory changes in expenditures are positively and significantly associated with total caloric intake and fat intake, as well as a (delayed) adult BMI. Additionally, Figure 2 shows that even though obesity rates are still considerably low in China, there is a rapid shift towards increased obesity among the Chinese population, which is in line with the findings of Popkin (2001) and Du et al. (2002). According to our data, Chinese obesity prevalence increased from 0.19% in 1997 to 4.01% in 2011. Furthermore, our data suggests that obesity in China was higher in urban than in rural areas, while in Russia it was lower in urban areas compared to rural areas (2011 and 2008, respectively).

[3] The World Health Organization (2013) defines overweight as an BMI>25 and obesity as an BMI>30.

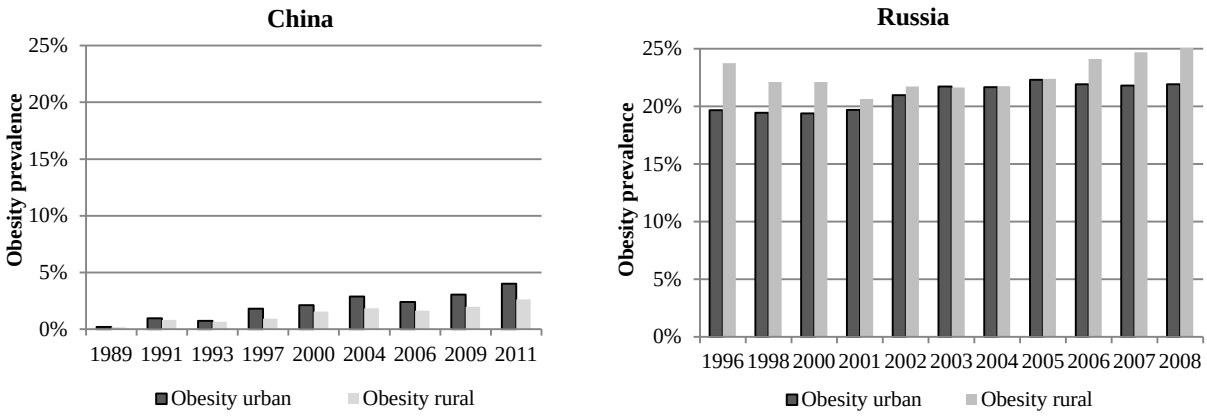

Figure 1: Prevalence of overweight or obesity [in % of sample]

Source: Own calculations based on RLMS-HSE (1996-2008) and CHNS (1989-2009)
Note: With a significantly positive trend for total obesity rates over time at the 5% level.

Besides physical as well as psychological problems, obesity is known to drastically increase a person's risk of diet-related chronic diseases, including diabetes, cardiovascular diseases, and cancer (WHO 2003). Several studies show that the incidence of chronic diseases such as diabetes, gallstones, hypertension and heart disease increases with the degree of overweight or obesity (Field et al. 2001; Mokdad et al. 2003; Sowers 2003; Hedley et al. 2004). Therefore, chronic diseases analyzed in this study are diabetes and cardiovascular diseases such as hypertension, heart attacks, and stroke. We do not consider cancer due to data limitations.

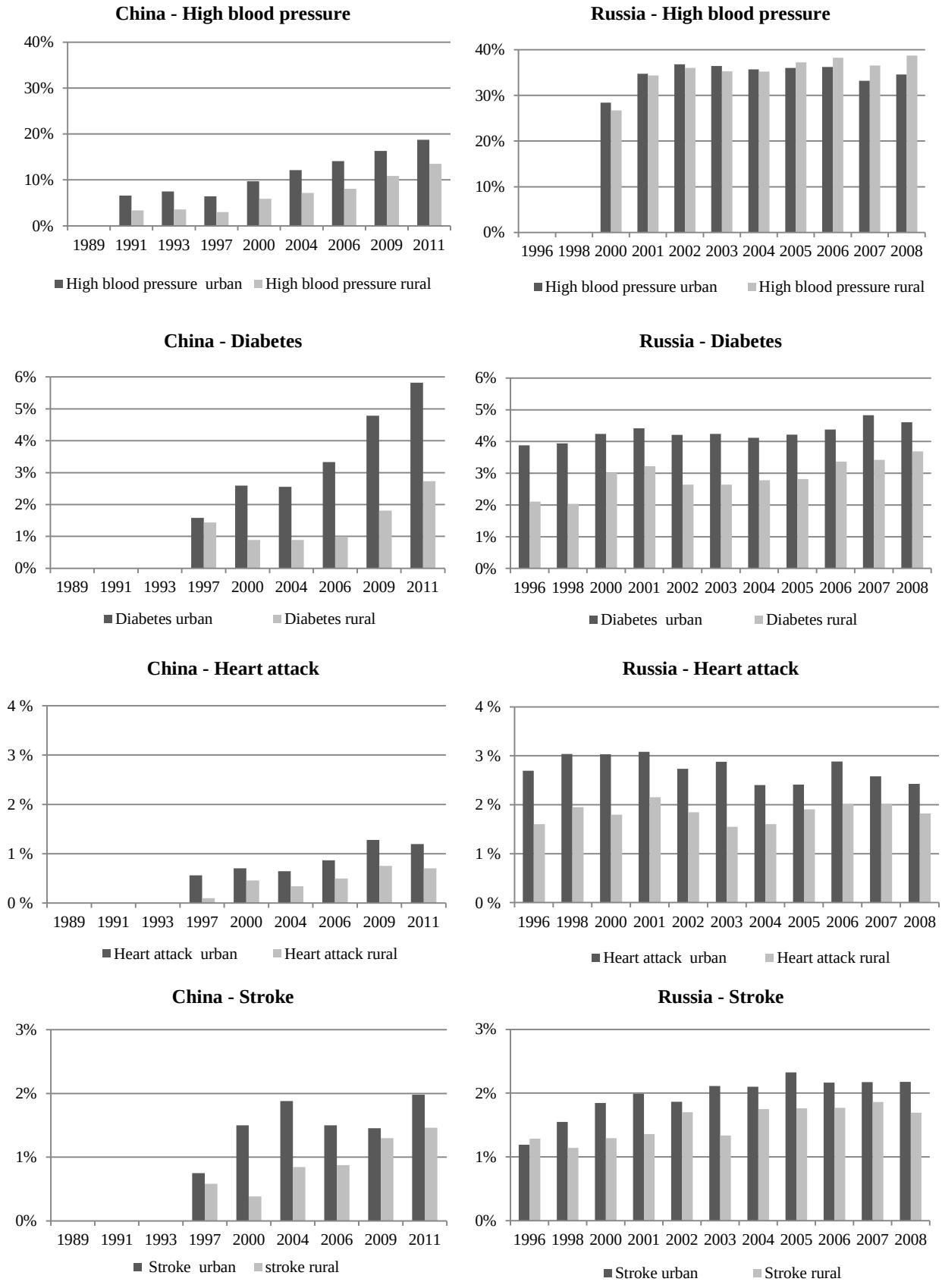

Figure 2: Prevalence of nutrition-related diseases [in % of sample]

Source: Own calculations based on RLMS-HSE (1996-2008) and CHNS (1989-2009)
Note: With a significantly positive trend in total prevalence rates over time at the 5% level, except for heart attacks in Russia.

According to the WHO (2003), 60% of the burden of chronic diseases will occur in developing or emerging countries such as China. In total, 71% of deaths due to ischaemic heart disease (IHD), 75% of deaths due to stroke, and 70% of deaths due to diabetes occur in these countries. For a graphical illustration of the development of these nutrition-related chronic diseases see Figure 2. Nevertheless, interpreting the trends in the prevalence of these considered chronic diseases is not as straightforward as the incidence of obesity, due to a lagged incidence of nutrition-related chronic diseases. However, as presented in figure 2, there is a considerable annual increase in prevalence rates of these chronic diseases, which is especially pronounced in China. We can also observe that prevalence rates in Russia still exceed those in China. Only for diabetes, prevalence rates in urban China caught up and overtook Russia at an alarming speed. Generally, food-related chronic diseases were higher in urban than in rural areas except of the prevalence rates of high blood pressure in Russia, which were higher in rural than in urban areas since 2005.

In summary, higher growth rates of the occurrence of obesity in China suggest a certain catching-up effect and increasing problems with chronic diseases in the longer run, which is supported by studies of Du et al. (2002), Kelly et al. (2008) and Popkin (2001). Such an epidemiologic transition to the predominance of non-communicable diseases, especially in urban China, requires immediate and effective intervention policies with changes in health care strategies (Rozenfeld 1996; WHO 2003). Diet-related chronic diseases cause tremendous costs to both countries' health care system as well as their national productivity. According to the World Bank data, Russian's per capita health care expenditure (PPP), defined as the sum of public and private health expenditures and covers the provision of health services, family planning activities, nutrition activities, and emergency aid, increased from 306.05 constant 2011 international $ in 1995 to 1,523.14 constant 2011 international $ in 2012. China's per capita health care expenditure (PPP) increased somewhat slower, from 73.73 constant 2011 international $ in 1996 to 577.85 constant 2011 international $ in 2012 (see Figure 3). Whereas this increase mainly reflects increasing income and welfare levels, nutrition-related diseases of affluent societies certainly contribute to this effect.

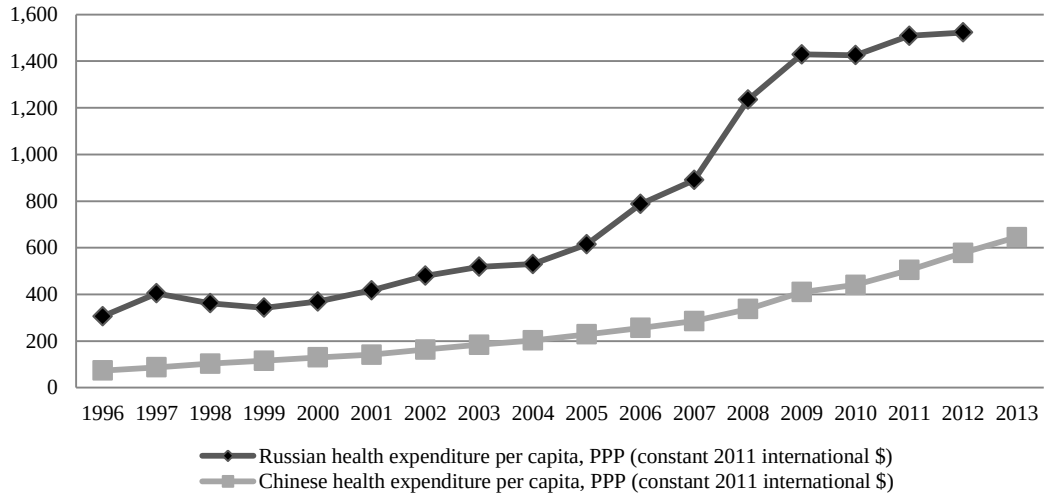

Figure 3: Health expenditure per capita, PPP [in constant 2011 international $]

Source: Own presentation based on World Bank (2014).

Besides public health care costs it is especially interesting to focus on private financial health expenditure in order to consider arising financial problems for Chinese and Russian households. Possibly due to the development of a public health care system (including a comprehensive health insurance), the Chinese private health expenditure share in percent of total health expenditure has decreased from 53.41 % in 1996 to 44.20 % in 2013. Russian private health expenditure share on the other hand has increased from 28.56 % in 1996 to 51.95% in 2013. Especially worrisome is that out-of-pocket health expenditure (any direct outlay by households in percent of private health expenditure) is especially high in both countries. In China however, out-of-pocket health expenditure decreased from 94.82 % in 1996 to 76.65 % in 2013, while it increased in Russia from 63.21 % in 1996 to 92.42 % in 2013 (see Figure 4). This is problematic as with higher rates of private health expenditures, the quality of health services could vary with household incomes, even though the access to basic public health care is publicly provided (Denisova 2010: 347). Especially informal payments for health care are deeply embedded in the health care system in transition countries (Ensor 2004).

Figure 4: Private health expenditure [in % of total health expenditure]

Source: Own presentation based on World Bank (2014).

4 Nutrition transition in China and Russia

The increase of chronic diseases connected to an unbalanced and excessive eating behavior has become a major concern to policy-makers in emerging countries, too. Nevertheless, emerging countries such as China are yet lagging behind in implementing related interventions (WHO, 2003, 2015; Mazzocchi *et al.*, 2009). To understand potential policy leverage, it is necessary to analyze the extent and features of nutrition transition in these countries. Therefore, in this section, we start by providing insights into traditional eating habits of the Chinese and Russian populations as well as current trends in their consumption patterns.

4.1 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).

Table 1: Chinese average per-capita food consumption by food groups (kg/year)

	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
Other foods	15	17.4	17.5	18.2	21.1
Households of rural settlement type					
Food groups					
Carbohydrates	71.7	88.4	96.7	103.8	95
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
Other Proteins	17.1	21.9	23.2	25.8	27
Fruits	1.7	4.1	4.9	9.2	12.5
Vegetables	80.5	91.9	102.2	102	95
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

Source: Authors' calculations based on CHNS (1997-2009).

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/year). 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.

Figure 5 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 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.

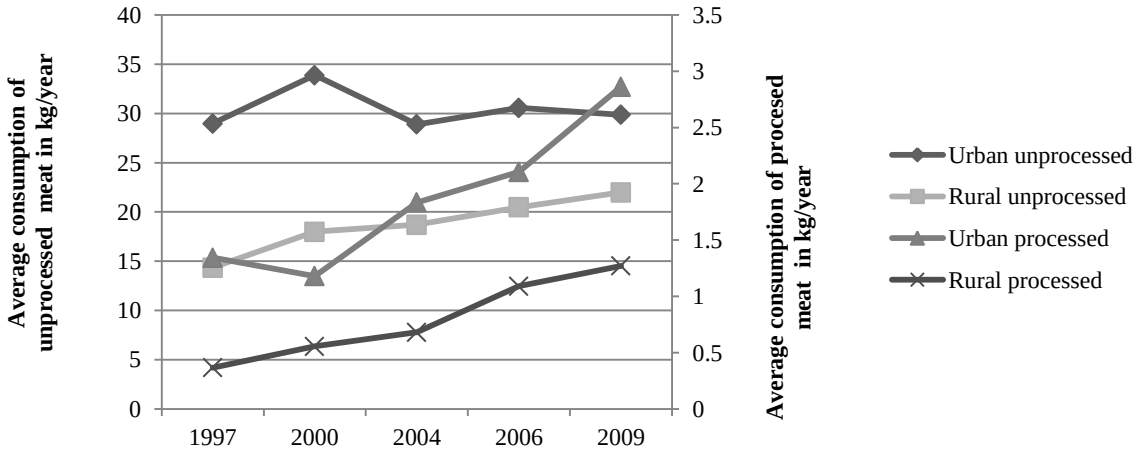

Figure 5: Per-capita consumption of unprocessed and processed meat in China

Source: Authors' calculations based on CHNS (1997-2009).

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 kilograms 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 item.[4] Instead, the expenditure for other food products, mainly consisting of convenience foods, sweets, and drinks increased tremendously.

Table 2: Chinese mean expenditure shares of food groups

	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%
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%

Source: Authors' calculations based on CHNS (1997-2009).

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 effect 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

[4] 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) report that especially results for meat consumption might be biased by excluding foods eaten away from home.

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.

4.2 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 former 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 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/year in 2008) than in rural areas (55.00 kg/year 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 kg to 175 kg in urban areas, and from 272 kg 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 kg to 38.95 kg) and urban (44.31 kg to 50.75 kg) areas, while the consumption of vegetables decreased from 72.6 kg to 58.4 kg in urban households, and from 64.1 kg 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).

Table 3: Russian average per-capita food consumption by food groups (kg/year)

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Households of urban settlement type											
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
Households of rural settlement type											
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

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

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 per year (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 kg and 70.4 kg per year, 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 per year, while in Germany, an annual maximum meat intake of about 31.3 kg per capita is recommended (German Association of Nutrition 2013). The World Cancer Research Fund advises that the consumption of meat, especially processed meat, should not exceed 26 kg per year. 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; Savva and Kafatos 2014; Tárraga López et al. 2014; Choi and Kim 2014; Marckmann et al. 2015).[5] Furthermore, figure 5 illustrates that Russians consume more unprocessed meat than processed meats, with higher consumed amounts of unprocessed and processed meat in urban areas.

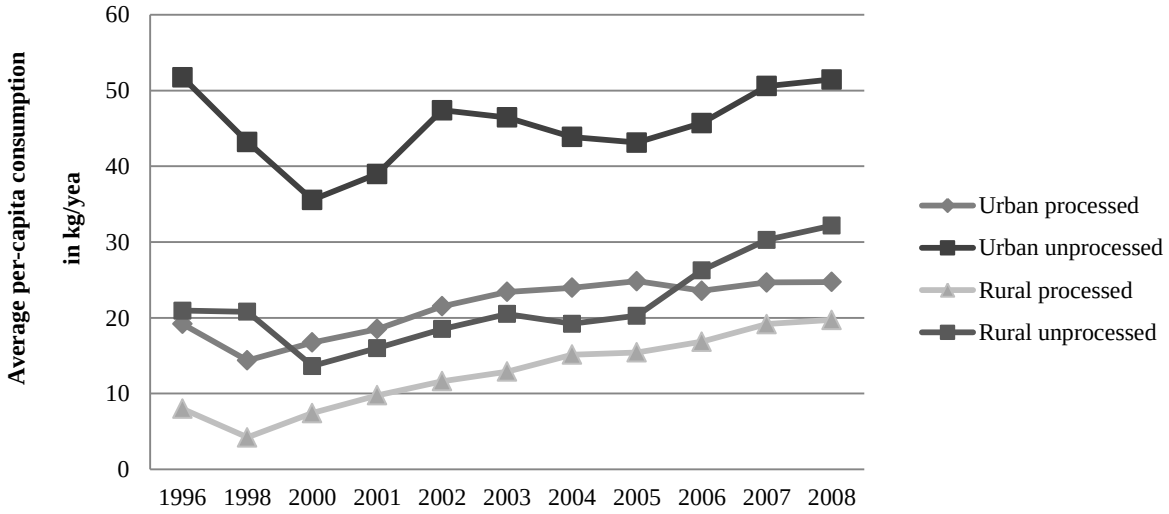

Figure 6: Per-capita consumption of unprocessed and processed meat in Russia

Source: Authors' calculations based on RLMS-HSE (1996-2008).

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.

[5] 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).

Table 4: Russian expenditure shares of food groups

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Households of urban settlement type											
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%
Households of rural settlement type											
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%

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

5 Empirical Analysis

To analyze trends in expenditure and price elasticity of food demand, we apply the Quadratic Almost Ideal Demand System (QUAIDS) of Banks et al. (1997). The QUAIDS provides more flexibility than the standard Linear Approximation Almost Ideal Demand System (LA/AIDS) of 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 two-stage budgeting model according to Deaton and Muellbauer (1980).

5.1 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 foods [6]. The problem of zero observations is controlled for by applying the consistent generalized Heckman procedure (Tauchman 2010).[7] In order to provide unconditional expenditure and price elasticities for the second stage, we follow Carpentier and Guyomard (2001).

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.

5.2 Empirical results

We first provide unconditional expenditure elasticities for our nine food aggregates. To analyze changes over time, we provide yearly demand elasticities for each of the food 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 Table 5 and Table 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. 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.

---

[6] 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.

[7] Shonkwiler and Yen (1999) point out that the generalized Heckman procedure by Heien and Wessells (1990) is inconsistent and propose an alternative consistent estimation procedure. Tauchmann (2005) compares 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 shows 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) introduces a consistent generalized Heckman estimator.

Table 5: Unconditional expenditure elasticities of Chinese households (1997-2009)

	1997	2000	2004	2006	2009
Total household sample					
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[a]			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
Urban households only					
First stage OLS estimation urban					
Food	0.63	0.65	0.67	0.71	0.61
Second stage QUAIDS estimation urban					
Carbohydrates	0.42	0.33	0.42	0.34	0.37
Milk and dairy	0.81	0.83	0.93	0.97	0.83
Meat	0.89	0.87	0.89	1.15	0.84
Fish	1.03	1.02	0.84	0.90	0.94
Other proteins	0.39	0.33	0.53	0.55	0.38
Fruits			0.52	0.64	0.49
Vegetables	0.48	0.48	0.49	0.55	0.44
Fat and Oils	0.83	0.88	0.71	0.75	0.59
Other foods	0.74	1.05	0.72	0.77	0.63
Rural households only					
First stage OLS estimation rural					
Food	0.63	0.79	0.83	0.67	0.78
Second stage QUAIDS estimation rural					
Carbohydrates	0.52	0.57	0.64	0.44	0.57
Milk and dairy	0.97	1.09	1.26	0.98	1.16
Meat	1.03	1.17	1.22	1.29	1.08
Fish	0.79	1.83	1.43	0.84	1.39
Other proteins	0.41	0.52	0.69	0.54	0.53
Fruits			0.63	0.59	0.62
Vegetables	0.46	0.64	0.65	0.52	0.57
Fat and Oils	1.53	1.90	0.80	0.51	0.36
Other foods	0.67	1.14	0.88	0.77	0.82
Observations	3173	3557	3334	3033	3064
Share of urban households	34 %	35%	35%	36%	38%

Source: CHNS, 1997-2009.
Note: [a] Price data on fruits for 1997 and 2000 is missing in the CHNS. Therefore, we aggregated fruits and vegetables in 1997 and 2000 in the vegetables group.
All numbers significant at the 5%-level are printed in bold letters. 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%).

Table 6: Unconditional expenditure elasticities of Russian households (1996-2008)

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total household sample											
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
Urban households only											
First stage OLS estimation urban											
Food	0.97	1.00	0.92	0.92	0.90	0.88	0.80	0.82	0.85	0.82	0.77
Second stage QUAIDS estimation urban											
Carbohydrates	0.66	0.59	0.77	0.72	0.67	0.66	0.56	0.52	0.66	0.45	0.42
Milk and dairy	0.82	0.69	0.91	0.87	0.79	0.75	0.67	0.71	0.75	0.82	0.80
Meat	1.15	1.26	1.01	1.14	1.13	1.07	1.04	1.07	0.95	1.03	0.93
Fish	1.29	1.45	1.01	0.96	1.09	0.97	0.98	0.99	0.90	0.95	0.90
Other proteins	1.28	1.32	1.09	0.91	0.83	0.86	0.84	0.84	0.83	0.86	0.83
Fruits	1.21	1.30	0.97	1.09	1.03	1.07	0.85	0.89	1.12	1.06	0.87
Vegetables	1.31	1.21	1.16	1.01	0.99	1.00	0.99	1.03	0.97	1.02	0.79
Fats and oils	0.96	1.39	1.03	0.78	0.74	0.74	0.64	0.64	0.80	0.52	0.66
Other foods	1.57	1.29	0.97	0.95	1.04	1.01	0.82	0.80	0.90	0.91	0.91
Rural households only											
First stage OLS estimation rural											
Food	1.02	1.03	0.94	1.00	0.93	0.94	0.88	0.89	0.85	0.91	0.85
Second stage QUAIDS estimation rural											
Carbohydrates	0.72	0.80	0.82	0.88	0.76	0.78	0.77	0.78	0.74	0.71	0.63
Milk and dairy	0.83	0.36	0.80	0.73	0.63	0.61	0.48	0.51	0.50	0.67	0.72
Meat	1.24	1.47	1.10	1.33	1.29	1.23	1.20	1.17	0.99	1.17	1.07
Fish	1.40	1.70	1.17	1.15	1.21	1.21	1.10	1.15	0.95	1.11	1.12
Other proteins	1.38	1.77	1.28	0.84	0.76	0.84	0.80	0.78	0.78	0.86	0.86
Fruits	1.32	1.50	1.03	1.31	1.09	1.24	0.90	0.90	1.16	1.19	0.99
Vegetables	1.39	1.31	1.44	1.08	0.81	1.05	1.08	1.07	0.95	1.01	0.52
Fats and oils	1.08	1.63	1.16	1.07	1.09	1.07	0.94	0.96	0.96	0.83	0.92
Other foods	1.65	1.40	1.11	1.09	1.06	1.14	0.93	0.92	0.90	1.01	1.05
Observations	3397	3497	3723	4221	4371	4400	4412	4234	5119	5094	4956
Share of urban households	77%	77%	74%	76%	76%	76%	76%	75%	72%	76%	77%

Source: RLMS-HSE, 1998-2008.
Note: All numbers significant at the 5%-level are printed in bold letters.
The category ‘mutton’ was not included in Russian analysis due to this food’s low consumption share among the meat aggregate (less than 5%).

Compared with the results of other studies on Chinese food demand (Huang and Rozelle 1998; Gould 2002; Yen et al. 2004; Gould and Villarreal 2006; Dong and Gould 2007; Liao and Chern 2007; Gale and Huang 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 (see Table B 1 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. Analyzing the trend over the considered period, we can state that for Russia expenditure elasticities decreased for all food groups. 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 disproportionally with rising household expenditure.

Table 7: Unconditional price elasticities of Chinese households

	1997	2000	2004	2006	2009
Total household sample					
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[a]			-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
Urban households only					
First stage OLS estimation urban					
Food	-0.55	-0.55	-0.71	-0.44	-0.71
Second stage QUAIDS estimation urban					
Carbohydrates	-0.20	-0.32	-0.26	-0.03	-0.23
Milk and dairy	-1.13	-1.03	-0.71	-0.77	-0.84
Meat	-0.54	-0.43	-0.67	-0.22	-0.33
Fish	-0.35	-0.33	-0.18	-0.19	-0.42
Other proteins	-0.48	-0.37	-0.63	-0.46	-0.67
Fruits			-0.52	-0.88	-0.33
Vegetables	-0.31	-0.11	-0.28	-0.18	-0.26
Fat and Oils	-0.18	-0.11	-0.03	-0.14	-0.27
Other foods	-0.11	-0.39	-0.45	-0.52	-0.55
Rural households only					
First stage OLS estimation rural					
Food	0.63	0.79	0.83	0.67	0.78
Second stage QUAIDS estimation rural					
Carbohydrates	0.52	0.57	0.64	0.44	0.57
Milk and dairy	0.97	1.09	1.26	0.98	1.16
Meat	1.03	1.17	1.22	1.29	1.08
Fish	0.79	1.83	1.43	0.84	1.39
Other proteins	0.41	0.52	0.69	0.54	0.53
Fruits			0.63	0.59	0.62
Vegetables	0.46	0.64	0.65	0.52	0.57
Fat and Oils	1.53	1.90	0.80	0.51	0.36
Other foods	0.67	1.14	0.88	0.77	0.82
Observations	3173	3557	3334	3033	3064
Share of urban households	34 %	35%	35%	36%	38%

Source: CHNS, 1997-2009.
Note: a Price data on fruits for 1997 and 2000 is missing in the CHNS. Therefore, we aggregated fruits and vegetables in 1997 and 2000 in the vegetables group. 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%).
All numbers significant at the 5%-level are printed in bold letters.

Table 8: Unconditional price elasticities of Russian households

	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total household sample											
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
Urban households only											
First stage OLS estimation urban											
Food	-0.73	-0.76	-0.64	-0.63	-0.60	-0.57	-0.51	-0.53	-0.53	-0.50	-0.45
Second stage QUAIDS estimation urban											
Carbohydrates	-1.02	-1.16	-1.08	-0.98	-1.11	-0.90	-0.81	-0.88	-1.08	-1.01	-0.94
Milk and dairy	-0.96	-1.20	-0.93	-0.81	-1.09	-0.87	-1.15	-0.96	-1.07	-0.95	-1.11
Meat	-1.42	-1.43	-1.46	-1.33	-1.28	-1.20	-1.43	-1.46	-1.41	-1.41	-1.02
Fish	-1.11	-0.85	-1.33	-1.59	-1.15	-0.82	-1.24	-1.14	-1.36	-1.24	-0.83
Other proteins	-0.62	-0.77	-0.49	-0.91	-0.73	-0.88	-0.76	-0.99	-0.90	-0.84	-0.62
Fruits	-1.26	-1.49	-1.28	-0.93	-0.99	-1.28	-0.91	-0.86	-0.95	-1.28	-1.01
Vegetables	-1.22	-1.10	-0.59	-1.07	-0.65	-0.92	-1.00	-1.13	-1.05	-1.27	-1.24
Fats and oils	-0.92	-1.80	-1.23	-1.00	-0.62	-0.97	-0.69	-0.96	-0.85	-1.03	-1.17
Other foods	-1.10	-1.07	-1.08	-1.20	-1.27	-1.33	-1.42	-1.22	-1.19	-1.11	-1.08
Rural households only											
First stage OLS estimation rural											
Food	-0.68	-0.70	-0.62	-0.67	-0.60	-0.61	-0.57	-0.57	-0.54	-0.57	-0.52
Second stage QUAIDS estimation rural											
Carbohydrates	-1.22	-1.34	-1.40	-1.34	-1.32	-1.25	-1.17	-1.22	-1.31	-1.21	-1.13
Milk and dairy	-0.95	-1.67	-0.74	-0.48	-1.19	-0.77	-1.29	-0.89	-1.05	-0.83	-1.08
Meat	-1.52	-1.47	-1.79	-1.35	-1.25	-1.15	-1.47	-1.48	-1.49	-1.45	-1.00
Fish	-1.13	-0.77	-1.37	-1.70	-1.17	-0.81	-1.25	-1.15	-1.36	-1.24	-0.87
Other proteins	0.69	-0.10	0.52	-0.73	-0.45	-0.74	-0.42	-0.97	-0.83	-0.73	-0.31
Fruits	-1.53	-1.98	-1.54	-0.85	-0.96	-1.48	-0.82	-0.76	-0.89	-1.34	-1.00
Vegetables	-1.45	-1.32	0.21	-1.15	0.11	-0.74	-0.96	-1.21	-1.07	-1.57	-1.54
Fats and oils	-0.97	-1.90	-1.24	-1.06	-0.80	-1.04	-0.85	-1.03	-0.95	-1.06	-1.16
Other foods	-1.12	-1.09	-1.10	-1.20	-1.25	-1.33	-1.44	-1.23	-1.20	-1.12	-1.09
Observations	3397	3497	3723	4221	4371	4400	4412	4234	5119	5094	4956
Share of urban households	77%	77%	74%	76%	76%	76%	76%	75%	72%	76%	77%

Source: RLMS-HSE, 1998-2008.
Note: All numbers significant at the 5%-level are printed in bold letters. The category ‘mutton’ was not included in Russian analysis due to this food’s low consumption share among the meat aggregate (less than 5%).

Table 7 and Table 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. 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. 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. Meat products and fats have the highest own-price elasticity in absolute terms in Russia in 2008. 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, see also see Table B 2 in Appendix B). 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 most price elastic (-1.27), followed by fats and oils (-0.99).[8] 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 Brazil. 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

[8] 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.

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.

6 Conclusions

Considering the observed period of economic growth, our data implies a nutrition transition taking place in both China and Russia. In both countries, nutrition-related chronic diseases are generally increasing. Thereby, the higher growth rate of the occurrence of obesity in China suggests a certain catching-up effect and tremendously increasing problems with chronic diseases in the longer run in China. Such an epidemiologic transition toward the predominance of chronic diseases, especially in urban China, requires immediate and effective intervention policies with changes in health care strategies because they cause tremendous costs to both countries' health care systems as well as their national productivity.

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.

The estimated expenditure elasticities lead us to assume a continuing increase in the intake of meat and fish in both countries. Furthermore, rising household expenditures will probably have a strong positive effect on fruit and vegetable consumption in both countries. However, it is important to stress the ambivalent implication of rising meat consumption for urban and rural areas, especially in China. On the one hand, rising meat consumption is important for solving problems of malnutrition, e.g. iron deficiencies in rural China. On the other hand, this trend might also increase the incidence of chronic diseases in Chinese urban areas, where intake of meat and fat has already reached the level or rural Russia. In Russia, where meat intake is already at a higher level, nutrition guidelines should rather discourage the intake of meat. Especially processed meat increases the risk for certain nutrition-related diseases for its higher fat and salt content. Still, the demand for meat products was found to be rather elastic, which means that price fluctuations would affect meat consumption. In contrast, we find evidence for relatively low price elasticities for fats and oils, though only for China. For these products, taxing would probably not efficiently decrease the rather unhealthy demand for saturated fats. 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.

References

Abegunde, D. O., & Stanciole, A. E. 2008. The economic impact of chronic diseases: How do households respond to shocks? Evidence from Russia. *Social Science & Medicine*, **66**(11), 2296–2307.

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? Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, D.C., 4-6 August 2013. Available from: 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. 1989–2009. 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, Aguiar, D R D de, 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.

Denisova, I. 2010. Adult mortality in Russia, *Economics of Transition*, **18,** 333–363.

Deutsche Gesellschaft für Ernährung. 2013. *Vollwertig essen und trinken nach den 10 Regeln der DGE*. [2013]. Available from: https://www.dge.de/ernaehrungspraxis/vollwertige-ernaehrung/10-regeln-der-dge/

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. [1999]. Available from: http://nbn-resolving.de/urn:nbn:de:gbv:3:2-22887

Ensor, T. 2004. Informal payments for health care in transition economies, *Adjusting for Market Failure: Challenges in Public Health Alternatives*, **58**, 237–246, available at: http://www.sciencedirect.com/science/article/pii/S0277953603000078.

Feng Z, Shi D. 2006. Chinese food consumption and nourishment in the last 20 years. *Resources Science*, **28**, 2-8. (in Chinese)

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., …Colditz, G. A. 2001. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine*, **161**(13), 1581–1586.

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]. Available from http://www.ers.usda.gov/media/200564/err32fm_1_.pdf

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.

Government Committee of Statistics (GKS). 2011. *Federal State Statistics Service Russia*. [2013-01]. Available from: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/en/main/

Government of the Russian Federation. 2013. Government Regulation of the Russian Federation dated February 28, 2013 No. 54 "Statement of methodical recommendations for determining the consumer basket of main socio-demographic population strata in subjects of the Russian Federation". (in Russian). [2013-02-28]. Available from: http://base.garant.ru/70308360

Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., & Flegal, K. M. 2004. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *Jama*, **291**(23), 2847–2850.

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],Available from: http://www.nofima.no/publikasjon/30E275080AE38600C1257233003B7CC9

Hovhannisyan V, Gould B W. 2011. Quantifying the structure of food demand in China: An econometric approach. *Agricultural Economics*, **42** (Suppl. 1), 1-17.

Hovhannisyan 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.

Kalichman, L., Livshits, G., & Kobyliansky, E. 2006. Indices of body composition and chronic morbidity: A cross‐sectional study of a rural population in central Russia. *American Journal of Human Biology*, **18**(3), 350–358.

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 (2005)*, **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*. Selected Paper Presented at the American Agricultural Economics Association Annual Meeting, Portland, Oregon, USA, 29 July-1 August 2007. Available from: 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, 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.

Mazzocchi, M., Traill, B. and Shogren, J.F. 2009. Fat economics: *Nutrition, health, and economic policy*, Oxford University Press, Oxford.

Min S, Bai J, Seale Jr. J, Wahl T. 2015. Demographics, Societal Aging, and Meat Consumption in China. *Journal of Integrative Agriculture*, in press.

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]. Available from: 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]. Available from: http://www.eaber.org/node/22223

Monteiro C, Mondini L, Souza A L de, 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.

Mokdad, A. H., Ford, E. S., Bowman, B. A., Dietz, W. H., Vinicor, F., Bales, V. S., & Marks, J. S. 2003. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *Jama*, **289**(1), 76–79.

Muhammad A, Seale J L Jr., Meade B, Regmi A. 2011. International Evidence on Food Consumption Patterns: An Update Using 2005 International Comparison Program Data. *Economic Research Service Technical Bulletin. No.* 1929. [2005-05, revised 2013-02]. Available from: http://www.ers.usda.gov/publications/tb-technical-bulletin/tb1904.aspx#.UukwgrTBNcU

National Bureau of Statistics. 2010. *Rural Households Survey Yearbook of China*. China Statistics Press, Beijing.

Nugent, R. 2008. Chronic diseases in developing countries. *Annals of the New York Academy of Sciences*, **1136**(1), 70–79.

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*. PhD thesis, University of Michigan, Department of Econometrics, Ann Arbor, USA.

Poi B P. 2012. Easy demand-system estimation with quaids. *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 in figures. Russia Longitudinal Monitoring survey, RLMS-HSE, 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. Available from: 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*. [2006-12, revised 2007-04]. Available from: http://iis-db.stanford.edu/pubs/21679/Which_are_better_community_prices_or_unit_values.pdf

Rozenfeld, B.A. 1996. "The crisis of Russian health care and attempts at reform", in DaVanzo, J. (with the assistance of Farnsworth, G. (Ed.), *RAND conference proceedings: Russia's demographic "crisis"*, Santa Monica, California, 163–174.

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.

Sowers, J. R. 2003. Obesity as a cardiovascular risk factor. *The American Journal of Medicine*, **115**(8), 37–41.

Staudigel M, Schröck R. 2014. Food Demand in Russia: Heterogeneous Consumer Segments over Time. *Journal of Agricultural Economics*, in press.

Stillman, S., & Thomas, D. 2008. Nutritional Status during an Economic Crisis: Evidence from Russia. *The Economic Journal*, **118** (531), 1385–1417.

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, Y., Monteiro, C., & Popkin, B. M. 2002. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *The American Journal of Clinical Nutrition*, **75**(6), 971–977.

Wang, L. 2005. *On the investigation of citizens' nutrition and health in China. General report 2002*. Beijing: People's Medical Publishing House.

Wang, Y., Mi, J., Shan, X. Y., Wang, Q. J., & Ge, K. Y. 2007. Is China facing an obesity epidemic and the consequences?: The trends in obesity and chronic disease in China. *International Journal of Obesity*, **31**(1), 177–188.

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*. Available from: 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 (WHO). 2003. Diet, nutrition and the prevention of chronic diseases: Report of the joint WHO/FAO expert consultation, *WHO Technical Report Series*, Vol. 916, Geneva.

World Health Organization. 2014. *WHO fact sheet 310: The top ten causes of death*. [2014-05]. Available from: http://www.who.int/mediacentre/factsheets/fs310/en/

World Health Organization (WHO). 2015. WHO/Europe obesity data: clarification: *Presentation at the 22nd European Congress on Obesity (ECO2015) in Prague, Czech Republic, Press release*, Geneva.

Yang Y. 2005. *China Food Composition Tables 2004*. Beijing Medical University Press, Beijing. (in Chinese)

Yang, G., Kong, L., Zhao, W., Wan, X., Zhai, Y., Chen, L. C., & Koplan, J. P. 2008. Emergence of chronic non-communicable diseases in China. *The Lancet*, **372**(9650), 1697–1705.

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.

Appendix A: QUAIDS estimation model

Same as the LA/AIDS model, QUAIDS is derived as a generalization of the price-independent generalized logarithmic (PIGLOG) demand system with the indirect utility function

$$(1)\quad \ln V(\mathbf{p},m)=\left[\left\{\frac{\ln m-\ln a(\mathbf{p})}{b(\mathbf{p})}\right\}^{-1}+\lambda(\mathbf{p})\right]^{-1},$$

where **p** is the vector of prices for a set of goods *i* with $i=1,...,n$ for which the consumer has budgeted *m* units of currency.

The term $\frac{\ln m-\ln a(\mathbf{p})}{b(\mathbf{p})}$ is the indirect utility function of a system with budget shares linear in log total expenditure (PIGLOG demand system), indicating that (1) is clearly a generalization of the AIDS model (Lambert 2006: 178). Further, the price index $\ln a(\mathbf{p})$ is assumed to be a transcendental logarithm function, $b(\mathbf{p})$ is the Cobb-Douglas price aggregator, and $\lambda(\mathbf{p})$ is a differentiable, homogeneous function of prices with the following specifications:

$$(2)\quad \ln a(\mathbf{p})=\alpha_0+\sum_{i=1}^{n}\alpha_i \ln p_i+\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij}\ln p_i \ln p_j ,$$

$$(3)\quad b(\mathbf{p})=\prod_{i=1}^{n} p_i^{\beta_i} ,$$

$$(4)\quad \lambda(\mathbf{p})=\sum_{i=1}^{n}\lambda_i \ln p_i .$$

Given these specifications, the QUAIDS expenditure share equations for goods *i* are

$$(5)\quad w_i=\alpha_i+\sum_{j=1}^{n}\gamma_{ij}\ln p_j+\beta_i \ln\left\{\frac{m}{a(\mathbf{p})}\right\}+\frac{\lambda_i}{b(\mathbf{p})}\left[\ln\left\{\frac{m}{a(\mathbf{p})}\right\}\right]^2 .$$

To assure consistency with the neoclassical demand theory, the following additivity, homogeneity, and symmetry restrictions are required:

$$(6)\quad \sum_{i=1}^{n}\alpha_i=1,\quad \sum_{i=1}^{n}\beta_i=0,\quad \sum_{i=1}^{n}\lambda_i=0,\quad \sum_{i=1}^{n}\gamma_{ij}=0\ \forall\ j ,$$

(7) $\sum_{j=1}^{n}\gamma_{ij}=0, \quad \forall i$,

(8) $\gamma_{ij}=\gamma_{ji}, \quad \forall i \neq j$.

Further, the price index $a(\mathbf{p})$ must be homogeneous of degree 1 in prices and expenditure, and $b(\mathbf{p})$ homogeneous of degree 0.

Demographic scaling used in this study is based on the works of Ray (1983) and Poi (2002, 2012). Let **z** represent a vector of characteristics *r* with $r=1,...,s$ and $y^R(\mathbf{p},\mathbf{u})$ denote the expenditure function of a reference household, then the parameterized expenditure function for each household has the form

(9) $y(\mathbf{p},\mathbf{z},\mathbf{u})=\left[1+\boldsymbol{\rho}'\mathbf{z}\right]\dfrac{\prod_{j=1}^{n}p_j^{\beta_j}\left[\prod_{j=1}^{n}p_j^{\boldsymbol{\eta}_j'\mathbf{z}}-1\right]}{\frac{1}{u}-\sum_{j=1}^{n}\lambda_j\ln p_j}e^R(\mathbf{p},\mathbf{u})$.

with $\boldsymbol{\rho}$ a vector of parameters to be estimated and η_j the *j*th column of the parameter matrix $\boldsymbol{\eta}$. Given equation (9) the expenditure share equation takes the form

(10) $w_i=\alpha_i+\sum_{j=1}^{n}\gamma_{ij}\ln p_j+[\beta_i+\boldsymbol{\eta}_i'\mathbf{z}]\ln\left\{\dfrac{m}{\overline{m}_0(\mathbf{z})\,a(\mathbf{p})}\right\}+\dfrac{\lambda_i}{b(\mathbf{p})c(\mathbf{p},\mathbf{z})}\left[\ln\left\{\dfrac{m}{\overline{m}_0(\mathbf{z})\,a(\mathbf{p})}\right\}\right]^2$

with

(11) $\overline{m}_0(\mathbf{z})=1+\boldsymbol{\rho}'\mathbf{z}$,

(12) $c(\mathbf{p},\mathbf{z})=\prod_{j=1}^{n}p_j^{\boldsymbol{\eta}_j'\mathbf{z}}$,

and the additional adding up restriction requires

(13) $\sum_{j=1}^{n}\eta_{rj}=0$ for all r=1, …, s.

As the elasticities are more easily interpreted and relevant for policy implications than the QUAIDS parameter estimates, expenditure elasticities are calculated by the differential of equation (10).

With the expenditure elasticity being $\eta_i=\dfrac{\left[\frac{\partial w_i}{\partial \ln m}\right]}{w_i}+1$, we get

$$(14)\ \eta_i = 1 + \frac{1}{w_i}\left[\beta_i + \boldsymbol{\eta}_i'\mathbf{z} + \frac{2\lambda_i}{b(\mathbf{p})c(\mathbf{p},\mathbf{z})}\ln\left\{\frac{m}{\overline{m}_0(\mathbf{z})a(\mathbf{p})}\right\}\right].$$

The uncompensated price elasticities $e_{ij}^u = \frac{\left[\frac{\partial w_i}{\partial \ln p_j}\right]}{w_i} - \delta_{ij}$, where δ_{ij} is the Kronecker delta with value of one for own-price elasticity and zero for cross-price elasticity, are given by

$$(15)\quad \begin{aligned} e_{ij}^u = -\delta_{ij} + \frac{1}{w_i}\left(\gamma_{ij} - \left[\beta_i + \boldsymbol{\eta}_i'\mathbf{z} + \frac{2\lambda_i}{b(\mathbf{p})c(\mathbf{p},\mathbf{z})}\ln\left\{\frac{m}{\overline{m}_0(\mathbf{z})a(\mathbf{p})}\right\}\right]\right)\times \\ \left(\alpha_j + \sum_k \gamma_{jk}\ln p_k\right) - \frac{\left(\beta_j + \boldsymbol{\eta}_j'\mathbf{z}\right)\lambda_i}{b(\mathbf{p})c(\mathbf{p},\mathbf{z})}\left[\ln\left\{\frac{m}{\overline{m}_0(\mathbf{z})a(\mathbf{p})}\right\}\right]^2. \end{aligned}$$

In order to provide expenditure elasticities that are comparable with other studies, we calculate unconditional expenditure and price elasticities for each of the nine food aggregates by following the approach of Carpentier and Guyomard (2001: 226). With the conditional expenditure elasticity of commodity *i* conditional on the expenditure elasticity of the aggregate group F, being $\eta_{(F)i}$, we get the following unconditional expenditure elasticity for commodity *i*

$$(16)\ \eta_i = \eta_{(F)i}\eta_F .$$

Unconditional uncompensated price elasticity $\tilde{e}_{ij}^u$ calculated from the within uncompensated price elasticities e_{ij}^u for commodity *i* within aggregate group F and commodity *j* within aggregate groups H is given by

$$(17)\ \tilde{e}_{ij}^u = e_{ij}^u + w_{(H)j}\left(\frac{\delta_{FH}}{\eta_{(H)j}} + e_{FH}\right)\eta_{(F)i}\eta_{(H)j} + w_{(H)j}w_H\eta_F\eta_{(F)j}\left(\eta_{(H)j} - 1\right),$$

where $w_{(H)j}$ is the budget share of commodity *j* within aggregate group H. For the third stage meat aggregates, we follow the formula provided by Bouamra-Mechemache et al. (2008: 655) to calculate the unconditional elasticities from their conditional counterparts.

Appendix B: Comparison of results with other studies

Table B 1: Expenditure elasticity comparisons with other studies for China and Russia

	Expenditure Elasticities – China									
Commodity	Huang and Rozelle (1993,1994)	Gould (1995-1997)	Yen et al. (2000)	Dong and Gould (2001)	Gould and Villarreal (2001)	Gale and Huang (2002-2003)	Liao and Chern (2002-2003)	Hovhannisyan and Gould (2003)	Zheng and Henneberry (2004)	Zhou et al. (1995-2010)
Grains	0.51	1.3	0.82	0.97	1.16	0.06	0.54	0.40	0.79	0.15
Oils and Fats			0.98	1.22	1.34	0.23	0.78		0.72	0.59
Meats	0.85						1.34		1.04	0.55
Dairy/egg		1.36								
Dairy			1.19	1.19	1	0.7		1.74	1.37	1.69
Egg			1.04					0.29	0.82	-0.11
Vegetables	1.4	1.03	0.83	0.95	0.95		0.74	0.60	0.81	0.74
Fruits	2.32	1.07	0.6	0.72	0.85	0.35	1.07	1.35	0.98	1.14

	Expenditure Elasticities – Russia		
Commodity	Elsner (1996)	Goodwin et al. (1996)	Staudigel and Schröck (1995-2010)
Grains			0.86
Oils and Fats	0.91		0.86
Meats	0.77		1.16
Dairy/eggs	1.10		
Dairy			0.80
Eggs	0.64	1.62	
Vegetables	1.40		0.97
Fruits	1.05		0.97

Note: The years in parentheses are the years of data used.

Table B 2: Own-price elasticity comparisons with other studies for in China and Russia

Commodity	Own-Price Elasticities – China								
	Huang and Rozelle (1993, 1994)	Gould (1995-1997)	Yen et al. (2000)	Dong and Gould (2001)	Gould and Villarreal (2001)	Liao and Chern (2002-2003)	Hovhannisyan and Gould (2003)	Zheng and Henneberry (2004)	Zhou et al. (1995-2010)
Grains	-0.57	-0.91	-0.9	-0.60	-0.64	-0.73	-1.16	-1.22	-0.62
Oils and Fats			-0.55	-0.71	-0.75	-1.08	-1.09	-1.31	-0.35
Meats	-0.74							-0.85	-0.62
Pork		-1.44	-0.21	-0.58	-0.66	-0.82	-0.89		
Dairy/egg		-1.15							
Dairy			-1.4	-0.41	-0.39		-1.04	-1.21	-0.45
Egg			-0.7				-0.80	-0.85	-0.53
Vegetables	-0.82	-1.38	-0.72	-0.68	-0.66	-0.62	-0.46	-0.5	-0.77
Fruits	-0.54	-1.21	-0.76	-0.70	-0.71	-0.69	-0.70	-0.86	-0.84

Commodity	Own-Price Elasticities – Russia		
	Elsner (1996)	Goodwin et al. (1996)	Staudigel and Schroeck (1995-2010)
Grains			-1.27
Oils and Fats	-1.11		-0.99
Meats	-0.73		-0.88
Dairy/egg	-0.95		
Dairy			-0.97
Egg	-0.59	-0.37	
Fish		-0.32	
Vegetables	-1.04		-1.05
Fruits	-0.91		-0.91

Note: The years in parentheses are the years of data used