



The rising cost of a healthy diet

Annexes:

Changing relative prices of foods in high income and emerging economies

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Annex I: Summary of key literature for the US

Table I.1: Summary of key US literature on relative prices

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	Testing the hypothesis that low-energy-density foods are not only more costly per kilocalorie, but have increased disproportionately in price as compared to high-energy-density foods.	Retail prices for a list of 372 foods and beverages belonging to a food frequency questionnaire database, were obtained from major supermarket chains in Seattle, Washington in 2004 and 2006.	<p>Cross-sectional study. Energy densities of food items were calculated and expressed as \$/100 g edible portion and as \$/1,000 kcal.</p> <p>Foods were stratified by quintiles of energy density and the differences in energy cost and in percent price change were tested using analyses of variance.</p>	<p>Foods with high energy density provided highest dietary energy at least cost.</p> <p>Foods in the bottom quintile of energy density (excluding beverages) cost \$18.16/1,000 kcal compared to only \$1.76/1,000 kcal for foods in the top quintile.</p> <p>Over the two years, least energy dense foods changed in price by +19.5%, while the most energy-dense foods changed in price by -1.8%.</p> <p>Energy-dense foods are not only the least expensive, but also most resistant to inflation.</p>	Monsivais & Drewnowski, 2007

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	How have prices of fruits and vegetables changed relative to prices of less-healthy foods?	Bureau of Labour Statistics U.S. city average food price data. Monthly prices 1980 – 2006, deflated by CPI; for 4 dessert and snack foods (chocolate chip cookies, cola, ice cream, and potato chips), 11 fresh fruits and vegetables (iceberg lettuce, whole carrots, cabbage, celery, Red Delicious apples, bananas, dry beans, cucumbers, peppers, broccoli, and tomatoes).	They excluded from the analysis any fresh fruits and vegetables that changed little over the period in question – though broccoli and tomato which were included were found to have actually changed quite a lot too. Foods with high seasonality (prices not appearing throughout the year) seasonal periods were excluded.	An increase in the price of fruits and vegetables relative to less healthy foods could reduce consumers' incentives to purchase fruits and vegetables and result in less healthy diets. It is difficult to tell whether prices of fruits and vegetables have increased relative to healthier foods in the US because quality (and processing) improvements in many fresh fruits and vegetables means the same item is not being compared across time. For those commonly consumed fruits and vegetables for which quality has remained fairly constant, analysis of price trends reveals a price decline similar to that of dessert and snack foods. For those foods considered, they suggest the price of a healthy diet has not changed much relative to an unhealthy one	Kuchler & Stewart, 2008
Level 1	In the late 1800s, USDA compared food costs relative to their energy and nutritive value. This study seeks to re-establish relations between food cost, energy, and nutrients using up-to-date data on nutrient content of foods and their prices.	Data from the USDA Food and Nutrient Database for Dietary Studies 1.0 (FNDDS 1.0) and the Center for Nutrition Policy and Promotion food prices database were used. For 1387 foods, the following key variables were collected: energy density (kcal/g), serving size (g), unit price (\$/100g), serving price (\$/serving), and energy cost (\$/kcal).	A regression model tested relationship between nutrients and unit price (\$/100g). Comparisons between food groups were tested by using one-factor analyses of variance. Relations between energy density and price within food groups were tested by using Spearman's correlations.	Grains and fats supply the lowest-cost dietary energy. Vegetables had the highest energy cost for any other food group except fruit. Serving sizes increased with water content and varied inversely with energy density. Highest prices per serving were for meats, poultry, and fish; lowest for fats. Carbohydrates, sugar, and fat had lower price per 100g, while protein, fibre, vitamins, and minerals had higher price per 100g. Grains and sugars were cheaper than vegetables and fruit per calorie and were cheaper than fruit per serving.	Drewnowski, 2010

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	How does people's intake of key nutrients relate to the cost of their diets and to their socio-economic status?	Data on 1,266 adults in Seattle – demographics, and nutrient intakes. Supermarket food prices in Seattle used to compute estimated prices for 384 foods featuring in the food frequency questionnaire.	<p>Telephone survey was used to sample demographic data for a sample of adults in the Seattle Obesity Study. Dietary intakes were assessed using a food frequency questionnaire.</p> <p>Nutrient intakes were energy-adjusted and converted into quintiles.</p> <p>Cost of diets for each respondent was estimated using prices from the area.</p>	<p>Eating more fibre, vitamins A, C, D, E, and B12, beta carotene, folate, iron, calcium, potassium, and magnesium meant higher diet costs. This cost differential was highest for vitamin C, beta carotene, potassium, and magnesium.</p> <p>Eating more saturated fats, trans fats and added sugars was associated with lower diet costs.</p> <p>Lower cost lower quality diets were more likely to be consumed by people with lower socio-economic status.</p> <p>Nutrients associated with a lower risk of chronic disease were associated with higher diet costs, while those nutrients associated with higher disease risk were linked with lower-cost diets.</p>	Aggarwal et al., 2012
Level 1	Are healthier foods more expensive than less healthy foods?	<p>US government food group recommendations, at ChooseMyPlate.gov.</p> <p>4,439 food items are analysed. Data on types and quantities of food consumed from the National Health and Nutrition Examination Survey (NHANES). Data on food prices from the USDA's Center for Nutrition Policy and Promotion (CNPP) food prices database. Data on food group classification, saturated fat, added sugars and sodium content from USDA Food Pattern Equivalent Database.</p>	<p>Estimate the cost for 4,439 food items by 1) price per calorie, 2) price per edible gram, & 3) price per average portion eaten. Prices of healthy and less healthy foods compared.</p> <p>Healthy foods defined as a) containing some food in at least one of the major food groups (fruits, vegetables, grains, dairy, & high-protein) equal to at least half the portion size used by the Dietary Guidelines for Americans 2010 (so they can be said to contribute significantly to recommended diets); and b) containing only moderate levels of saturated fats, added sugars, sodium.</p> <p>Cost of meeting recommendations for each food group also assessed.</p>	<p>Healthy foods cost less than less healthy foods by edible gram and portion size, but not by calorie.</p> <p>Vegetables and fruits for example are relatively low in calories and tend to be a relatively expensive way to buy food energy.</p> <p>Less healthy foods (called “moderation foods” in this report)—especially those high in saturated fat and added sugar—tend to be high in calories and to have a low price per calorie.</p> <p>In terms of edible weight or average portion size, grains, vegetables, fruit, and dairy are less expensive than most protein foods and foods high in saturated fat, added sugars, and/or sodium.</p> <p>It costs less to meet the grains, dairy, and fruit recommendations of the ChooseMyPlate.gov food recommendations than those for vegetables or protein foods.</p>	Carlson & Frazão, 2012

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	How much do food costs, food energy, and food nutrient profiles differ across 100 items	Cross-sectional survey of 225 stores in 18 counties across the Lower Mississippi Delta of Arkansas, Louisiana, and Mississippi.	Energy, nutrient, and cost profiles for food items were calculated and price per 100 g edible portion converted to price per serving. Foods were grouped into 6 food groups and mean differences compared with ANOVA.	Significant differences across each measure by food group were found. Energy density was highest for fats/oils/sweets, while nutrient density was highest for vegetables. Price per serving was lowest for fats/oils/sweets and highest for meats. “Educational messages focusing on a complete diet should consider the role of food costs and provide specific recommendations for increasing nutrient-dense foods by replacing a portion of the meat serving at meals with culturally acceptable lower-cost nutrient-dense foods.”	Connell et al., 2012
Level 1	Is the relationship between energy density of foods and price per kilocalorie real or spurious?	4430 different foods and 25 different food sub groups from the National Health and Nutrition Examination Study (NHANES) 2003-04.	Perform statistical tests to check the relationship. (Develop and demonstrate a simple test for the degree of spurious correlation between price of food per kilocalorie and energy density and apply to foods.)	Over all foods the relationship is spurious between price per kilocalorie and energy density. By food groups, 92% of the relationships between price per kilocalorie and energy density are spurious.	Davis & Carlson, 2012

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	How do prices of healthier versus less healthy foods/diet patterns relate?	<p>27 studies from 10 countries. Papers from MEDLINE (2000–2011), expert consultations and reviews of reference lists and related citations. Of the studies used, 12 were market surveys, 15 dietary surveys.</p> <p>Number of foods evaluated by the market surveys ranged from 2 to 133, with prices collected from between 1 and 1,230 stores. Number of participants covered by dietary surveys ranged from 30 to 78,191.</p> <p>Several studies reported prices for more than one food comparison or from different types of stores, contributing more than one estimate to the analysis.</p>	<p>Systematic review and meta-analysis of price of healthy versus less healthy foods/diet patterns; accounting for key sources of heterogeneity.</p> <p>Studies included report mean retail price of foods or diets stratified by healthfulness.</p> <p>Random effects Models used to quantify price differences between healthier/less healthy options across food types, diet patterns, and units of price (by serving, day, and calorie).</p> <p>[Prices deflated and converted to US\$ PPP 2011]</p>	<p>Of the food groups, meats/protein saw largest price differences between healthy and less healthy options: former cost \$0.29/serving (95% CI \$0.19 to \$0.40) and latter \$0.47/200 kcal (\$0.42 to \$0.53).</p> <p>Smaller price differences (across healthier/less-healthy) per serving were seen for grains (\$0.03), dairy (–\$0.004), snacks/sweets (\$0.12) and fats/oils (\$0.02; $p < 0.05$ each). Differences were not significant for soda/juice (\$0.11, $p = 0.64$).</p> <p>Comparing top vs bottom quantile of food-based diet patterns, healthier diets cost \$1.48/day (\$1.01 to \$1.95) and \$1.54/2000 kcal (\$1.15 to \$1.94) more.</p> <p>Comparing nutrient-based patterns, price per day was not significantly different (top vs bottom quantile: \$0.04; $p = 0.916$), though price per 2000 kcal was \$1.56 (\$0.61 to \$2.51) more. Adjusting for intensity of difference in health quality yielded similar results.</p> <p>NOTE: This is a review including studies from beyond the US, but over half of the studies reviewed used US data: of the 27 studies included, 14 were in the US, 2 in Canada, 6 in Europe, and the remaining 5 were from South Africa, New Zealand, Japan, and Brazil.</p>	Rao et al., 2013

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	How effective are price-based interventions to promote consumption of healthier foods in workplace and school settings?	A review of studies looking at interventions in schools and worksites lowering the prices of healthy options, or increasing the availability of healthy options	Studies examined included: one offering lower prices and promotion of lower-fat snacks in vending machines at 12 worksites and 12 secondary schools; one looking at impact of 50% price reduction of fresh fruit and baby carrots in 2 secondary schools	<p>For the first study, price reductions of 10%, 25% and 50% on lower-fat snacks increased sales by 9%, 39% and 93%, respectively, compared to usual-price conditions.</p> <p>For the second study, sales of fresh fruit increased 4-fold while prices were reduced, from 14 items per week to about 63 items per week, while sales of baby carrots increased 2-fold, from 37 packets per week to 77 packets per week. Sales returned to baseline levels with reinstatement of usual prices</p> <p>School-based environmental interventions to increase availability and promotion of lower-fat foods and healthier snacks can increase purchase of these foods among adolescents</p> <p>Findings imply that removing price incentives for “supersize” portions on high-fat, energy-dense foods might be an effective strategy to limit the purchase and consumption of low nutrient-density foods.</p> <p>Pricing strategies potentially could be used to encourage fruit and vegetable consumption through government price subsidization or to influence food choices among participants in government-sponsored food assistance programs.</p>	French, 2005

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	What is the link between young adults' intake of fruit and vegetables; and the prices of fruits and vegetables, other food at home groceries, and fast food, and the availability of restaurants and food stores?	2002 wave of data collected from US young adults aged 18-23 in the 1997 National Longitudinal Survey of Youth.	Geographically merged youth data with information on food prices, restaurants, and food store availability. Estimation of multivariate negative binomial count models	Higher levels of fruit and vegetable intake were associated with lower fruit and vegetable prices (price elasticity of -0.32). This own-price effect was robust to the inclusion of other food prices and food outlet availability. Young adults with lower-income and lower-education, those with lower educated mothers and middle-income parents were the most price sensitive. No statistically significant cross-price effects on fruit and vegetable consumption were found with other grocery prices (meat, dairy and bread); or fast food prices. Fiscal policy instruments such as subsidies on fruits and vegetables may help to increase their intake among in particular, young adults of relatively low socioeconomic status.	Powell et al., 2009a

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	How do price changes affect demand for various foods?	<p>Review of 160 US studies on price elasticity of demand for major food categories.</p> <p>Review of original research articles published in English between 1938 and September 2007. As well as peer-reviewed journals, included working papers, dissertations, and USDA technical reports</p>	Mean elasticities assessed by food category and variations in estimates by study design assessed.	<p>Price elasticities for foods and non-alcoholic beverages ranged from 0.27 to 0.81 (absolute values). Food away from home, soft drinks, juice, and meats were most responsive to price changes (0.7–0.8).</p> <p>For example, a 10% increase in soft drink prices should reduce consumption by 8% to 10%.</p> <p>“Estimates were relatively less inelastic for soft drinks (0.79), juice (0.76), meats (0.68–0.75), fruit (0.70), and cereals (0.60) and most inelastic for eggs (0.27), sugars and sweets (0.34), cheese (0.44), and fats and oils (0.48). Food away from home was most responsive to changes in prices among other categories (0.81) and more elastic than demand for food at home (0.59; however, the latter value is based on 7 studies)”</p> <p>Studies estimating price effects on substitutions from unhealthy to healthy food and price responsiveness among at-risk populations are needed.</p>	Andreyeva et al., 2010

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	What is the relation between prices of food at home (groceries), fast food away from home, and availability of foods shops and restaurants, with the frequency of adolescents food consumption.	<p>Data on adolescents from Child Development Supplement of the Panel Study of Income Dynamics was combined at the zip code level with external economic contextual data.</p> <p>Adolescent consumption of fruit and fruit juices, meat, non-meat protein, dairy, grains and sweets included.</p>	Multivariate regression analyses used to estimate associations between food consumption categories and economic contextual factors. Regressions were also estimated by households' poverty status.	<p>Neither fast food nor food at home prices were significantly associated with any of the food consumption categories in the full sample.</p> <p>But, among poor adolescents, higher fast food prices were associated with higher levels of nonmeat protein consumption.</p> <p>Food store outlet availability had some very small significant associations with some food consumption categories but no significant associations were found for restaurant outlets.</p> <p>Food away from home prices such as fast food prices and supermarket and grocery store availability were associated with some food consumption categories among low-income youths – related policies deserve further examination.</p>	Powell and Han, 2011
Level 1 to 2	To examine the association between food prices and food consumption in 5 th and 8 th grade children.	Consumption data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), price data from American Chamber of Commerce Researchers Association (ACCRA), and contextual outlet density data from Dun and Bradstreet (D&B)	Individual-level random effects models were used	<p>Factors including the price of fast food, median household income, and fast food restaurant outlet densities were significantly associated with fast food consumption patterns in the children.</p> <p>A 10% increase in the price of fast food was associated with 5.7% lower frequency of weekly fast food consumption.</p>	Khan et al., 2012

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	What evidence exists from field interventions on assessing effectiveness of monetary subsidies on promoting healthier food purchases and consumption?	<p>Literature on field experiment interventions on adolescents 12-17 or adults 18 and over were included. Population sub-groups included school/university students, metropolitan transit workers, and low-income women.</p> <p>Studies in English language over 1990 to 2012 included.</p> <p>24 articles on 20 distinct experiments were included.</p>	<p>Systematic review of evidence. Evidence included randomized control trials, cohort studies, and pre-post studies.</p> <p>Subsidies included price discounts or vouchers for healthier foods: fruits, vegetables, low-fat snacks sold in supermarkets, cafeterias, vending machines, farmers' markets, or restaurants.</p> <p>Outcome variables looked at were food purchases or consumption.</p>	<p>All the studies but one found subsidies on healthier foods to significantly increase the purchase and consumption of promoted products. The one null finding likely owed to its small financial incentive (50 cents towards the purchase of any fruit or vegetable).</p> <p>Limitations of the studies included were: small and convenience samples, short intervention and follow-up duration, and lack of cost-effectiveness and overall diet assessment.</p> <p>Overall however, subsidising healthier foods tends to be effective in modifying dietary behavior. Future studies should examine its long-term effectiveness and cost-effectiveness at the population level and its impact on overall diet intake.</p> <p>NOTE: Study assesses interventions in 7 countries, most of them in the US (14); with one each in New Zealand, France, Germany, Netherlands, South Africa and the UK.</p>	An, 2013

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Levels 2 and 3	Seeks to assess causes of the obesity epidemic to distinguish between important and less important behavioural changes, and relate them to environmental incentives.	<p>Literature review and analysis of data on major causes of the overweight and obesity epidemic in the US.</p> <p>Looks for instance at trends in calorie consumption.</p>	Literature review, economic analysis.	<p>In order to prevent obesity, interventions need to affect the whole population, not only selected subgroups.</p> <p>There have been very large changes in food consumption patterns, while there seems to have been no similar dramatic change in physical activity. Data support fewer changes in physical activity levels than people commonly believe have occurred.</p> <p>In food availability trends, a rise in caloric sweeteners and carbohydrates stands out.</p> <p>In all areas and population groups surveyed, average daily discretionary calories from salted snacks, biscuits, sweets and soft drinks exceed the discretionary calories recommended in the Dietary Guidelines for energy balance and essential nutrients – for example, by over 60% in Los Angeles to over 120% in Louisiana.</p> <p>The ratio of consumed to recommended discretionary calories is a significant predictor of BMI in the population, in contrast to fruit/vegetable consumption and physical activity.</p> <p>While many policies focus on positive messages like increasing fruit and vegetable intake and physical activity, more emphasis on reducing calorie consumption, especially sugar-sweetened beverages and salty snacks may be a promising lever and should get more attention. Most adults exceed the amount of ‘discretionary calories’ for energy balance</p> <p>Though boosting fruit/vegetable consumption may be good for other health reasons, it is not likely to be an effective tool for obesity prevention.</p>	Sturm, 2008

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 3	To what extent do food prices and restaurant outlet density influence adolescent fruit and vegetable consumption, their BMIs, and their chance of being overweight?	<p>Data on adolescents grades 8 and 10, from the Monitoring the Future, nationally representative surveys from 1997 to 2003.</p> <p>Fast food and fruit and veg prices from the American Chamber of Commerce Researchers Association and fast food and full service restaurant outlet density from Dun & Bradstreet.</p>	<p>Price indices were created for fast foods (simple average of the 3 prices: McDonald's Quarter Pounder with cheese, Pizza Hut or Pizza Inn pizza, and a KFC or Church's Chicken chicken meal); and for fruits and vegetables [weighted average of 7 fruits and vegetables (bananas, canned peaches, canned sweet peas, canned tomatoes, lettuce, potatoes, and frozen corn) based on household expenditure shares].</p> <p>Repeated cross-sections of individual-level data are analysed</p>	<p>Fast food meal prices are important determinants of adolescents' body weight and eating habits: a 10% increase in the price of a fast food meal leads to a 3.0% increase in the probability of frequent fruit and vegetable consumption, a 0.4% decrease in BMI, and a 5.9% decrease in probability of overweight.</p> <p>The price of fruits and vegetables, and restaurant outlet density are less important determinants.</p> <p>Changes in all observed economic and socio-demographic characteristics together only explain roughly one-quarter of the change in mean BMI and one-fifth of the change in overweight over the 1997-2003 sampling period.</p>	Powell et al., 2007
Level 1 to 2 and 1 to 3	Does changing the cost of unhealthy foods in relation to healthy foods (i.e. via tax or subsidy measures) lead to changes in food consumption patterns and overall diet enough to reduce people's weights?	Literature review; data from multiple sources	<p>Study of empirical evidence regarding food and restaurant price sensitivity of weight outcomes.</p> <p>Literature review of studies published between 1990 and 2008.</p>	<p>Studies reviewed showed that when statistically significant links were found between food and restaurant prices (taxes) and weight outcomes, effects were generally small in magnitude.</p> <p>In some cases however they were larger for populations of lower socio-economic status, as well as for those at-risk of overweight or obesity.</p> <p>Limited evidence suggests small taxes or subsidies are not likely to produce significant changes in BMI or obesity prevalence, though stronger pricing interventions may have some measurable effects on Americans' weight outcomes: especially for children, adolescents, low socio-economic status populations, and those most at risk for overweight.</p>	Powell and Chaloupka, 2009

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 3	Do fiscal pricing policies such as soda taxes lower soda consumption, and in turn, reduce weight among adolescents in the US?	Cross-sections of individual level data on adolescents was drawn from the Monitoring the Future surveys (nationally representative) and combined with state-level tax data, as well as local area contextual measures for the years 1997 to 2006.	Multivariate linear regression analyses to examine the associations between state-level grocery store and vending machine soda taxes and adolescent body mass index (BMI).	No statistically significant associations between state-level soda taxes and adolescent BMI were discovered. A weak economic and statistically significant effect was found between rates of soda tax in vending machines and BMI among teens at risk for overweight. State-level tax rates would need to be raised substantially from existing levels to detect significant associations between taxes and adolescent weight.	Powell et al., 2009b

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 3	To what extent are the poor dietary behaviours and high overweight prevalence of adolescents driven by: Economic contextual factors such as food prices and food store/ restaurant availability, as well as racial/ethnic and Socio-economic factors?	<p>Studies included use nationally representative data, focus on US Adolescents</p> <p>Food price data from American Chamber of Commerce Researchers Association (ACCRA) covering over 300 US cities; fruits and vegetables, dairy, meat, fast foods and soft drink prices included.</p> <p>Data on food outlet density from Dun and Bradstreet (D&B) for 28,050 zip codes. Census 2000 data on neighbourhood racial and ethnic characteristics, socio-economic status (SES), and measures of population, urbanization, and region.</p> <p>BMI data from National Longitudinal Survey of Youth</p>	Synthesis of a number of studies – both cross-sectional and longitudinal – dealing with the question of how prices of healthy foods have changed relative to less healthy foods; how restaurant and food store availability varies by the socioeconomic status of neighbourhoods, and their race and ethnicity (multivariate analysis of food store availability); and how relative changes in food prices have influenced youth BMI, keeping additional factors controlled (such as supermarket availability, and availability of physical-activity related facilities)	<p>Healthy foods increasingly cost more than less healthy ones. Fast food outlet numbers are growing. Real prices of fruits and vegetables, dairy products, and meat were generally flat over 1990 – 2007; real prices of fast foods and soft drinks fell by 12% and 32% respectively over the same period.</p> <p>Chain supermarkets in African-American areas only 52% as prevalent as in White areas. Hispanic populations have one-third the access of non-Hispanics. Small grocery shops and non-chain supermarkets more prevalent in racial and ethnic minority zip codes and in low-income areas. Over 1997 to 2008, increasing gap in access to supermarkets between African-American and White neighbourhoods and lower and higher income areas seen.</p> <p>Low- to middle-income areas have 1.25–1.3 times as many fast food restaurants as high-income areas. Proportion of fast food restaurants compared to total restaurant availability in the US went from 17% in 1997 to 30% in 2006. Fast-food restaurants and convenience stores are readily available around US secondary schools, especially those in larger cities and/or low income neighbourhoods.</p> <p>Longitudinal, individual-level, fixed effects results confirm cross-sectional findings that the price of fast food, but not availability of fast food restaurants, has a significant effect on teen BMI; with price elasticity of –0.08 (compared with the price elasticity of –0.10 estimated using a cross-sectional model).</p> <p>Weight of teens in lower to middle-SES families was most sensitive to fast food prices. No significant relationships between food outlet density measures and adolescent BMI, although outlets were only matched at the broad county level.</p>	Powell et al., 2010

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 3	Are the small state sales taxes on soda likely to change consumption and weight gain among children, or are larger taxes needed?	<p>Data from Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K); nationally representative. 1998 kindergarten students followed to fifth grade (spring 2004)</p> <p>Data on over 7,000 children</p> <p>Combined with data on state-level grocery store soda taxes that were in effect for the year over which the study data were collected. Data from Robert Wood Johnson Foundation.</p>	<p>All sugar-sweetened beverages are included but referred to as ‘soda’ given this accounts for the major share of consumption.</p> <p>Dependent variables: soda consumption in the past week, soda purchases at school, changes in BMI between grades 3 and 5.</p> <p>Other variables included: child’s age in months, race and ethnicity, sex, family income measures, mother’s education level, parents’ reports of the number of times the child was vigorously physically active per week, weekly television hour, and measures of parent-child interaction. For analysing BMI birth weight was also included.</p> <p>Best-fit models were determined. Relating taxes and consumption, the best-fit model was a gamma regression with a log link. Relating taxes and BMI, OLS was the best-fit.</p> <p>Variation in tax-rates is cross-sectional, even if the individual outcome variable (BMI change) is longitudinal</p>	<p>Existing taxes on soda, typically not much higher than 4 percent in grocery stores, do not substantially affect overall levels of soda consumption or obesity rates.</p> <p>However, sub-groups of at-risk children (those already overweight, those from low-income families, or those who are African American) may be more sensitive than others to soda taxes, particularly when soda is available in schools.</p> <p>A higher impact could be attained from these small state taxes were their revenues used to develop other obesity prevention schemes.</p>	Sturm et al., 2010

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Levels 1 to 2 and 1 to 3	What associations exist between on the one hand, price indices of fast foods and fruits and vegetables, and on the other the dietary intakes and BMI of US children and adolescents?	Data from the Continuing Survey of Food Intakes by Individuals (CSFII; 1994–1998) for 6759 children (2–9 y) and 1679 adolescents (10–18 y).	<p>Indices on fast food and fruit and vegetable prices were linked to individual CSFII diet data at the city level.</p> <p>Main outcomes included intakes of selected nutrients and food groups; a fast-food consumption index, diet quality using the 2005 Healthy Eating Index, and BMI.</p>	<p>Among 2 to 9 year olds, a higher fast-food price index (by \$1) was associated with intakes of lower fast-food consumption index, higher Healthy eating Index, higher intake of fibre, calcium, dairy, and fruits and vegetables. The fruit and vegetable price index was related to lower fibre intake and higher BMIs.</p> <p>Findings for 10 to 18 year olds were less consistent.</p> <p>Significant associations were almost equally balanced between low and high family income groups, with some significant interactions between food prices and family income observed, particularly among the younger group of children.</p> <p>Suggest among U.S. children aged 2–9, higher fast food prices are associated with better dietary quality, while higher fruit and vegetable prices are linked to higher BMIs and lower fibre intakes.</p>	Beydoun et al., 2011
Level 1 to 2 and 1 to 3	How do food prices influence youth diet and weight gain, leading to geographic disparities in obesity?	Observational study using individual-level survey data of children in grade 5 (average age 11 years) and regional food prices based on store visits in 2004.	<p>Examine the association between regional prices and how frequently fruits and vegetables, and less healthy snack items are consumed among elementary school children in the USA.</p> <p>Multivariate regression analysis used. Dependent variables – self-reported consumption frequency. Main explanatory variables are metropolitan area food prices relative to cost of living.</p>	<p>Price variation across metropolitan areas exists, and lower real prices for vegetables and fruits predict significantly higher intake frequency. Higher dairy prices predict lower frequency of milk consumption, while higher meat prices predict increased milk consumption. Similar price effects were not found for fast food or soft drink consumption.</p> <p>The geographic variation in food prices across the USA is sufficiently large to affect dietary patterns among youth for fruit, vegetables and milk. This suggests that either the price variation is too small to affect children’s consumption frequency of fast food or soft drinks, or that the consumption of these foods is less price-sensitive.</p>	Sturm and Datar, 2011

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 3	Systematic review of recent U.S. studies on the price elasticity of demand for sugar-sweetened beverages (SSBs), fast food, and fruits and vegetables. Also systematically reviews the direct associations of prices/ taxes with weight outcomes.	<p>Reviews 41 studies for the US looking at the relationship between prices/ taxes/ subsidies and consumption or weight outcomes</p> <p>21 studies were included as part of the review on the effect of prices on consumption.</p> <p>20 studies were included as part of the review on the effects of prices on body weight outcomes.</p>	Review of literature published between Jan 2007 and March 2012, excluding simulation studies.	<p>Mixed results seen. Some signs that fiscal policies have stronger effect on those on low incomes and on SNAP programme.</p> <p>For fast food, several studies could not find significant estimates of price elasticity. The two that did found inelastic response.</p> <p>Fruit and vegetables show moderate inelasticity, though combining the categories, this falls to around -0.25 to -0.30.</p> <p>Longitudinal studies suggest that cross-section analyses are less reliable, since they do not take into account individual fixed effects.</p> <p>By and large, people are sensitive to prices, with low income groups especially so for subs on fruit and vegetables, and youth for fast food and SSBs.</p>	Powell et al., 2013

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 to 3	<p>What is the current understanding of the role of economic factors in the US obesity epidemic?</p> <p>Seeks to dispel some widely held, incorrect, beliefs.</p>	Review and synthesis of literature; Includes trends in BMI from analysis of data from Behavioral Risk Factor Surveillance System in the US for example; data on consumption from USDA.	<p>Literature review and analysis of trends. Examines data on trends in BMI for different groups (socio-demographic and geographic), trends in people's time use, food availability and intake, and trends in the built environment.</p> <p>Policy approaches are assessed and discussed.</p>	<p>Rising obesity rates coincided with increases in leisure time (rather than increased work hours), increased fruit and vegetable availability (rather than a decline in healthier foods), and increased exercise uptake.</p> <p>As a share of disposable income, Americans now have the cheapest food available in history, which fuelled the obesity epidemic.</p> <p>Weight gain was surprisingly similar across socio-demographic groups or geographic areas, rather than specific to some groups (at every point in time however, there are clear disparities): therefore to understand the role of the environment in the obesity epidemic, it is necessary to understand changes over time affecting all groups, not differences between subgroups at a given time.</p> <p>Economic and technological changes in the environment drove the obesity epidemic.</p> <p>Evidence for effective economic policies to prevent obesity is limited. Taxes or subsidies could nudge behaviour toward healthier diets; but even large price changes for healthy foods would only partially close the gap between diet guidelines and actual consumption.</p>	Sturm and An, 2014

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	How prices of food in fast food restaurants, the density of restaurants, and other factors including cigarette use; might influence BMI	Height and weight data from repeated cross-sections of Behavioral Risk Factor Surveillance System (BRFSS), 1984 to 1999 (telephone survey of people ≥ 18 years). 15 states in the 1984 survey; 33 in 1987, 45 in 1990, and all 51 States in 1996. Data on fast-food and full-service restaurants, and full service prices from 1982, 1987, 1992, and 1997 Census of Retail Trade. Fast food restaurant prices and food-at-home prices from ACCRA Cost of Living Index (American Chamber of Commerce Researchers Association) - 250 to 300 cities.	Self-reported data on height and weight were corrected for measurement error, using correction factors obtained by a statistical model relating actual weight and height data to reported weight and height data for people 18 years and older in the Third National Health and Nutrition Examination Survey (NHANES III) for eight demographic groups, defined by race/ethnicity and sex. State-level variables were merged with BRFSS data Other variables included in the analysis: price of cigarettes, state location, race/ethnicity, schooling, marital status.	A 10% increase in prices at fast-food restaurants reduces probability of obesity by 0.65%; 10% increase in prices at full-service restaurants reduces probability of obesity by 0.67%; 10% increase in price of food at home reduces probability of obesity by 0.62%. Per capita number of restaurants and the real price of cigarettes have positive and significant effects on BMI and probability of being obese. Real prices of: fast-food restaurant food, food-at-home, and full-service restaurant food have negative and significant effects. Effects of the clean indoor air laws do not show a consistent pattern Race/ethnicity, schooling, marital status, and household income explain little of the changes in obesity through time; with the last three variables predicting reductions in obesity because schooling, real household income, and divorced portion of population grew in the period at issue, while the married portion of population fell.	Chou et al., 2004

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	What is the association between food prices and food outlet density, and changes in the BMI of primary school children in the USA?	Data from the Early Childhood Longitudinal Study, following a nationally representative sample of kindergarten children for 4 years (up to grade 3). Individual-level data merged to (a) metropolitan data on food prices and (b) per capita number of restaurants, grocery stores and convenience stores in the child's home and school zip code.	Mean changes analysed with least-squares regression; median changes and 85 th percentile changes with quantile regression.. Dependent variables were BMI changes over 1 and 3 years. Controlling for baseline BMI, age, real family income and socio-demographic characteristics.	<p>Geographic variation in fruit and vegetable prices is large enough to explain a meaningful amount of the differential gain in BMI among primary school children across metropolitan areas. Lower real prices for vegetables and fruits predicted a significantly smaller gain in BMI between kindergarten and grade 3; half of this effect occurring between grades K and 1.</p> <p>Lower meat prices raised BMI, though generally by a smaller magnitude, while the effect was not significant for BMI gain over 3 years.</p> <p>Differences across subgroups were not statistically significant, owing to small sample sizes in subgroup analyses – but effects were meaningfully larger for children in poverty, children already at risk for overweight or overweight in kindergarten, and Asian and Hispanic children.</p> <p>No significant effects for dairy or fast-food prices, nor for outlet density after controlling for individual characteristics and random intercepts to adjust standard errors for the sampling design.</p>	Sturm and Datar, 2005
Level 1 to 3	How sensitive are people's weights (BMI, being overweight or obese) to relative food prices.	Nationally representative, survey data including measures of BMI over 1982 – 1996 from the National Health Interview Survey (NHIS) Data on individual food prices from the US Bureau of Labour Statistics for 1980 - 2003	They combine the food price data at the regional level [Constructing indices of 'healthful' and 'unhealthful' foods (their index weights foods equally)] with micro data from the NHIS; cross-sectional. (Though price data is through time, they don't have longitudinal data on individuals.)	<p>Findings suggest a 1% growth in BMI and incidence of being overweight or obese is explained by relative prices of healthful and unhealthful foods.</p> <p>Estimates imply that a 100% tax on unhealthful foods could reduce average BMI by around 1%; while the same tax could reduce incidence of overweight by 2% and obesity by 1%.</p> <p>Conclude that their estimates suggest statistically significant but economically insubstantial effects.</p>	Gelbach et al., 2009

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	What is the relationship between adolescent BMI and fast food prices and fast food restaurant availability?	<p>Four waves of the 1997 National Longitudinal Survey of Youth.</p> <p>Adolescents aged 12 to 17 in 1997, followed 1997 to 2000</p>	<p>Panel data estimation methods, accounting for individual-level unobserved heterogeneity.</p> <p>Also control for: general food prices, the availability of full-service restaurants, supermarkets, grocery stores, convenience stores and commercial physical activity-related facilities.</p> <p>Cross-sectional and longitudinal models are compared.</p>	<p>Longitudinal individual-level fixed effects results confirm cross-sectional findings: price of fast food but not availability of fast food outlets has a statistically significant effect on teen BMI with an estimated price elasticity of -0.08 – such that a 10% increase in the price of fast food would lead to 0.8% decrease in teen BMI. The cross-sectional model may over-estimate the price of fast food effect on BMI by about 25%.</p> <p>Evidence suggests the association is stronger for low- to middle-socio-economic status teens (those in low income households with mothers with low education).</p>	Powell, 2009
Level 1 to 3	How important are food prices and restaurant and food shop outlet availability for children's body mass indices (BMIs)?	<p>1998, 2000 and 2002 waves of the child-mother merged files from the 1979 cohort of the National Longitudinal Survey of Youth combined with fruit and vegetable and fast food price data obtained from the American Chamber of Commerce Researchers Association and outlet density data on fast food and full-service restaurants and supermarkets, grocery stores and convenience stores obtained from Dun & Bradstreet.</p>	Random effects estimation model	<p>A 10% increase in the price of fruits and vegetables is linked to a 0.7% increase in child BMI.</p> <p>Influence of fast food prices was not statistically significant in the full sample, but weakly negatively associated with BMI among adolescents with an estimated price elasticity of -0.12.</p> <p>The association between food outlet density and child BMI differed depending on whether it was defined as per capita or per land area basis.</p> <p>Associations of fruit and vegetable and fast food prices with BMI were significantly stronger (economically and statistically) among low- versus high-socioeconomic status children. Estimated fruit and vegetable and fast food price elasticities were 0.14 and -0.26, respectively, among low-income children and 0.09 and -0.13, respectively, among children with less educated mothers.</p>	Powell and Bao, 2009

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	How effective are policies on vending machine restrictions and taxes on soft drinks on children's BMI?	<p>Nationally representative data on soft drink consumption and vending machine restrictions from the Early Childhood Longitudinal Study–Kindergarten Cohort. Focus on grades 5 and 8 (only waves with soft drink consumption and access data)</p> <p>Soft drink taxes effect on soft drink consumption and weight among children and adolescents analysed with data from the National Health and Nutrition Examination Survey (NHANES) III (1988–1994) and IV (1999–2006).</p>	Cross-sectional study, merging data across different surveys	<p>No evidence can be found that, as currently practiced, neither taxes nor vending machine restrictions are effective at reducing children's weight.</p> <p>While students with limited access to vending machines consumed less soda from these sources, frequency of consumption varied little across the restricted and non-restricted groups. For grade 5 children, 86% in schools with access to soft drinks reported drinking any soft drink in the past week, compared to 84% of those in schools with limited access.</p> <p>Changes that may increase their effectiveness, include comprehensive restrictions on access to soft drinks in schools and imposing higher tax rates.</p>	Fletcher et al., 2010

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	How have trends in the relative prices of foods (in older cohort of adults) affected people's BMI measures?	<p>Health and Retirement Study data, original cohort (with at least one member of the household born between 1931 and 1941) first interviewed in 1992; followed biennially until 2004. Sample of 3,111 individuals; data on BMI and other factors</p> <p>Data on food prices from the ACCRA Cost of Living data, published quarterly by the American Chamber of Commerce Researchers Association (ACCRA), for > 200 cities. Data from 1992 to 2003</p>	<p>An index of the price of foods is constructed out of foods measured in price per calorie (so increases in the index can be interpreted in relative increases in the price of high-calorie foods)</p> <p>Regressions are performed with different models: with BMI and food prices alone, with these together with the other variables; regressions with logs of BMI and prices per calorie are also run; coefficients returned interpreted as elasticities.</p> <p>Other variables included: prices of cigarettes, gasoline, non-food goods (except cigarettes/ gasoline); self-reported diagnosis of chronic conditions, self-rated health, marital status, whether working for pay, household income/wealth, health insurance status, time dummies.</p>	<p>A 10 percent drop in price per calorie is associated with a BMI increase of approximately 0.26 units, or a 0.77% rise within two years.</p> <p>The effect of food prices on BMI is thought to be statistically similar across obese and non-obese populations. No significant difference was established across poor and non-poor populations.</p> <p>While the short- term effect of price per calorie on BMI appears relatively small, the long-run effect of price per calorie may be larger. After ten years, a permanent 10% reduction in price per calorie is linked to BMI increasing by 1.05 units (2.5%). Over the full span of the study, this equates to a rise in BMI of 2.2 units, or 5.1% – non-trivial compared to total growth in mean BMI over the period.</p>	Goldman et al., 2011

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	What effect do changing prices of certain foods have on children's BMIs?	<p>Nationally representative sample of kindergarten students entering in 1998/99 were followed to 8th grade (2007). The sample of students without any explanatory variable data missing was 15,090.</p> <p>(Hawaii was excluded owing to lack of food price data).</p> <p>Food prices are from the Quarterly Food-At-Home Price Database constructed from Nielsen Homescan Data (whereby households report Food-at-home purchases from all stores). The database includes market prices for areas across the US including 26 metropolitan markets.</p>	Longitudinal study. This is a fixed-effects model that provides short run estimates of price effects.	<p>10% decrease in low-fat milk price (previous quarter) decreases BMI 0.35%; 10% decrease in price of dark green vegetables* (previous quarter) decreases BMI 0.28%. These price changes have a larger effect on children with higher BMI than children of average weight.</p> <p>10% increase in price of carbonated beverages (one year prior) decreases BMI 0.42% (with a greater effect on children in low-income*** households); 10% price increase in fruit juices (100% juice) or starchy vegetables** (one year prior) decreases BMI 0.3%. These two price changes have a greater impact on children of average weight than on Children with higher BMIs.</p> <p>Decrease in the price of sweet snacks (previous quarter) increases BMI 0.27% - though sometimes observed changes are more delayed.</p> <p>Notes: *Dark green vegetables includes for instance spinach and broccoli, while **starchy vegetables includes for instance potatoes and corn; ***low-income households refers to those with income below 200% of the Federal poverty line.</p>	Wendt & Todd, 2011

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	What effect do food prices have on clinical obesity – including body mass index (BMI) and percentage body fat (PBF)	<p>Data from several waves of National Health and Nutrition Examination Survey (NHANES); cross-sectional, nationally representative, for the years 1999-2000, 2001-2002, and 2003-2004 – these have measures of body fat as well as BMI.</p> <p>Youths aged 12 through 18. Data from National Health and Nutrition Examination Survey (NHANES); merged with food price data by county and year.</p> <p>Food prices from the Council of Community and Economic Research (C2ER) Cost of Living Index, which has been published quarterly since 1968 for between 250 and 300 cities</p> <p>Also data on sex, race/ethnicity, household headship, size, education.</p>	<p>Body fat measures derived from bioelectrical impedance analysis (BIA) and dual energy x-ray absorptiometry (DXA).</p> <p>Regression with obesity outcomes a function of real prices of a calories in food for home consumption, food sold by fast-food restaurants; and youth and household characteristics including race and ethnicity, age in months, family income relative to the poverty threshold, household type (head married, headed by female, headed by male), household size, and household head education; as well as fixed effects for the year over which data is observed and county in which the subject resides.</p>	<p>Increases in real price per calorie of food – for home consumption, and in the real price of fast food lead to lower obesity in youths; while increases in real prices of fruits and vegetables lead to higher obesity in youths.</p> <p>Percentage body fat (PBF) measures derived from BIA and DXA are no less sensitive – and in some cases more sensitive to such price changes than BMI.</p> <p>Prices of fruits and vegetables are more important in determining female PBF than male PBF. A 10% rise in fruit and vegetable prices causes PBF rises of 9% for females and 7% for males (significant only for females).</p> <p>On the other hand, the price of a calorie in food consumed at home or in fast-food restaurants plays a more important role, as reflected by elasticities, in male than in female body fatness</p>	Grossman et al., 2013

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	To examine associations between local food prices and children's BMI, weight and food security outcomes.	<p>Nationally representative data from the Early Childhood Longitudinal Study-Birth Cohort, a nationally representative study of children from infancy to age 5</p> <p>Linked to local food price data from the Council for Community and Economic Research (C2ER) Cost-of-Living Index (n = 11,700 observations).</p>	<p>Ordinary least squares (OLS), linear probability, and within-child fixed effects (FE) models were used.</p> <p>Focus on a subsample of households under 300% of the Federal Poverty Level.</p>	<p>Ordinary Least Squares and Fixed Effects models indicate higher-priced fruit and vegetables are linked to higher BMIs for children. This relationship is driven by prices of fresh (versus frozen or canned) fruits and vegetables.</p> <p>In Fixed Effects models, higher prices for soft drinks are linked to a lower likelihood of being overweight, but (surprisingly) higher fast food prices are also linked with a greater likelihood of being overweight.</p>	Morrissey et al., 2014

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	To investigate the concurrent growth of obesity and relative food price reduction between 1976 and 2001 and see how they are related. Also to control for a number of other variables – see next column.	National Health Interview Survey; Consumer Price Index (CPI), Current Population Survey (CPS), County Business Patterns (CBP) and Historical Metropolitan Area Definitions (HMAD); all over 1976-2001.	<p>Uses first-difference and fixed effects approaches - both consistently suggest relative food prices have strong impacts on obesity; with more pronounced impacts among the low-educated.</p> <p>Dependent variables were changes in: BMI, obesity. Independent variables included were changes in: relative food prices at home, relative food prices away from home, female hours work per week, female wage rates, male hours of work per week, male wage rates; unemployment rates, income per capita, grocery/ convenience stores per capita; restaurants per capita; fitness & recreational centres per capita; as well as changes at an individual level in family income, age; and marital status, race, education, and sex.</p>	Findings suggest relative food price reductions over the time period could plausibly explain some 18% of the increase in obesity among US adults in metropolitan areas.	Xu et al., 2014

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Levels 1 to 2, 3,4	To examine association of food prices with individual intake in the US	<p>20-year longitudinal study including 12,123 respondent days from 5,115 participants in the Coronary Artery Risk Development in Young Adults (CARDIA) Study.</p> <p>Data from 1985-86, 1992-93, and 2005-06 were used since in these years dietary data was collected.</p> <p>Variables examined include food prices, dietary intake, overall energy intake, weight, and HOMA insulin resistance (HOMA-IR) scores</p>	Variables were assessed using conditional log-log and linear regression models.	<p>The real (2006) prices of soda and pizza decreased over time; the price of whole milk increased.</p> <p>A 10% rise in the price of soda or pizza was linked to a 7.12% or 11.5% decrease in energy from these foods respectively. A \$1.00 increase in price of soda was linked to a fall in daily energy intake of 124 kcal, a lowering of weight by 2.34lbs, and a lowering of HOMA-IR score by 0.42; similar trends were observed for pizza.</p> <p>A \$1.00 increase in the price of both soda and pizza was associated with greater falls in total energy intake of 181.49kcal, in body weight of 3.66 lbs), and HOMA-IR of 0.45.</p> <p>Policies aimed at altering the price of soda or away-from-home pizza may be effective mechanisms to steer US adults toward a more healthful diet and help reduce long-term weight gain or insulin levels over time.</p>	Duffey et al., 2009

Source: Authors construction – sources see RH column. Note: this is not an exhaustive list of the literature, but focuses on key, relatively recent literature.

Annex I References

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Annex II: Charting relative price trends and summary of key literature for the UK

Table II.1: Summary of key UK literature on relative prices

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	What is the geographical and time heterogeneity of estimated price of an unhealthy basket of 'junk' food relative to fruit and vegetable prices?	UK data from the National Food Surveys, the Household Expenditure Surveys, and the Living Costs and Food Survey. Data runs from 1997 to 2009	Data harmonized across the surveys and merged to compose a set of household figures. An 'unhealthy' basket of food has been constructed focusing on the 'big 6' foods high in fats, sugar, and salt identified by the Food Standard Agency: confectionery, soft drinks, crisps/savoury snacks, fast food, pre-sugared breakfast cereals and pre-prepared convenience foods. The 'healthy' basket includes fruit and vegetables. Regional prices are also estimated.	The prices of fruits and vegetables increased by about 7% relative to all foods over the 13 year period; while the price for junk food relative to all foods fell about 15%. Consumers have adjusted to some of these increases in fruits and vegetable prices by choosing cheaper options. Prices of junk foods moved in a similar way between London and Scotland. Fruits and vegetable prices rose in both places, but to a smaller extent in Scotland than in London.	Capacci et al., 2012

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	<p>To estimate mean energy density of the Scottish diet and the range of energy density across Scottish households. Also relates dietary costs with energy density.</p> <p>Spending is also examined, relating energy density to diet costs.</p>	<p>Purchase data from the Expenditure and Food survey (EFS) -- now the UK Living Costs and Food module of the Integrated Household Survey)</p> <p>Focus on Scottish households, with data from 2001 to 2008</p> <p>Examines impact of factors including socio-economic status, household composition, and for households meeting dietary recommendations compared to those who are not.</p>	<p>Energy density (for food and milk) is compared to a baseline from the World Cancer Research Fund suggesting the energy density goal for diets (excluding drinks, but not milk as this is classed as a 'food') is 125kcal per 100g of food and milk on average.</p>	<p>Households with the lowest quintile for energy density fell under the WCRF threshold, averaging 123kcal/100g.</p> <p>People in more deprived quintiles consume more energy-dense diets and spend less per 2000kcal than their less-deprived neighbours.</p> <p>Diets (food and milk) are more energy dense on average for single-parent households (183 kcal/100g) and other households with children (177 kcal/100g) than for households without children (single households for instance had an average of 169 kcal/100g)</p> <p>Mean energy density for food and milk consumed in households meeting targets for fat consumption ($\leq 35\%$ of food energy) and fruit and vegetable consumption ($>400\text{g/day}$) was 136 kcal per 100g. For households not meeting these targets, the equivalent figure was 175kcal/100g. Moreover, of the sample, only 309 households were meeting targets, compared to 4,168 households not meeting targets.</p> <p>Households in the fraction (quintile) with the least energy-dense diet consume around 123 kcal per 100g of food and milk, while those in the quintile with the most energy-dense diets consume 231 kcal per 100g of food and milk. Moreover, the cost paid per 2000 kcal for households in the lowest quintile of energy density is almost £5, while the equivalent cost for households in the highest quintile of energy density is just £3.76</p>	Wrieden and Barton, 2011.

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1	To track change over time in the prices of more and less healthy foods to determine price changes in affordability of a healthy diet in the UK	Economic data for 94 foods and beverages from the UK Consumer Price Index were linked to food and nutrient data from the UK Department of Health's National Diet and Nutrition Survey to produce a dataset covering 2002-2012.	Food items were assigned to a food group and categorized as 'more healthy' or 'less healthy' using a nutrient profiling model developed by the Food Standards Agency. Statistical significance was tested using a t-test and repeated measures ANOVA.	Mean (standard deviation) 2012 price/1000 kcal was £2.50 (0.29) for less healthy items and £7.49 (1.27) for more healthy items. ANOVA results confirmed that all prices rose over 2002–2012, but more healthy item prices rose faster than less healthy ones in absolute terms: £0.17 compared to £0.07/1000 kcal per year on average for more and less healthy items, respectively (p,0.001). “Since 2002, more healthy foods and beverages have been consistently more expensive than less healthy ones, with a growing gap between them. This trend is likely to make healthier diets less affordable over time, which may have implications for individual food security and population health, and it may exacerbate social inequalities in health. The novel data linkage employed here could be used as the basis for routine food price monitoring to inform public health policy.”	Jones et al., 2014
Level 1	What are the direct and indirect cost differences associated with eating a 'healthy' or 'unhealthy' diet.	Data from a baseline postal questionnaire for the UK Women's Cohort Study. Includes food frequency questionnaire (FFQ) supplemented by telephone interview of a sub-sample. 15,191 women aged 35 to 69 with similar numbers of meat-eaters, fish-eaters, and vegetarians. Prices from the 1995 National Food survey and the Tesco home shopping catalogue	Developed a healthy diet indicator (hdi) with values from 0 (least health) to 8 (healthiest) based on WHO recommendations. Cost of diets were calculated using prices and compared across hdi groups.	Women in the healthy diet group were almost four times as likely to be vegetarian and have a higher educational level. The direct cost difference between highest and lowest hdi groups was £1.48 day (equivalent to £540 year), with higher spending on fruits and vegetables the main reason why healthy diets were more expensive. 49% per cent of the food budget went to fruit and vegetables in hdi group 8 compared to 29% in hdi group 0. 52% of those questioned in both extreme hdi groups did not think that it was difficult to eat healthily. Factors predicting a healthy diet included: spending more money, being a vegetarian, having a higher energy intake, having a lower body mass index (BMI) and being older.	Cade et al., 1999

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	To determine food price elasticities and cross-price elasticities for several UK food products and use them in policy scenarios	Data from the Family Food Module of the Living Costs and Food Survey data.	<p>A Dynamic Almost Ideal Demand System (DAIDS) model is used</p> <p>Paper also provides elasticities to show how changes in food prices and food expenditure affect the intake of various nutrients by the UK population.</p> <p>Elasticities generated are used in scenarios. Of particular interest are: Scenario I - A fruit and vegetables subsidy of five percent and its effect on low income households; and Scenario II - A change in price of dairy and eggs.</p>	<p>Elasticities and cross-price elasticities are generated for aggregate food groups as well as sub-categories of food groups (detailed in long annexes)</p> <p>Subsidising fruit by 5% leads low income households to: increase fruits & nuts consumption by 2.92%; increase vegetable consumption by 0.615%; increase consumption of fish by 0.48%; increase dairy & egg consumption by 0.255%; increase meat consumption by 0.14%; decrease consumption of alcohol by 0.245%. The effect on the consumption of fats & starches is almost negligible (+0.08%).</p> <p>Subsidising vegetables by 5% increases vegetable consumption of low income households by 3.23%, and meat consumption by 0.45%. It decreases alcohol consumption by 0.615%, decreases fish consumption by 0.225%, and has a negligible effect on dairy, eggs, fats and starches.</p> <p>Nutrient elasticities show that subsidising fruits by 5% would increase intake of fructose (+1.365%) and vitamin C (+1.955%), while subsidising vegetable prices would increase the intake of carotenes (+1.935%), Vitamin C (+0.795%) and fibre (+0.485%).</p> <p>A 1% increase in the price of dairy & egg products results in declines in intake of beneficial nutrients such as calcium (-0.38%), iron (-0.348%), vitamin D (-0.459%) and zinc (-0.838%). While higher prices for dairy and egg products reduce calorie intake, they also reduce intake of nutrients that are beneficial to health.</p>	Tiffin et al., 2011

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	To estimate what impacts a tax on saturated fats would have on consumption, and who would bear the burden of the tax	<p>Uses very disaggregated data (at household (hh) and product level) with nutritional information at the product level.</p> <p>Data focus on butter and margarine purchases (as this accounts for highest share of saturated fat consumption in UK hh, 13.3% on average)</p> <p>154 butter/margarine products</p> <p>TNS World Panel data for 2006, all purchases of food using handheld scanners, with prices from till receipts for over 15K hh</p>	<p>Estimate impact of tax on consumer substitution patterns in differentiated product markets using a discrete choice demand model for specific food products. Focus on butter and margarine (highly substitutable products)</p> <p>Specification includes hh characteristics: size, income, region, class and type (with/out children, pensioner, single/dual parent), whether the main shopper is overweight.</p> <p>Estimated coefficients used to calculate own and cross-price elasticities for each product.</p>	<p>Saturated fat intensity varies from 0g to 57g across butter and margarine products.</p> <p>Short-term impact of a tax that adds 10p to the price for each 100g of saturated fat is considered (it's assumed firms don't change prices or reformulate product in the short-term): increases price by 12.5% on average across the products – ranging from 0% rise for 500g pack of Gold Lowest Extra Light, to 50% for a 500g pack of Netto vegetable spread.</p> <p>Volume of saturated fat and sodium purchased fall. On average, hh substitute to smaller pack sizes, so that they cut down more on overall purchase than they do on saturated fat intensity by substituting within the butter/margarine group.</p> <p>A 10p per 100g of saturated fat tax would reduce saturated fat intake on average by 3.8%, while increasing spending by 8.8%. The tax is predicted to have a slightly stronger effect on households with lower incomes (reducing it by 4 to 4.5% among households with incomes of <20k), and pensioners (reducing it by almost 4%).</p>	Griffith et al., 2009

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2	To explore the importance of retail promotions on sugary food purchases in Scotland	<p>Data covers 2006-2011, using home scanner panel data representative of the Scottish population. Dataset is the Kantar Worldpanel dataset for Scotland. Contains weekly purchase of food and drink for home consumption and information about prices paid, whether the product was on promotion, and type of promotion.</p> <p>The full panel (all the years) covers 3,694 households, though not all are observed each year as it is a rotating panel dataset whereby households remain in the sample for a maximum of three years.</p>	<p>Sugary foods in 3 categories are observed: take-home confectionary, frozen confectionary and ice cream, and non-diet soft-drinks.</p> <p>Purchasers are split into those with children at different ages, and those without children.</p>	<p>Results indicate that consumers respond to promotions on these sugary foods. In particular, the category of families with children have significantly increased purchases of sugary products over the period reviewed, owing in large part to price promotions.</p> <p>The dataset used in the paper is the Kantar Worldpanel dataset for Scotland (KWDS),</p> <p>Any growth observed in 2011 for take home confectionary and soft drinks owes only to the use of temporary price reductions. Growth in frozen confectionary and ice cream in contrast was driven mainly by price reductions in 2008 and 2009, multibuy promotion in 2010 and Y for £X promotion in 2011.</p> <p>Not using any promotions (relying on full-price) negatively affected the growth of purchases of the three categories of sugary products between 2008 and 2011.</p> <p>Results by different type of household show that young households and families with children have substantially increased purchases of sugary products, driven by different types of retail promotions</p> <p>Evidence from the top four supermarkets in Scotland show that their use of promotions have increased over time, reinforcing the idea that retailers have been using promotions to keep the expenditure growing during the recession. The authors suggest regulating the use of promotions in unhealthy food categories may have positive effects on quantities consumers buy.</p>	Revored-Giha and Akaichi, 2014

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
1 to 2	To illustrate patterns and trends in beverage intake in Great Britain and estimate how taxes might influence this consumption.	Surveys of individual diet intake and household food expenditures examined. Data from 1986 to 2009	Analysis of consumption data and estimates of the potential for pricing policy to promote healthier beverage buying patterns.	<p>In 2008–9, daily energy intake from beverages accounted for 21% of total energy intake for children aged 1.5 to 18; for 14% of total energy intake for children aged 4 to 18, and 18 % of total energy intake for adults aged 19 to 64.</p> <p>Since the 1990s high-fat dairy product consumption has decreased, while consumption of fruit juices and reduced-fat milk has increased for pre-schoolers, children and adolescents.</p> <p>Adults’ intake of high-fat milk, sweetened tea and coffee and other energy-containing drinks fell, while intake of reduced-fat milk, alcohol (especially beer) and fruit juice rose.</p> <p>Modelling suggested a 10 % increase in the price of SSB would reduce consumption by 7.5ml per person per day; while a 10 % tax on high-fat milk would reduce high-fat milk intakes by 5 ml/capita per day and boost reduced-fat milk intakes by 7 ml/capita per day.</p>	Ng et al., 2011

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 3	To model the overall and income specific effect of a 20% tax on sugar sweetened drinks on the prevalence of overweight and obesity in the UK.	<p>United Kingdom. Adults 16 and over. Data on price and purchase of drinks from the Living Costs and Food Survey, 2010 of 5263 households.</p> <p>Drink consumption data from the National Diet and Nutrition Survey (2008-10), a representative survey of UK diets in order to include consumption estimates by age group (sample of 2126)</p> <p>Population from 2011 census</p> <p>BMI and population data from the Health Survey for England, 2010, and the Scottish Health Survey, 2010 (Wales survey not used as it records self-reported BMI and N. Ireland survey not used as sample size was too small)</p> <p>English survey data used to estimate prevalence of overweight and obesity for Northern Ireland and Wales.</p>	<p>Econometric and comparative risk assessment modelling study.</p> <p>Sugar sweetened drinks (SSD) defined as soft drinks with added sugar.</p> <p>Weighted estimates for prevalence obesity constructed for sex, age, and income groups (income groups separated into 3).</p> <p>Price elasticities estimated to simulate effect of tax on energy consumption.</p> <p>Modelled changes in consumption on proportion of overweight and obese people using a comparative risk assessment model called PRIME. PRIME can model changes in body weight as a result of changes in total energy intake</p>	<p>Average own price elasticity for sugar sweetened drinks is -0.92 for concentrated and -0.81 for non-concentrated drinks.</p> <p>A 20% tax is predicted to decrease SSD intake by 15%, non-concentrated SSD by 16%. Other drinks increase to compensate, particularly diet drinks, tea and coffee, milk, and fruit juice. A trend exists for greater changes in consumption of SSD (non-concentrated) and water with higher incomes, while at lower incomes there are more changes in diet soft drinks, milk, and fruit juice.</p> <p>A 20% tax on SSD estimated to reduce the number of obese adults in the UK by 1.3% or 180k people and the number who are overweight by 0.9% or 285k people.</p> <p>Predicted reductions in prevalence of obesity for income thirds 1 (lowest income), 2, and 3 (highest income) were 1.3%, 0.9%, and 2.1% (differences were not significant)</p> <p>The effect on obesity declined with age.</p> <p>Annual revenue from the tax estimated to be £276m (£272m to £279m), with increases in total expenditure on drinks for income thirds 1, 2, and 3 of 2.1%, 1.7%, and 0.8% respectively.</p> <p>“Taxation of sugar sweetened drinks is a promising population measure to target population obesity, particularly among younger adults.”</p>	Briggs et al., 2013

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
1 to 2 and 1 to 4	What would the impacts on consumption and public health be of a tax applied to food products which were linked to an increased risk of diet-related conditions? (Focus on 'fat tax' for saturated fats where the proceeds are used to subsidise fruit and vegetable consumption)	Household consumption data from the Expenditure and Food Survey is used to estimate a full system of demand for food in England and Wales; from this own- and cross-price elasticities of demand are derived. Nutrient conversion tables used to determine saturated fats content of each item and form the basis for the fat tax rates.	<p>Modelling study;</p> <p>Fat tax rates are computed whereby; for every percentage of saturated fats, price of the corresponding food group is increased by 1%; Tax revenue generated from this is imagined redistributed as a subsidy on fruits and vegetables.</p> <p>Based on variations in prices and price elasticities, new consumption levels are computed for each food group. Based on figures generated before and after implementing the tax-subsidy scheme, nutrient intake levels are computed.</p> <p>Relative risk estimates for a range of health conditions are used to estimate from this the public health impact of the scheme – for whole population and by socio-economic groups.</p>	<p>Expenditures on all food groups to decrease slightly as a result of a coupled fat tax/ thin subsidy. Quantities of taxed products consumed decline (e.g. cheese falls 20.2%; beef 7.0%; eggs 5.7%), while fruit & vegetable consumption rises by 9.2%, with fruit benefiting more than vegetables from the increase. The scheme does not increase households' expenditures; moreover most changes in consumption remain under 10%, indicating no dramatic effect on diet patterns. While this may help make the scheme more palatable, it is not clear if the health impact will be sufficient.</p> <p>Modest changes in nutrient intakes seen but intake of saturated fatty acids and cholesterol fall by 4.5% and 5.4% respectively. Other nutrients including sodium and all fats, plus total energy intake decrease; while protein, fibre, fruit & vegetable intakes increase (by 4.5% for the last). Free sugar intake increase 1.7%. No marked difference across socio-economic groups in nutrient intakes. Moreover, changes described are not sufficient to bring nutrient intake levels within the limits suggested by the Department of Health, with lower socio-economic groups being farther from these guidelines.</p> <p>Epidemiological consequences in the general population include: a drop in the relative risk of conditions such as coronary heart disease, cancer and major chronic diseases (-4.3%, -2.7%, and -1.3%, respectively) and a 1.3% increase in the risk of type 2 diabetes (due to the fall in poly-unsaturated fatty acids intake, which have a protective effect against type 2 diabetes). These changes are not equally distributed across socio-economic groups, with higher categories benefiting more than lower ones. Limitations: Changes observed are low and impacts on public health modest. Marginal increase in risk of type 2 diabetes indicates the scheme is not well targeted with respect to nutrients: Taxing saturated fatty acids has the consequence of reducing consumption of all types of fatty acids, including those beneficial to health.</p>	Arnoult et al., 2008

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 2 and 1 to 4	What are the effects, by income group, of targeted food taxes and subsidies on nutrition, health and expenditure in the UK.	Expenditure data from the Expenditure and Food Survey; estimates of price elasticities of demand for food from a report based on the National Food Survey 1988–2000. Estimates of effect on CVD and cancer mortality of changing fat, salt, fruit and vegetable intake were taken from previous meta-analyses.	Model based on consumption data and demand elasticity was used to predict the effects of four food tax-subsidy options. Resulting changes in demand, expenditure, nutrition, cardiovascular disease (CVD) and cancer mortality were estimated.	<p>A tax on the principal sources of dietary saturated fat is unlikely to reduce cardiovascular disease (CVD) or cancer mortality. Extra deaths are expected since although fat consumption falls, so too does fruit and vegetable consumption owing to cross-price elasticities.</p> <p>A tax on ‘less healthy’ foods (defined according to a nutrient profiling model) could increase CVD and cancer deaths by 35–1300 a year.</p> <p>A tax on ‘less healthy’ foods and subsidising fruits and vegetables by 17.5% could avert up to 2900 CVD and cancer deaths every year.</p> <p>Taxing ‘less healthy’ foods and using all tax revenue to subsidize fruits and vegetables could avert up to 6400 CVD and cancer deaths a year.</p> <p>All scenarios would place a higher burden on lower income families, while positive health effects would not necessarily be greater for lower income groups – though in the last two scenarios, likely deaths averted through the tax-subsidy scheme may be more for poorer than richer people.</p>	Nnoaham et al., 2009

Causal chain level	Question / hypothesis addressed	Data: sample size, subjects, variables, time, location, source	Method	Key findings	Source
Level 1 to 4	To examine the effects on nutrition, health and expenditure of extending value added tax (VAT) to a wider range of foods in the UK.	Consumption patterns and elasticity data were taken from the National Food Survey of Great Britain. The health effects of changing salt and fat intake were from previous meta-analyses.	<p>Modelling – based on consumption and elasticity of extending VAT to other foods – and estimating changes in demand, expenditure, nutrition, and health.</p> <p>3 different tax regimes examined:</p> <ol style="list-style-type: none"> 1) Tax on main sources of saturated fat in diets 2) Tax on foods defined as unhealthy by a nutrient profile models developed for the UK Food Standards Agency nutrient scoring system 3) Tax on foods to obtain the best health outcome 	<p>(1) Taxing only the main sources of saturated fat is unlikely to reduce prevalence of cardiovascular disease since a fall in saturated fat is offset by a rise in salt consumption.</p> <p>(2) Taxing unhealthy foods might avert around 2,300 deaths per year, chiefly by reducing salt intake.</p> <p>(3) Taxing a wider range of foods could avert up to 3,200 cardiovascular deaths in the UK per year (a 1.7% reduction).</p> <p>The authors conclude: “Taxing foodstuffs can have unpredictable health effects if cross-elasticities of demand are ignored. A carefully targeted fat tax could produce modest but meaningful changes in food consumption and a reduction in cardiovascular disease.”</p>	Mytton et al., 2007

Descriptive statistics for the UK

Implicit prices

Implicit unit prices have been constructed using expenditure and quantity data recorded in national food surveys from 1974 to 2012. Prices are shown in pence per 100g of foodstuff, 100ml of drink, or 2 eggs¹, deflated to values of 2005/06. Prices have been deflated by the GDP deflator.

Table II.2 sets out the prices to be shown from each food group

Table II.2. Selected food prices for the UK

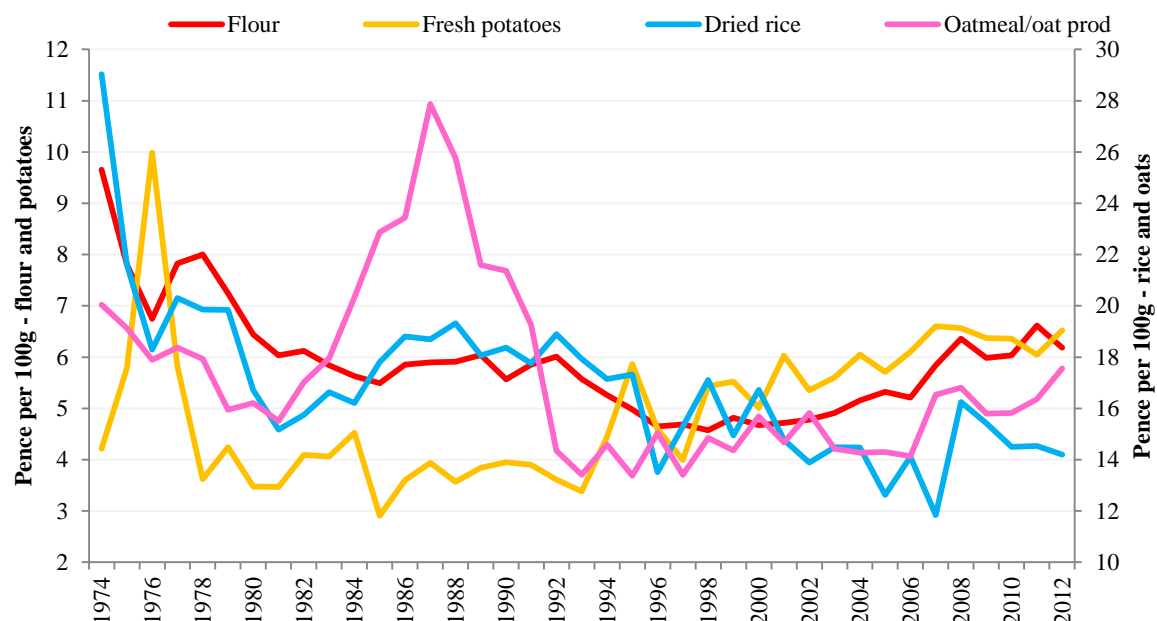
Food group	Selected food
Staples	Flour, fresh potatoes, rice, oatmeal/ oat products
Fruits & vegetables	Fresh green vegetables; fresh oranges; fresh onions, leeks, shallots; fresh tomatoes, fresh bananas
Meat and dairy	Eggs, chicken (uncooked, whole chicken or in pieces), liquid whole milk
Fat and sugar	Butter, sugar, other vegetable and salad oils (excluding olive oil)
Processed foods	Ice cream, chocolate biscuits, chips (frozen / not frozen), Ready meals and convenience meat

Staples

Prices of staples were relatively volatile in the 1970s. Figure SSS shows trends for selected staples from 1974 to 2012. While ‘bread’ might be expected to be a key staple in the UK, it is also considered a processed food. Moreover, differences in bread quality and thus price are extreme across the UK. For these reasons it is excluded here.

¹ One egg weighs around 50g

Figure II.1. Price trends for selected staple foods by weight, 1974 to 2012



Source: Constructed with data from UK DEFRA

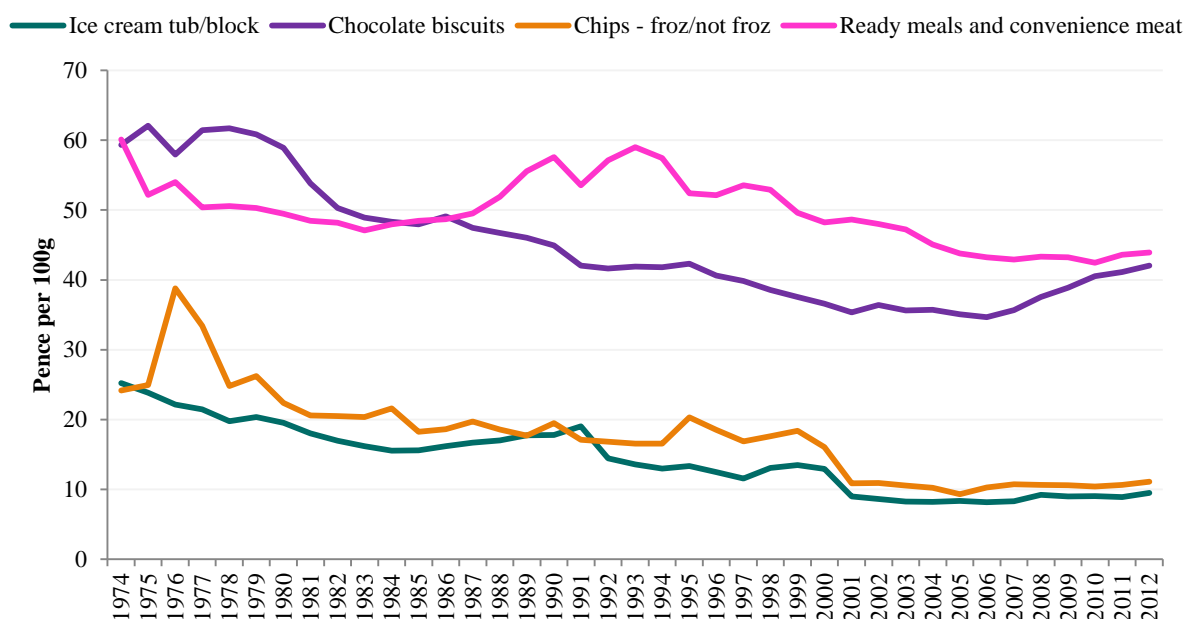
- In level, (wheat) flour and potato unit prices are considerably below unit prices for rice and oatmeal (hence flour and potato are on the left axis, rice and oatmeal the right)
- Flour prices have been probably the most stable of this selection. They trended down from the mid-1970s to the mid-1990s, before beginning to rise slightly to 2012.
- Potato prices spiked dramatically around the mid-1970s (drought in 1975); changed little in real terms over the 1980s in to the mid-1990s, before rising slightly in real terms.
- Rice prices trended down over the whole period, coming from relatively high levels in the mid-1970s. The spike in food prices in 2008 is also evident, though not particularly dramatic.
- Oatmeal and oat product prices saw a dramatic increase over the first half of the 1980s, sunk equally dramatically to the early 1990s, before rising slightly to 2012.

Processed

The original list for processed foods included: pasta, salted/savoury biscuits, cola, and beer; these have not been used: Pasta and cola data unfortunately does not extend far enough back in time. Salted/savoury biscuits are replaced by chocolate biscuits as more grams of these are recorded consumed than for 'Cream crackers and other unsweetened biscuits', and the confidence levels on chocolate biscuit data are better². Beer is not included because taxes on alcohol influence price trends unduly for the purpose of looking at how technological progress has improved prices of processed products. Ice cream, chips, and ready meals and convenience meat (including items such as sausage rolls for instance) are included instead. Prices of all of these declined over most of the period: See Figure II.2.

² DEFRA data tables include estimates for relative standard error coded with ticks and crosses.

Figure II.2. Price trends for selected processed foods by weight, 1974 to 2012



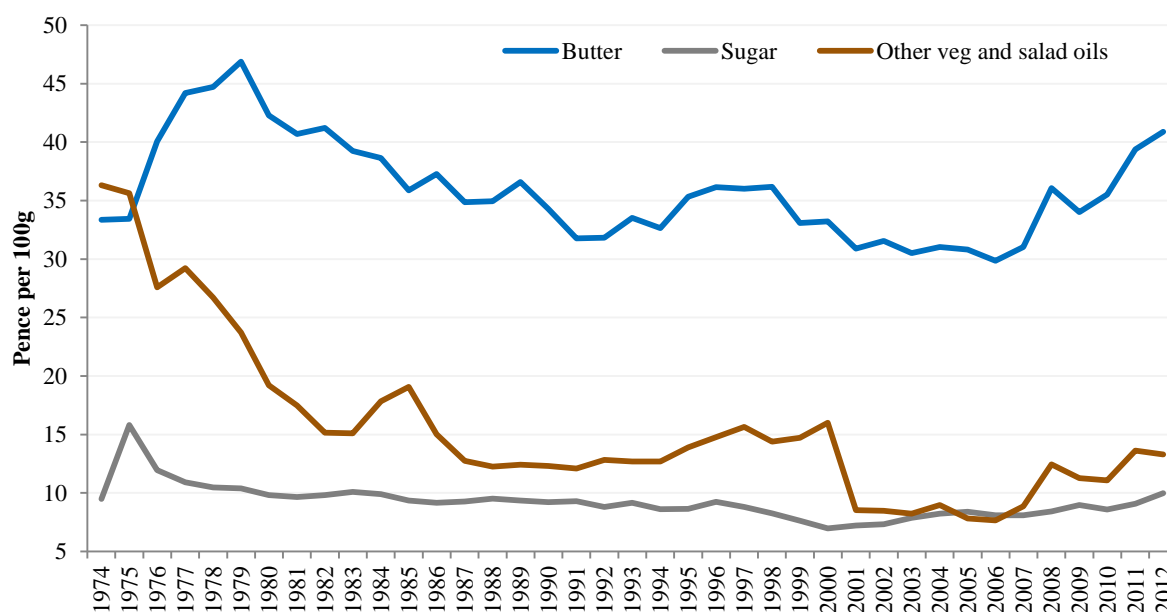
Source: Constructed with data from UK DEFRA

- All of these price series declined over most of the period, though a few turned up or stabilised towards the end of the period.
- Chips show the same spike as potatoes in the 1970s.
- Chocolate biscuits interestingly increased from 2006 onward.

Fats & sugar

Trends in prices of butter, sugar, and vegetable oils are shown in figure II.3.

Figure II.3: Price trends for selected fats and sugar by weight, 1974 to 2012



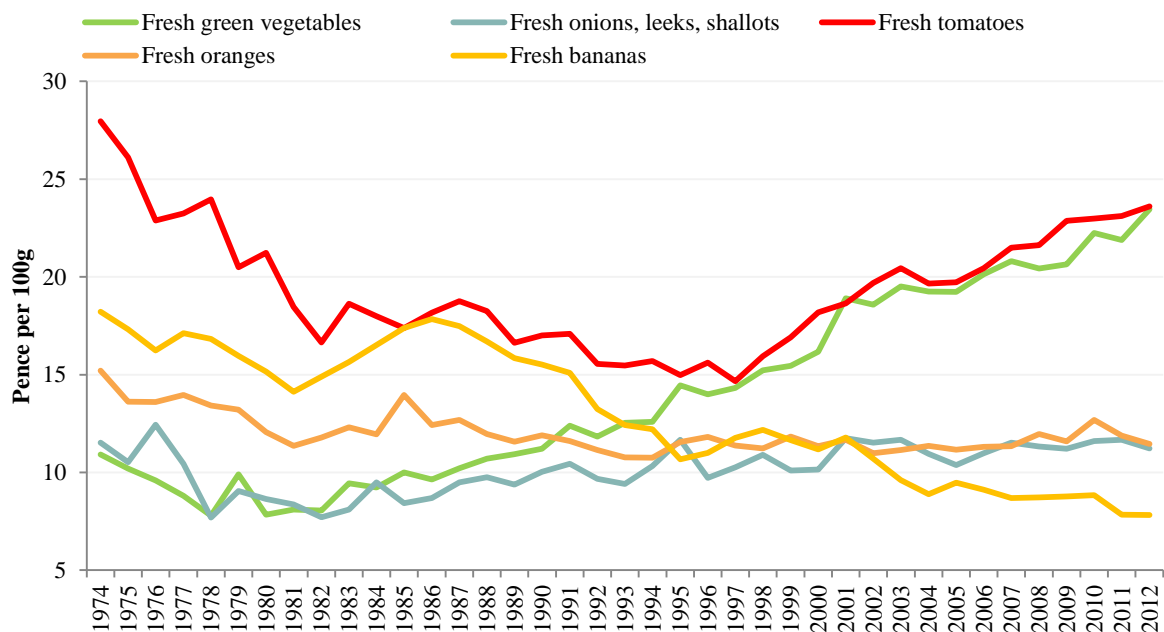
Source: Constructed with data from UK DEFRA

- Butter prices rose when the UK joined the Common Market, but then fell by almost one third through to the mid-2000s: subsequently prices have risen since the 2007/08 food price spike.
- Sugar prices fell through to early 2000s, but since have risen to levels seen earlier.
- Vegetable oils prices fell heavily in the 1970s since when they have declined a little, with some increases after 2007. Overall, however, edible oils are much cheaper than they were in the early 1970s.

Fruit and vegetables

Price trends in selected popular fruits and vegetables in the UK are shown in Figure II.4.

Figure II.4. Price trends for selected fruits and vegetables by weight, 1974 to 2012

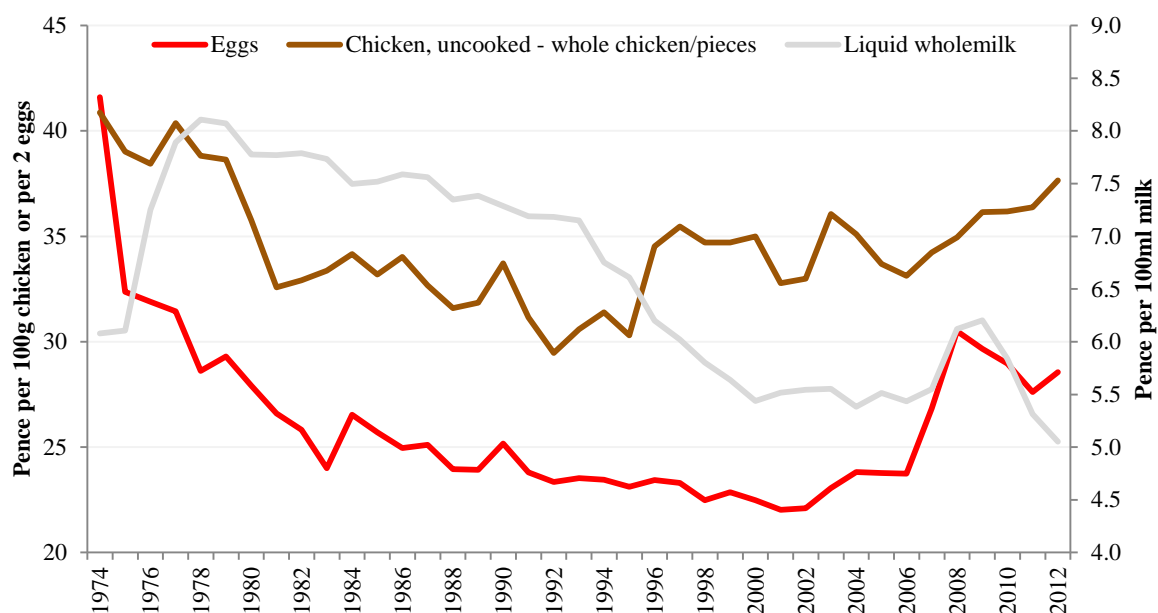


Source: Constructed with data from UK DEFRA

Prices of most fruit and veg fell from the mid-1970s to the early 1980s. Subsequently three trends can be seen:

- Tomato and fresh green veg prices have increased notably since the early 1990s for tomato and since the late 1970s for fresh green veg;
- Prices of imported fruit, oranges and bananas, have tended to fall; and,
- Onion, shallot and leek prices have increased marginally.

Figure II.5. Real unit prices of selected meat and dairy products, 1974 to 2012



Source: Constructed with data from UK DEFRA

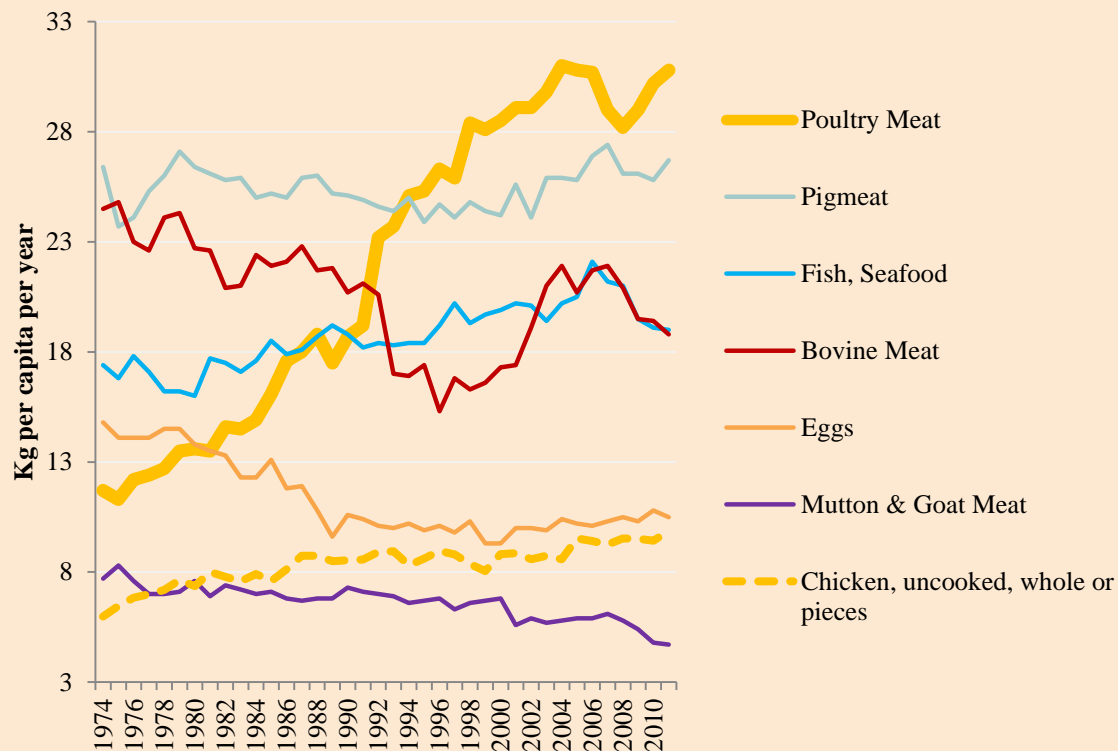
- Egg prices fell heavily in the 1970s, then fell gradually through to the early 2000s since when they have risen with the 2007/08 price spike;
- Milk prices rose with the UK entry into the Common Market in the early 1970s, then fell, albeit interrupted by the 2007/08 price spike, through to 2012; and,
- Chicken prices fell strongly from the mid-1970s to the early 1990s, but since then have risen almost back to their levels in the mid-1970s.

Box II.1. Poultry in the UK: the most-consumed meat

Poultry consumption has boomed in the UK to overtake pork as the most consumed meat. Beef consumption has dropped, as has egg consumption, and mutton/goat consumption).

Implicit price falls for chicken have not been dramatic, but these only account for uncooked chicken, whole and pieces, while much of the chicken may be consumed cooked in or outside homes. Consumption of poultry charted by FAO and of 'chicken, uncooked, whole and in pieces; by the family food survey both show rises over the period, though the FAO dataset has risen much faster: See Figure II.6

Figure II.6. Meat and egg consumption in the UK: 1974 to 2011



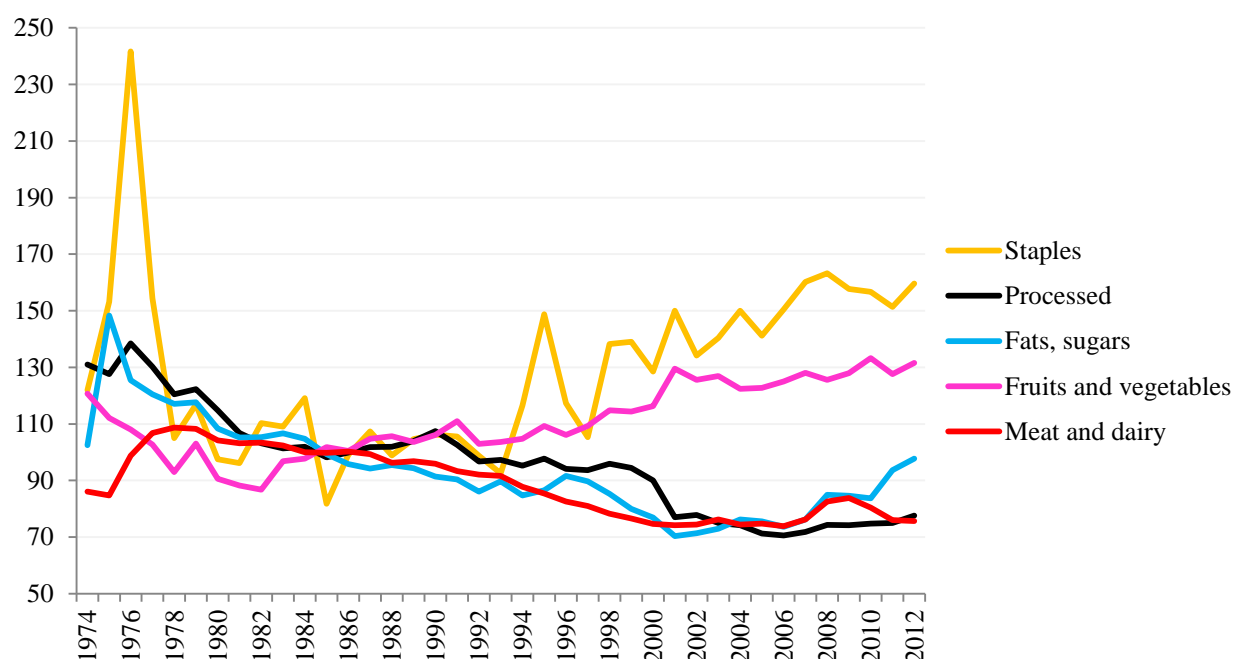
Source: Data from FAOSTAT for series displayed as solid lines. Data for 'Chicken, uncooked, whole or pieces' shown in the dashed line from DEFRA.

Prices as weighted indices (1984-86 = 100)

To create these indices, the real price series were converted to indices against a 1984/86 baseline (given the high volatility prior to c 1983 it seemed better to base things afterwards).

Weighted by grams consumed, an average was taken across the sub-indices to create indices for the clusters of food groups: see Figure II.7.

Figure II.7. Price indices for food groups, 1984-86 = 100



Source: Constructed with data from DEFRA

Note: Staples index includes: Flour, fresh potatoes, dried rice, and oatmeal/oat product. Processed index includes: Ice cream tub/block, chocolate biscuits, chips (frozen or not frozen), and ready meals and convenience meat. Fats and sugars index includes: Butter, vegetable oils excluding olive oil, and sugar. Fruits and vegetables index includes: fresh green vegetables, fresh onions (including leeks and shallots), fresh tomatoes, fresh oranges, and fresh bananas. Meat and dairy index includes: Eggs, chicken (uncooked, whole or in pieces), liquid wholemilk.

The indices show some of what we might have imagined: cost of processed food falling away from most other food groups, with fats and sugars not that far away. Meat and dairy shows falls, though driven largely by the dairy component (milk was weighted almost 90% of the three constituents in 1974, and just over half by 2012). Staples, interestingly, appear to have risen in cost relatively the most: though this is driven much by the potatoes component (88% of the weight in 1978 to 75% in 2012). Fruits and vegetables rose the second highest. The weights across the fruits and vegetables are relatively more even than across other categories, though fresh green vegetables accounted for close to half in 1974, it fell to 29% by 2012.

Other variables

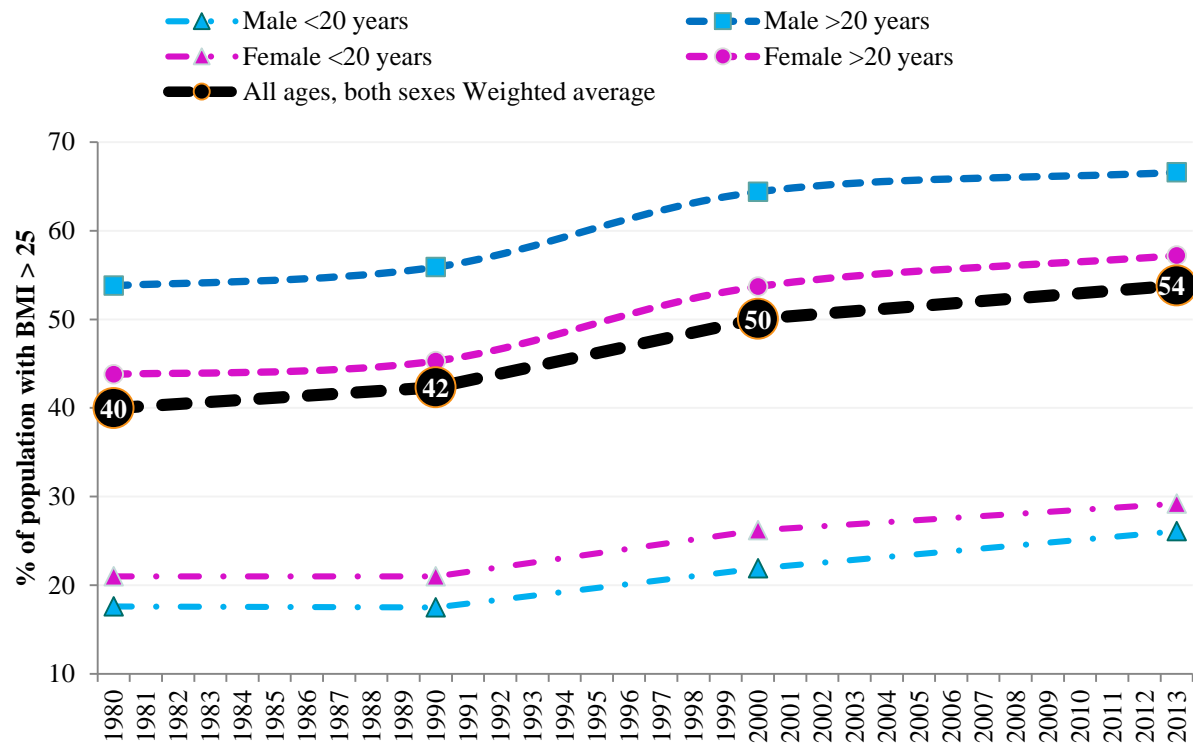
Overweight and obesity in the UK

Two recent sources chart trends in UK overweight and obesity over around the last 3 decades.

Ng et al., (2014) show estimates for four points in time for different demographics: Females (>20 years old), young females (<20 years old), males (>20 years old), and young males (<20 years old) – see Figure ABC.

Stevens et al. (2012) provide estimates for adult (>20 years old) males and females estimated for all years from 1980 to 2008: see Figure II.8

Figure II.8. Trends in overweight and obesity in the UK: 1980, 1990, 2000 and 2013

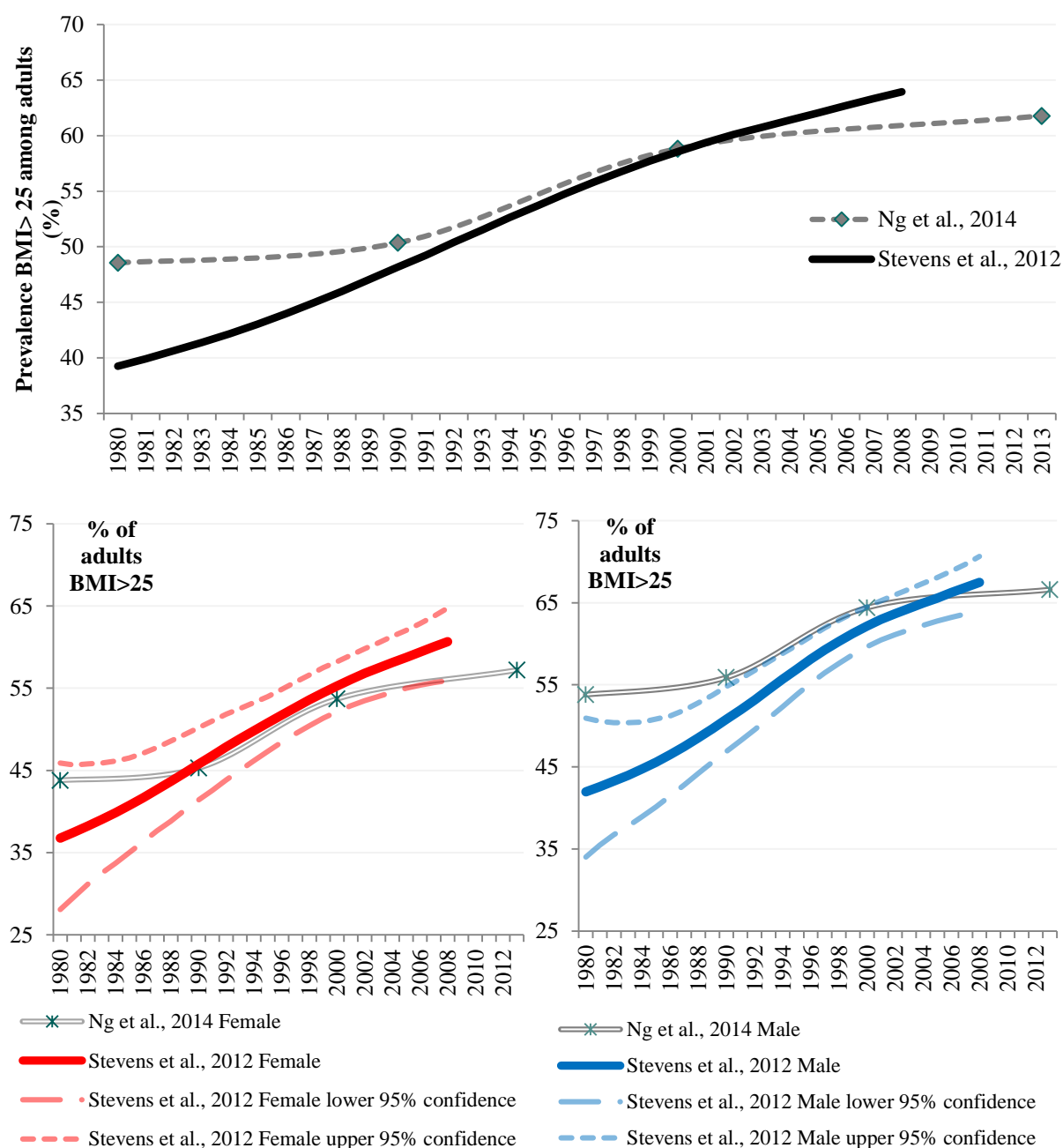


Source: Data from Ng et al., 2014. Note: Weighted average calculated weighted by proportion of male and female populations in each age group.

The work of Ng et al. (2014) suggests overweight and obesity in the UK increased faster over the 1990s than over the 1980s or 2010s.

An earlier study (Stevens et al, 2012) estimated adult obesity prevalence from 1980 to 2008. Their figures suggest similar levels – though beginning in the 1980s at generally lower levels. They suggest more rapid rises in the 1980s, fairly similar trends through the 1990s, and a sharper rise post 2000 than the other data: See Figure II.9 for a comparison across adult averages and across adults by sex.

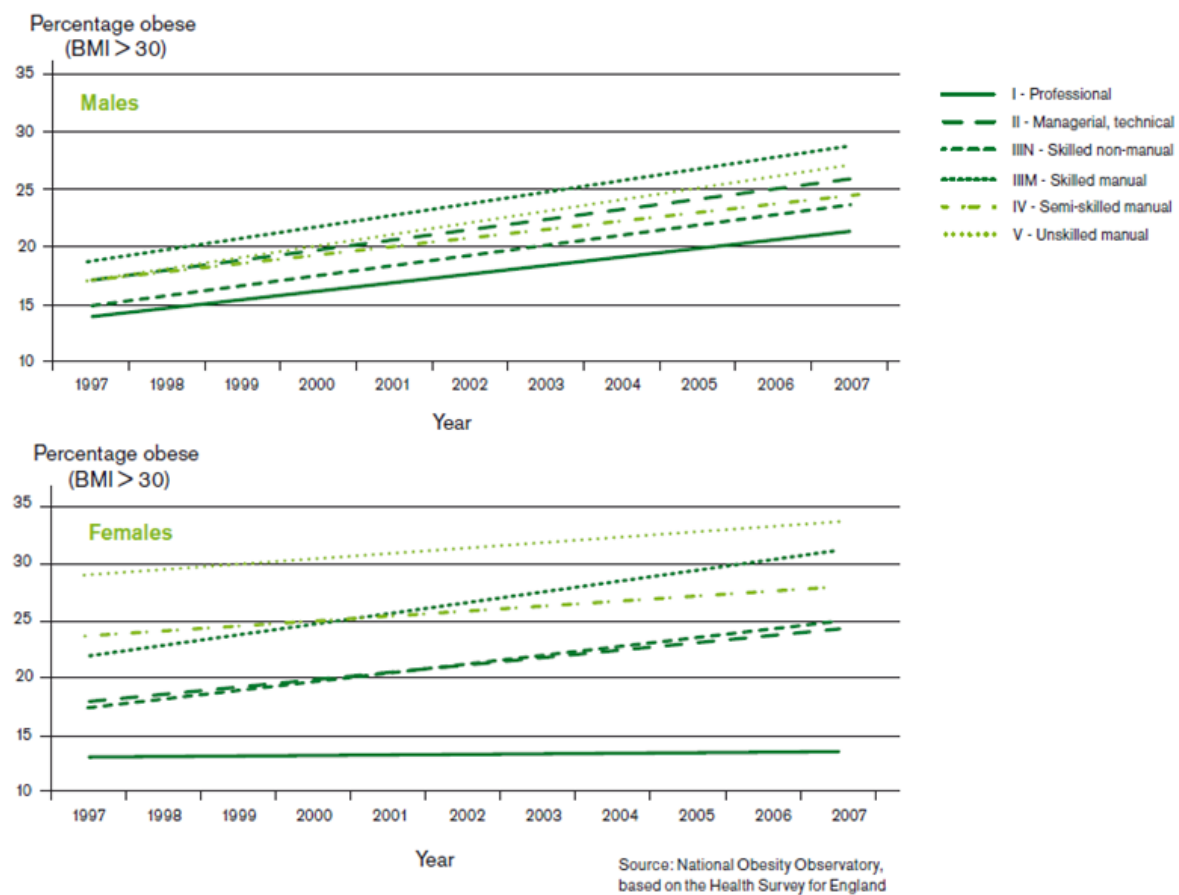
Figure II.9. Prevalence of overweight and obesity in UK adults, male and female; 1980 to 2008 or 2013: comparing across two estimates



Source: Data from Stevens et al., 2012 and Ng et al., 2014.

Another interesting study of the time series of obesity trends separated by job category shows that for professional women, the rates did not rise between 1997 and 2007: See Figure II.10

Figure II.10. Trends in male and female obesity in the UK by job category: 1997 to 2007



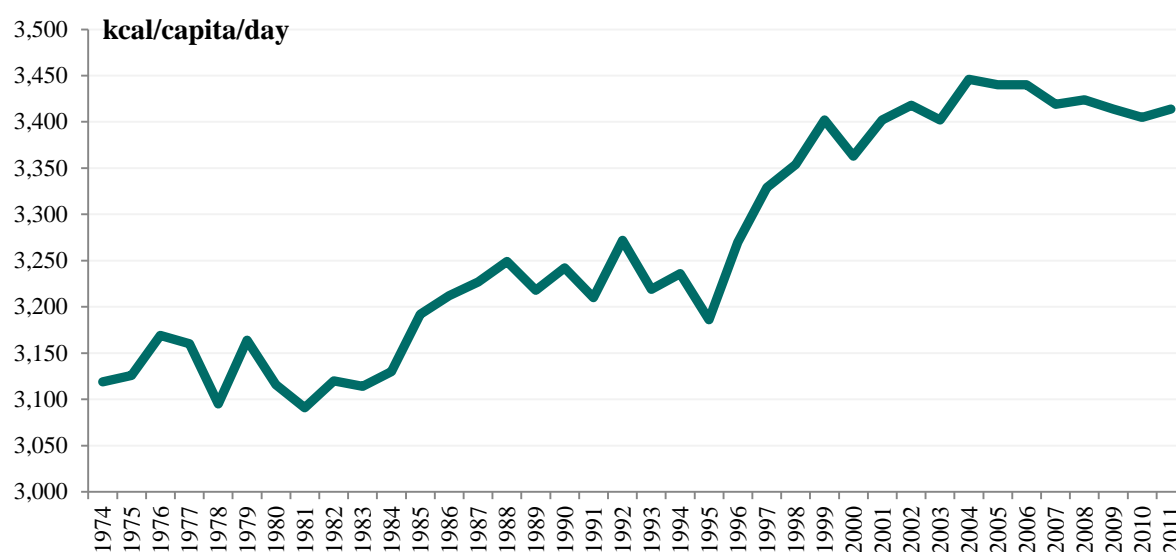
Source: Figure 2.15 in *The Marmot Review*, 2010

Food supply, kcal per person per day in the UK

Figure II.11 shows how per capita calorie supply has shifted in the UK from the mid-1970s to 2011, the latest year for which FAOSTAT data was available.

From the mid-1970s to the mid-1980s, calories supplied per person were relatively unchanged. They increased over much of the 1980s, before flattening for the first half of the 1990s. In the second half of the 1990s calories supplied jumped up again, before rising slowly through the first half of the 2000s, after which they fell very slightly.

Figure II.11. UK food energy supply per person per day, 1974 to 2011



Source: FAOSTAT

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Annex III: More detail on country cases – Mexico, Brazil, South Korea, China

III.1 Mexico

Results: descriptive statistics for Mexico

Annual prices from 1980 to 2014 for Mexico are analysed. Prices have been constructed using data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for early 2015 from Mexico City (Procuraduría Federal del Consumidor (México), accessed 25/02/2015.

Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices. Table III.1 sets out the prices to be shown from each food group

Table III.1.1. Selected food prices for Mexico

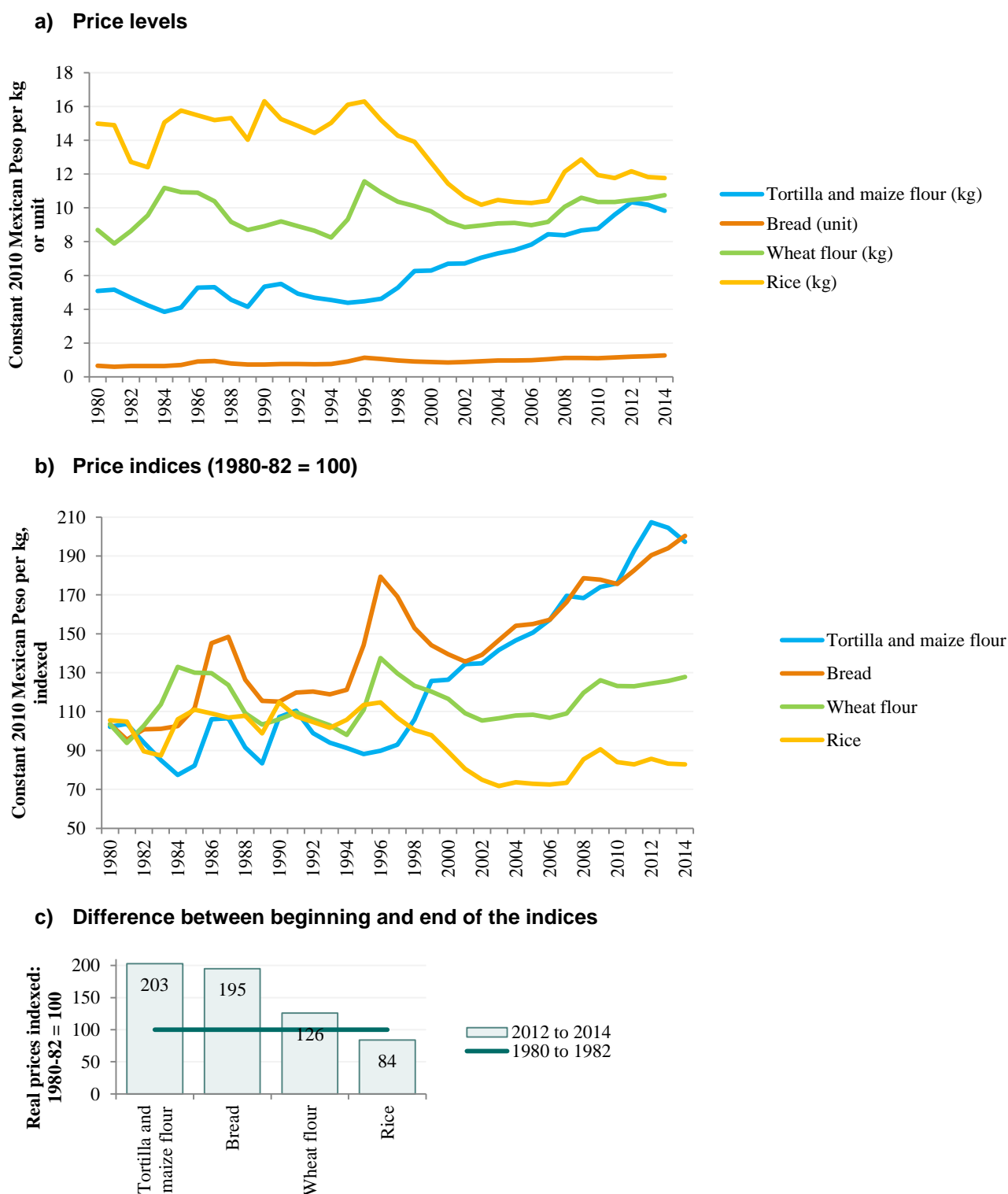
Food group	Selected food
Staples	Tortilla and maize flour, bread, wheat flour, rice
Fruits & vegetables	Apple, banana, orange, grapes, pear, tomato, potato, onion, fresh vegetables
Meat and dairy	Chicken, fresh milk, processed milk, egg
Fat and sugar	Oils and edible fats, vegetable oils and fats, sugar
Processed foods	Ice cream, chocolate and snacks, ready meals

Staples

Constant prices and price indices

Key Mexican staples – tortilla and maize flour – increased dramatically in price after the late 1990s. Relatively speaking bread prices also rose, though wheat flour prices were quite stable. Rice prices fell after the late 1990s.

Figure III.1.1. Constant 2010 annual prices, price indices, and changes over the time period for selected staples in Mexico, 1980 to 2009



Source: Data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for 2015 from Mexico City (Procuraduría Federal del Consumidor (México), accessed 25/02/2015).

Note: Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices.

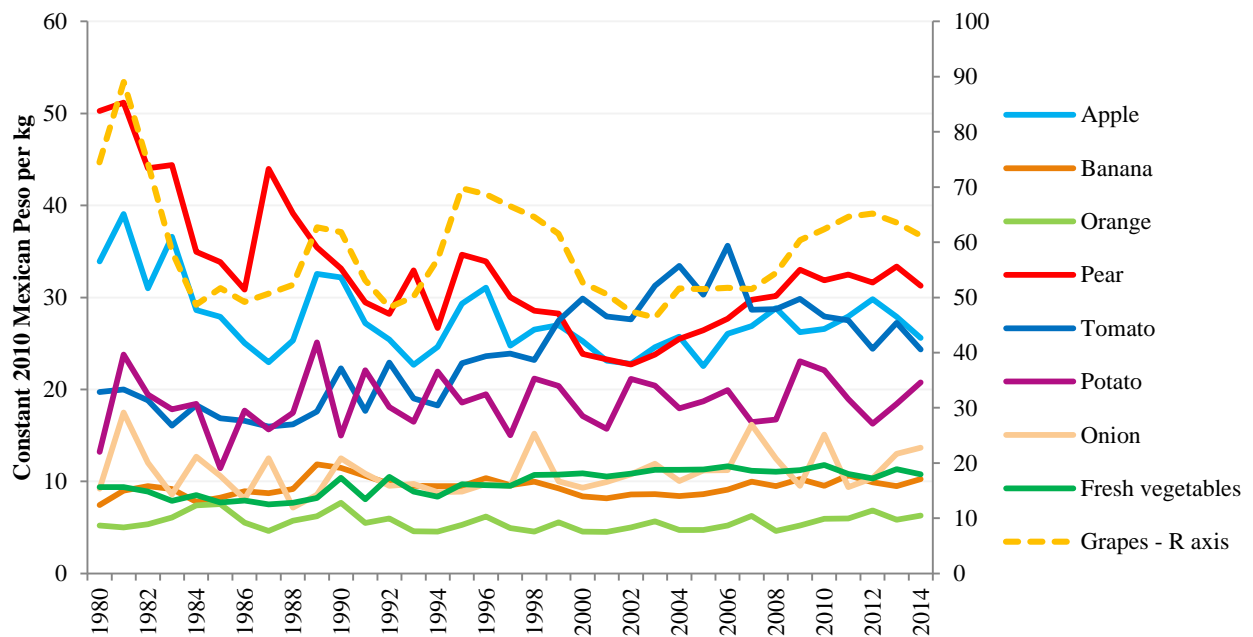
Fruits and vegetables

Constant prices and price indices

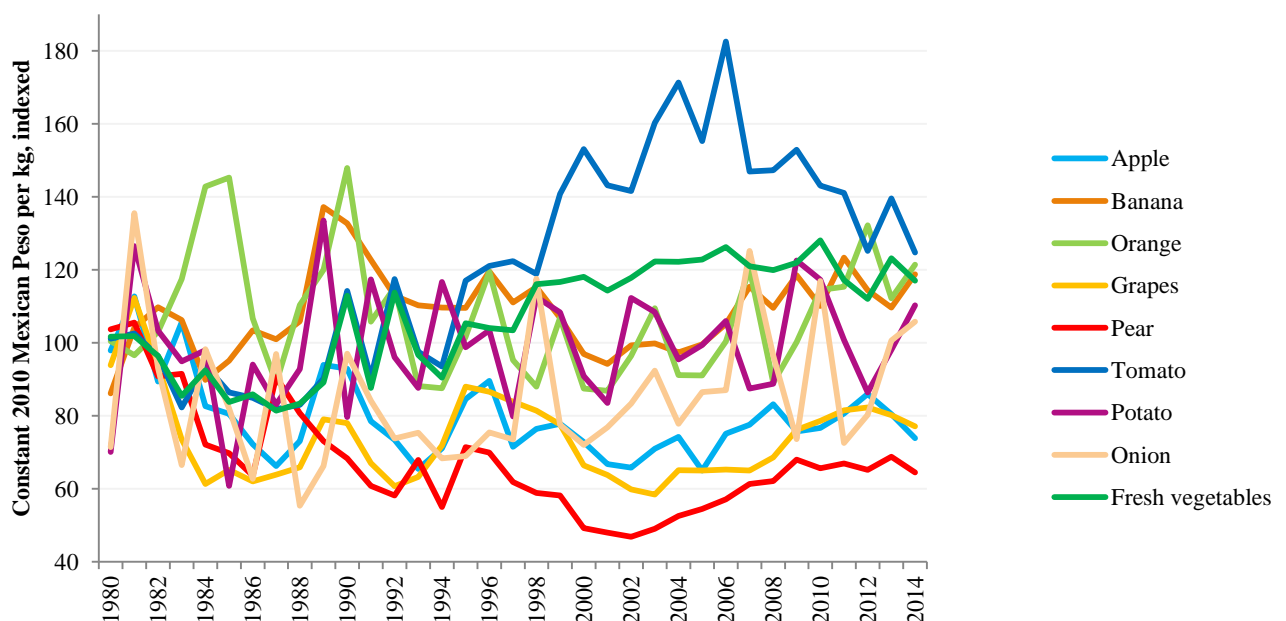
Fruit and vegetable prices have been quite volatile in Mexico also – though changes in these have been less dramatic than changes observed for staples. Three of the fruit prices have fallen – though in some cases from relatively high levels. Tomato prices have risen the most.

Figure III.1.2. Constant 2010 annual prices, price indices, and changes over the time period for selected fruits and vegetables in Mexico, 1980 to 2009

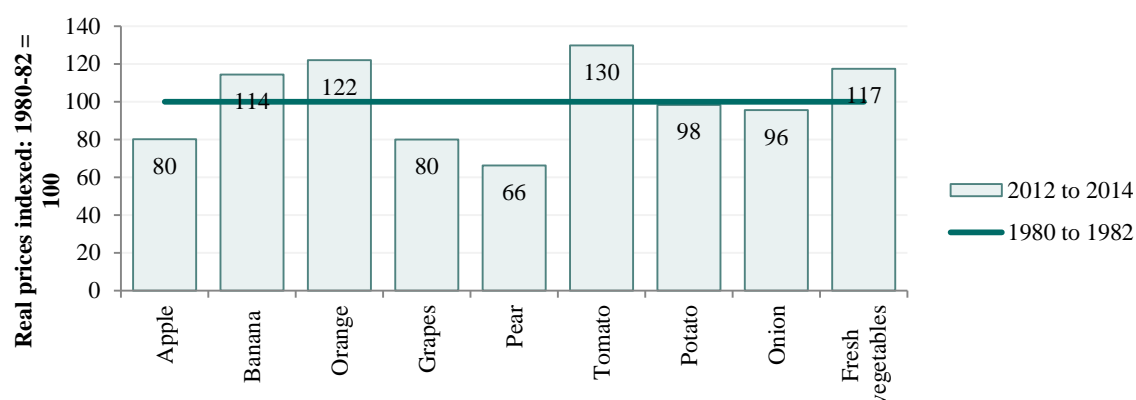
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices

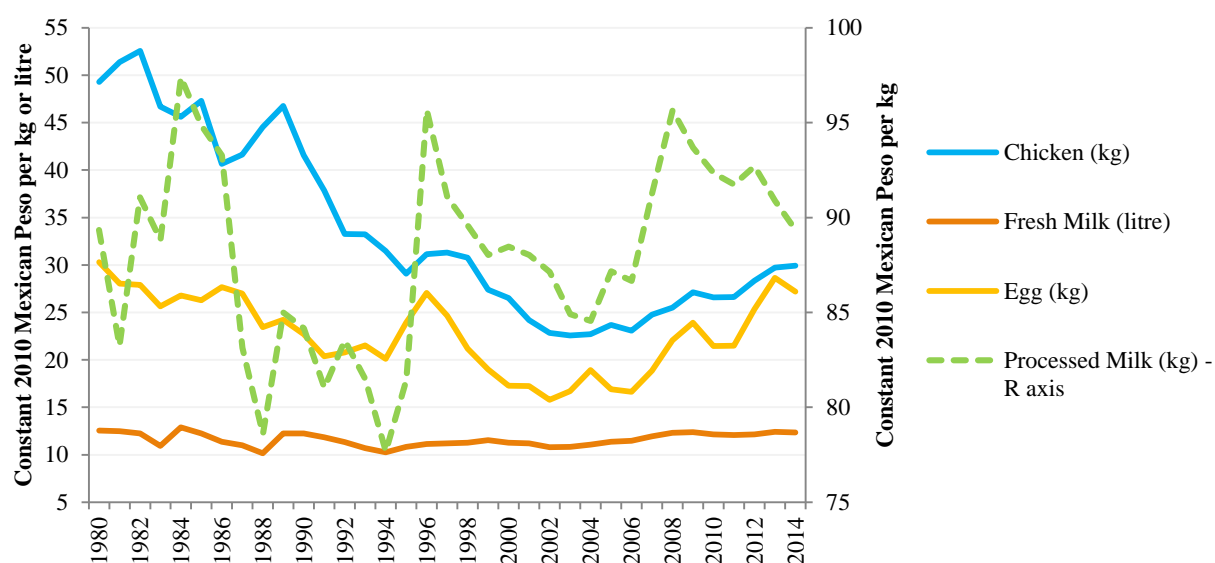


Source: Data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for 2015 from Mexico City (Procuraduría Federal del Consumidor (México)), accessed 25/02/2015.

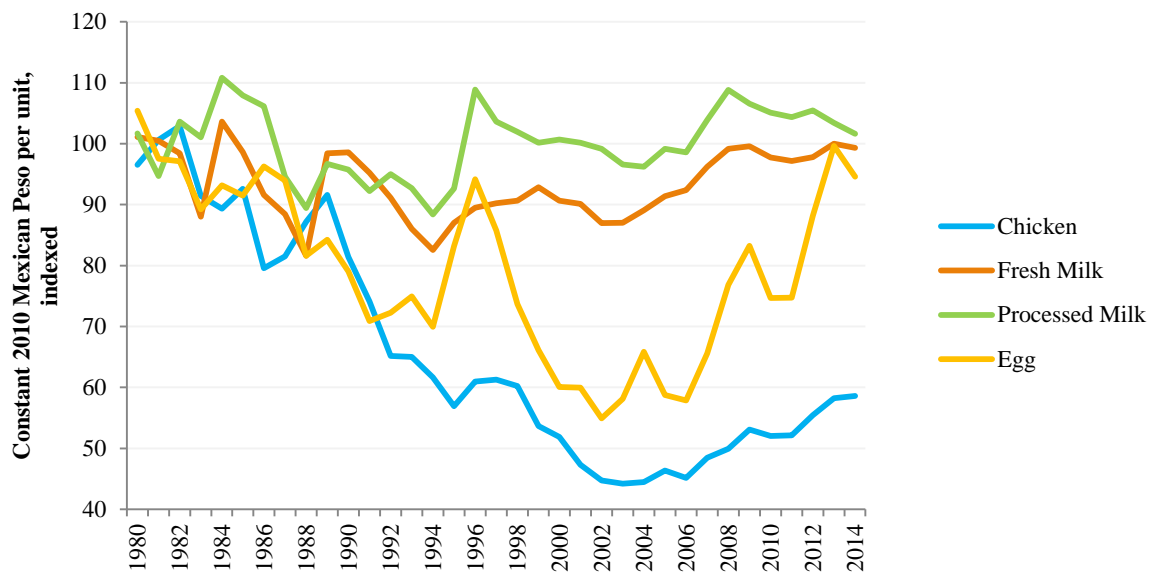
Note: Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices.

Figure III.1.3. Constant 2010 annual prices, price indices, and changes over the time period for selected meat and dairy in Mexico, 1980 to 2009

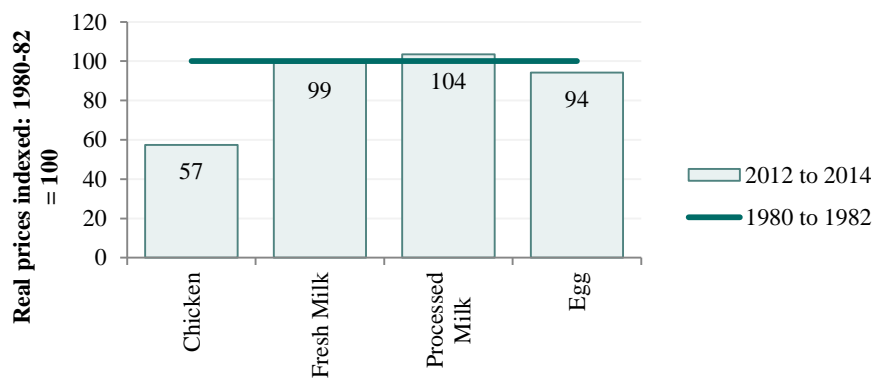
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



Source: Data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for 2015 from Mexico City (Procuraduría Federal del Consumidor (México), accessed 25/02/2015).

Note: Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices.

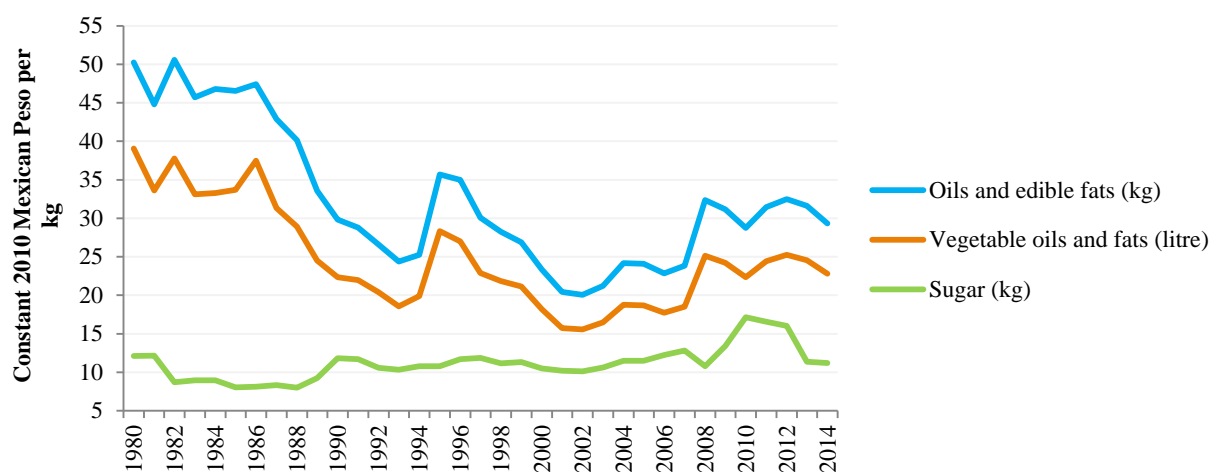
Oils, fats, and sugar

Constant prices and price indices

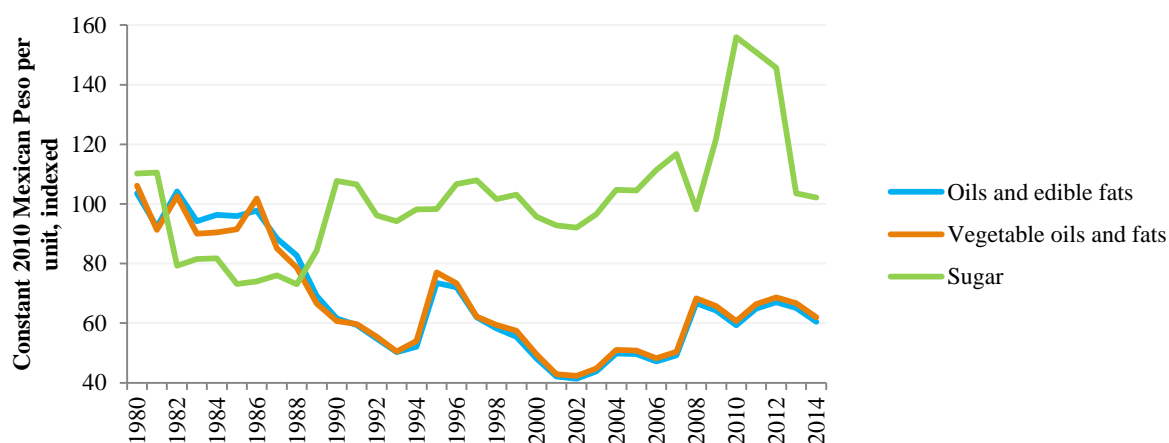
Prices of oils and fats have fallen dramatically in Mexico from the 1980s to the 2000s, despite following a generally rising trend since around 2002. Sugar prices have increased – though only slightly.

Figure III.1.4. Constant 2010 annual prices, price indices, and changes over the time period for selected sugar and fats in Mexico, 1980 to 2009

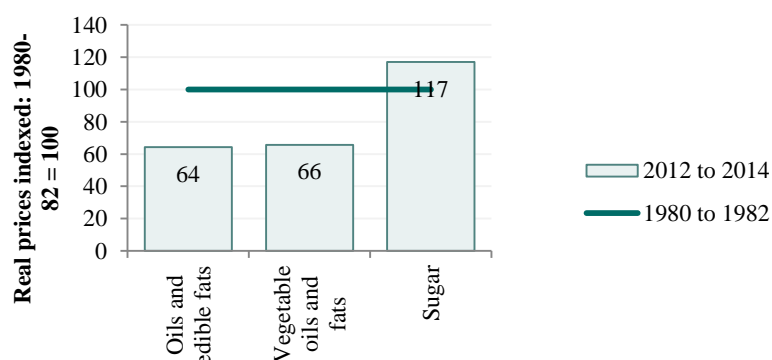
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



Source: Data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for 2015 from Mexico City (Procuraduría Federal del Consumidor (México), accessed 25/02/2015).

Note: Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices.

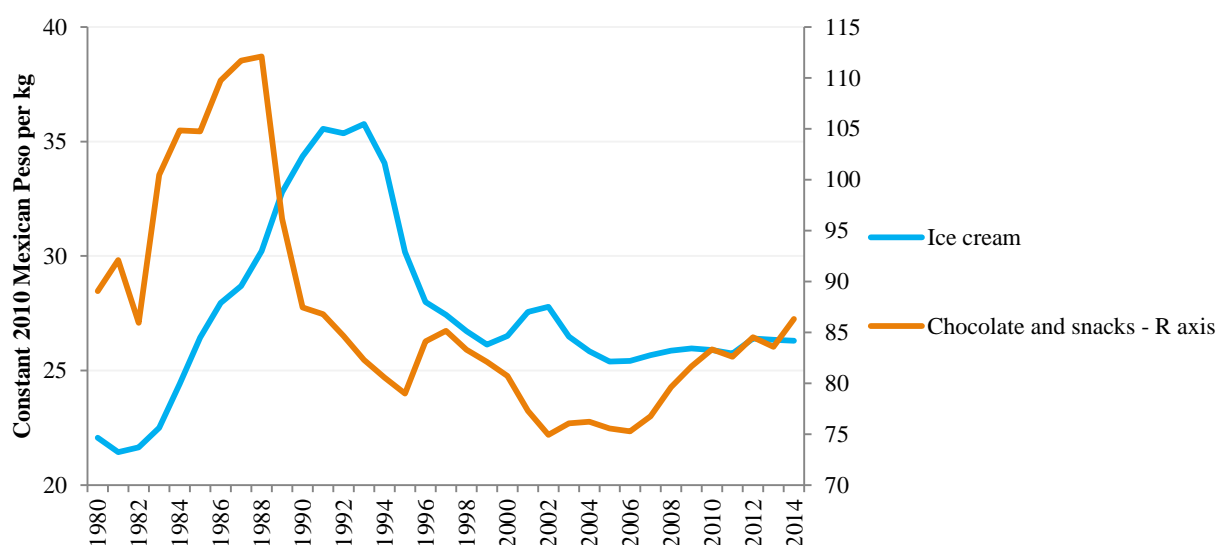
Processed foods

Constant prices and price indices

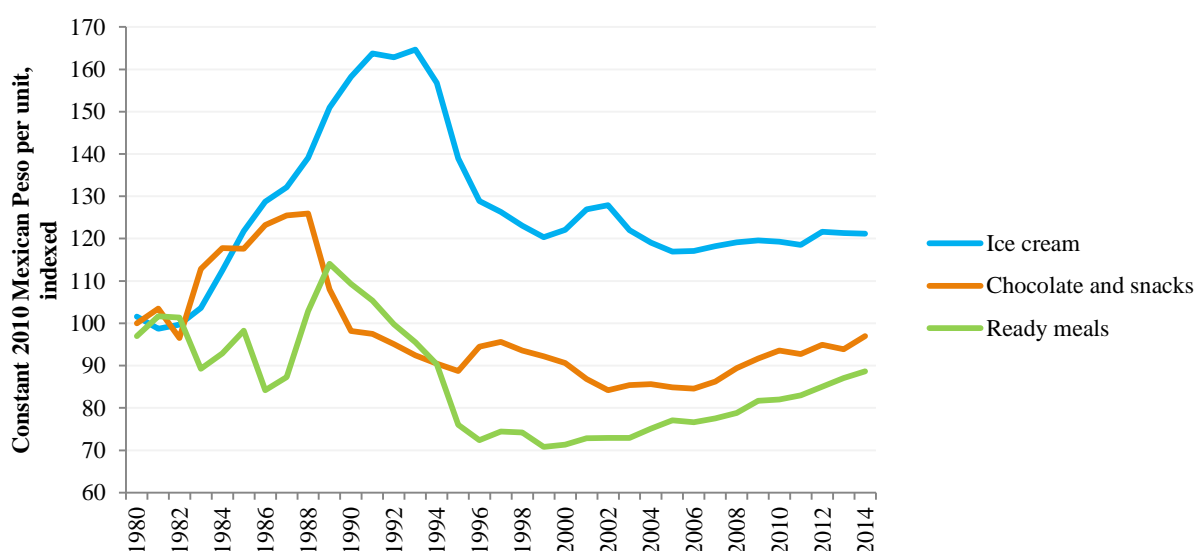
Processed food prices follow different patterns, with ice cream prices rising dramatically to the early 1990s, after which they fall. Chocolate and snacks saw a spike around the mid- to late 1980s, after which they fell to 2006. After 2006 a slight rise is evident. Ready meals prices which fell from the early to late 1980s, spiked around 1990, fell again to around the year 2000, after which they rose through to 2014. Though the overall volatility makes it difficult to interpret a simple price change from the beginning to the end of the series, ice-cream prices were about 20% higher in 2012-14 than in 1980-82, while chocolate and snacks finished at around the same level, and ready-meals were slightly cheaper.

Figure III.1.4. Constant 2010 annual prices, price indices, and changes over the time period for selected processed foods in Mexico, 1980 to 2009

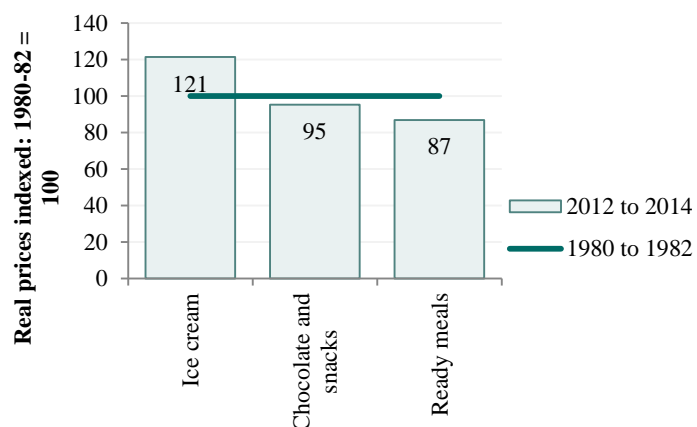
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



Source: Data from Dr. Joel Alberto Vargas Hernandez, deflated by Mexican CPI from World Bank WDI. Original data on price indices for selected foods for Mexico from INEGI Mexico, combined with data on actual food prices for 2015 from Mexico City (Procuraduría Federal del Consumidor (México), accessed 25/02/2015).

Note: Food price series were constructed using national average price indices and price levels in early 2015 for Mexico City—these levels were assumed as 2014 price levels for the purposes of simplicity. Resulting price trends indicate prices rather than actual observed prices.

Prices for ready meals were not constructed as a price level for these was not available

III.2 Brazil

Changes in relative prices of different foods in Brazil

Results: descriptive statistics for Brazil

Annual average prices from 1980 to 2009 for São Paulo city are analysed, with data from the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nial/precos_medios.aspx?cod_sis=4) from Dr Rafael Claro. These prices have been deflated to 2009 levels with CPI data and corrected for currency changes over the period.

Table III.2.1 sets out the prices to be shown from each food group

Table III.2.1: Selected food prices for São Paulo city

Food group		Selected food
Staples		Rice, beans, bread rolls
Fruits and vegetables	Fruits	Pineapple, orange, imported apple, Brazilian apple, papaya, watermelon, tangerine, banana, Brazilian banana
	Vegetables	Brazilian and Italian zucchini, cress, lettuce, onion, carrots, chayote, cabbage (in a package), bell pepper, green cabbage, and tomato.
Meat and dairy		Beef, milk type C, milk type B (Note: Pasteurised milk in Brazil is classified into types A, B, and C according to fat content and to Brazilian standards of microbial counts; type B milk having fewer microbes than type C.)
Fat and sugar		Sugar, soy oil
Processed foods		Fresh cheese, mozzarella cheese, cooked ham (no water), hot dogs, bologna, regular sausage, sweet biscuit

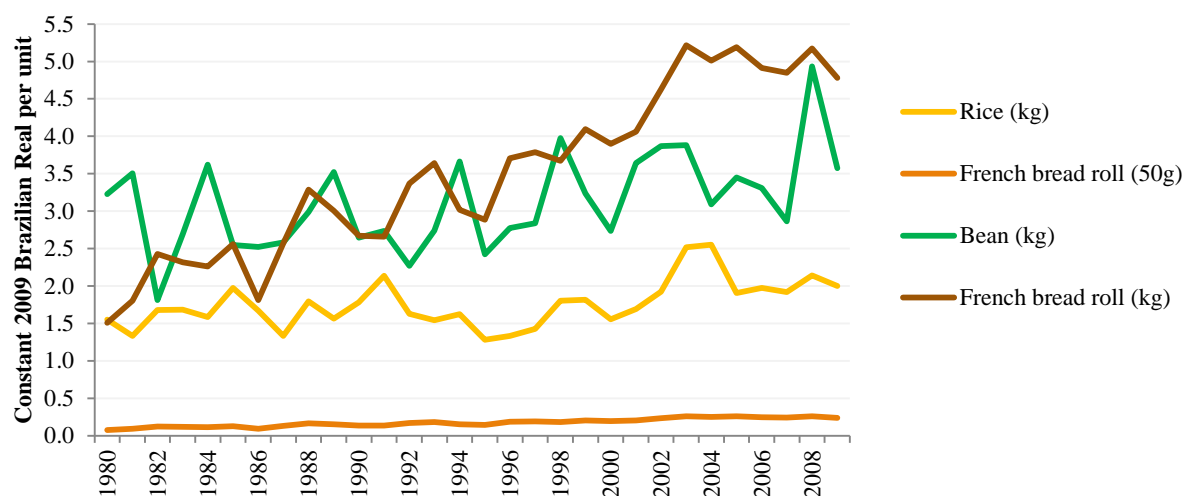
Staples

Constant prices and price indices

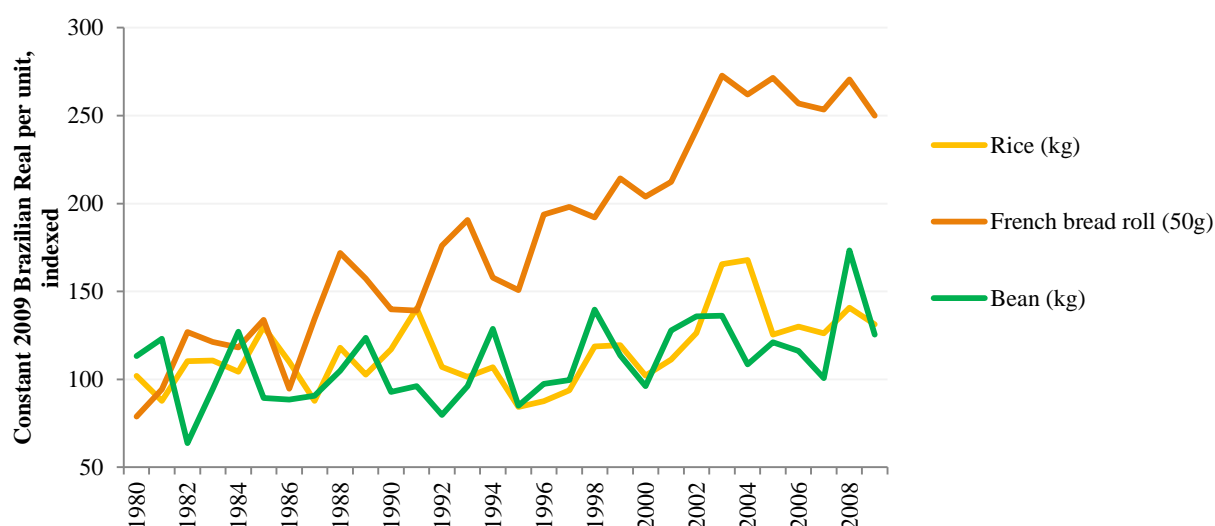
The figures below show how staples prices have evolved in real terms – for rice, beans, and for bread rolls – from 1980 to 2009. Bread roll prices show a clear rise, while prices of beans and rice appear to have risen much less.

Figure III.2.1. Constant 2009 annual prices, price indices, and changes over the time period for selected staples in São Paulo, 1980 to 2009

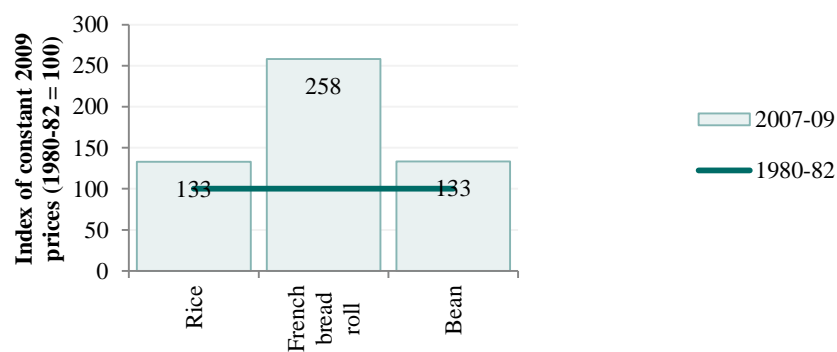
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

Fruits & vegetables

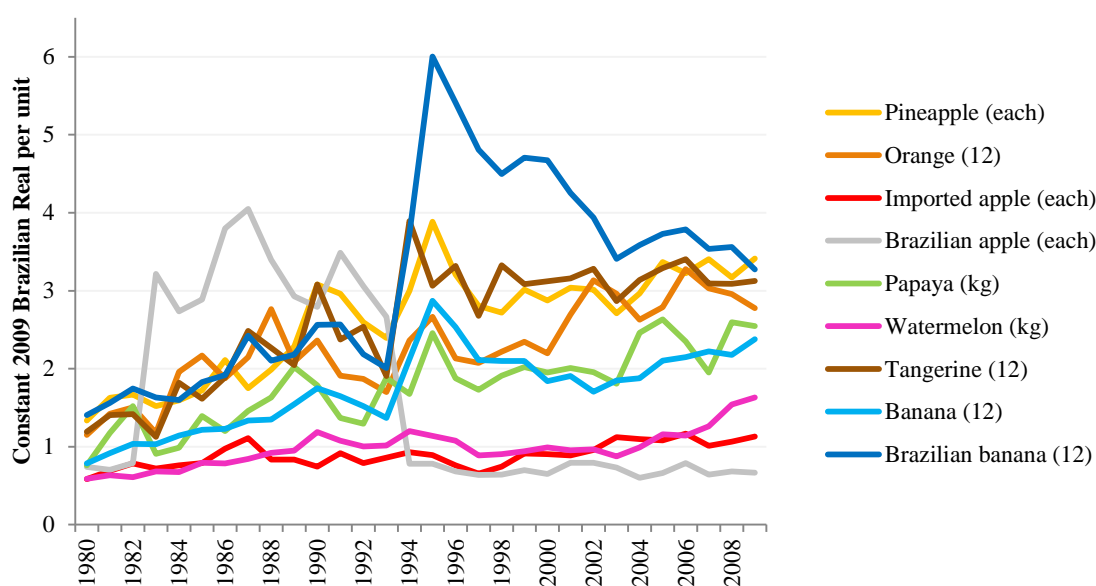
Fruits

Constant prices and price indices

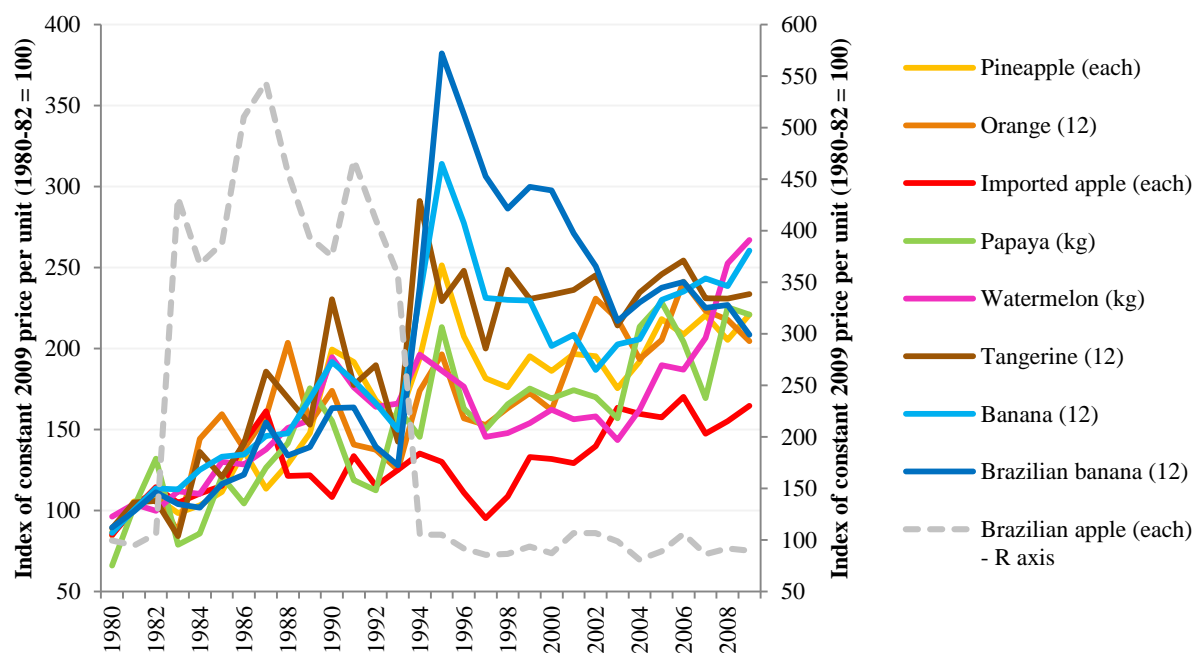
Most real prices for fruits have increased, with the exception of local apples. Several prices saw spikes around 1995. Between 1980-1982 and 2007-09, banana prices increased the most, followed by watermelon, and tangerine.

Figure III.2.2. Constant 2009 annual prices, price indices, and changes over the time period for selected fruits in São Paulo, 1980 to 2009

a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



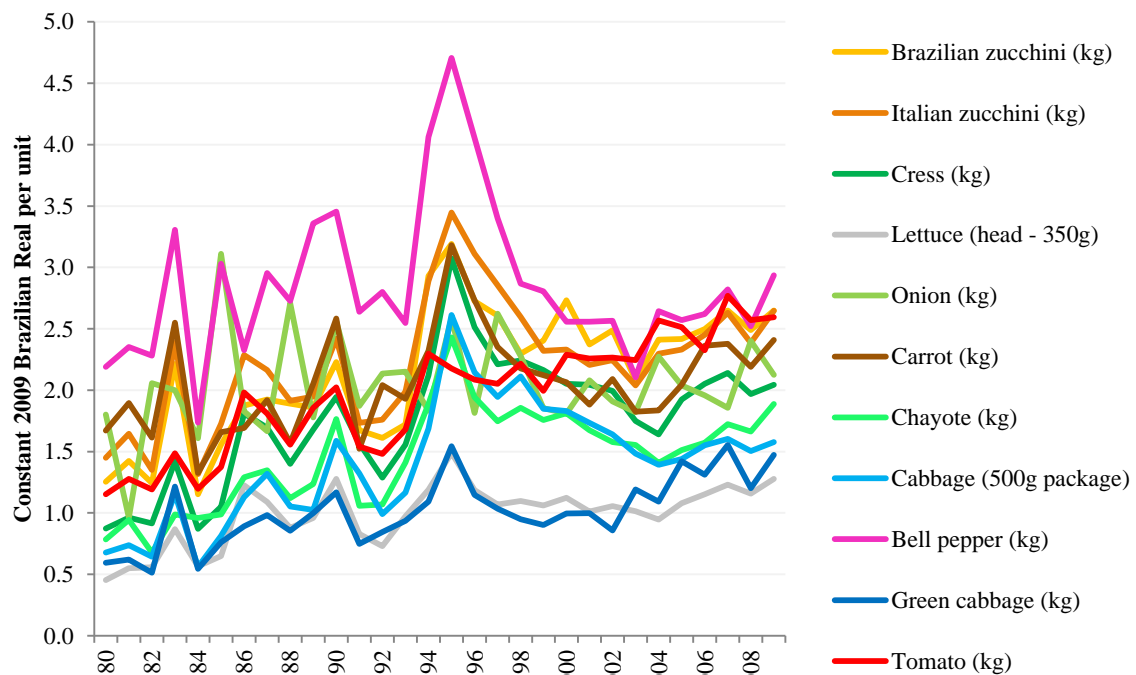
Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

Vegetables

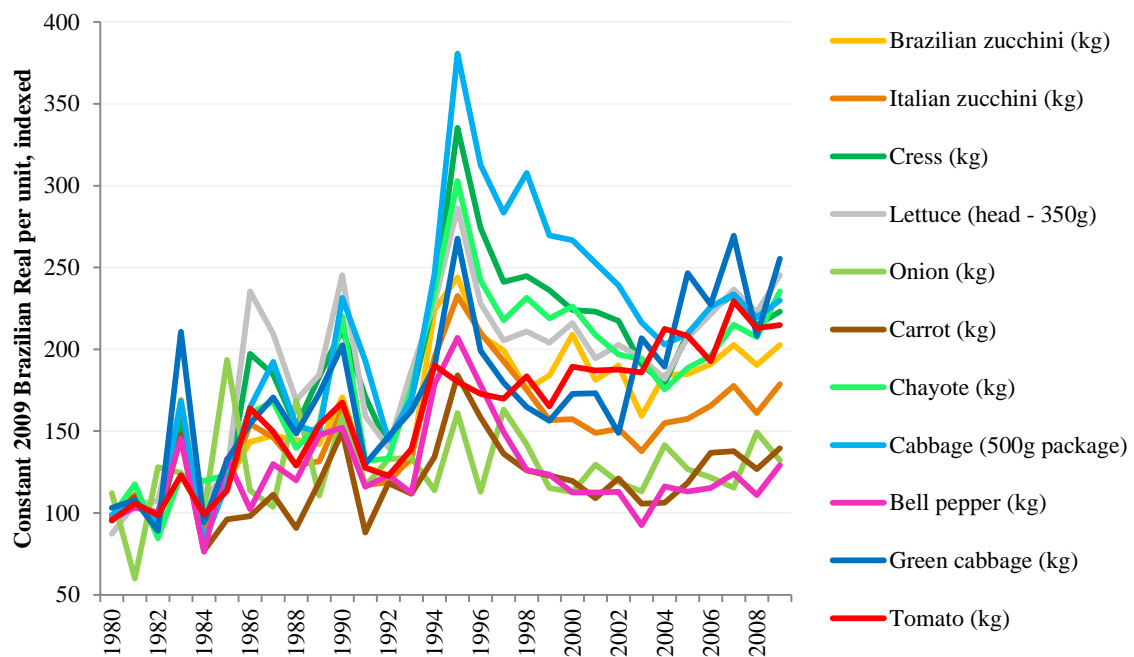
In real terms, all vegetable prices increased over this period, with again several spikes over 1995. Relative to their levels in 1980-1982, by the end of the series, prices had risen the most for green cabbage, followed by lettuce, and cress. Smallest price rises relatively were observed for bell pepper (already among the higher priced ingredients) onions, and carrots.

Figure III.2.3. Constant 2009 annual prices and price indices for selected vegetables in São Paulo, 1980 to 2009

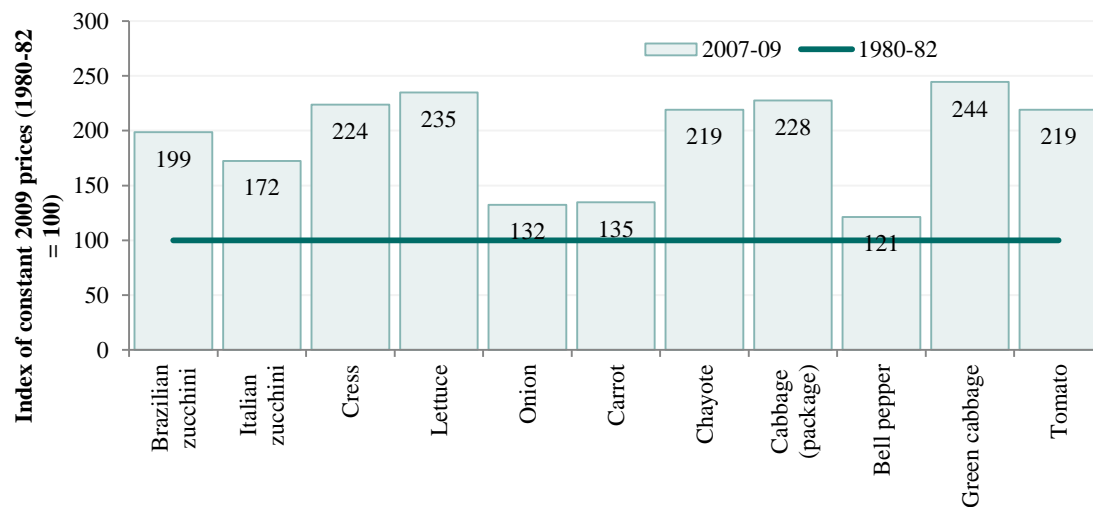
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



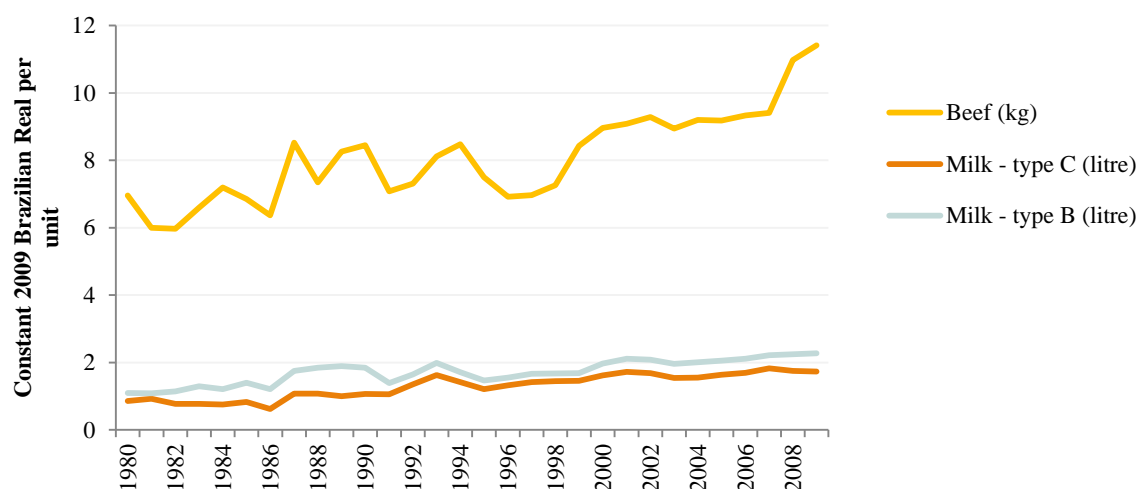
Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

Meat & dairy

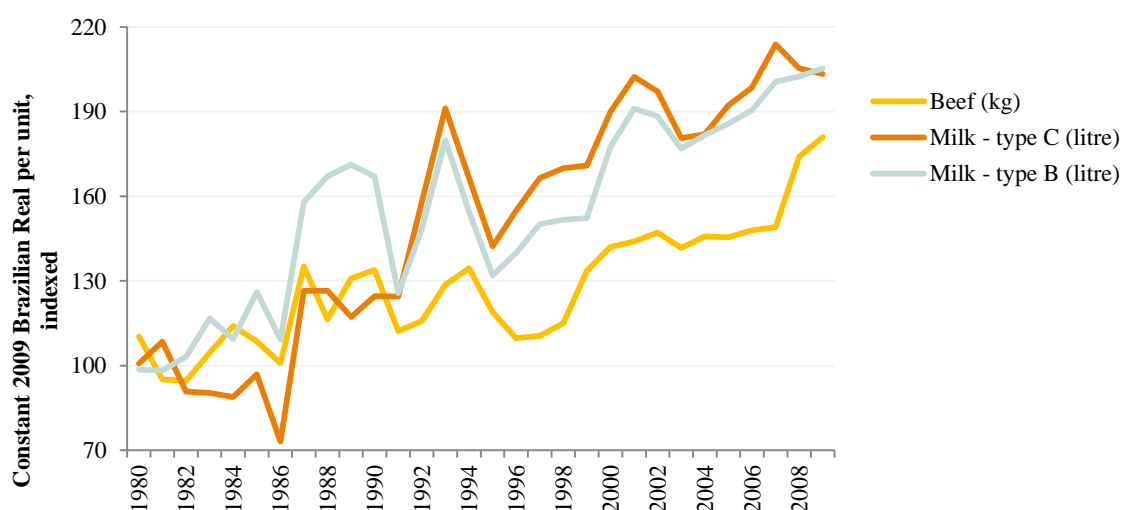
Prices of beef and milk show rises over the period to a relatively similar extent. By 2007-09, milk prices were about double their levels in the early 1980s, while beef prices were about 70% more.

Figure III.2.4. Constant 2009 annual prices and price indices for selected meat and milk in São Paulo, 1980 to 2009

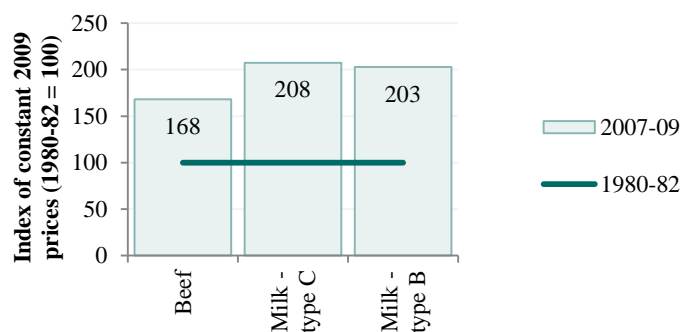
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices

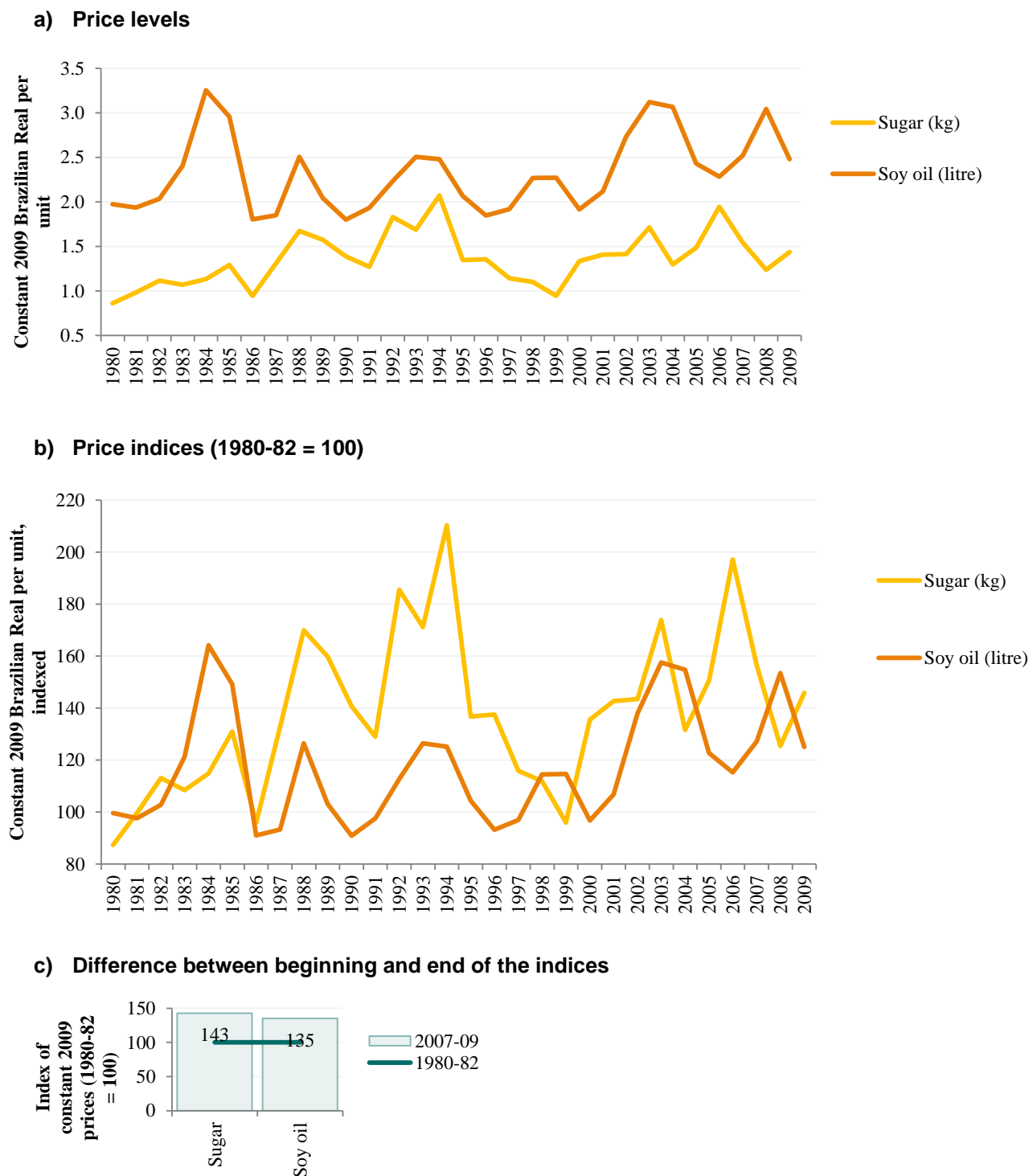


Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

Sugar and oil

Though sugar and oil prices both increased from the beginning to the end of the series, given volatility in the whole series it is not clear whether any such rises are particularly significant. Sugar remains an extremely cheap product in Brazil, in 2009 costing under US\$0.80 a kilogram.

Figure III.2.5. Constant 2009 annual prices and price indices for selected meat and milk in São Paulo, 1980 to 2009



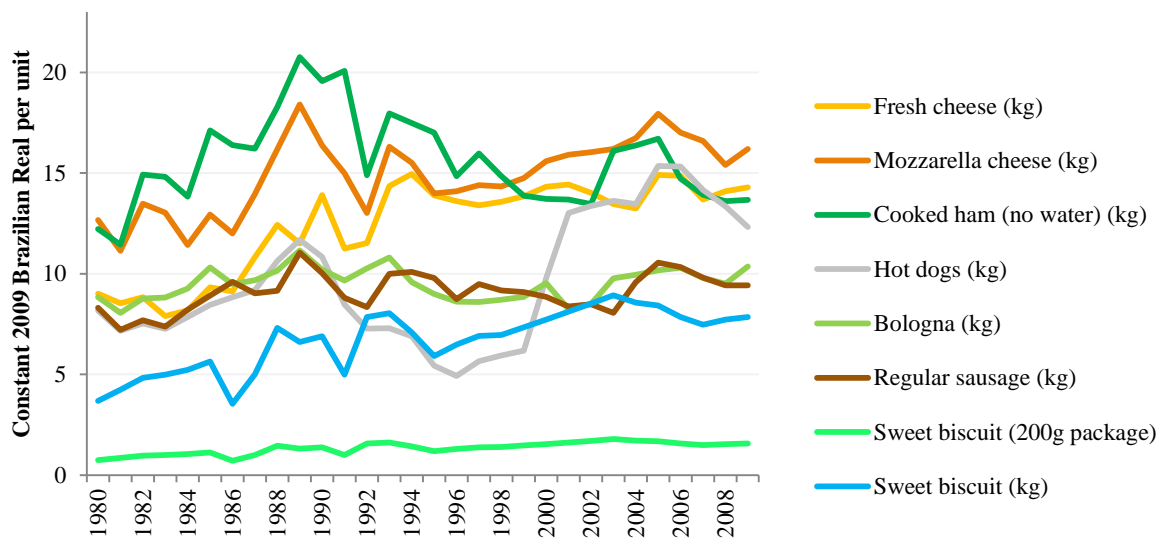
Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

Processed foods

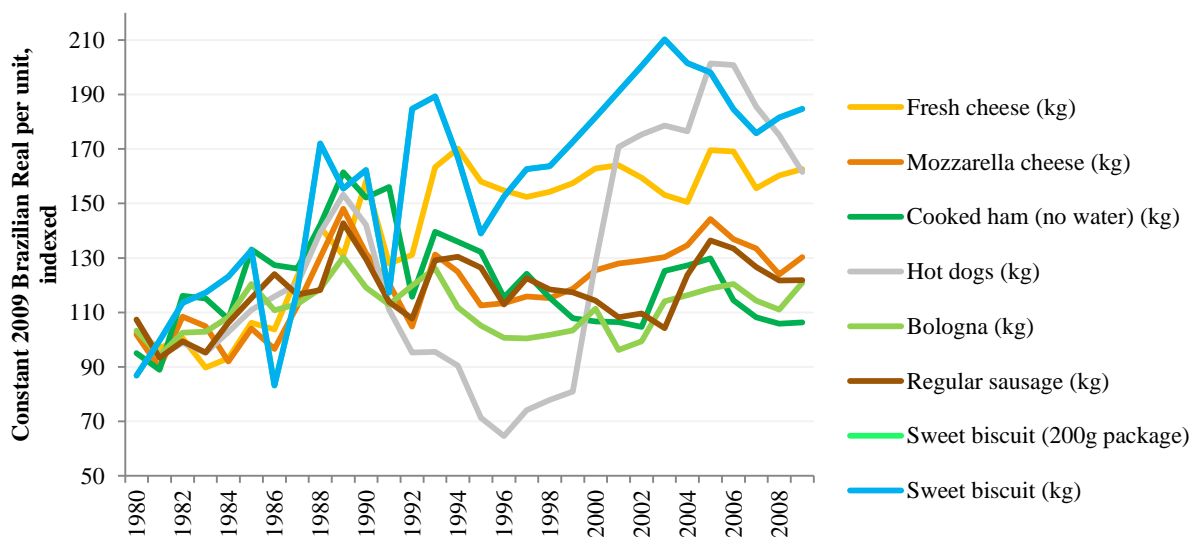
Processed food prices all increased over the period shown also – though to a smaller extent than the majority of increases seen for fruits and vegetables. Largest increases were seen for sweet biscuits (in 200g packages) – though these were coming from quite a low base originally – followed by hot dogs and fresh cheese. Very minor increases were observed for cooked ham and bologna, and relatively minor increases for regular sausage and mozzarella cheese.

Figure III.2.6. Constant 2009 annual prices and price indices for selected processed foods in São Paulo, 1980 to 2009

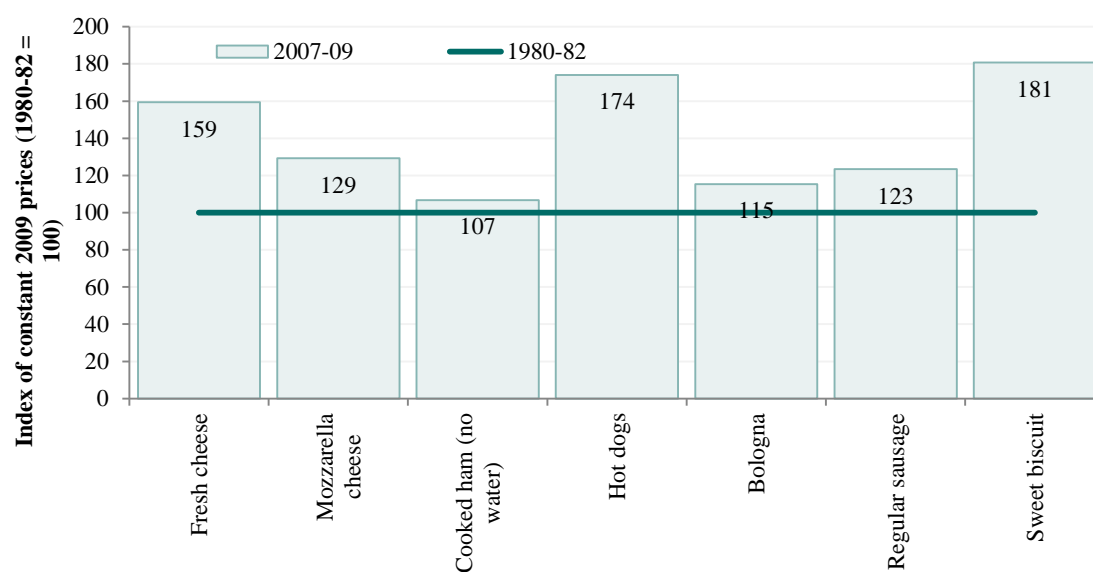
a) Price levels



b) Price indices (1980-82 = 100)



c) Difference between beginning and end of the indices



Source: Data from Dr. Rafael Claro, originally Data collected by the Institute of Agricultural Economics of São Paulo State (available at: http://ciagri.iea.sp.gov.br/nia1/precos_medios.aspx?cod_sis=4), deflated to 2009 levels with CPI data and corrected for currency changes.

III.3 South Korea

This annex was authored by Euna Han

Changes in relative prices of different foods in Korea

Results: descriptive statistics for Korea

Implicit prices

Implicit unit prices have been constructed using a Monthly Report of Cost of Living in January 2006 in Korea and Consumer Price Index for individual food items between 1975 and 2013. Prices are shown in Korean won per 100 g of foodstuff, 100 ml of drink and ice cream, or 2 eggs. All prices were deflated to values of 2006 using Consumer Price Index. Food groups and selected food items in each group are listed in Table III.3.1.

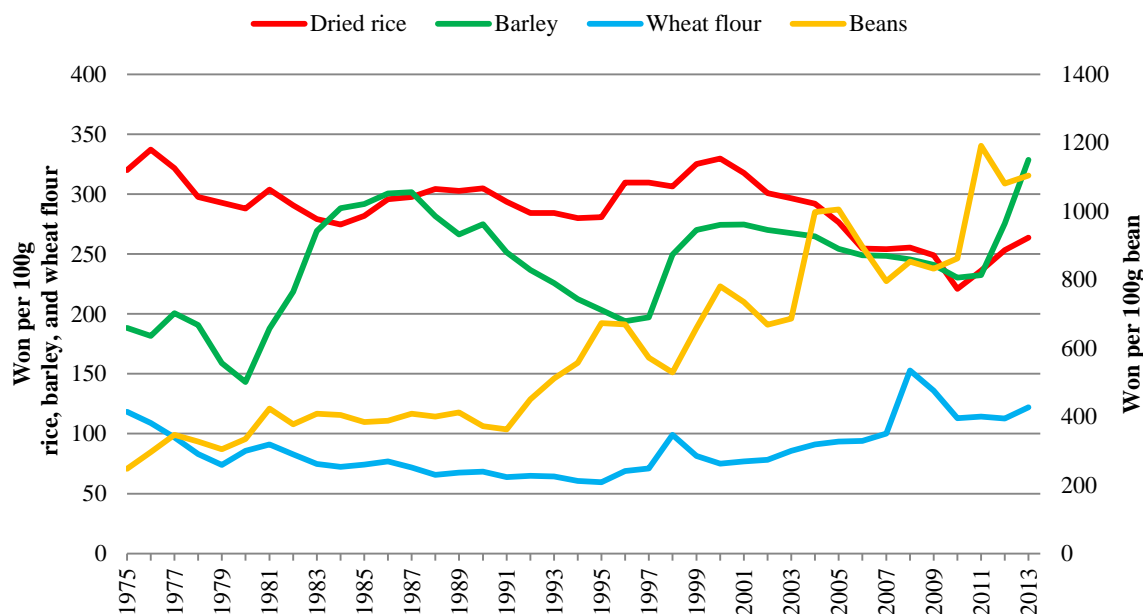
Table III.3.1 Selected food group and food items

GROUP		FOOD
STAPLES		Dried rice Barley Bean Wheat flour
PROCESSED		Sweets (candy & chocolate) Ice cream Biscuit Chips Ramen Convenience meat (sausage & ham)
MEAT AND DAIRY		Beef Pork Chicken Egg Fish Milk
FRUIT AND VEGETABLES (ALL FRESH)	Fruit	Apple Pear Tangerine Banana
	Vegetables for Kimchi	Cabbage Daikon Green onion Garlic
	Other vegetables	Bean sprout Squash Onion
FATS, SUGAR AND SPICES		Vegetable oil (except for olive oil) Sugar Soy sauce Fermented paste

Staples

Figure III.3.1 shows trends for selected staples between 1975 and 2013. Four staples were included in the description; rice, barley, wheat flour, and bean. We did not include bread given that it can be considered as a processed food, and it is not a main staple in Korean context.

Figure III.3.1. Price trends for selected staple foods by weight, 1975 to 2013



Source: Constructed with data from Statistics Korea, Economic Statistics Bureau, Price Statistics Division (ESPS)

- In level, bean unit price is considerably higher than unit prices of rice, barley, and wheat flour. Therefore, we denoted rice, barley and wheat flour on the left axis and bean on the right.
- Prices of beans showed upward trend over the study period between 1975 and 2013. Bean prices increased 187% from 1985 to 2013, and such increase sustained over the entire investigation period.
- Rice price showed downward trend with 6% decrease from 1985 to 2013. Rice is the most important staple in Korean food culture given that a traditional Korean meal is served with a bowl of rice and a couple of side dishes of vegetables and meat.
- Barley price showed much fluctuation during the study period, showing decrease by 30% from 1985 to 1995, but turned to an increasing trend between 1995 and 2005.
- There were two spikes in price of wheat flour although the overall trend was relatively stable during the study period. Even though Korean economy has been growing rapidly, it suffered major economic turmoil with currency crisis in 1982, 1998, and 2008. The crisis in 1982 started from the end of 1970s and became worse thereafter to the extent that inflation rates reached 28.7% and 21.6% in 1980 and 1981, respectively. Korea received financial aid from International Monetary Bank at the end of 1997. We can observe spikes in staple prices in those three points of time, particularly for wheat flour which had been mostly imported from abroad.

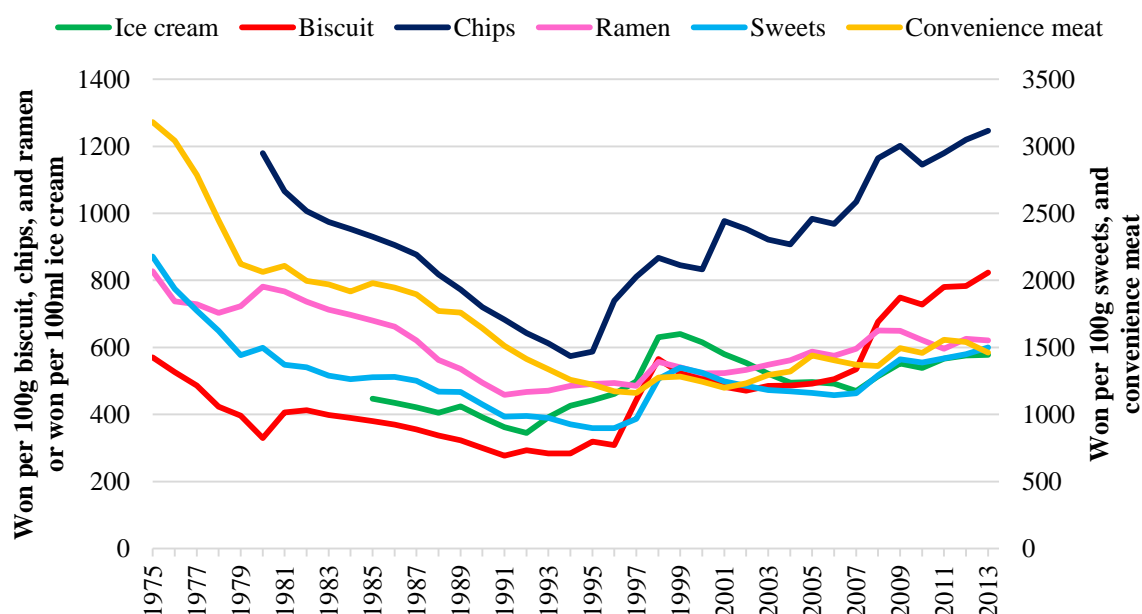
Table III.3.2. Big differences (in percentages) between years in implicit prices for staples

STAPLES	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
RICE	-12	0	-1	-6
BARLEY	55	-30	25	13
BEAN	55	75	49	187
WHEAT FLOUR	-37	-20	57	65

Processed foods

Processed foods included sweets (candy and chocolate), biscuit (all kinds), salty chips, ice cream, convenience meat (sausage and ham), and ramen (instant noodle). Ramen is one of the most popular fast foods in Korea which is the world largest consumer of ramen (Han, Powell, and Kim, 2012). Unlike the U.S. or the U.K., prices of some of the selected processed foods showed u-shape trends over the study period in Korea. Korean economy dramatically improved over the past decades (International Monetary Fund, 2010) with rapid westernization in dietary pattern (Lee and Sobal, 2003). However, there was a major economic turmoil at the end of 1997 when real prices of almost all processed foods for this study turned to increasing trends.

Figure III.3.2. Price trends for selected processed foods by weight, 1975 to 2013



Source: Constructed with data from Statistics Korea, ESPS

- Despite u-shape price trends of the selected processed foods, prices of ramen and convenience meat decreased by 9% and 26%, respectively, from 1985 to 2013.
- We can also observe steeper upward trends since 1998 for prices of biscuit and chips, all of which are made from imported wheat flour. The spikes in the prices of the selected processed foods in 2008 are possibly due to economic crisis at the end of 1997 in Korea. Most of the selected processed foods are made from wheat flour which is mostly imported from abroad.

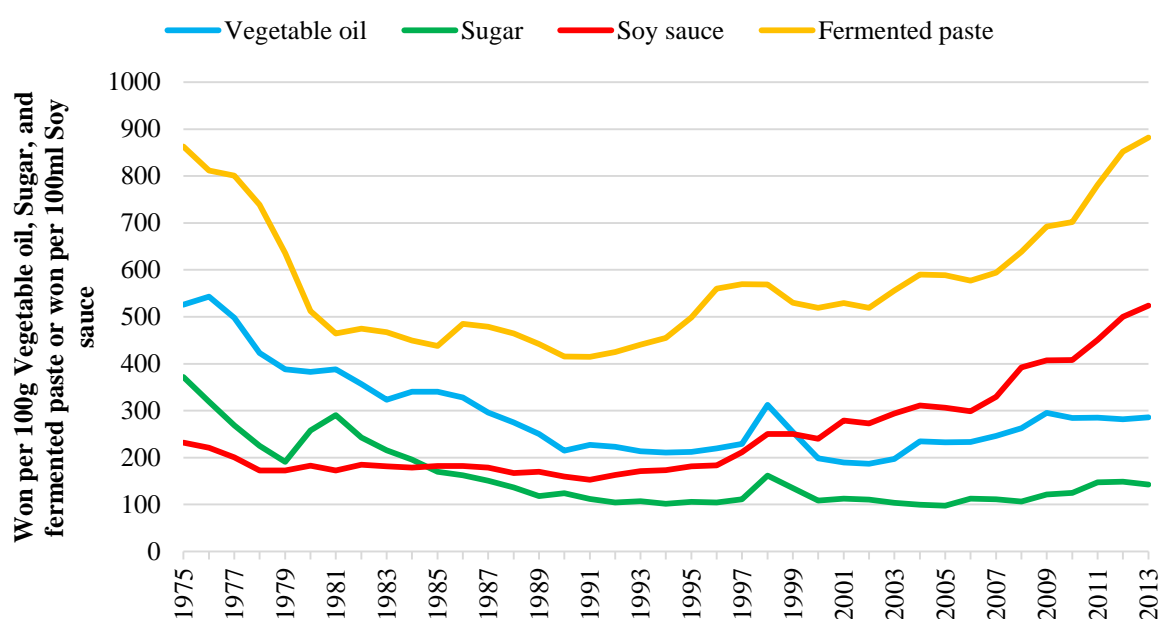
Table III.3.3. Big differences (in percentage) between years in implicit prices for selected processed foods

PROCESSED FOODS	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
SWEETS	-41	-30	29	17
ICE CREAM	-	-1	12	29
BISCUIT	-33	-16	54	117
CHIPS	-	-37	67	34
RAMEN	-18	-28	20	-9
CONVENIENCE MEAT	-38	-38	18	-26

Fats, sugar & spices

Trends in prices of fermented paste, soy sauce, sugar, and vegetable oil (except for olive oil) are shown in figure 3. Fermented paste for Korean foods is like butter for Western foods, and it is one of the key elements for traditional Korean meals. However, it should be noted that the primary issue surrounding traditional fermented paste is its sodium content rather than fat or calorie.

Figure III.3.3. Price trends for selected fats, sugar and spices by weight, 1975 to 2013



Source: Constructed with data from Statistics Korea, ESPS

- In level, unit prices of vegetable oil, sugar, and soy sauce are considerably below unit price of fermented paste.
- Whereas vegetable oil and sugar overall showed a decreasing time trend over the study period, price of soy sauce showed an overall increasing trend during the same period.

- Prices of sugar and vegetable oil showed spikes in 1981. As aforementioned, those spikes in 1981 are related to economic crises by the end of 1997, which increased prices of all imported goods including sugar and vegetable oil.
- Prices of vegetable oil and sugar remained relatively stable given that they decreased only by 16%, from 1985 to 2013, whereas price of soy sauce and fermented paste increased by 101% and 804%, respectively, from 1985 to 2013.

Table III.3.4. Big differences (in percentages) between years in implicit prices for selected fats, sugar, and spices

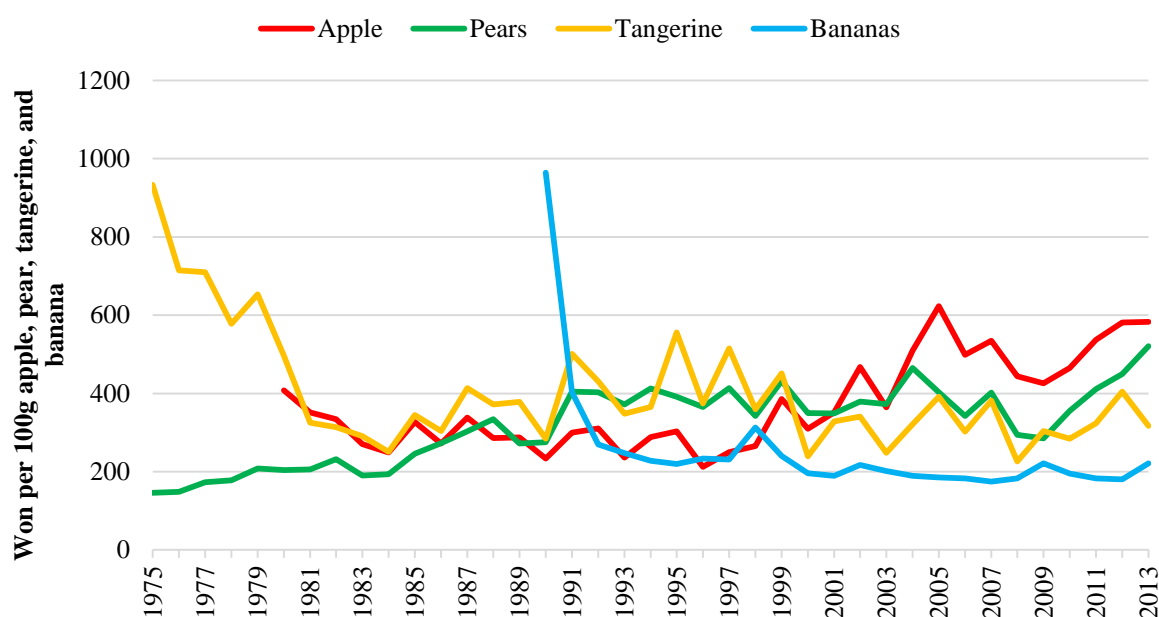
FATS, SUGAR, AND SPICES	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
VEGETABLE OIL	-35	-38	10	-16
SUGAR	-54	-38	-7	-16
FERMENTED PASTE	-21	-1	69	187
SOY SAUCE	-49	14	18	101

Fruit and vegetables

Price trends in selected popular fruit and vegetables in Korea are shown in Figures 4 and 5. Fruit included apples, tangerines, pears, and bananas. Even though price of bananas before 1990 are not available, we opted to include bananas in this descriptive analysis, given that they are the most imported fruit during the past decade and one of the most popular fruit particularly since the 90's. Apples, pears, and tangerines are mostly domestic produces.

Vegetables for this analysis included fresh bean sprout, squash, onion, cabbage, daikon, green onion, and garlic. The last four vegetables (cabbage, daikon, green onion, and garlic) are the main ingredients for Kimchi which is the most representative Korean food. It is the key side dish in any traditional Korean meal, and sometimes served even with western foods such as pizza or hamburgers in many Western restaurants in Korea.

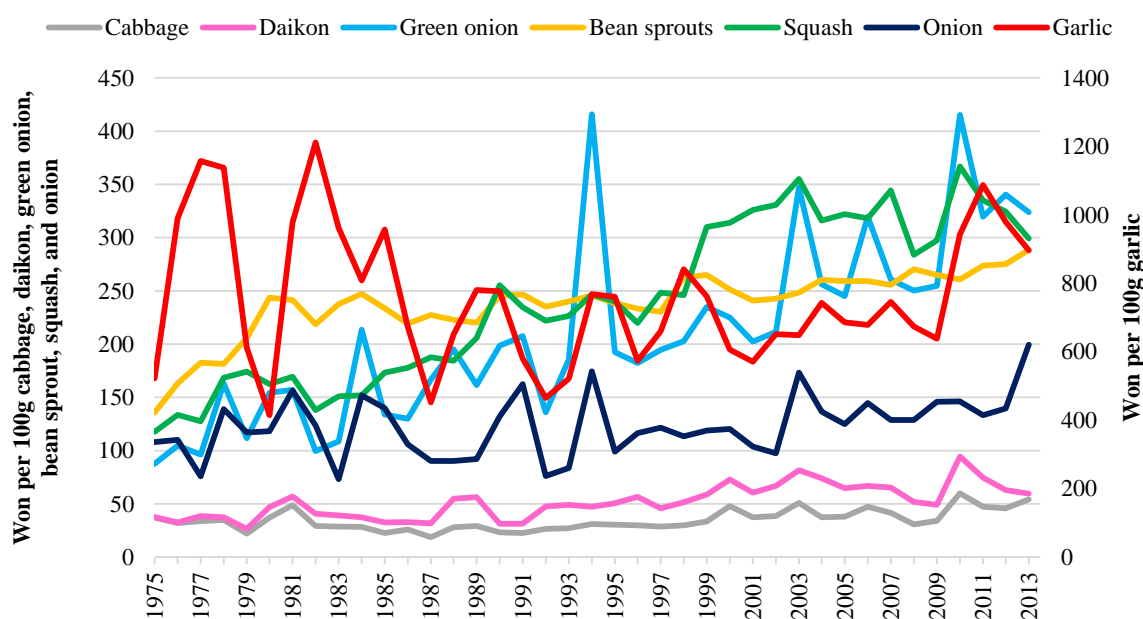
Figure III.3.4. Price trends for selected fruit by weight, 1975 to 2013



Source: Constructed with data from Statistics Korea, ESPS

- Prices of domestic fruits (apples, pears, and tangerines) showed some fluctuations without clear direction of changes during the study period. Those prices showed much more fluctuation during the investigation period than other food groups such as staples, processed foods, fats, sugar and spices.
- Price of banana, the most imported and frequently consumed fruit in Korea, showed a big drop from the first year when its price was investigated (1990) to the very next year (1991). It showed almost no changes ever since.

Figure III.3.5. Price trends for selected vegetables by weight, 1975 to 2013



Source: Constructed with data from Statistics Korea, ESPS

- In level, unit prices of cabbage, daikon, green onion, bean sprout, squash, and onion are considerably below unit price of garlic. The figure presents garlic on the right axis and all other selected vegetables on the left.
- Cabbage and daikon prices are stable during the study period despite slight upward trends.
- Prices of garlic and green onion, and onion showed much more fluctuation and tended to increase over the study period than other selected vegetables.
- Bean sprout and squash are domestically produced mostly, and thus, no apparent changes in prices corresponding to three major economic crises in 1982, 1998, and 2008.

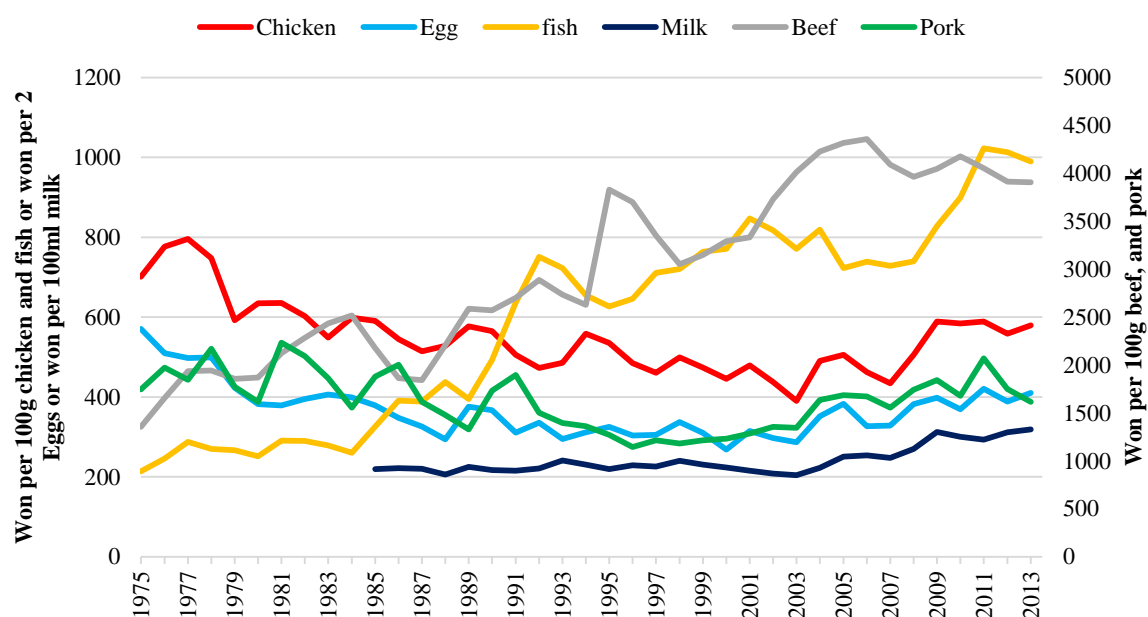
Table III.3.5. Big differences (in percentages) between years in implicit prices for selected fruit and vegetables

FRUIT AND VEGETABLES	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
APPLE	-	-7	106	79
PEAR	68	60	3	112
TANGERINE	-63	61	-30	-8
BANANAS	-	-	-16	-
CABBAGE	-39	33	25	138
DAIKON	-13	55	28	83
GREEN ONION	53	44	27	142
GARLIC	83	-20	-10	-6
BEAN SPROUT	72	2	9	23
SQUASH	47	38	34	72
ONION	29	-29	26	43

Meat and dairy

We included red meat (beef and pork), chicken, eggs, milk, and fish in meat and dairy group. Domestically grown beef is generally more expensive than imported beef in Korea, *ceteris paribus*, but we opted to average domestic and imported beef in this investigation based on the assumption that they are equally consumed. Fish included raw mackerel and cutlass fish, both of which are very popular in Korea. Figure 6 presents beef and pork on the right axis and other meat and dairy products on the left.

Figure III.3.6. Real unit prices of meat and dairy products, 1975 to 2013



Source: Constructed with data from Statistics Korea, ESPS

- Price of beef showed a big increase over the years with a much higher increase rate than other meat and dairy products except for fish.
- Beef and pork prices are far above prices of other meat and dairy products, and the gaps between price of beef and prices of other meat and dairy products became larger over the years.
- Prices of fish also showed upward trends, but Pork price was more stable than fish price over the years. Price of pork remained higher than price of fish across all years. Price of fish showed the largest increase from 1975 to 1985 by 203% among the meat and dairy products of interest.
- Prices of chicken, eggs, and milk are far below prices of beef, pork, and fish. Although price of milk is the lowest among prices of the meat and dairy products of interest, the magnitude of the increase of price of milk was higher than prices of chicken or eggs.

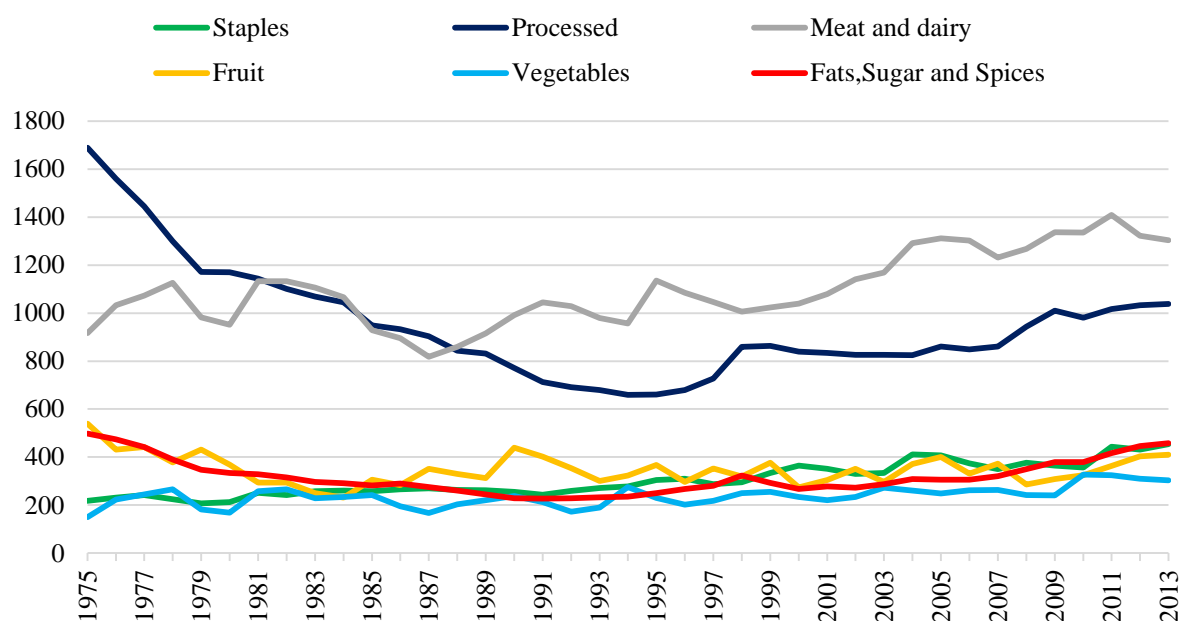
Table III.3.6. Big differences (in percentages) between years in implicit prices for selected meat and dairy

MEAT AND DAIRY	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
BEEF	61	76	13	80
PORK	8	-32	33	-14
CHICKEN	-16	-9	-6	-2
EGG	-34	-14	18	8
MILK	-	0	14	45
FISH	53	92	15	203

Prices as weighted indices (2006 = 100)

We generated price indices against a 2006 baseline. Korean government releases price indices for public use for yearly and monthly bases since January 1975 for almost all products in the market. However, nominal prices of foods are available only for January 2006. Therefore, year 2006 was used as the baseline, and real prices adjusting deflation were calculated with price indices. Price index for each food group is a simple yearly average of all food items in each food group. This is based on the assumption that all items in each food group are equally consumed.

Figure III.3.7. Price indices for food groups, 1975-2013, 2006=100



Source: Constructed with data from Statistics Korea, ESPS

Note: Staples index includes: Rice, barley, wheat flour, and bean. Processed foods index includes: Sweets, ice cream, biscuits, chips, ramen (instant noodle), and convenience meat. Meat and dairy index includes: beef, pork, chicken, egg, milk, and fish. Vegetables index includes: cabbage, daikon, green onion, garlic, bean sprout, squash, and onion. Fruit index includes apple, pear, tangerine, and banana. Fats, sugar, and spices index includes vegetable oil, sugar, soy sauce, and fermented paste.

- The indices show that costs of meat and dairy increased during the study period between 1975 and 2013, whereas price of processed foods decreased over the same time period. For other food groups, price changes over the study period were relatively small.
- It seems noteworthy that meat and dairy price index surpassed the processed food index from 1989. This implies that processed foods were relative more expensive than meat and dairy products before 1989, whereas they became cheaper since 1989 with the gap in price indices between the two food groups being larger in later years.

Table III.3.7 Big differences (in percentages) between years in price indices for food groups

FOOD	1975 VERSUS 1985	1985 VERSUS 1995	1995 VERSUS 2005	1985 VERSUS 2013
STAPLES	18	18	34	76
PROCESSED FOODS	-44	-30	30	9
FATS, SUGAR AND SPICES	-43	-12	23	62
FRUIT	-43	20	9	34
VEGETABLES	62	-5	8	25
MEAT AND DAIRY	1	22	16	40

Annex III.3 References

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Statistics Korea. **Households and Household Members by Type of Household (2005)**

http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1GA0501&conn_path=I3

Statistics Korea. **Households and Household Members by Type of Household (2010)**

http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1IN1002&conn_path=I3

III.4 China

This annex was authored by Satoru Shimokawa

Approach and method:

- Select food representative of major food groups in China.
- Obtain a record of their retail prices in China going back to 1984.
- Deflate the prices to state them in constant terms in China.
- Describe the changes in food prices in China.
- Describe changes in food consumption in China.
- Describe changes in the prevalence of overweight and obesity in China.

Aim: to determine the relative movements of prices of foods from different groups.

Method:

Data come from China Statistical Yearbooks (CSY) 1990–2013, and China Health and Nutrition Survey (CHNS). From the CSY, we obtained yearly retail price indices by food groups during 1984-1989 (consumer price indices were not reported) and yearly consumer price indices by food groups during 1990-2012 (CSY1990 reports price data for 1984-89). From the CHNS, we obtained data on unit prices (in level) by food categories in 1989, 1991, 1993, 1997, 2000, 2004 and 2006.

Although the CSY also provides food price indices during 1951-1983, we focus on the period after 1983 because there were no formal food markets in China before 1984. During 1951-1983, foods were distributed through employment units (*danwei*) in urban areas and through collective units (e.g., people's communes) in rural areas. Thus the price data during this period is purchasing prices that were decided by the government and highly distorted by political intentions.

We will report food prices for urban and rural areas separately because food prices tend to be different between these two areas in China.

Food prices in level and nominal price indices have been deflated through time by the GDP deflator from International Monetary Fund, World Economic Outlook Database, October 2014.

Table III.4.1. Selection of foods

	China Health and Nutrition Survey (CHNS)	China Statistical Yearbooks
Staples	<ul style="list-style-type: none"> • Wheat flour • Rice 	<ul style="list-style-type: none"> • Grain (rice and flour)
Fats and sugars	<ul style="list-style-type: none"> • Vegetable oils (but not olive oil) • Sugar 	<ul style="list-style-type: none"> • Oil and Fat
Fruits and vegetables	<ul style="list-style-type: none"> • Green vegetables • Cabbage • Apple • Orange 	<ul style="list-style-type: none"> • Vegetables (Dried and Fresh) • Dried and Fresh Melons and Fruits
Meat and dairy	<ul style="list-style-type: none"> • Pork (lean and fatty) • Chicken (whole cleaned) • Egg • Milk (fresh milk) 	<ul style="list-style-type: none"> • Meat, Poultry and Processed Products
Processed food		<ul style="list-style-type: none"> • Cake, biscuit and bread

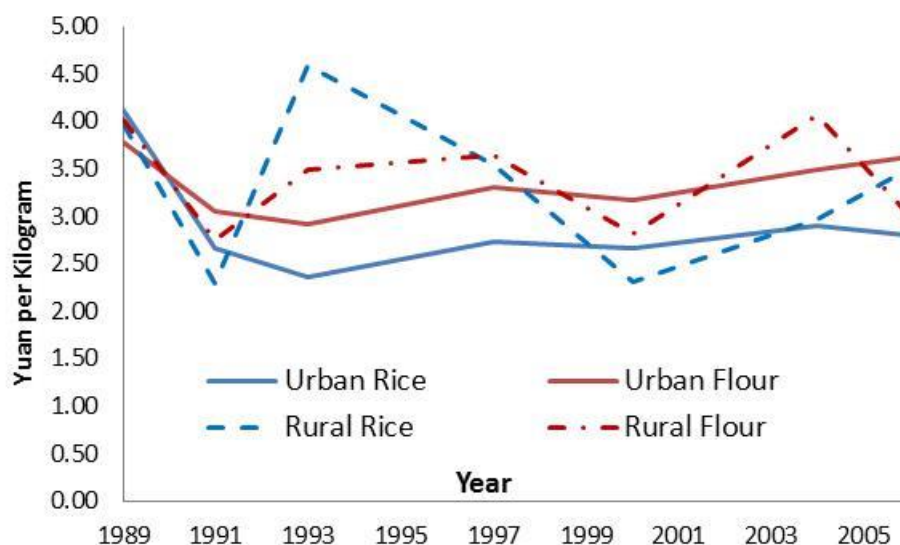
Results: descriptive statistics for China

The CHNS collected food price data at the county level. It collected two-types of food prices: prices at larger supermarkets, and prices at free markets. We used the prices at free markets because the prices are available since 1989 while the prices at large supermarkets are available only from 2000.

Staples

Figure III.4.1 shows trends in unit prices for wheat flour and rice from 1989 to 2006. Flour is a dominant staple cereal in northern China, and rice is a dominant staple cereal in southern China. Solid lines are for urban areas, and dotted lines are for rural areas.

Figure III.4.1. Trends in Price Level for Selected Staple Foods in Urban and Rural Areas in China, 1989 to 2006



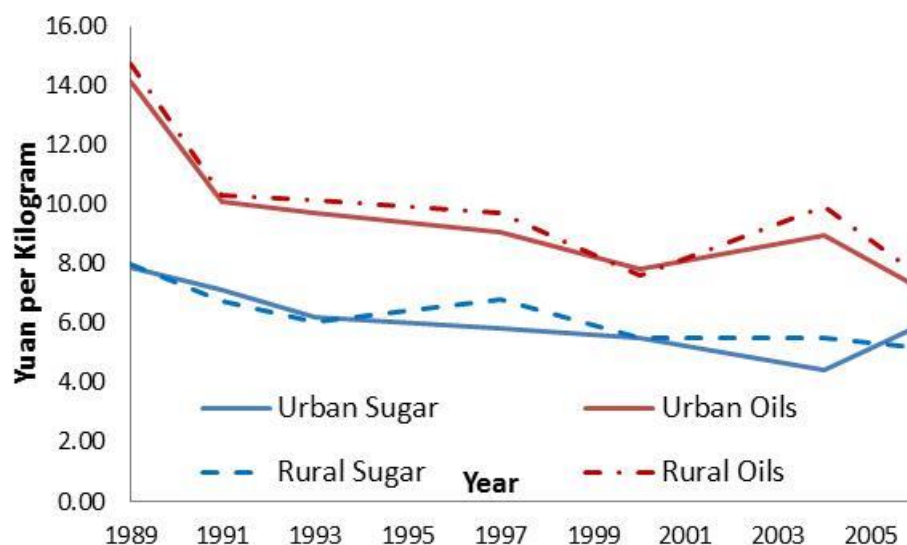
Source: Constructed with data from China Health and Nutrition Survey 1989 - 2006

- In urban areas, rice unit prices were lower than flour unit prices after 1991 (about 0.5 yuan/kg lower).
- In urban areas, both flour and rice prices were more stable than in rural areas during the period, and they have trended up after 1993: rice prices increased by 23%, and flour unit prices increased by 24%.
- In rural areas, while rice unit prices tended to be lower than flour unit prices, rice unit prices became higher than flour unit prices in 1993 and 2006.
- In rural areas, flour unit prices were more stable than rice unit prices. Rice unit prices peaked in 1993 (4.59 yuan/kg), dropped to 2.32 yuan/kg in 2000, and started increasing again after 2000. While flour unit prices showed similar changes, the magnitude of the changes was smaller than those in rice prices—changes ranged between 2.75 yuan/kg and 4.07 yuan/kg.

Oil & sugar

Figure III.4.2 shows trends in unit prices for vegetable oils and sugar.

Figure III.4.2. Trends in Price Level for Vegetable Oils and Sugar in Urban and Rural Areas in China, 1989 to 2006



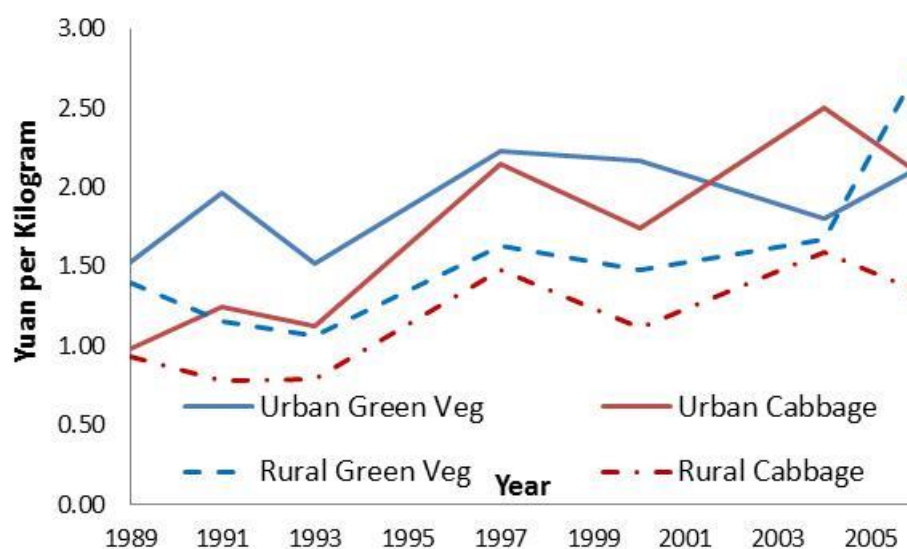
Source: Constructed with data from China Health and Nutrition Survey 1989 - 2006

- Sugar unit prices were lower than vegetable oil unit prices in both areas during the period.
- Unit price levels were similar between urban and rural areas for both vegetable oils and sugar.
- Unit prices for both vegetable oil and sugar have trended down noticeably during the period. During the period, vegetable oil unit prices decreased by 35%, and sugar unit prices decreased by 36%.

Vegetables and Fruit

Figure III.4.3 presents trends in unit prices for selected vegetables, and figure 4 presents trends in unit prices for selected fruits. Fruit unit prices are available only in 2004 and 2006.

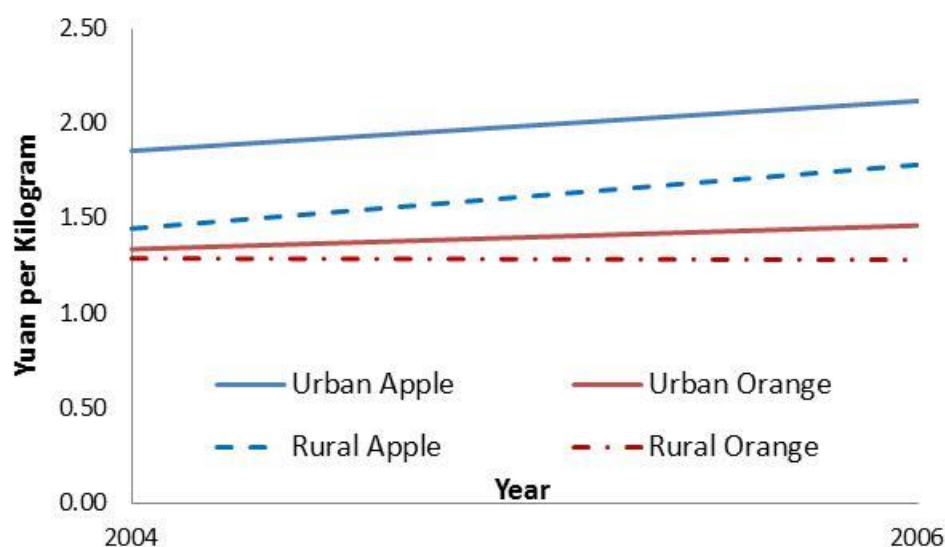
Figure III.4.3. Trends in Price Level for Selected Vegetables in Urban and Rural Areas in China, 1989 to 2006



Source: Constructed with data from China Health and Nutrition Survey 1989 - 2006

- Overall, vegetable unit prices were lower in rural areas than in urban areas except for green vegetable unit prices in 2006.
- In rural areas, green vegetable unit prices were higher than cabbage unit prices during the period. In urban areas, green vegetable unit prices were higher than cabbage unit prices until 2000, they became lower than cabbage unit prices in 2004, and they increased to almost the same level to cabbage unit prices.
- In both areas, green vegetable unit prices have trended up noticeably during the period. Green vegetable unit prices increased by 18% in urban areas and 96% in rural areas; cabbage unit prices increased by 112% in urban areas and 45% in rural areas.

Figure III.4.4. Trends in Price Level for Selected Fruits in Urban and Rural Areas in China, 2004 to 2006



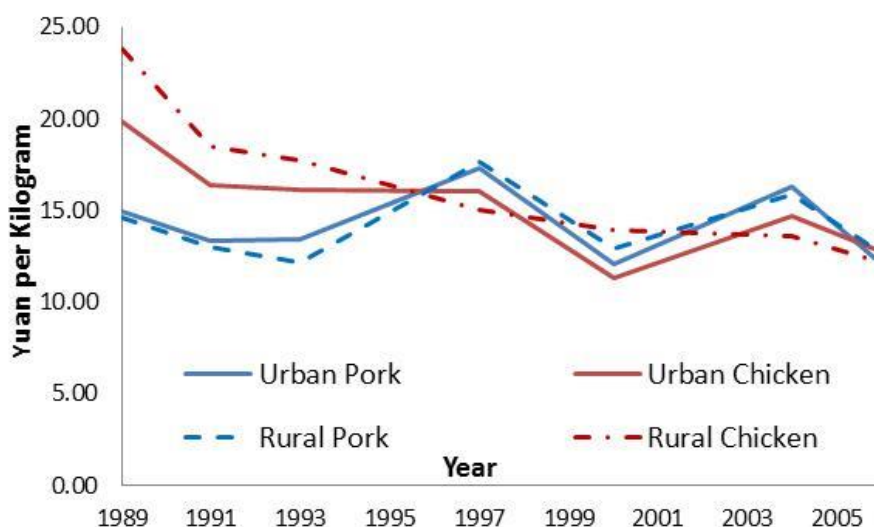
Source: Constructed with data from China Health and Nutrition Survey 1989 – 2006

- Fruit unit prices were lower in rural areas than in urban areas.
- Apple unit prices were lower than orange unit prices.
- Between 2004 and 2006, apple unit prices increased by 14% in urban areas and by 22% in rural areas, and orange unit prices increased by 9% in urban areas and decreased by 1% in rural areas.

Meat and dairy

Figure III.4.5 presents trends in selected meat unit prices from 1989 to 2006. We select prices for whole cleaned chicken and for fatty and lean pork. Figure 6 presents trends in unit prices for eggs and milk (domestic fresh whole milk).

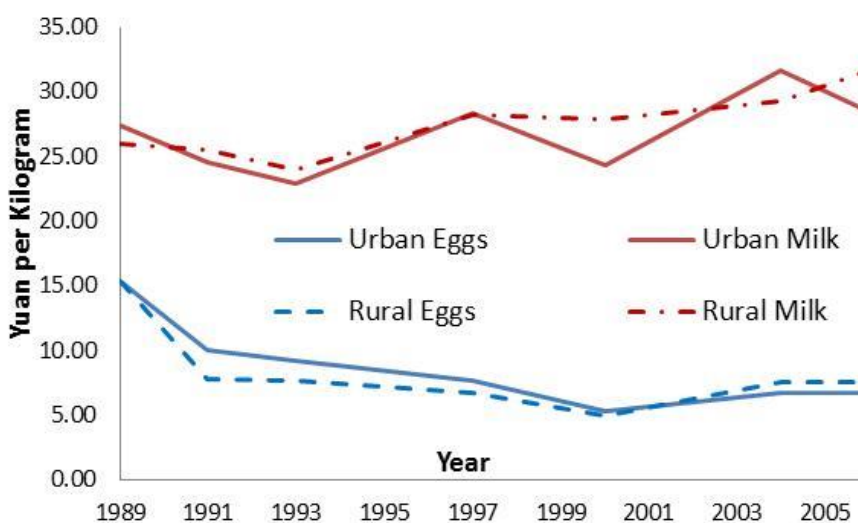
Figure III.4.5. Trends in Price Level for Selected Meats in Urban and Rural Areas in China, 1989 to 2006



Source: Constructed with data from China Health and Nutrition Survey 1989 - 2006

- Overall, chicken unit prices were higher than pork unit prices from 1989 to 1993, and pork unit prices tended to be higher than chicken unit prices after 1993.
- Pork unit prices were similar between urban and rural areas. Chicken unit prices tended to be lower in urban areas than in rural areas until 2000, and they became slightly higher in urban areas than in rural areas after 2000.
- In both areas, chicken unit prices have decreased substantially. Chicken unit prices decreased by 26% in urban areas and by 49% in rural areas; pork unit prices decreased by 19% in urban areas and by 13% in rural areas.
- Pork unit prices were fluctuating between 12 yuan/kg and 17 yuan/kg in both areas during the period.

Figure III.4.6. Trends in Price Level for Selected Eggs and Milk in Urban and Rural Areas in China, 1989 to 2006

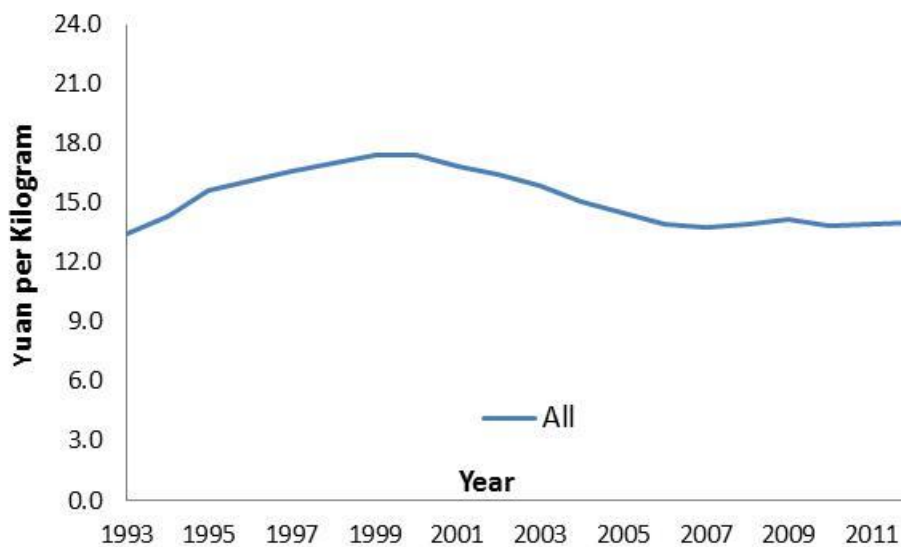


Source: Constructed with data from China Health and Nutrition Survey 1989 - 2006

- Milk unit prices are higher than egg unit prices in both areas.
- Egg unit prices and milk unit prices are similar between urban and rural areas.
- Egg unit prices trended down during the period. They decreased by 56% in urban areas and by 51% in rural areas.
- Milk unit prices trended up during the period. They increased by 4% in urban areas and by 22% in rural areas.

Processed food

Figure III.4.7. Trends in Price Level for Cake, Biscuit and Bread in China, 1994 to 2006



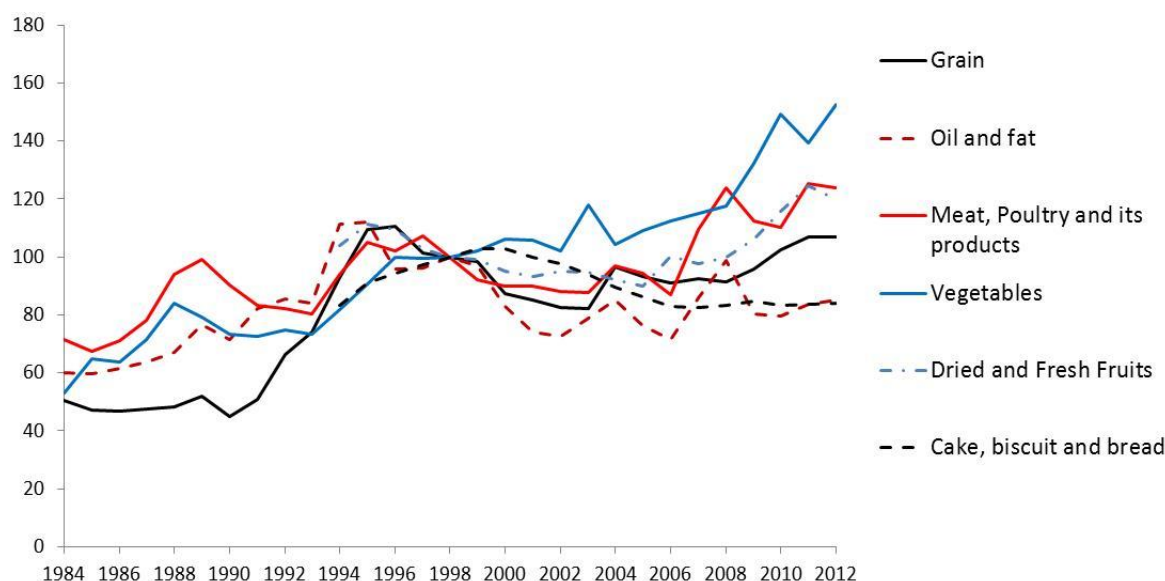
Source: Estimated with price indices from China Statistical Yearbooks, 1994-2013, and a unit price in 2014.

- Because a unit price of this category is not available in either CSY or CHNS, we constructed the price level from price indices in CSY and the unit price of the category in 2014 obtained from http://www.numbeo.com/food-prices/country_result.jsp?country=China.
- The unit price increased during 1993-2000 (peaked at 17.4 yuan/kg) and started decreasing afterward, and it is very stable after 2006.

Prices as weighted indices (1998 = 100)

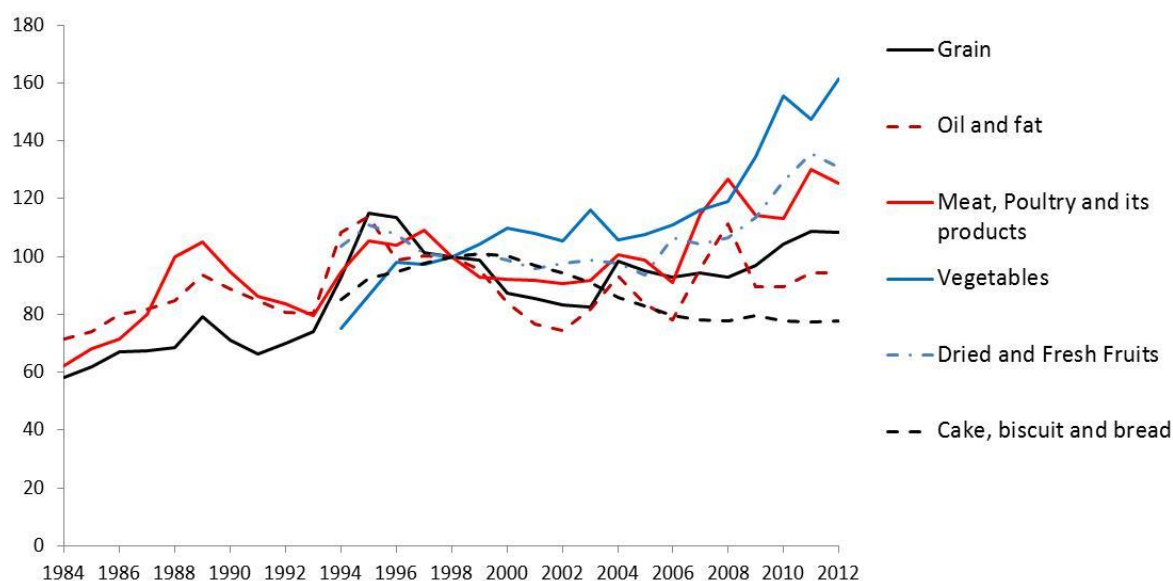
We converted nominal price indices (preceding year = 100) in the CSY to real price indices (1998 = 100) from 1984 to 2012. To convert from a nominal term to a real term, we employ GDP deflators over the same period. Then, the real price series were converted to indices against a 1998 baseline. Figure 8 shows trends in food prices in urban areas, and figure 9 shows trends in food prices in rural areas. Dried and fresh fruit prices in both areas and vegetable prices in rural areas are available only from 1994.

Figure III.4.8. Price indices for food groups in Urban Areas in China, 1984-2012 (1998 = 100)



Source: Constructed with data from China Statistical Yearbooks, 1990-2013.

Figure III.4.9. Price indices for food groups in Rural Areas in China, 1984-2012 (1998 = 100)



Source: Constructed with data from China Statistical Yearbooks, 1990-2013.

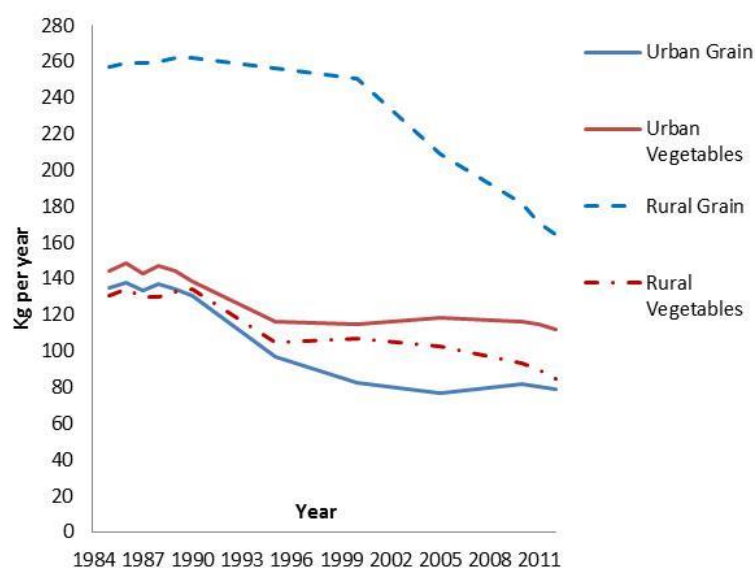
- Trends in food price indices were mostly similar between urban and rural areas during the period.
- A key difference between urban and rural areas was that vegetable prices increased slightly faster than meat prices in rural areas compared to in urban areas.
- In both areas, grain price indices were the most stable during the period. This may be because, since 1988, the Chinese government has serially intervened in the grain marketing system to mitigate the influence of the gradual abolition of government grain procurement and urban rationing systems.

- In both areas, vegetable prices have increased most rapidly among the food groups during the period; they increased by 86% in urban areas and 115% in rural areas between 1994 and 2011.
- Meat prices started increasing rapidly after 2006 in both areas (increased by 42% in urban areas and 37% in rural areas), while they have trended down during 1997–2006 (decreased by 19% in urban areas and 17% in rural areas).
- Dried and fresh fruit prices showed similar changes to the changes in meat prices. Dried and fresh fruit prices have slowly trended down during 1995–2005 (decreased by 19% in urban areas and 16% in rural areas); they increased rapidly after 2005 (increased by 33% in urban areas and 40% in rural areas).
- Oil and fat prices have slowly trended down since 1995 in both areas (decreased by 24% in urban areas and 17% in rural areas).
- Cake, biscuit and bread prices have been consistently decreasing after 1999 in both areas (decreased by 17% in urban areas and 23% in rural areas). The magnitude of the decrease after 1998 is one of the largest among the food groups.

Consumption level by food groups

Figure III.4.10 shows trends in annual consumption of grains and vegetables. Figure 11 shows trends in annual consumption of total meats, chicken and eggs.

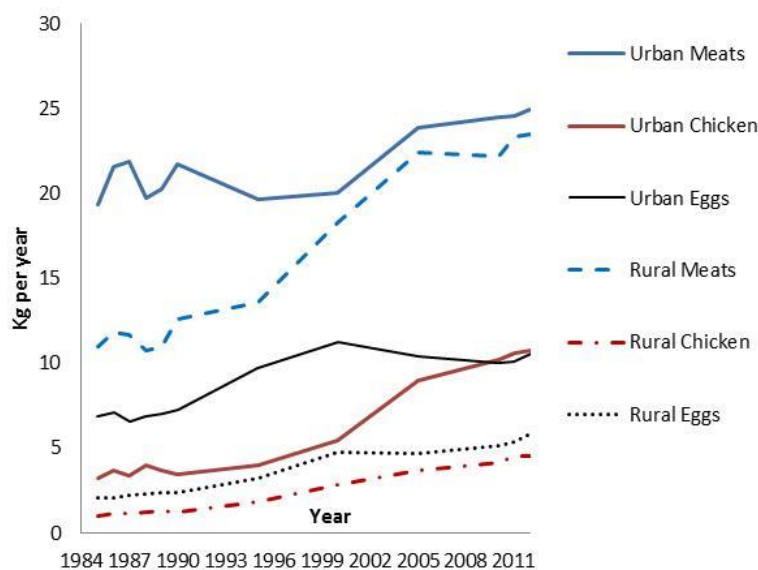
Figure III.4.10. Annual consumption of grains and vegetables in China, 1985-2012



Source: Constructed with data from China Statistical Yearbooks, 1990-2013.

- Grain consumption was much higher than vegetables consumption in rural areas; vegetable consumption was higher than grain consumption in urban areas.
- Grain consumption was much higher in rural areas than in urban areas; vegetable consumption was higher in urban areas than in rural areas.
- Grain consumption decreased more rapidly than did vegetable consumption.
- Grain consumption in urban areas decreased by 42% during the period; the consumption in rural areas rapidly dropped by 38% after 2000.
- Vegetable consumption decreased by 22% in urban areas and 35% in rural areas during the period.

Figure III.4.11. Annual consumption of meats and eggs in China, 1985–2012



Source: Constructed with data from China Statistical Yearbooks, 1990-2013.

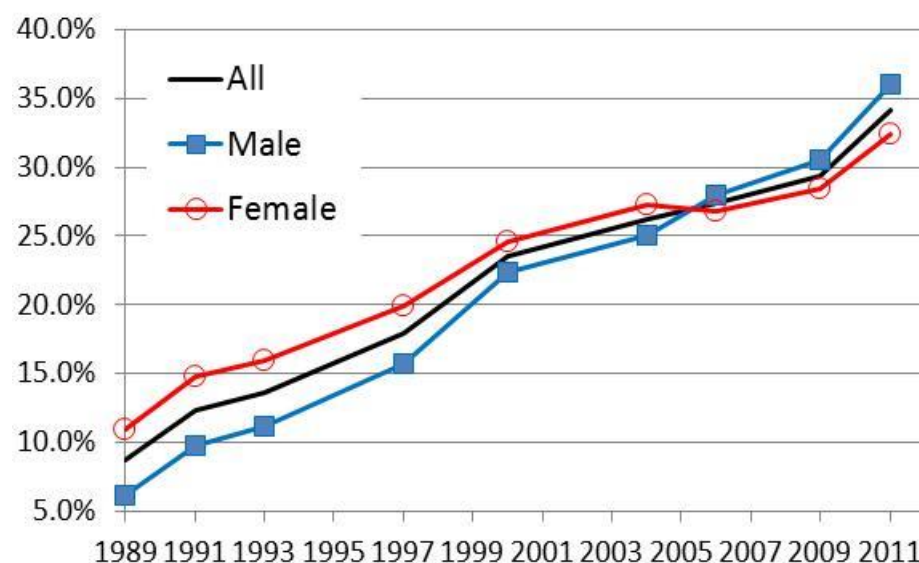
- Total meat consumption in urban areas was almost the double of the consumption in rural areas in 1984; the consumption in rural areas rapidly increased and reached almost the same level to that in urban areas after 2000.
- Chicken consumption in urban areas was more than the double of the consumption in rural areas during the period.
- Total meat consumption in urban areas has trended up during the period (increased by 59%); the consumption in rural areas rapidly increased between 1990 and 2005 (increased by 51%) and stayed at the high level after 2005.
- The increasing meat consumption in urban areas was mostly explained by an increase in chicken consumption; the increasing meat consumption in rural areas was mostly due to an increase in other meats' consumption (e.g., pork).
- Egg consumption in urban areas was almost the double of the consumption in rural areas during the period; the consumption increased by 54% in urban areas and 186% in rural areas during the period.

Other variables

Overweight and obesity among Adults (aged 20-60 years old) in China

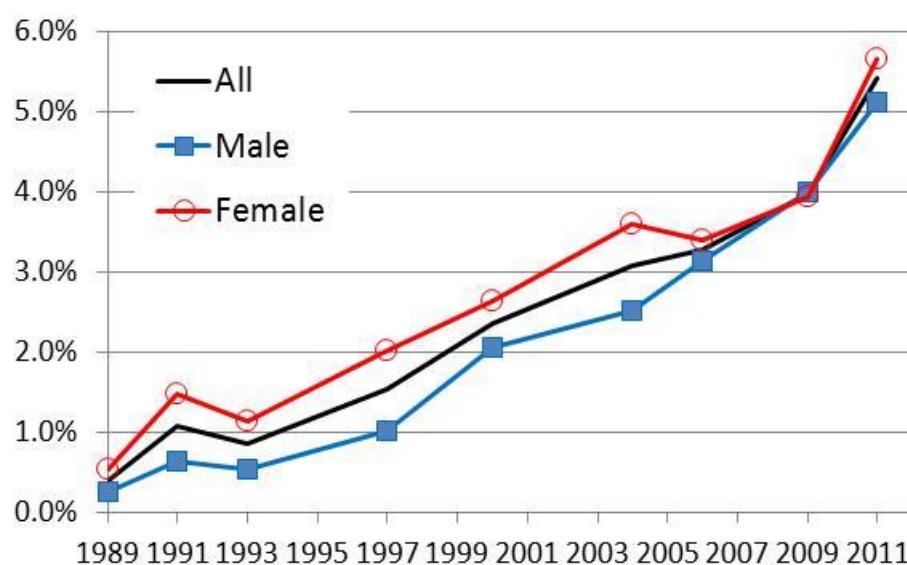
We use data from the CHNS in 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011. Figures 12 and 13 present the prevalence of overweight (BMI [kg/m^2] ≥ 25) and obesity (BMI [kg/m^2] ≥ 30) among adults aged 20–60 in China from 1989 to 2011, respectively.

Figure III.4.12. Prevalence of overweight among adults (20-60 years old) in China, 1989–2011



Source: Constructed with data from China Health and Nutrition Survey 1989 - 2011

Figure III.4.13. Prevalence of obesity among adults (20-60 years old) in China, 1989–2011



Source: Constructed with data from China Health and Nutrition Survey 1989 - 2011

- Overall, both overweight and obesity rates increased rapidly during the period: An overweight rate increased from 8.7% in 1989 to 34.1% in 2011; an obesity rate increased from 0.4% in 1989 to 5.4% in 2011.
- Obesity rates were higher among females than among males.
- Overweight rates were higher among females until 2004 while they became higher among males after 2004.