The rising cost of a healthy diet

Changing relative prices of foods in high-income and emerging economies

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Report
May 2015

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ISSN: 2052-7209

Key messages

- In high income countries over the last 30 years it seems that the cost of healthy items in the diet has risen more than that of less healthy options, thereby encouraging diets that lead to excess weight.
- It seems the same may apply in emerging economies, such as Brazil, China, Korea and Mexico, where prices of fruit and vegetables have been rising more than most other foods, including energy-dense processed foods.
- A strong case emerges for using taxes and subsidies to offset these changes to encourage more consumption of healthy foods and less of unhealthy items.

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Abbreviations & Glossary

BLS	US Bureau of Labour Statistics
BMI	Body Mass Index, body mass compared to square of height, kg/m2. BMI of 25 or more indicates overweight, 30 or more indicates obese
CPI	Consumer Price Index
Eatwell Plate	UK government guide to the composition of a healthy diet
Energy density	A measure of calories per unit of food
FAFH	Food away from home – food consumed outside people's homes as in restaurants etc.
FAO	Food and Agriculture Organizsation of the United Nations
GDP	Gross Domestic Product
HIC	High-Income Country
LIC	Low-Income Country
MIC	Middle- Income Country
Nutrient density	A measure of how many 'healthy' nutrients are in a food, usually by weight
Potato chips	US term, the same as UK potato crisps
Prices, constant or real	Nominal prices from which inflation in general price levels have been removed, either by use of a consumer price index or GDP deflator
Prices, indices	Prices expressed as ratio of those at a base year, when values are usually set to 100. Indices may or may not be adjusted for inflation. The price indices constructed in this paper have been adjusted for inflation.
Prices, nominal	Prices as observed at a given time, with no adjustment for inflation
SNAP	Supplemental Nutrition Assistance Program (USA)
SSB	Sugar-sweetened beverage (or 'soda' in US English)
UMIC	Upper Middle Income Country
USDA	United States Department of Agriculture
WCRF	World Cancer Research Fund

Acknowledgements

Many thanks to the following for their contribution to this report:

- For China, the report uses data from the China Health and Nutrition Survey (CHNS), so we thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention, Carolina Population Center (5 R24 HD050924), the University of North Carolina at Chapel Hill, the NIH (R01-HD30880, DK056350, R24 HD050924, and R01-HD38700) and the Fogarty International Center, NIH for financial support for the CHNS data collection and analysis files from 1989 to 2011 and future surveys, and the China–Japan Friendship Hospital, Ministry of Health for support for CHNS 2009;
- For Korea, Heejo Ku and Jae-eun Myung provided excellent research assistance;
- For Mexico, Dra Alejandra Donají Benítez Arciniega (UAEMex Medicine Faculty) provided valuable support;
- Fumiaki Imamura (Cambridge) and colleagues kindly supplied data on changing diets in the four countries;
- Corinna Hawkes (WCRF) peer reviewed the report, and her detailed and incisive comments on an earlier version helped to sharpen the thinking; and,
- Deborah Eade copy-edited the report.

This report forms part of the ODI project 'Shockwatch: managing risk and building resilience in an uncertain world', which is supported by the UK Department for International Development (DFID).

The interpretations and opinions expressed in the report are not necessarily those of the above mentioned persons, nor of the Overseas Development Institute. The main authors are solely responsible for any errors and omissions.

Summary

Motivations and questions

In 2014 our previous study 'Future Diets' (Keats and Wiggins 2014) described how across the world an increasing share of the population is overweight and obese, with the rate of increase particularly pronounced in developing countries. No nation, however, has stemmed the rising rates of people who are overweight and obese. Effective policies to combat obesity have yet to be proved, if only because no country has yet tested a sufficiently comprehensive set of policies. The causes of excess weight are multiple, including rising incomes, urbanisation and more sedentary occupations, the influence of media and advertising, and changing relative prices of different foods. This last element is the focus of this report.

The report starts from two working hypotheses:

a. When the relative prices of foods change, people will consume more of foods that have become relatively less expensive, and less of those that have become relatively more expensive. People on low incomes are expected to be more sensitive to prices than those on higher incomes; and,
b. When consumption of foods with high calorie content per unit weight (energy-dense foods) increases at the expense of food that is less dense in energy, we may expect to see a significant increase in the prevalence of overweight and obese people.

If these hypotheses are correct, they would suggest that using taxes and subsidies to influence diets is likely to be effective.

To the best of our knowledge, there is no existing study that compares the changing costs of foods from separate food groups across a sample of developing and emerging economies. The report focuses on four countries: three upper-middle-income countries (UMICs) – Brazil, China and Mexico; and one high-income country (HIC), the Republic of Korea, which was still a developing country in 1990. They have been chosen since they represent emerging economies that are growing faster than most industrialised countries, and where since 1990 significant changes may be expected in both diets and the relative prices of foods. Analysis of prices in the United Kingdom (UK) has been added to provide some comparison. The literature from the United States (USA) has been reviewed given the large number of studies that report on the price of food, the effect on food consumption and in some cases the consequences for body weight.

While changes in prices of some foods such as bananas, beverages, cereals, dairy produce, edible oils and sugar on international and national markets are regularly reported, less is known about the evolution of national retail prices of food in the form presented to consumers. Hence the central questions posed in this report:

- What changes have been seen in the retail cost of food in the four countries since 1990? Are there systematic differences in the evolution of prices for different foods, and hence changes in relative prices?
- In particular, has processed food become cheaper relative to unprocessed staples, fruit and vegetables, meat and dairy produce? This may be expected since much of the retail cost of processed food arises in manufacturing and logistics, where technical advances have reduced unit costs, perhaps by more than advances in farming have reduced the cost of agricultural produce.

It was possible to examine only a sample of the many foods on offer in retail outlets, the aim being to have at least one example from the following food groups:

• Staples	Cereals, root crops, legumes
• Fruit and vegetables	Fruit and vegetables
• Meat, fish and dairy	Minimally processed animal products and milk products
• Oils, fats, and sugar	Vegetable oils and fats, animal fats, sugar
• Highly processed foods	Foods usually produced by industrial processes

What is already known? Insights from the literature

Published studies for the UK and the USA frequently report the following, even if contrary findings and qualifications can be found in many other studies:

- Most studies find that healthier foods cost more than less healthy ones. Moreover this effect has increased over the last 30–40 years, as energy-dense, processed foods have become cheaper relative to less energy-dense fruit and vegetables.
- Consequently healthy diets tend to cost more than less healthy diets. This is not inevitably so: choosing cheaper healthy items and substituting them for costlier less healthy ones might both improve diet and save money. But for most consumers, this would require both the ability to see the distinctions, and the discipline to follow a particular diet.
- Although it seems that some energy-dense processed foods have become notably cheaper compared to fruit and vegetables, the nature of the latter have changed

– with higher-value prepared items common in food outlets, and also available all year round. Taking such added value into account the change in relative prices may be less than is at first apparent.
- Consumption of most foods responds to price changes, although for many foods the response is relatively inelastic – but far from perfectly so. Those on low incomes are most likely to respond to changing prices.

  Studies of the impacts of food taxes that often seem to trigger tiny changes in consumption obscure these findings, but this is because most studies observe or model the effects of very low taxes, 5% or less being typical.
- Cross-price effects matter in assessing the nutritional effects of price changes. Taxes on fat or salt content may affect consumption of other, complementary foods leading to less consumption of beneficial nutrients. Using tax revenues to subsidise such complementary foods would counter this effect.
- Studies of the impacts of changes in prices on body weight produce a surprisingly strong consensus that higher prices of unhealthy options reduce body mass index (BMI), as do cheaper healthier options. 'Surprising' since body weight is the outcome of many factors, yet prices changes can be seen to make a difference. The strongest effects are seen among those on low incomes who are most sensitive to the cost of food.

There are fewer studies on the four emerging economies, but they indicate the following:

- Some studies link changes in diets, above all those involving more consumption of processed foods, to processed food and cooking oil becoming cheaper than other foods.
- In Latin America, the rising consumption of ultra-processed foods and sugar-sweetened beverages (SSBs) is notable. Some see this as the consequence of heavy marketing by the large corporations that manufacture much of this food and drink.
- The possibility of using taxes to reduce consumption of processed food and SSBs is actively being studied, with most authors seeing the potential to significantly reduce consumption. Mexico has already introduced taxes on both SSBs and energy-dense food. These, which came into effect in January 2014, will be the focus of intense scrutiny to see what effects they have.

Data and methods

Key data for this report are series for food prices from 1990 to recent years in the four countries plus the UK. Retail prices were sought for representative foods – those frequently consumed – from the food groups listed above.

In most cases, directly observed retail prices were used. For Mexico, however, a food price index was used and calibrated to price levels from observed prices in Mexico City. In the UK, household surveys reported both spending and quantity for 330 foods. Hence it was possible to create unit prices paid by dividing expenditure by the quantity.

Price series have been deflated by either the consumer price index (CPI) or the Gross Domestic Product (GDP) deflator to remove the effect of inflation and allow comparison over time. Once prices were deflated, indices of theses deflated prices were constructed to see how much prices of different foods in each country had changed since the same base year.

More formal testing of price changes was carried out by regressing time on deflated and logged prices from 1990 to a recent year, in most cases 2012. This allowed a test of whether a significant (log-linear) trend can be inferred, and if so, what the average annual price change has been.

Results

The key findings from the analysis come from estimated annual price changes (see Figure A).

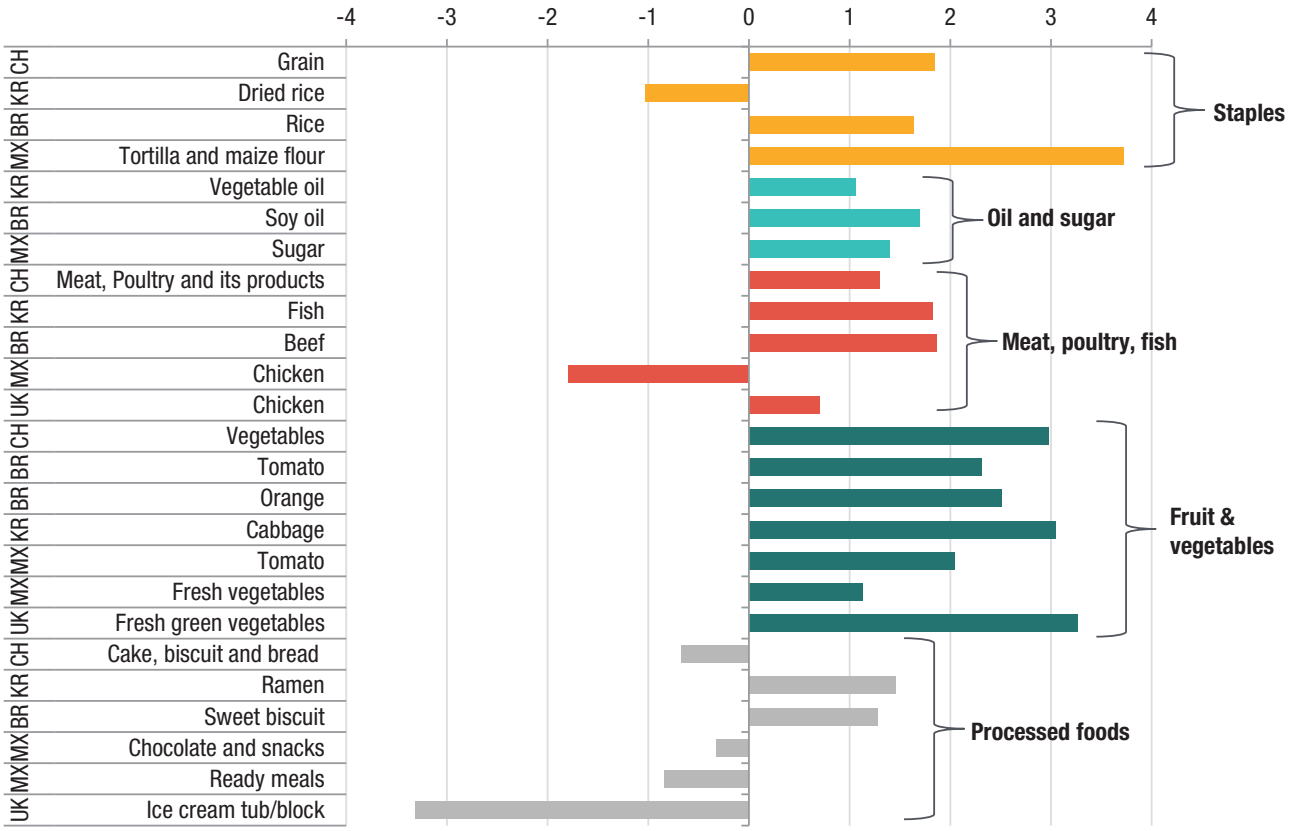
Two things are readily apparent. One is that prices of fruit and vegetables have risen substantially since 1990, mainly by between 2% and 3% a year on average – or by 55–91% between 1990 and 2012. The other is that four of the six processed products for which estimates are significant show price falls since 1990. Most of the other foods have seen their prices rise by 1–2% a year, with the exception of the price falls for rice in Korea and chicken in Mexico.

Discussion

If the detected trends are real they prompt questions about the reasons for them. If, for example, technical progress in farming were uniform, so that unit costs of production were falling for all agricultural output, and if advances in the logistics of food wholesaling and retailing were similarly uniform, then we might expect the costs of most foods to move roughly in line with one another. But that is not the case.

So why have fruit and vegetables become more costly compared to other items? It is not as though there have not been technical advances in horticulture: on the contrary some of the most sophisticated seeds, soil nutrition, water control, and prevention of pests and diseases are seen precisely in the gardens and glasshouses in which so many fruit and vegetables are grown. While there is a world of difference between Dutch heated glasshouses and the tiny plots of green beans of central Kenya, in both cases, compared to other agriculture in their neighbourhoods, these systems are both more intensive and use more sophisticated technology than most other local farm enterprises. Moreover, advances in transport mean that fruit and vegetables are traded more than in the past, so that retail managers should be able to source from low-cost suppliers no matter where they may be.

Figure A: Estimated average annual price changes from 1990



Source: Table 5.1

Hypotheses can be imagined: horticulture may well have a stepped supply function, so that while small quantities of fruit and vegetables can be supplied at low unit cost, once a particular volume is reached, costs rapidly escalate to a significantly higher level. It may also be that the changes in quality noted explain the increased relative prices. Or, it may not be a matter of cost but of increased demand from those consumers who appreciate the health benefits of fruit and vegetables. These hypotheses merit a separate study.

Why does not the same apply to some processed foods? One possibility is that much processed food does not rely on costly farm ingredients, but rather is manufactured from relatively cheap ingredients, the added value being largely in factory processes of combining the ingredients and enhancing their flavour. Advances in manufacturing and flavouring probably help reduce unit costs in factory. That said, processed foods are not uniform in quality and pricing, since for any sub-category, there are usually products that are branded, sold on their special characteristics, usually with a price premium – as applies, for example, to SSBs, which compete with cheaper, unbranded options. This may explain why not all the processed foods considered show declining constant prices. Again, additional studies might shed light on this.

Evidence presented in the literature review suggests that prices do affect consumption, especially for people on low incomes. Hence it is no surprise to see much study of the potential of taxes on less healthy options to reduce their consumption, perhaps even with subsidies on more healthy options to raise theirs. Most such studies indicate that imposing taxes would reduce consumption. But two qualifications apply.

One is that there may be cross-price effects, whereby when taxes raise the cost of a particular food, not only does its consumption fall, but so too does that of complements (foods which are typically consumed together, such as bread and butter). When those complements contain valued nutrients it is thus possible for taxes to reduce the quality of diet. In theory this problem can readily be tackled by placing a subsidy on the valued complement to offset the cross-price effect. In practice, learning which foods really are complements, to what extent, and then determining an optimal level of subsidy, could lead to a thicket of regulations that have to be adjusted in the light of emerging evidence, creating high administrative costs and giving the impression that such fiscal measures are just too difficult to contemplate. The question is how strong cross-price effects are and whether they may be remedied by other measures to encourage healthier diets.

The other is the apparently seductive argument that small taxes would create only small effects: that considerable change in consumption would require high

taxes that would look disproportionate and unfair – say, more than the rate of value-added tax (VAT) of 20% in the UK. But a logical flaw applies. The policy question is not so much, 'how large a tax would be necessary to bring down consumption of less healthy food X to recommended or insignificant levels', but 'how much benefit would be derived from imposing a politically acceptable tax on less healthy food X?' The answer to the former may be a number so high as to be dismissed from the debate; but the answer to the latter may be as striking as that provided by Nnoaham et al. (2009) for the UK: that taxes and subsidies of less than 20% could save no fewer than 6,400 premature deaths a year from coronary heart disease (CHD) and cancers. The argument about 'small taxes, small gains' is tantamount to arguments that condemn doing good because perfection is unattainable.

In terms of what might be taxed and subsidised, this report suggests that energy-dense foods might be taxed, while fruit and vegetables, whose prices often rise compared to other foods, might be subsidised.

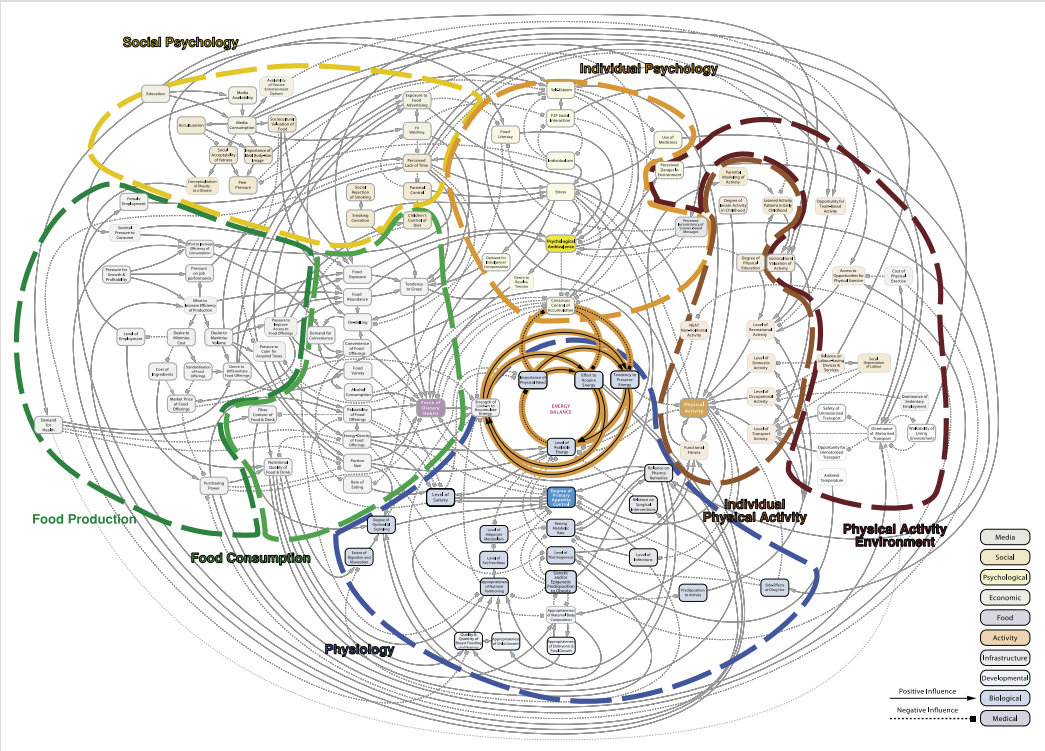
Much comes down to the political appetite to contemplate taxing foods. Events in Mexico suggest that some emerging economies may steal a march on HICs in this respect. The evidence presented in this report suggests that the Mexican taxes should achieve considerable good, thereby providing valuable lessons for other developing and emerging economies.

1. Introduction

Box 1A: Mapping drivers of overweight and obesity: spaghetti junctions ahead

A multitude of factors influence an individual's chance of being overweight or obese. The UK Foresight study on obesity identified broad thematic clusters of Social and Individual Psychology, Food Production and Consumption, Physiology, Individual Physical Activity and Physical Activity Environment, outlined in thick dotted lines on their diagram of interactions (Figure 1A1).

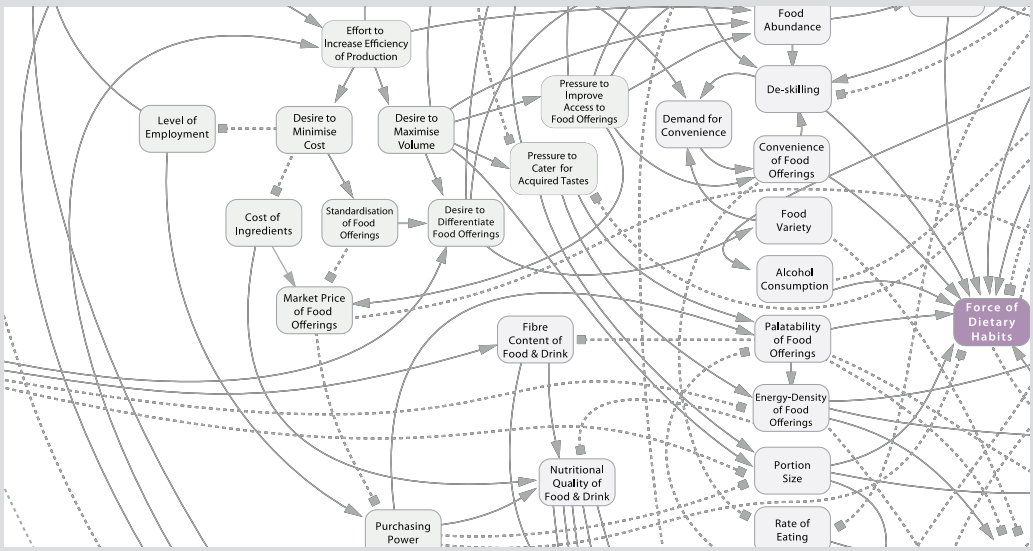
Figure 1A1: Foresight's causal map of overweight and obesity clustered by type of driver



Source: Map 5 in Butland et al. 2007

Within each of the clusters multiple factors interact. Below is the food consumption cluster where many of the economic factors come into, see Figure 1A2.

Figure 1A2: Extract from Foresight's causal map of overweight and obesity



Source: Section of Map in Butland et al. 2007

The prevalence of people who are overweight and obese is increasing across the world, especially so in developing countries (Keats and Wiggins 2014; Ng et al. 2014; Popkin and Slining 2013; Stevens et al. 2012). Some emerging economies now have almost the same prevalence of overweight and obesity as seen in high-income countries (HICs). The costs are high. Not only does excess weight make people more susceptible to heart disease, some cancers, strokes and type-2 diabetes, but also it leads to economic losses and higher costs of health care (Gortmaker et al. 2011).

No nation has stemmed the rising rates of people who are overweight and obese. Effective policies to combat obesity have yet to be proved, if only because no country has yet tested a sufficiently comprehensive set of policies. Causes of excess weight are widely agreed to be multiple, ranging from the simple economics of rising income and falling costs of many energy-dense processed foods, which allows people to eat more, to more sedentary lives associated with urbanisation, to socio-cultural effects of advertising and media images, and even to potential addiction to highly palatable foods (Hawkes 2008; Kearney 2010; Swinburn et al. 2011). Often the problem is seen as arising from systemic change. A systems map of the drivers of overweight and obesity, developed in the UK government's Foresight programme (Butland et al. 2007) (see Box 1A), shows just how complex (and interrelated) the drivers are believed to be.

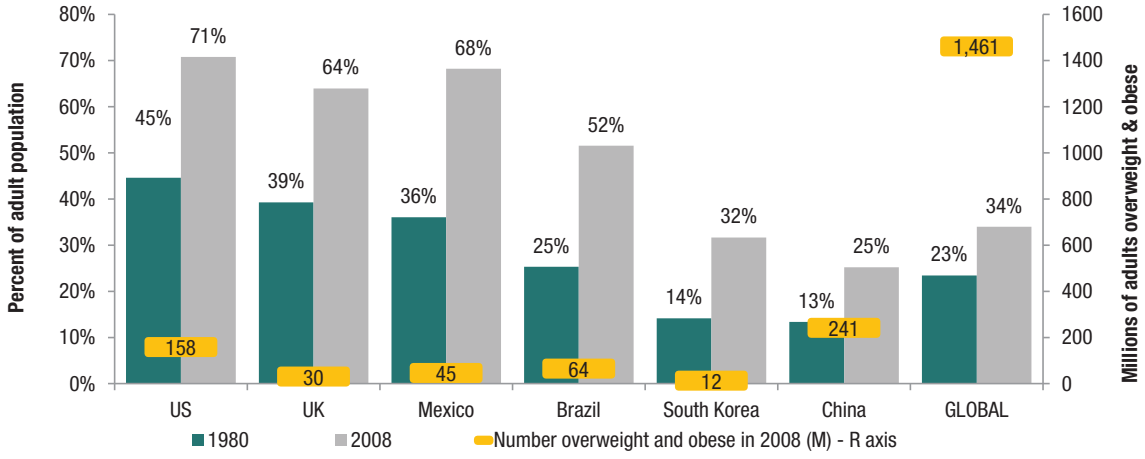
This report addresses one part of the system: the way in which prices of food influences choice of diet. If diets have tended to include more energy-dense foods, and especially processed food, is this largely because these foods have become relatively cheap compared to food less dense in energy and often unprocessed? The answer has implications for policy: namely the effectiveness of using taxes and subsidies to influence diets, and hence public health.

To the best of our knowledge, no existing study compares the changing costs of foods for separate food groups across a sample of developing and emerging economies. Although a simple exercise, it could therefore be of considerable interest to others studying causes and potential policy responses to rising levels of obesity.

This report aims to understand better how relative prices of different foods have changed since at least 1990, or earlier when data permit, and how this may have led to dietary changes. Plenty has been documented about changing relative prices of foods for HICs, as will be seen in the literature review of studies of food prices in the USA and the UK. Less, however, is known about changes in prices in developing countries, above all in emerging economies where the prevalence of overweight and obese people is growing fastest. This report aims to help fill this knowledge gap. It focuses on four countries: three upper-middle-income countries (UMICs) – Brazil, China, and Mexico – and one HIC, the Republic of Korea, which was still a developing country in 1990. They have been chosen since they represent emerging economies[1] that are growing faster than most of the industrialised countries, where since 1990 significant changes may be expected in both diets and the relative prices of foods. An analysis of prices in the UK has been added to provide some comparison.

Each of these four countries has seen a rapid increase in the burden of overweight and obesity since the 1980s (see Figure 1.1). Although prevalence is still relatively low in the Asian examples, it has grown markedly from

Figure 1.1: Prevalence of adult overweight and obesity in four countries plus the UK and USA, 1980–2008



Source: Compiled from data in Stevens et al. 2012

Notes: China: Latest estimates for overweight and obesity in adults 20–60 years over 35% for men and over 30% for women in 2011 – see Figures 12 and 13 in Annex III.4. Rapid increases in excess weight for those under age 20 from 2008 to 2013: for girls from 4.5% to 13%, for boys from 7% to 23%. (He 2013). Mexico: between 2002 and 2012 much of the increase in people overweight and obese came from already overweight people becoming heavier.

1 By 2015 the Republic of Korea is not usually regarded as an emerging market, but was seen as such at the start of the study period in 1990.

the 1980s. Of the selected countries, China has seen the smallest proportional increase in overweight and obesity, though the sheer size of China's population means the burden of overweight and obese adults, though representing only 25% of the population, outstrips by some 50 million the burden in the UK and USA.

The medical costs of excess weight are already considerable and rising:

- **Brazil**: annual cost of disease related to excess weight is estimated at US$2.1 billion, of which US$21 million is directly attributable to overweight and obesity (Bahia et al. 2012).
- **China**: direct medical costs of adult chronic diseases attributable to overweight and obesity were estimated at around Yuan 21 billion in 2003 [US$2.74 billion] (Zhao et al. 2008). Economic losses from premature deaths from heart disease, strokes, and diabetes were estimated in 2005 at US$18 billion (WHO Factsheet at: http://www.who.int/chp/chronic_disease_report/media/china.pdf?ua=1).
- **Mexico**: Diabetes has been a leading cause of death in Mexico since 2002, followed by cardiovascular disease (CVD) and brain disease. Prevalence of type-2 diabetes in adults is up from 6% in 2000 to over 9% in 2012 (Valdés Ramos 2012).

The four countries have also seen significant changes in their diets for at least the last 20 years, for similar reasons to those seen in HICs: rising incomes, urbanisation, more sedentary occupations, changes in costs of food and the influence of marketing and media on tastes. Box 1B reports on how while diets across the world have come to contain more healthy foods, in the four emerging economies they have also tended to include more unhealthy ones.

The rest of the report is set out as follows. Section 2 states the research questions and objectives, and presents the hypothesised causal chain from food prices to obesity. Section 3 reviews the literature on food prices and their relation to consumption. This begins with the quite large US literature, reviewed because more is known about the obesity in the USA than anywhere else. Following that some of the literature for the UK and the four emerging economies is reviewed. Section 4 records the sources of data and the methods used to analyse it. Section 5 presents the findings. Finally Section 6 concludes and discusses the results.

More detailed information for the emerging economies can be found in Appendix III.

Box 1B: Changing diets in the four countries, UK and USA

From detailed surveys of diets across the world, diets have been assessed for the extent to which healthy and unhealthy foods are consumed (Imamura et al. 2015). The foods were categorised as follows:

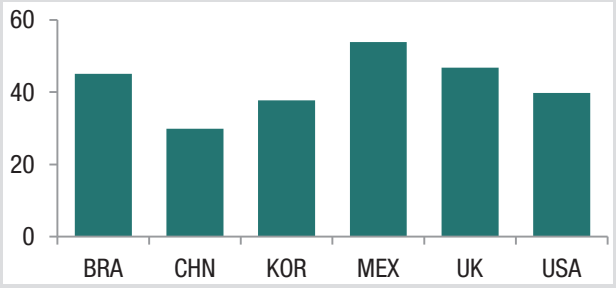
- Healthy items: fruits, vegetables, beans and legumes, nuts and seeds, whole grains, milk, total polyunsaturated fatty acids, fish, plant omega-3s and dietary fibre.
- Unhealthy items: unprocessed red meats, processed meats, sugar-sweetened beverages (SSBs), saturated fat, trans fat, dietary cholesterol and sodium.

Each country was given a standardised (1–100) score according to intake relative to the global sample. For unhealthy options, higher scores represent less consumption of these.

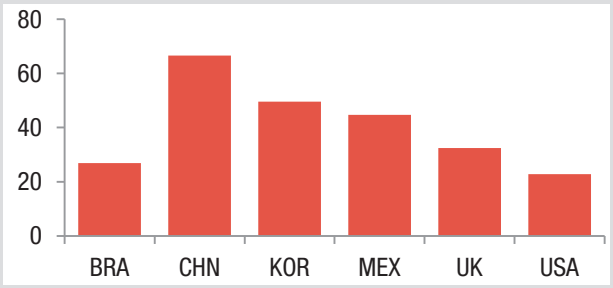
Of the six countries, diets in Mexico, the UK and Brazil contain the most healthy options, while China and Korea have the least (see Figure 1B1, panel A). The differences, however, are not that large. More striking are the differences in consumption of unhealthy foods (see panel B), where China, Korea and Mexico have least consumption, while Brazil and the USA have the highest.

Figure 1B1: Average diets, six countries, 2010, standardised scores

(a) Healthy options (b)



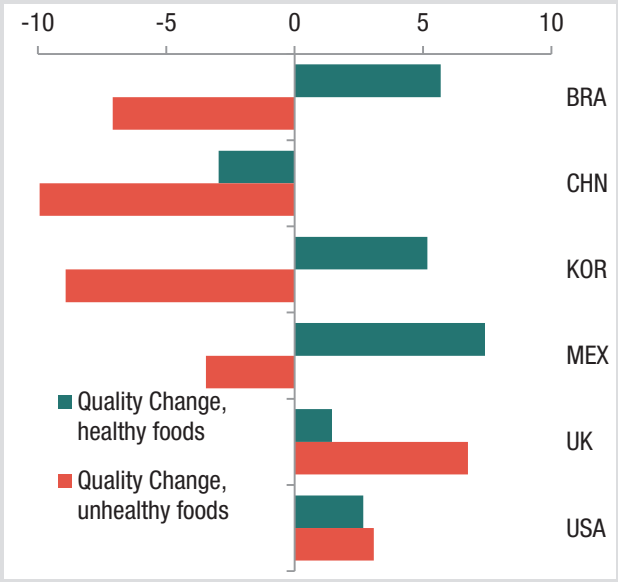
Unhealthy options



Source: Fumiaka Imamura, personal communication

Even more striking, however, are the changes in these scores seen since 1990 (see Figure 1B2). All countries have seen an increase in consumption of healthy items, except for China. For unhealthy foods, the UK and the USA have seen less consumption of these items, but all the emerging economies have seen rising consumption of unhealthy foods.

Figure 1B2: Changes in consumption of healthy and unhealthy foods, six countries, 1990–2010, changes to standardised scores



Source: Fumiaka Imamura, personal communication

In sum, it seems that in most of the six countries, diets contain increasing quantities of healthy items, offset in the four emerging economies by increasing quantities of unhealthy items.

2. Research questions and objective

This report starts from two working hypotheses:

a) When the relative prices of foods change, people will consume more of foods that have become relatively less expensive, and less of those that have become relatively more expensive. People on low incomes are expected to be more sensitive to prices than those on higher incomes; and,
b) When consumption of foods with high calorie content per unit weight (energy-dense foods) increases at the expense of food less dense in energy, then we may expect to see a significant increase in the prevalence of overweight and obese people.

The causal chain that runs from food costs to consumption to obesity and ill health is set out in Table 2.1. The logic runs from factors that affect food prices – both changes in costs that affect them directly and other factors – to changes in food prices which, together with factors such as incomes, lead to changes in the purchase and consumption of food, which together with other factors such as physical activity, lead to changes in body weight that finally lead to ill health. This chain has been used to structure the review of literature for the USA, where some limit themselves to level 1, others try to connect 1 to 2, or to 2, 3 and 4 or go straight from 1 to 3 or 4.

While changes in the prices of some foods such as bananas, beverages, cereals, dairy produce, edible oils and sugar on international and national markets are regularly reported, less is known about the evolution of retail prices in national markets for food in the form presented to consumers. Hence the central questions posed here are:

- What changes have been seen in the retail cost of food in the four countries since 1990? Are there systematic differences in the evolution of prices for different foods, and hence changes in relative prices?
- In particular, has processed food become cheaper relative to unprocessed staples, fruit and vegetables, meat and dairy produce? This may be expected since much of the retail cost of processed food arises in manufacturing and logistics, where technical advances have reduced unit costs, perhaps by more than advances in farming have reduced the cost of agricultural produce.

It was possible to examine only a sample of the many foods on offer in retail outlets, the aim being to have at least one example from the following food groups:

• Staples	Cereals, root crops, legumes
• Fruit and vegetables	Fruit and vegetables
• Meat, fish and dairy	Minimally processed animal products and milk products
• Oils, fats, and sugar	Vegetable oils and fats, animal fats, sugar
• Highly processed foods	Foods usually produced by industrial processes

The groups have been constructed largely for their nutritional characteristics, with staples being a prime source of energy; fruit and vegetables for their vitamins and minerals; meat, fish and dairy for protein; and, oils, fats and sugars for energy in particularly concentrated form. To these conventional groups have been added highly processed foods, that is those that

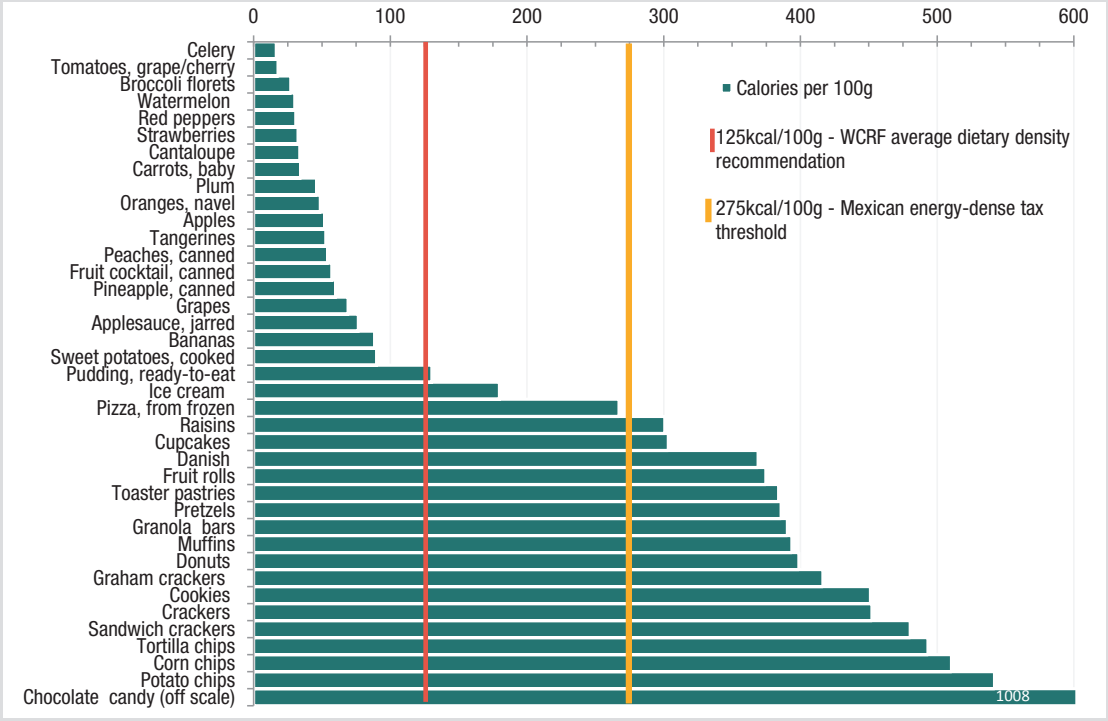
Table 2.1: Causal chain from costs of food to consumption, obesity and ill health

Level	Direct links	Other factors
0	Increases in productivity … in • Agriculture; • Food processing; and, • Food transport, storage, distribution and retailing … that reduce unit costs of food.	Public policy: Taxes, Subsidies Pricing as marketing strategy – offers, loss leaders, etc.
1	Change in food prices, constant, net of inflation • Absolute, compared to other goods and services • Relative, one food or group of foods, compared to another	Incomes Transfers – food stamps Preferences – influenced by advertising, public education, media, peers Availability – e.g. food 'deserts'
2	Change in (purchase and) consumption	Genetic and physical factors – ability to use energy, store fat Physical activity – influenced by work, transport, sports and leisure options, etc.
3	Change in weight (BMI, fat composition)	Remedial medical interventions such as prescribed drugs
4	Disease and ill heath: • Premature death, disability, illness • Costs of health care • Economic losses	

Box 2A: Energy density of foods

Foods vary considerably in their energy density, as Figure 2A1 for selected snacks in the USA shows.

Figure 2A1: Energy density of selected healthy and less healthy snacks, USA, kcal per 100 grams



Source: Constructed with data from USDA (thresholds added)

Foods in low in energy for weight are seen as being part of a healthy diet. The British Nutrition Foundation classifies food by energy density as follows:

- Very low < 60 kcal per 100 grams
- Low 60 to 150 kcal per 100 grams
- Medium 150 to 400 kcal per 100 grams
- High > 400 kcal per 100 grams

*Source: http://www.nutrition.org.uk/healthyliving/fuller/what-is-energy-density.html*s

The World Cancer Research Fund (WCRF) recommends diets in which most items contain less than 125 kcal per 100 grams.

Mexico discourages consumption of foods with more than 275 kcal per 100 grams through the imposition of a tax (see section 3.6).

Energy density is just one dimension of a healthy diet. The Imamura et al. (2015) study outlined in Box 1B reflects a medical consensus on ten healthy foods or categories and ten unhealthy options (the study was able to measure only seven of the ten).

Lock et al. (2010) summarise a consensus on healthy diets as follows:

- A systematic review of dietary recommendations defined by expert panels and published between 1990 and 2004 for the prevention of nutritional deficiencies and infectious and chronic diseases, identified a broad consensus across 94 reports. Consensual expert opinion suggests that healthy diets should contain large amounts of cereals, vegetables, fruits, and pulses, while limiting the amount of red and processed meat, resulting in a high intake of dietary fibre and micronutrients and a low intake of fats, saturated fatty acids, added sugars, and salt. (WCRF 2007)
- In addition to maintenance of energy balance (total caloric intake vs total energy expenditure) and healthy weight, a healthy diet to provide adequate population nutrition and reduce chronic disease risk consists of: 15–30% of total energy as fat, of which saturated fat should be less than 10% and trans fatty acids less than 1%; 55–75% of total energy as total carbohydrate, of which added sugars should be less than 10%; 10–15% of total energy as protein from mainly plant sources; less than 5 g per day of salt; and more than 400 g per day of fruits and vegetables. (WHO/FAO 2003)

have been produced industrially, often adding to the main ingredients additional fat or oil, salt, sugar and flavourings to enhance taste and palatability.

Three of these food groups are of particular interest for their potential role in diets that lead to obesity. Foods that are typically dense in energy (see Box 2A) make it possible to eat large amounts of calories before feeling full. They include the two categories of fats, oils and sugar; and highly processed foods. Fruit and vegetables constitute the other group, partly because most are not dense in energy, and partly because it is widely considered that diets in HICs should include more of these items (see, for example, USDA 2015). If it were the case that prices of oils, fats, sugars and processed foods were falling relative to fruit and vegetables, this would be a cause for concern since it would be an economic encouragement to select less healthy items in diets.

Additional analysis would be necessary to trace these effects along the causal chain. For the time being, the aim is kept simple and straightforward: to record changes in the prices of foods from different categories. In subsequent research we hope to follow up this question by addressing the probable consequences of changes in relative prices of foods, asking:

- Do changes in the relative prices of food correlate with changing levels of consumption of the main food groups?
- Do they correlate with changing levels of overweight and obesity?
- Where energy-dense foods have become relatively cheaper than other foods, have there been more rapid increases in levels of overweight and obesity?

3. What is already known?

3.1 United States

3.1.1 Background: the high rates of overweight and obese people in the USA

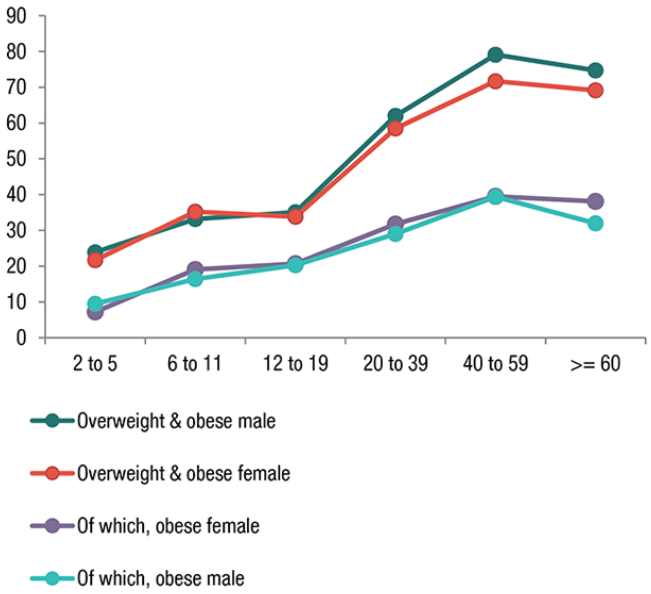
Overweight and obesity rates in the USA are among the highest in the world, and the highest among OECD countries (see Figure 3.1). Some 74% of US adult males were estimated to be overweight or obese in 2008, a figure exceeded only by rates in eight small Pacific island nations[2] and Kuwait. US adult females had slightly lower estimated rates of overweight and obesity, some 68% in 2008,[3] although still extremely high.

In 2008, the direct medical cost of overweight and obesity in the USA was estimated at US$113.9 billion, about 0.77% of US GDP that year according to World Bank data (Tsai et al. 2011).[4]

Obesity has been rising in the USA:

> In spite of increased recognition and media attention to the problem, the obesity epidemic continues to worsen. Just between 2000 and 2005, the prevalence of obesity in the USA increased by 24%, while the number of severely obese [body mass index (BMI) > 40] cases increased by 50%, high-lighting the importance of change over time. When looking at trend data, changes in BMI appear to be very similar across all population groups, although the prevalence at any point is highest among groups with lower income and education, and some ethnic minorities. (Sturm 2008)

Figure 3.1: Prevalence of overweight and obesity, USA, by age and sex, 2011–12



Source: Compiled from data from Tables 3 and 4 in Ogden et al. 2014

While obesity is an individual condition, its widespread prevalence and increase suggest that the drivers must include factors that affect many people, not just individuals.

US diets are far from the nutritionist's idea of well balanced. They contain too much oil, protein-rich food, cereals and sugar, and too few fruits and vegetables.

> To meet 2005 *Dietary Guidelines*, typical Americans would need to more than double their current intake of vegetables and whole-grain foods while reducing their intake of solid fats and added sugars by half (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005). (Kuchler and Stewart 2008)

Thirty years ago, diets were not quite so unhealthy: calorie availability in the USA has risen markedly since the 1970s. Sturm (2008) reports that the increase in available energy comes almost entirely from carbohydrates, especially SSBs and snack foods:

> The availability of sugar-sweetened beverages and snack items has increased particularly quickly. Between 1970 and 2005, caloric sweeteners increased by 20 pounds per capita per year; sweets and confectionary goods increased by 3 pounds… The availability of sugar-sweetened beverages increased by 8.5 gallons per capita per year from 1985 to 2005; 40% of this increase was due to fruit-flavored drinks and sports drinks, and the remainder was due to carbonated soft drinks.

Sturm considers these increases to be more than enough to explain the epidemic of obesity, even when considering waste.

Over the 40 years from 1970 to 2009, total energy availability increased almost 11% per capita, according to Carden and Carr (2013). Energy from protein, carbohydrates and fat increased by around 5%, 10% and 15% respectively.[5]

2 Nauru, Cook Islands, Tonga, French Polynesia, Samoa, Palau, Kuwait, Kiribati and the Marshall Islands (data from Stevens et al. 2012).

3 On this indicator the USA lags behind some other countries in prevalence (those already mentioned for the case of men, as well as the Federated States of Micronesia, Saint Kitts and Nevis, Puerto Rico, Netherlands Antilles, Egypt, Belize, Barbados, South Africa, Fiji, UAE, Bahrain, Dominica, Bahamas, Qatar, Solomon Islands, Mexico and Saudi Arabia) (data from Stevens et al. 2012).

4 By way of comparison, the USA spent around US$49.1 billion on foreign aid in 2008.

5 They believe that too much emphasis is placed on the increased intake of fructose for which they see they see no increase from 1970 to 2009: increases in glucose and fat were the main contributors.

Studies of food prices in the USA typically pose the following questions:

- Are healthier foods more costly than less healthy foods?
- How have the prices of different foods changed over time relative to one another?
- How does consumption respond to price changes – including those induced by taxes and subsidies?
- What effect do price changes have on levels of obesity and associated ill health?

3.1.2 Costs of food: healthy and less healthy foods compared

A common way to define the healthiness of foods is by reference to energy density, since it is assumed that a diet of energy-dense foods will lead to over-consumption before the appetite is sated. Studies comparing the cost per calorie across foods usually show that those dense in energy have the lowest costs per calorie.

For example, when 372 foods in Seattle in 2006 were measured for price and energy content, a clear inverse relation between energy density and cost per unit of energy could be seen (see Figure 3.2) (Monsivais and Drewnowski 2007). When foods, other than beverages, were sorted into five quintiles by their energy density, the average cost per 1,000 kcal varied from US$1.76 for the most energy-dense food to US$18.16 for the least.

Plotting the costs of different snack foods in the USA against their energy density shows a similar pattern (see Figure 3.3). Fruit and vegetables are notably more costly per calorie than most processed snacks.

Connell et al. (2012) confirm, drawing on data from the Lower Mississippi delta, that fats, oils and sweets are much cheaper per calorie compared to fruit and vegetables.

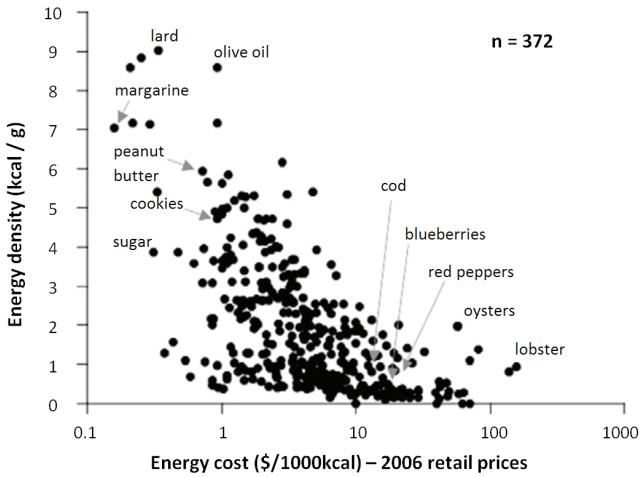
Unusually, Davis and Carlson (2012) suggest that the relationship between price per calorie and energy density is a spurious correlation, using a sample of over 4,000 different foods, although encompassing fewer food groups than Monsivais and Drewnowski (2007) – for instance, excluding oils, from 2003/04. A regression of energy density on price, however, for the data they present in Table 1, gives an R-square of 0.41 (with highly significant F-statistic).

Other studies have assessed foods for a wider range of healthy characteristics. For example, Drewnowski (2010) found that carbohydrates, sugar and fat had lower price per gram, while protein, fibre, vitamins and minerals had higher prices per gram.

Carlson and Frazão (2012) defined less healthy foods as those high in saturated fat, added sugar and/or sodium, or that contribute little to meeting dietary recommendations. Again they confirmed that healthy foods cost more than less healthy foods when measured in terms of the price of food energy.

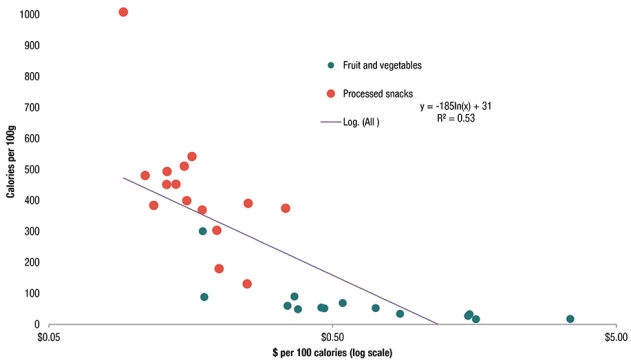
Given the evidence that healthier foods cost more than less healthy foods, it is no surprise that *studies report that healthier diets cost more than less healthy ones*. For example, people in the Puget Sound region who eat more vitamins, minerals, and fibre have diets that cost more (Aggarwal et al. 2012). Higher intakes of dietary fibre, vitamins A, C, D, E, and B12, beta carotene, folate, iron, calcium, potassium, and magnesium were associated with higher diet costs – especially so when the main source of the nutrient came from fruit and vegetables. Conversely, higher intakes of saturated fats, trans fats and added sugars were associated with lower diet costs.

Figure 3.2: Relationship between cost of per unit of energy and energy density for 372 foods in Seattle area supermarkets, 2006



Source: Figure 2 in Monsivais and Drewnowski 2007
Note: Linear regression gives R^2= 0.38.

Figure 3.3: Energy density and price per calorie for selected snack foods, fruit and vegetables, USA, 2008



Source: Constructed with data from USDA ERS database available at http://www.ers.usda.gov/data-products/fruit-and-vegetable-prices.aspx#.UuphpLS7Tm4
Note: Horizontal axis is a log scale.

> Based on current eating habits, compliance with dietary guidelines is likely to entail higher diet costs for the consumer. (Drewnowski 2010)

Women with high-nutrient diets were found to have more costly diets on average than men with high-nutrient diets, reflecting women's relatively higher consumption of fruit and vegetables, and men's relatively higher consumption of meats.

If healthier diets cost more than less healthy ones, then those on low incomes, being sensitive to food prices, are likely to choose less healthy options. For those on very low incomes, healthy diets simply become unaffordable.

> The fact that energy-dense foods (megajoules/kilogram) cost less per megajoule than do nutrient-dense foods means that energy-dense diets are not only cheaper but may be preferentially selected by the lower-income consumer. In other words, the low cost of dietary energy (dollars/megajoule), rather than specific food, beverage, or macronutrient choices, may be the main predictor of population weight gain. (Drewnowski 2007)

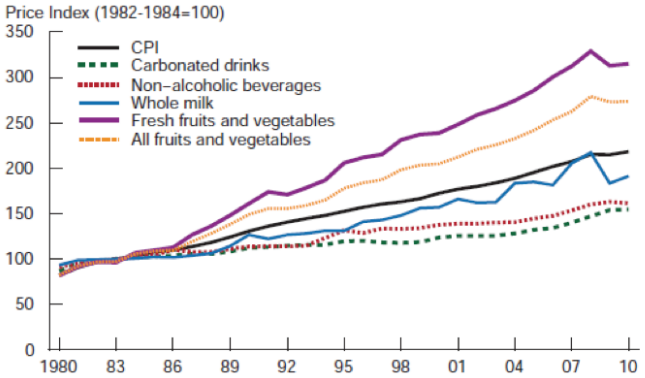
Not all studies find that healthier diets are more expensive. For example, Drewnowski and Eichelsdoerfer (2009) looked at whether a Mediterranean diet – considered to be relatively healthy since it is rich in vegetables, fruits, beans, whole grains, olive oil and fish – cost more than people's current diets. While their findings suggested some nutrient-rich low-energy-density foods associated with the Mediterranean diet were expensive, others that also fit within the Mediterranean dietary pattern were not.

When Bernstein et al. (2010) studied the diets of US nurses graded by the Alternative Healthy Eating Index (AHEI), which has been linked to lower rates of cardiovascular disease, they found that significant increases in healthiness indices could be obtained from spending more on nuts, soy and beans, and whole grains, while reducing spending on red and processed meats. In similar vein, Drewnowski and Rehm (2013) report that school meals can be made more nutritious, above all in potassium and fibre, by including more potato and beans.

3.1.3 Changes in prices over time

The key issues are changes in prices of different foods relative to one another. *Several studies show that energy-dense food has become cheaper over time, compared to foods less dense in energy.* For example, Gelbach et al. (2009) examined trends in 'healthy' foods – fresh fruit and vegetables, soda crackers, whole milk, light tuna and yoghurt – compared to 'unhealthy' foods – processed cheese, butter, cola, margarine, potato crisps, etc. – from 1982 to 1995. They found prices of the unhealthy foods fell farther than those for healthy foods. Similarly, Wendt and Todd (2011) found rising real prices for fruit and vegetables, and falling real prices for carbonated drinks from 1980 to 2010 (see Figure 3.4).

Figure 3.4: Price indices for selected foods and beverages in the USA, 1980–2010



Source: Figure 1 in Wendt and Todd 2011 (based on data from the Bureau of Labor Statistics). Note: Prices are annual average for urban consumers. 'All fruits and vegetables' include fresh, canned, and frozen. Base period 1982-84=100.

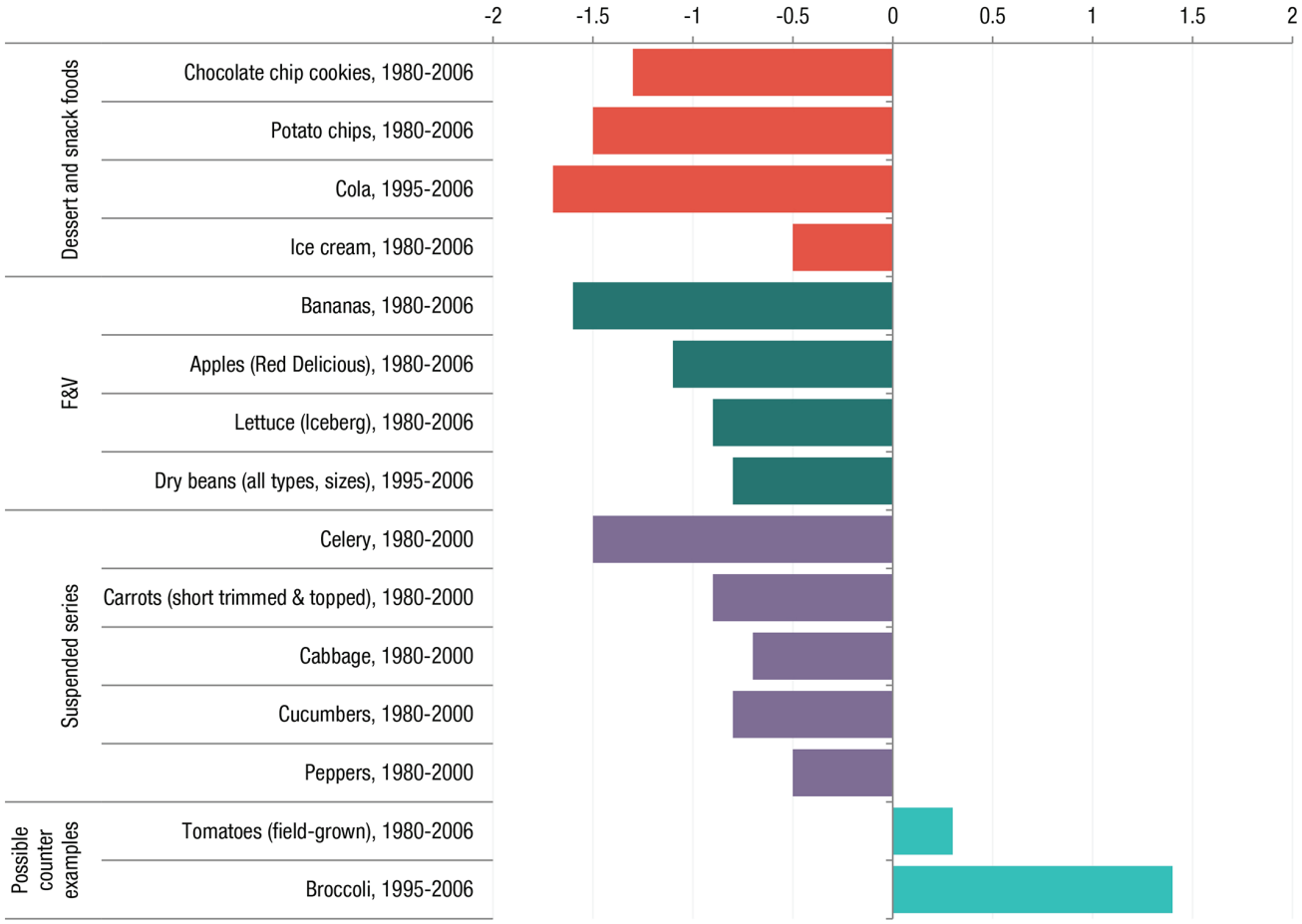
The study by Powell et al. (2013) confirms these trends: 'between 1980 and 2011 it became 2.2 times more expensive to purchase fresh fruits and vegetables compared to purchasing carbonated beverages'. Over the two years from 2004 to 2006 prices of prices of the highest quintile of energy-dense foods in Seattle dropped by 1.8%, while prices of the least energy-dense foods grew by 19.5% (Monsivais and Drewnowski 2007).

Changes in quality, seasonality and processing qualify these findings. Kuchler and Stewart (2008) studied monthly prices from the 1980s to the mid-2000s in US cities. They compared changes in prices for four processed foods to prices for 11 fruits and vegetables (see Figure 3.5).

In several cases, little difference was seen in price changes of foods in the two groups, although their attention was drawn to tomatoes and broccoli, which had risen in price while the prices of other fruit and vegetables and the processed foods had fallen.

This might, however, be explained by three changes in quality. One, some varieties of produce have changed over time. Tomatoes, for example, are increasingly marketed as vine tomatoes and other specialist tomatoes, which are sold at premium prices: the average tomato price over time will thus be biased upwards. Two, while in the past some fruit and vegetables were only available seasonally, by the mid-2000s most were on the shelves all the year round. The 1980 average annual price of strawberries was based on production during no more than four months of the US season: by 2006 the average year-round price included off-season fruit produced at higher cost or air-freighted to the USA, with additional transport costs. Three, some vegetables were increasingly sold washed, cut and bagged, as in the case of broccoli, with higher value added for the consumer.

Figure 3.5: Long-term average annual changes in retail prices for selected foods in the USA



Source: Tables 3 and 4 in Kuchler and Stewart 2008 (based on ERS calculations using Bureau of Labor Statistics), US City average price data and urban CPI.
Note: suspended series are those with prices not recorded between 2000 and 2006 (by 2000 bagged versions and prepared salads accounted for large share of produce sold).

> … value added through transportation, processing, wholesaling, and retailing has grown to account for about three-fourths of the retail price of fruits and vegetables, on average, compared with about two-thirds in the early 1980s (Stewart, 2006). These services serve two purposes: increased convenience and variety. (Kuchler and Stewart 2008)

3.1.4 Price changes and consumption

The most familiar studies dealing with the effect of prices on consumption look at own-price and cross-price elasticity of demand. Andreyeva et al. (2010) reviewed US literature on how price changes affect demand for major food categories, looking at a total of some 160 studies of price elasticity for major food categories, published between 1938 and 2007, mostly in the latter part of this period. They found own-price elasticities for foods and non-alcoholic beverages ranged from 0.27 to 0.81 (absolute values), which is relatively inelastic (see Table 3.1). Food away from home, soft drinks, juice, and meats were most responsive to price changes (0.7–0.8).

Powell et al. (2013) extend the period by reviewing studies of price elasticity from 2007 to 2012 (see Table 3.2). Although most foods have inelastic own-price elasticity of demand, demand for SSBs is relatively elastic.

More specific studies of price look at price response, but in the context of other factors affecting consumption, and some differentiate by economic and social status of different groups of consumers:

- Powell et al. (2009a) estimated the link between young adults' consumption of fruit and vegetables and the prices of those fruit and vegetables, prices of other food consumed at home, and fast food, as well as the availability of restaurants and food shops. Higher consumption of fruit and vegetables was associated with lower fruit and vegetable prices, with a price elasticity of –0.32. This own-price effect was robust to the inclusion of other food prices and the availability of food outlets.

Table 3.1: US own-price elasticity of demand, by food and beverage category, 1938–2007

Food and Beverage Category (a)	Absolute Value of Mean Price Elasticity	Estimate (95% CI)	Range	No. of Estimates
Food away from home	0.81	(0.56, 1.07)	0.23-1.76	13
Soft drinks	0.79	(0.33, 1.24)	0.13-3.18	14
Juice	0.76	(0.55, 0.98)	0.33-1.77	14
Beef	0.75	(0.67, 0.83)	0.29-1.42	51
Pork	0.72	(0.66, 0.78)	0.17-1.23	49
Fruit	0.70	(0.41, 0.98)	0.16-3.02	20
Poultry	0.68	(0.44, 0.92)	0.16-2.72	23
Dairy	0.65	(0.46, 0.84)	0.19-1.16	13
Cereals	0.60	(0.43, 0.77)	0.07-1.67	24
Milk	0.59	(0.40, 0.79)	0.02-1.68	26
Vegetables	0.58	(0.44, 0.71)	0.21-1.11	20
Fish	0.50	(0.30, 0.69)	0.05-1.41	18
Fats/oils	0.48	(0.29, 0.66)	0.14-1.00	13
Cheese	0.44	(0.25, 0.63)	0.01-1.95	20
Sweets/sugars	0.34	(0.14, 0.53)	0.05-1.00	13
Eggs	0.27	(0.08, 0.45)	0.06-1.28	14

Source: Table 1 in Andreyeva et al..2010
Note. Values were calculated based on the 160 studies reviewed. Absolute values of elasticity estimates are reported: the estimated elasticities are all negative in that quantity demanded falls with rising prices. The price elasticity of demand measures the percentage change in purchased quantity or demand with a 1% change in price. aIncluding restaurant meals and fast food.

Young adults with lower incomes and lower levels of education, those with lower educated mothers, and middle-income parents were the most price sensitive. They found no statistically significant cross-price effects on fruit and vegetable consumption from other grocery prices (meat, dairy and bread) or fast food prices.

- Powell and Han (2011) saw some price response among adolescents to the cost of fast foods, but only among those on low incomes.
- French (2005) looked at how effective price-based interventions might be to promote consumption of healthier foods in workplaces and schools. Reviewing several studies, she found price reductions of lower-fat snack options of 10%, 25% and 50% led sales of these snacks to increase by 9%, 39% and 93% respectively. Sales of fresh fruit and vegetables also increased when their prices were halved.
- Khan et al. (2012) reported that a 10% increase in the price of fast food was associated with 5.7% lower frequency of weekly consumption of fast food among children in grades 5 and 8.
- Sturm and Datar (2011) examined the varying prices of foods across US metropolitan areas. Among children in grade 5 (average age of 11), they found lower real prices for vegetables and fruits predict significantly higher frequency of intake. 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.
- Powell et al. (2013) showed clear trends towards increased intakes of SSBs and food eaten away from home (particularly fast food), for which prices had fallen; and low and little-changing consumption of fruit and vegetables for which prices had risen over the last two decades. They also saw stronger effects on those on low incomes and on the Supplemental Nutritional Assistance Program (SNAP) that is the USA's biggest national food-stamp welfare programme for those on low incomes and/or unable to work.

Table 3.2: Own-price elasticity of demand for four food groups in the USA, 2007–12

Food item	Price elasticity of demand	Range
Sugar-sweetened beverages	-1.21	-0.71 to -3.87
Fast food	-0.52	-0.47 to -0.57
Fruits	-0.49	-0.26 to -0.81
Vegetables	-0.48	-0.26 to -0.72

Source: Data from Table 2 in Powell et al. 2013

Several of these studies were motivated by an interest in the potential effects of taxes and subsidies on different foods. In a synthesis of 24 studies focusing on adolescents aged 12 to 17 and adults aged 18 and over predominantly in the USA[6], An (2013) brought together evidence from 20 distinct field interventions – price discounts or vouchers for healthier foods: fruits, vegetables, or low-fat snacks sold in supermarkets, cafeterias, vending machines, farmers' markets, or restaurants – to assess the effectiveness of subsidies on promoting healthier food purchases and consumption. In all cases but one, subsidies on healthier foods significantly increased their purchase and consumption. The one null finding was owing to its small financial incentive (50 cents towards the purchase of any fruit or vegetable).

3.1.5 Food prices and body weight

Several studies look at the impact of different pricing on consumption and link it to weight outcomes. *Most report that higher prices for unhealthy, and lower prices for healthy options, lead to lower body weights.*

For example, in a longitudinal study (Wendt and Todd 2011) followed a nationally representative cohort of kindergarten children entering in 1998/99 to grade 8 (2007) to determine the influence of changing prices of certain foods on children's BMIs. The evolution of relative prices they tracked showed prices of whole milk, non-alcoholic beverages, and carbonated drinks falling in real terms over the last 30 years, while prices of fruit and vegetables rose considerably. Moreover, with unhealthy options becoming cheaper, consumption rose. They found:

- A 10% decrease in the price of low-fat milk in the previous quarter was associated with a decrease in BMI of 0.35%,.
- A 10% decrease in the price of dark green vegetables – spinach, broccoli – in the previous quarter was associated with a decrease in BMI of 0.28%.
- A 10% increase in the price of carbonated beverages (one year prior) was associated with a decline in BMI of 0.42%, with a stronger effect on children in low-income households.
- A 10% price increase in fruit juices (100% juice) or starchy vegetables – potato, maize – (also one year prior) decreased BMI by 0.3%.
- A decrease in the price of sweet snacks in the previous quarter increased BMI by 0.27%, although sometimes observed changes were more delayed.

Powell et al. (2007) report the prices of fast food to be important determinants of adolescents' body weight and eating habits: a 10% increase in the price of a fast food meal leading to a 3% 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. Prices of fruit and vegetables, as well as density of restaurant outlets, were deemed less important determinants. Nonetheless, changes in all observed economic and socio-demographic characteristics together only explained roughly 25% of the change in mean BMI and 20% of the change in overweight between 1997 and 2003.

Duffey et al. (2009) saw that from the mid-1980s to the mid-2000s the prices of soda (SSB) and pizza fell while milk prices rose. They found that a 10% rise in the price of soda or pizza was linked to a 7.12% or 11.5% decrease in energy intake from these foods respectively. Price increases in both foods reduced body weight and susceptibility to diabetes.

Morrissey et al. (2014) found that for under-fives in low-income households, more costly fruit and vegetables were linked to higher BMIs among children, a relationship driven by prices of fresh fruit and vegetables rather than of frozen or canned options. Higher prices for soft drinks were also linked to a lower likelihood of the children being overweight. Counter-intuitively, however, higher fast-food prices were linked to a greater likelihood of children being overweight.

Looking at a population of adults of over 60 years of age, Goldman et al. (2011) found a 10% drop in price per calorie was associated with a BMI increase of approximately 0.26 units, or a 0.77% rise within two years. This effect of food prices on BMI was statistically similar across obese and non-obese populations, while no significant difference was established across poor and non-poor populations.

Although the short-term effect of price per calorie on BMI appears relatively small, the long-term effect 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%: a significant contribution to total growth of mean BMI over the period (Goldman et al. 2011).

In a study unusual for its inclusion of measures of the percentage of body fat (PBF) as well as BMI, Grossman et al. (2013) looked at the influence of food prices on clinical obesity – measured by BMI and PBF. Controlling for contextual variables, such as ethnicity, age, family income, household type and size, and education, they found that increases in real food prices (per calorie) – for home consumption, and in the real price of fast-food – led to lower obesity in youths aged 12 to 18 years, while increases in real prices of fruit and vegetables led to higher obesity.

Percentage body fat (PBF) measures were no less sensitive – and in some cases more sensitive to such price changes than BMI measures. Prices of fruit and vegetables were 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). On

6 While this study assesses interventions in seven countries, most of them are in the USA (14), with one each in France, Germany, the Netherlands, South Africa and the UK.

the other hand, the price of a calorie in food consumed at home or in fast-food restaurants plays a more important role in male than in female PBF (Goldman et al. 2011).

Powell (2009) and Powell et al. (2010) looked at prices as well the availability of fast-food outlets.[7] They found that the price of fast food, but not availability of fast-food restaurants, had a significant influence on BMI among teenagers, with price elasticity of –0.08 (compared with the price elasticity of –0.10 estimated using a cross-sectional model). The weight of teenagers in lower to middle-socio-economic status families was most sensitive to fast-food prices.

A sister study (Powell and Bao 2009) found fruit and vegetable prices almost equally strongly linked to children's BMI: a 10% increase in the price of fruit and vegetables was linked to a 0.7% increase in children's BMI. The influence of fast-food prices was not statistically significant in the full sample, but weakly negatively associated with BMI among adolescents, with an estimated elasticity of -0.12. Moreover, associations of fruit and vegetable and fast-food prices with BMI were significantly stronger (economically and statistically) among children from low-income households. 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.

Sturm and Datar (2005) also considered food prices and food-outlet density in examining changes in the BMI of US primary school children. Lower real prices for fruit and vegetables predicted a significantly smaller gain in BMI between kindergarten and grade 3, half of it occurring between grades kindergarten and grade 1. Lower meat prices raised BMI, though generally by a smaller magnitude, while the effect was not significant for BMI gain over three years. Effects were meaningfully larger for children living in poverty, children already at risk of being overweight or already overweight in kindergarten, and Asian and Hispanic children. No significant effects for dairy or fast-food prices were found.

Beydoun et al. (2011) looked at what influence price indices of fast foods and those for fruit and vegetables had on dietary intake and the BMI of US children and adolescents aged two to 18 years. Among two to nine-year-olds, a higher fast-food price index (by US$1) was associated with lower fast-food consumption, healthier eating patterns, and higher intake of fibre, calcium, dairy, and fruit and vegetables. The fruit and vegetable price index was related to lower fibre intake and higher BMIs. Their findings for 10 to 18-year-olds were less consistent. Significant associations were almost equally balanced between low- and high-income groups, with some significant interactions between food prices and family income observed, particularly among the younger group of children.

Chou et al. (2004) found that a 10% increase in prices at fast-food restaurants would reduce the probability of obesity by 0.65%, while a 10% increase in prices at full-service restaurants would reduce the probability of obesity by 0.67%, and a 10% increase in the price of food at home would reduce the probability of obesity by 0.62%.

Powell et al. (2013) observed higher fast-food prices were associated with lower weight, particularly among adolescents. Lower fruit and vegetable prices were generally found to link to lighter body weights among low-income children and adults. They conclude:

> The growing evidence base assessed herein indicates that changes in the relative prices of less healthy and healthier foods and beverages can significantly change consumption patterns and, may have significant impacts on weight outcomes at the population level, particularly among populations most at risk for obesity and its consequences. Raising the prices of less healthy options by taxing them has the added benefit of generating considerable revenues that can be used to support costly programs and other interventions aimed at improving diets, increasing activity, and reducing obesity, including subsidies for healthier foods and beverages. (Powell et al. 2013)

Other studies have found insignificant or negligible impacts of relative prices on body weights. The study by Gelbach et al. (2009) found that prices of unhealthy foods fell from 1982 to 1995 more than the prices of healthy foods, but that although changes in BMI were causally related to relative food prices, the degree of influence was small. A 100% tax on 'unhealthy' foods would reduce average BMI by less than 1% and reduce incidence of overweight by 2% and obesity by 1%.

Other studies have not been able to find a significant influence of relative food prices on BMIs. Han and Powell (2011), in a longitudinal study of over 10,000 young adults, were unable to find a significant effect of food prices on the prevalence of obesity among young women. For young men, a 10% increase in the price of fast food was linked to a 13% drop in the chance of being obese – although this finding lost its economic and statistical significance when individual fixed effects (e.g. work, marital status, and school enrolment) were introduced.

While food eaten away from home need not be unhealthy, data suggest that eating one meal a week away from home for the average US consumer leaves them roughly two pounds (approximately 1 kilogram) heavier each year (Todd et al. 2010). The share of US food spending outside the home has risen to almost 50%, compared with 25% in 1960 (Kumcu 2011).

7 Low- to middle-income areas have 1.25–1.3 times as many fast-food restaurants as high-income areas. The proportion of fast-food restaurants compared to the total number of restaurants in the USA 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.

3.1.6 Effects of taxes and subsidies on consumption and body weight

Taxes and subsidies on food and drink seek explicitly to change prices and thereby to influence consumption.

Studies of impacts of taxes on items such as soda typically find small effects, if any. Looking at data on adolescents, Powell et al. (2009) found no statistically significant associations between state-level taxes on soda (SSBs) and adolescent BMI. A weak economic and statistically significant effect was found between rates of tax on soda sold in vending machines and BMI among teenagers at risk of becoming overweight.

Powell and Chaloupka (2009) reviewed literature published between 1990 and 2008 to examine whether taxes or subsidies would lead to sufficient changes in patterns of food consumption and overall diet to reduce people's weights. When statistically significant links were found between food and restaurant prices (taxes) and weight outcomes, effects were generally small. Larger effects were seen among populations of lower socio-economic status, as well as for those at risk of overweight or obesity. They concluded that the (limited) evidence available (dealing entirely with small taxes or subsidies) indicated that small incentives would not be likely to yield significant changes in BMI or the prevalence of obesity, though stronger interventions may have some measurable impact on weight outcomes in the USA, especially for children, adolescents, populations of low socio-economic status, and those most at risk for overweight (Powell and Chaloupka 2009).

Likewise, Sturm et al. (2010), looking at children from kindergarten to grade 5, found existing taxes on soda (typically not much higher than 4%) did not substantially affect overall levels of soda consumption or obesity rates. Some sub-groups of at-risk children – those already overweight, from low-income families, or African Americans – were found to be more sensitive than others to soda taxes, particularly when such SSBs were available in schools.

Fletcher et al. (2010) found no evidence that taxes on soft drinks or restrictions on vending machines affected the BMI of children in grades 5 and 8. Analyses of the relationship between soda taxes to weight outcomes showed minimal impacts (Powell et al. 2013).

Schroeter et al. (2006) have gone so far as to suggest a tax on food away from home – a category of consumption implicated in the rise of obesity – might actually lead to increased obesity. Their model showed that while taxing meals away from home may reduce the frequency with which people consume them, the substitute of eating at home may actually lead to more calories being consumed, since so much of the food eaten at home is energy-rich.

These studies, however, looked at the impacts of relatively low taxes,[8] typically 5% or less, on a single food that might account for less than 10% of calorie intake.

3.1.7 Summary of the US literature

A consensus emerges from this literature, even if contrary findings and qualifications can be found in the many studies reviewed, as follows:

- Most studies find that healthier foods cost more than less healthy ones. Moreover this effect has increased over the last 30–40 years, as energy-dense, processed foods have become cheaper relative to less energy-dense fruit and vegetables.
- Consequently healthy diets tend to cost more than less healthy diets. That is not inevitable: choosing lower cost healthy items and substituting them for the more costly less healthy ones might both improve diet and save money. But for most consumers, this would require both the ability to see the distinctions, and the discipline to follow a particular diet.
- Although it seems some energy-dense processed foods have become notably cheaper compared to fruit and vegetables, the nature of the latter have changed – with higher-value prepared items common in food outlets, and available all the year round. Taking this added value into account the change in relative prices may be less than is at first apparent.
- Consumption of most foods responds to price changes, although for many foods the response is relatively inelastic. Those on low incomes are most likely to respond to changing prices.

  This finding has been diluted by studies of the impacts of food taxes that often seem to trigger tiny changes in consumption. Although food industry lobbyists use such studies to argue against taxes, the taxes studied or modelled are almost always very small, 5% or less being typical. It has never been expected that a 5% tax on SSBs, for example would cause a large reduction in their consumption.
- Studies of the impacts of changes in prices on body weight produce a surprisingly strong consensus that higher prices of unhealthy options reduce BMI, as do cheaper healthier options. 'Surprising' since body weight is the outcome of many factors, yet price changes can be seen to make a difference. The strongest effects are seen among those on low incomes, who are most sensitive to the cost of food.

8 Around 3% to 5% (some academics suggest SSB tax should be at 20% – see https://www.fmhs.auckland.ac.nz/en/soph/global-health/projects/informas/government-healthy-food-environment-policy-index.html).

3.2 United Kingdom

3.2.1 Background: obesity in the UK

Overweight and obesity rates in the UK are almost as high as US rates and significantly higher than in most European countries. In 2008, around 68% of adult males in the UK were estimated to be overweight or obese, while 61% of adult females fell into this category (data from Stevens et al. 2012).[9] Some 9% of UK children are already classified as obese when they start school, rising to 19% in year 6 (LGA 2014). Children's obesity varies by inequality, with around 25% of the most deprived children (by quintile of deprivation) aged from 10 to 11 in London in 2007/08 obese, compared to around 13% of the least deprived quintile (see Figure 11 in The Marmot Review 2010).

In 2006/07, overweight and obesity cost the National Health Service (NHS) £5.1 billion[10] – more than the cost of smoking (£3.3 billion), alcohol (another £3.3 billion) or physical inactivity alone (£0.9 billion) (Scarborough et al. 2011). It is estimated that one in seven hospital beds in the UK is occupied by a patient with diabetes, while the number of admissions to NHS hospitals with a primary diagnosis of obesity rose from 1,019 in 2001/02, to 11,736 in 2011/12 (LGA 2014).

Typical UK diets are not balanced in accordance with dietary recommendations, with excessive consumption of grains and other starchy foods, protein-rich foods, oils, fats, and sugar – coupled with particularly low intake of fruit and vegetables.

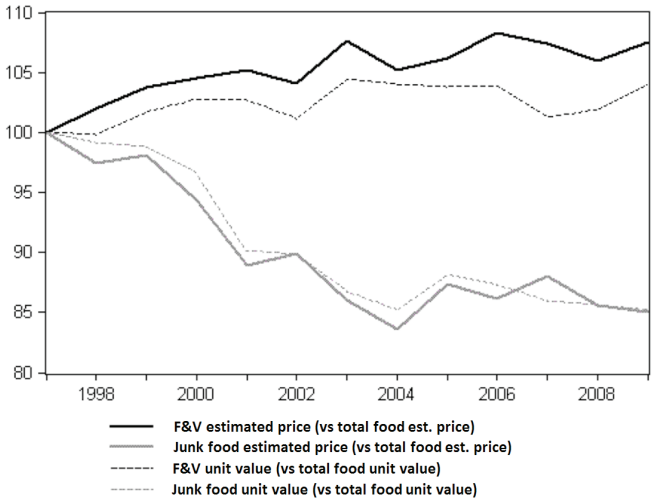
Studies have shown declining energy intakes in the UK. Prentice and Jebb (1995) reported declines in some measures of energy intake and more recently Griffith et al. (2013) confirmed the trend for lower consumption of dietary energy in the UK from 1980 to 2009, with significant reductions in calories bought for home consumption only partly offset by the rising share of eating out in aggregate consumption. Prentice and Jebb (1995) thereby inferred that rising obesity was the result of too little activity: 'modern inactive lifestyles are at least as important as diet in the aetiology of obesity and possibly represent the dominant factor'. Debate on this continues, some arguing that representing the main drivers as 'sloth' or 'gluttony' is 'overly simple' (Roberto et al. 2015).

3.2.2 UK trends in relative prices

The relatively few studies in the UK show healthy diets to be more costly than less healthy diets

Capacci et al. (2012) use household data for the UK from 1997 to 2009 to estimate prices of 'healthy' and 'unhealthy' bundles of foods. The former were restricted for simplicity to fruit and vegetables, excluding potatoes; while the latter were the 'big six' food groups – confectionery, soft drinks, crisps/savoury snacks, fast food, pre-sugared breakfast cereals and pre-prepared convenience foods; that is, those categorised by the Food Standards Agency (FSA) as high in fats, sugar and salt (HFSS) for the purposes of advertising regulations set by the Office of Communications (Ofcom), a public regulator.

Figure 3.6: Fruit and vegetables and 'junk' food, unit values and corrected prices relative to total food



Source: Figure 1 in Capacci et al. 2012

They estimate that prices of fruit 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 by about 15% (see Figure 3.6).

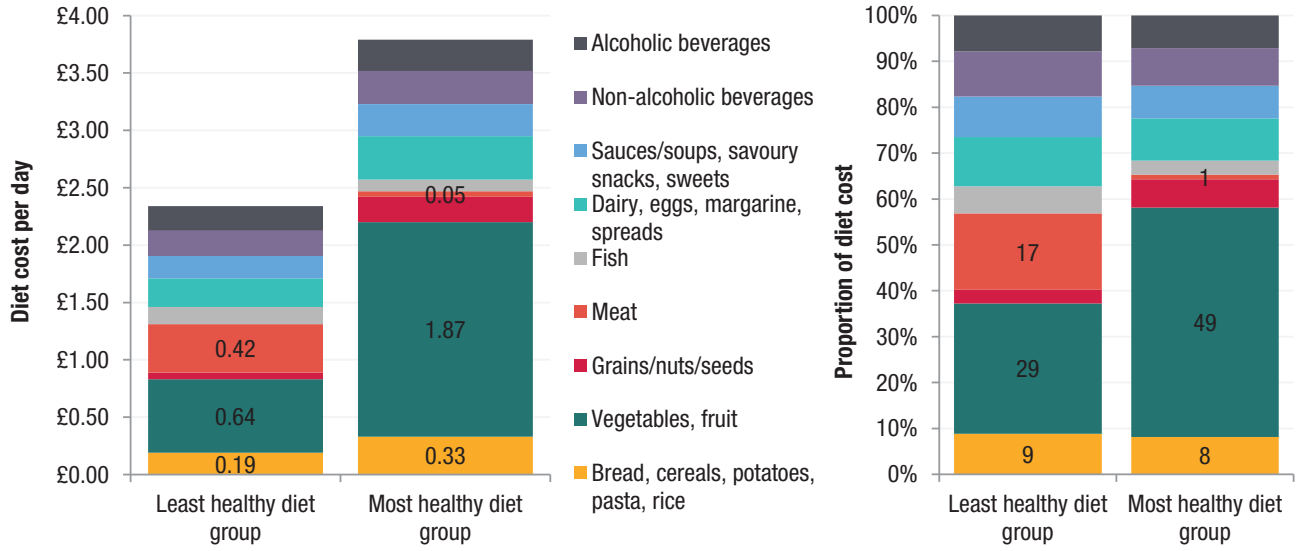
Since they analysed unit values, that is spending divided by quantity, rather than observed prices, they later produced a correction to infer prices. The difference arises since when as prices of a group of foods rises, consumers tend to switch towards cheaper items within the group including lower quality items, so their average unit value does not rise in line with prices.

Jones et al. (2014) classified 94 foods and beverages in the UK as 'more healthy' or 'less healthy' according to a nutrient-profiling model developed by the FSA. Mean prices in 2012 were £2.50 for less healthy and £7.49 for more healthy items by unit, while by 1,000 kcal less healthy items cost £0.29, while more healthy items cost £1.27. Moreover, while all prices rose from 2002 to 2012, the prices of more healthy items rose significantly faster than less healthy ones in absolute terms: £0.17 compared to £0.07/1,000 kcal per year on average for more and less healthy items, respectively.

9 Interestingly, while in men the prevalence of obesity grew across different job categories from 1997 to 2007 in a similar fashion, in women, prevalence of obesity increased across all job categories except 'professional', where it barely shifted at all over the time period – see Figure 11.10 in Annex II.

10 In comparison, England's spending on preventive health interventions for obesity, diet and lifestyle in 2006/07 was only £116 million (see Table 4.3 in The Marmot Review 2010).

Figure 3.7: Contribution of different food groups to daily diet costs of healthiest and least healthy group of eaters, adult women, UK, 1995–98



Source: Data from Table 3 in Cade et al. 1999

Comparing the differences in 'healthy' and 'unhealthy' diet costs for a group of over 15,000 UK women aged 35 to 69,[11] Cade et al. (1999) classified diets into eight grades of healthiness, based on WHO recommendations.[12] Women in the healthiest group spent on average 64% more on their food than women in the least healthy group (£2.33 per day compared to £3.81 per day). They also spent almost half of their food budgets on fruit and vegetables compared to less than a third in the least healthy group, and far less on meat — indeed, women in the healthiest diet group were almost four times as likely to be vegetarian. Figure 3.7 shows a breakdown of their different diet costs by food group.

A later study used the same women's cohort study data for 1995–98 to investigate a similar question, classifying diets in a slightly different way[13] according to how well they adhered to the UK Department of Health's 'Eatwell Plate', a guide to the composition of a healthy diet (Morris et al. 2014). They similarly concluded a healthy diet was more expensive than a less healthy one, with the healthiest costing twice the price of the least healthy, £6.63 per day and £3.29 per day, respectively.

Wrieden and Barton (2011) looked specifically at *energy density* of diets in Scotland, and compared costs of energy-dense and less energy-dense diets. Separating households into quintiles of energy density shows the quintile with the least energy-dense diet consumes approximately 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. The WCRF recommends not exceeding a dietary energy density on average of 125kcal per 100g of food.

Moreover, the cost paid per 2,000 kcal for households in the lowest quintile of energy density is almost £5, while the equivalent cost for households in the highest quintile is £3.76 (see Figure 3.8).

Diets were 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-person households, for instance, ate an average of 169 kcal/100g). Mean energy density for food and milk consumed in the 309 households meeting health targets for fat consumption (<=35% of food energy) and fruit and vegetable consumption (>400g/day) was 136 kcal per 100g. For the 3,859 households not meeting these targets, the equivalent figure was 175kcal/100g.

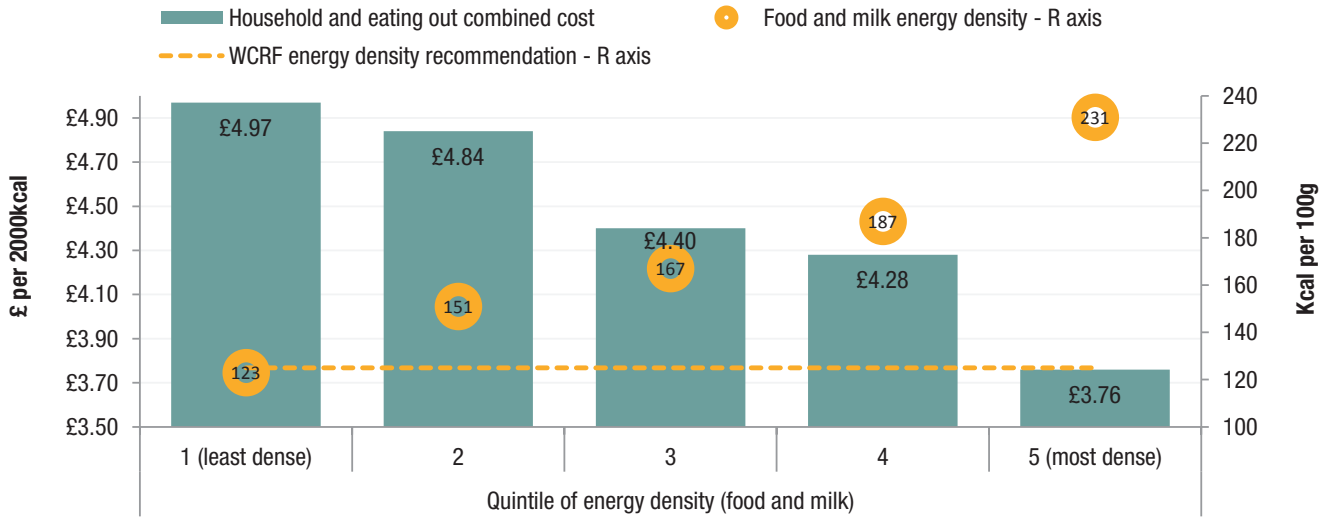
If healthier diets cost more in the UK, the fear is that people on low incomes may not be able to afford them. Banks et al. (2012) report this is not necessarily the case, and indeed the type of food retailer plays more of a role in the cost of food than do differences in food choice between healthy and less healthy options (see Box 3A).

11 Data from the UK Women's Cohort Study collected 1995–1998.

12 WHO healthy diet indicator components included: percentage of total energy from saturated fatty acids, from polyunsaturated fatty acids, from protein, from complex carbohydrates, and from free sugars (excluding fructose and lactose); grams of dietary fibre, of fruit and vegetables, of pulses, nuts, and seeds.

13 They looked at seven dietary patterns, with a diet healthiness score from 1 to 5. Worst diets were described as 'Monotonous low quality omnivore' (score of 1), followed by 'Traditional meat chips and pudding eater' (2); 'Conservative omnivore' and 'Low diversity vegetarian' (3); 'Higher diversity traditional omnivore' and 'High diversity vegetarian' (4); and 'Health conscious' (5).

Figure 3.8 Diet costs (per calorie) and energy density, Scotland, 2011



Source: Compiled fom data in Table 10 in Wrieden and Barton 2011
Notes: WCRF = World Cancer Research Fund. Kcal = kilocalories

3.2.3 Price changes and consumption

A recent rather comprehensive analysis, correcting shortcomings in earlier work, has assessed own- and cross-price elasticities for a large set of food groups, across income and geographical sub-sets of the UK population from 2001/02 to 2009 (Tiffin et al. 2011). Own-price elasticities for food groups range from the elastic -1.38 for fruit and nuts to the relatively inelastic -0.58 for meat. (see Table 3.3).

The authors then used these elasticities to see how changes in food prices and food expenditure would affect the intake of nutrients – where cross-price effects become significant. For example, higher prices of fat and starch, dairy and egg products would lead households to consume less fat and energy, as might be expected; but they would also lead to lower consumption of vitamins and micronutrients. A 10% increase in the price of dairy and egg products reduces the intake of beneficial nutrients such as calcium (-3.8%), iron (-3.5%), vitamin D (-4.6%) and zinc (-8.4%). The effects of subsidies can be modelled. Subsidising vegetables by 5% increases vegetable consumption of low-income households by 3.23%, but also raises consumption of meat by 0.45%, decreases alcohol by 0.62%, decreases fish by 0.23%, and has a negligible effect on dairy, eggs, fats and starches. It would increase the intake of carotenes (+2%), Vitamin C (+0.8%) and fibre (+0.5%).

Some studies have looked at the influence on purchasing of sales promotions that affect prices. Hawkes (2009a) synthesised the literature (not only from the UK) on the influence of sales promotions on food consumption. Although promotions lead to significant sales increases over the short term, it was not clear if changes in food consumption would persist after the promotion, owing to lack of information on longer-term effects.

Table 3.3: Estimates of food price elasticity in the UK, long-run
Change in consumption in response to price change

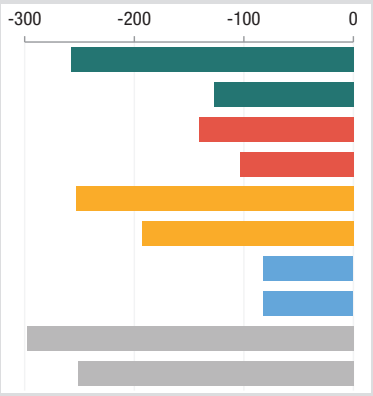
	Dairy & Egg	Meat	Fish	Fruit & Nuts	Veg.	Fats & Starches	Alcohol	Expend.
Dairy & Eggs	-1.00	-0.01	0.04	0.20	0.05	-0.13	0.01	0.85
Meat	-0.09	-0.58	0.04	-0.03	0.08	-0.48	-0.09	1.14
Fish	0.56	0.29	-0.70	-0.43	-0.01	-0.26	-0.09	0.64
Fruits & Nuts	0.38	0.01	-0.06	-1.38	-0.01	0.38	-0.07	0.76
Veg.	0.12	0.12	0.00	-0.01	-0.65	-0.32	0.03	0.72
Fats & Starches	-0.09	-0.09	-0.01	0.07	-0.10	-0.83	0.04	1.02
Alcohol	-0.27	-0.28	-0.05	-0.35	-0.10	-0.28	-1.12	2.46

Source: Table 4 Tiffin et al. 2011

Box 3A: Cheap eats and healthy treats: affordable for families of obese children in the UK?

Affordability is often cited as a factor in people's unhealthy diets. A recent randomised trial of obese children aged five to 16 looked at this question, comparing their actual diets to a theoretical, healthy diet based on the Eatwell Plate. The healthy diets were only slightly adjusted versions of the children's existing diets – a more acceptable option than pricing an alternative diet far removed from existing ones. Figure 3A1 shows some examples of adjustments between existing and healthy diets, and the impact they would have on energy intake.

Figure 3A1: Kcal changes associated with adjusting meals to healthier options



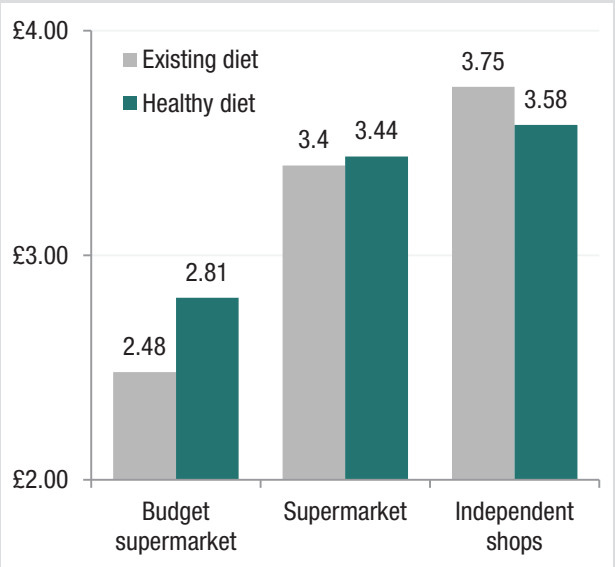
Original meal	Healthier option
2 slices white toast, paté, crisps, cola, large portion Honeynut Cheerios®, semi-skimmed milk	2 slices white toast, low-fat butter, apple, semi-skimmed milk, 1 portion Cheerios®, banana
Portion fried chicken	Portion roast chicken
Crisps, 3 slices white bread, butter	4 slices white bread, roast chicken, LF butter, salad
3 slices of pizza	2 slices vegetable pizza, mixed salad, orange juice
1 pack ready-made lasagne	½ pack of lasagne, carrots, apple
Cola	Zero cola
½ pint blackcurrant squash	½ pint no-sugar blackcurrant squash
1 slice of cheesecake, cream	1 fruit ice pop
1 pack of Haribo® Jellies	1 portion rice pudding with SS milk

Source: Data from Table 1 in Banks et al. 2012

Both diets were priced at three shops: a neighbourhood mid-range supermarket, a budget supermarket, and the local high street. The children's actual diet bought at a budget supermarket was the cheapest (£2.48/day). The healthier option at the same shop cost an additional 33 pence/day (£2.81). The same exercise in a mid-range supermarket incurred an additional cost of 4 pence per day (£3.40 versus £3.44).

Shifting from the unhealthy option bought at a mid-range supermarket to the healthier, budget-outlet option could save 59 pence per day. The healthier option was cheaper than the existing diet if purchased on the high street (£3.58 versus £3.75), although for both menus the high street was the most expensive option – see Figure 3A2. Even if switching from the existing to a budget supermarket healthy diet, the extra cost would be only about £10 per month.

Figure 3A2: Cost of different diets from three types of shop



Source: Data from Table 3 in Banks et al. 2012

They concluded that for many of the families of obese children, the extra cost of eating healthily would not necessarily be prohibitive, though cost may be a barrier for the most disadvantaged.

Source: Banks et al. 2012

Studying the specific case of the impact of promotions on sugary food purchases – take-home confectionary, frozen confectionary and ice cream, and non-diet soft drinks – in Scotland between 2006 and 2011, Revoredo-Giha and Akaichi (2014) found that consumers did indeed respond to promotions on sugary foods. In particular, families with children significantly increased purchases of sugary products over the six years reviewed, owing in large part to price promotions. Moreover, the use of such promotions by the four largest Scottish supermarkets increased over time, suggesting that retailers used promotions to keep people spending over the recession.

3.2.4 Effect of price changes – including taxes – on consumption and health in the UK

Several studies have modelled the likely impact of taxes and subsidies on eating habits, weight or health.

Briggs et al. (2013) model a 20% tax on SSBs on the prevalence of overweight and obesity of people aged 16 and over in the UK. Own-price elasticity for SSB is -0.92 for concentrated and -0.81 for non-concentrated drinks, so that a 20% tax on SSB decreases consumption of the former by 15% and the latter by 16%. To compensate, consumption of other drinks rises. Consumers on higher incomes tend to switch to water, while those on lower incomes switch to diet soft drinks, milk, and fruit juice.

Annual revenue from such a tax was estimated at £276 million. Total expenditure on drinks would rise by for 2.1% for the highest income tercile, by 1.7% for the middle tercile, and by 0.8% for the lowest tercile. The tax would reduce the number of obese adults in the UK by 1.3% (or 180,000 people), and the number of overweight by 0.9% (285, 000 people). Effects on obesity were stronger at younger ages, leading the authors to conclude: 'Taxation of sugar sweetened drinks is a promising population measure to target population obesity, particularly among younger adults' (Briggs et al. 2013).

Mytton et al. (2007) examine the effects on nutrition, health and expenditure of extending 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,[14] while the health effects of changing salt and fat intake were from previous meta-analyses. Three scenarios were considered: a tax on the main sources of saturated fat in diets; a tax on foods defined as unhealthy by a nutrient-profiling model developed for the FSA; and a tax on foods to obtain the best health outcome.

In the first scenario, they find that taxing only the key sources of dietary saturated fat is not likely to reduce prevalence of cardiovascular disease (CVD), mainly because a fall in saturated fat is offset by a rise in salt consumption. In the second scenario, they find that taxing unhealthy foods might prevent some 2,300 deaths per year, chiefly by reducing salt intake. Finally, in the third scenario, they find that a tax on a wider range of foods could prevent up to 3,200 CVD-related deaths in the UK per year, a reduction of 1.7%. The authors conclude that while a tax on certain foods can lead to unpredictable health effects if cross-price elasticities of demand are not taken into consideration, a carefully targeted 'fat tax' could have a modest but meaningful influence on people's diets and on the incidence of CVD.

In a related study, Nnoaham et al. (2009) explore similar tax scenarios, as well as tax-subsidy scenarios, to assess the impact on mortality from not only CVD, but also cancer. They find that a tax on the principal sources of dietary saturated fat is unlikely to reduce CVD[15] or cancer mortality. Indeed, rather than preventing deaths, it leads to extra deaths since although fat consumption falls, so too does the consumption of fruit and vegetables owing to cross-price elasticities. A tax on 'less healthy' foods (defined according to the FSA nutrient-profiling model) could even increase CVD and cancer deaths by 35 to 1,300 a year, for similar reasons.

In contrast, a tax on 'less healthy' foods combined with a subsidy on fruit and vegetables of 17.5% could avert up to 2,900 CVD and cancer deaths every year, while taxing 'less healthy' foods and using all tax revenue to subsidise fruit and vegetables could avert up to 6,400 CVD and cancer deaths a year. Each scenario would place a higher economic burden on lower-income families. In the last two scenarios however, many of the lives saved through tax-subsidy schemes would be those of poorer people.

2.5 Summary of the UK literature

- Healthy diets cost more than less healthy diets.
- Over the last 10–20 years, the cost of fruit and vegetables has risen compared to other foods, and especially processed food.
- Cross-price effects matter in assessing the nutritional effects of price changes. Taxes on fat or salt content may affect consumption of other, complementary foods, leading to lower intake of beneficial nutrients. Using tax revenues to subsidise such complementary foods would counter this effect.

14 The elasticities used here and in Nnoaham et al. (2009) described below are the same as those criticised by Tiffin et al. (2011) for being calculated on the basis of outdated economic and statistical approaches.

15 Though it reduces coronary heart disease (CHD), it increases strokes by a greater extent.

3.4 Brazil

3.4.1 Consumption of (ultra) processed food

Consumption of ultra-processed food and drink – that is, ready-to-eat or drink and foods that have been industrially prepared from ingredients, typically 'energy-dense, fatty, sugary or salty, and formulated to be hyper-palatable' (Monteiro et al. 2012) – has been rising, from just over 80 kg per capita per year in 1999 to around 110 kg per capita per year by 2013 (Moubarac 2014). Consumption of sugary drinks, as modelled from Euromonitor data, was among the highest for middle- and low-income households (Basu et al. 2013). Some ultra-processed foods, such as bread and sausages, have long formed part of Brazilian diets, while others such as crisps, biscuits, energy bars, and sugary drinks are more recent additions, encouraged by widespread marketing (see Box 3B).

From 1990 to 1996 households in São Paulo increased their spending on 'industrialised' (highly processed) food, while spending less on semi-prepared and non-processed foods (Barretto and Cyrillo 2001). More recently, between 1996 and 2009, surveys show consumers getting smaller shares of energy from more traditional, minimally processed foods, as the contribution of ultra-processed products has grown (see Figure 3.9).

Energy-dense foods tend to be cheaper per calorie than other foods (see Figure 3.10). Most of the raw or minimally processed foods – such as fruits and vegetables – have higher costs per calorie than do the moderately processed foods – such as sugar and oils. In terms of cost per kilocalorie, many of the highly processed foods were also relatively cheap, except for ready meals (Ricardo and Claro 2012).

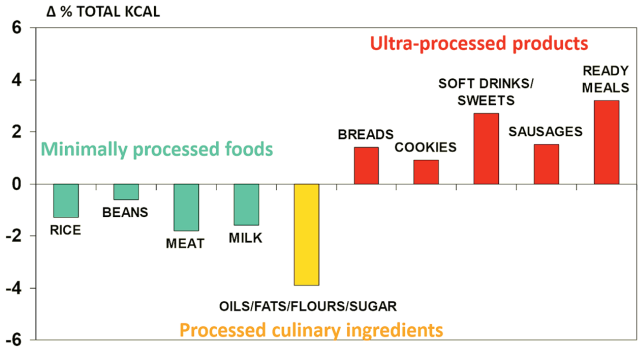
3.4.2 Effect of food prices and incomes on consumption

Looking at the influence of the price of fruit and vegetables on their contribution to people's diets in Brazil, Claro and Monteiro (2010) showed that a 1% fall in their price would increase their contribution to calorie intake by 0.79%. For São Paulo a lower elasticity of demand was found, a 1% price fall leading to only a 0.2% increase in consumption by calorie (Claro et al. 2007). They also recorded a small cross-price elasticity: a 1% increase in the price of other foods would increase fruit and vegetable contribution to calorie intake by 0.07%.

Income elasticities were also reported. For Brazil as a whole, the income elasticity of demand for fruit and vegetables was estimated at 0.27 (Claro and Monteiro 2010), and for São Paulo at 0.04 (Claro et al. 2007): that is, highly inelastic responses to income, although in both cases responses were greater among those on low incomes, as would be expected.

Prices are only one influence on food choice: a study of the diets of women aged 20 to 60 years in urban São Leopoldo in southern Brazil, (Lenz et al. 2009) found that healthy diets were more frequent among women with higher incomes and educational level, while women with lower incomes and less education were more likely to consume diets with higher health risks.

Figure 3.9: Proportion of energy from different food groups, urban household purchases, Brazil, 1996–2009



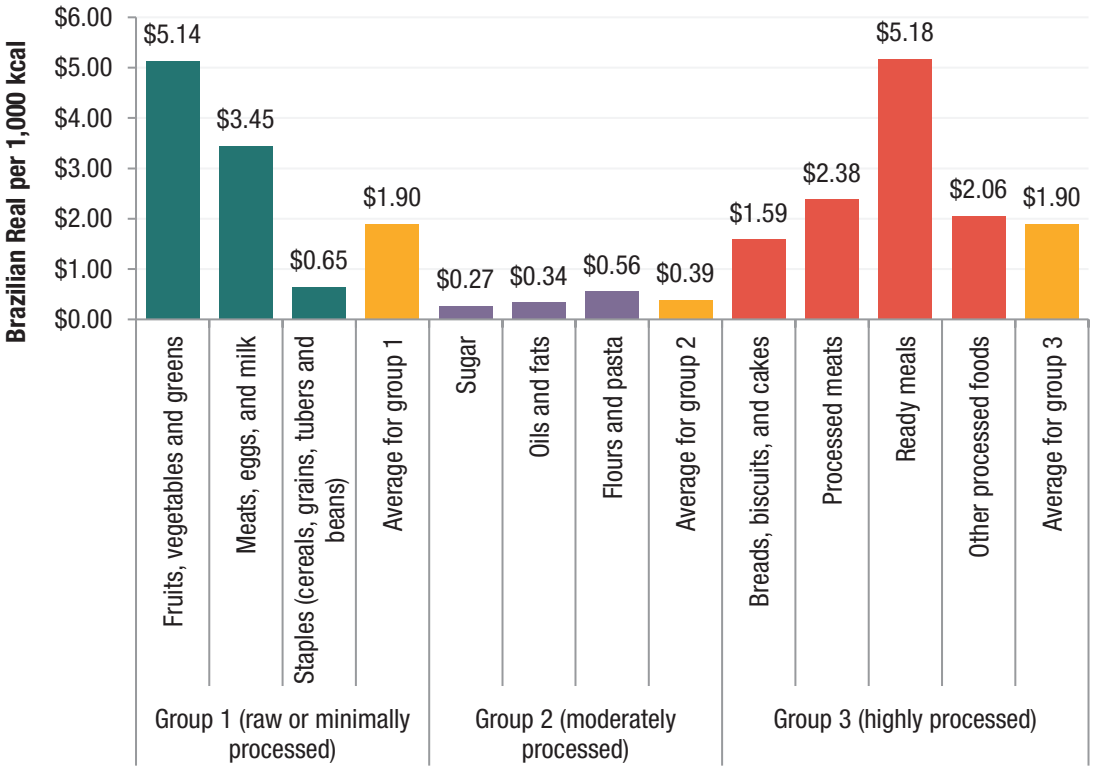
Source: Monteiro 2013

Box 3B: Marketing of processed food in Brazil

Monteiro and Cannon (2012) see powerful transnational food and snack companies – dubbed 'Big Food' and 'Big Snack' – playing a major role in people's increasing consumption of ultra-processed, fast or convenience foods. Such foods are increasingly difficult to avoid in contemporary Brazil:

> … we went for lunch to a workers' restaurant near the University of São Paulo, where a traditional freshly cooked meal of rice, beans, and a choice of meat, together with mixed salad, cost the equivalent of $US 6. We noticed that the bottled water offered was 'made' by a once Brazilian company now owned by Coca-Cola, and that the artisanal water-based ice lollies containing fruit juice, which are still sold by pedlars on Brazilian beaches and supplied by traders to simple restaurants, had been replaced by fatty, sugary brands of Nestlé ice cream. These same ice creams, together with other Nestlé 'popularly positioned products', which are 'targeted at and bought by low income consumers', are now being sold door-to-door in the outskirts of several Brazilian cities, on trains and subway stations, in retail chains that sell electronic and house appliances, and also on 'floating supermarkets' that take Nestlé products to remote Amazonian villages. (Monteiro and Cannon 2012)

Figure 3.10: Cost per kilocalorie for different food groups in Brazil



Source: Table 3 in Ricardo and Claro 2012

4.3 Food taxes

Taxes on less healthy foods may be particularly effective in Brazil. Investigating the effect of a tax on SSBs, Claro et al. (2012) used household food-consumption data collected in 2002–2003 for a sample of over 48,000 households in Brazil. Controlling for demographic variables, income, and prices of other foods and drinks, they found that an increase in the price of sugary drinks led to reduced consumption: a 1% price increase led to a 0.85% reduction in calories from sugary drinks. This effect was stronger for poor people (1.03% reduction), than for non-poor (0.63% reduction). Such high elasticities suggest that taxes might have a strong effect, particularly among poorer people: a tax of 30% on the average price of sugary drinks would reduce average consumption by about 25% (Claro et al. 2012).

3.5 China

3.5.1 Food prices in China

Cooking oil has become cheaper compared to other foods in China (see Figure 3.11) (Lu and Goldman 2010).

3.5.2 Effect of food prices on weight in China

To assess the effects of relative food prices on body weight and body fat over time, Lu and Goldman (2010) used a cohort study of 15,000 adults from over 200 communities in China from the China Health and Nutrition Survey (CHNS) from 1991 to 2006. They found that decreases in the price of energy-dense foods led to greater body fat; an effect they could not always find for body weight, leading them to conclude:

> … changes in food consumption patterns induced by varying food prices can increase percentage body fat to risky levels even without substantial weight gain. In addition, food prices and subsidies could be used to encourage healthier food consumption patterns and to curb obesity. (Lu and Goldman 2010)

Also using data from the CHNS, He's 2013 study of child obesity from the mid-1980s to the mid-2000s found an obesogenic environment to be a much more important factor in shaping obesity-related risk behaviour than was the more individual determinant 'willpower based on knowledge'. Interestingly, given how often rural parents migrate for work and leave children in the care of elderly family members, she also found:

> Children in the care of grandparents are healthier, probably due to the generally low degree of access to obesogenic foods and a closer intergenerational relationship that facilitates effective communication and promotes healthy lifestyle formation. (He 2013)

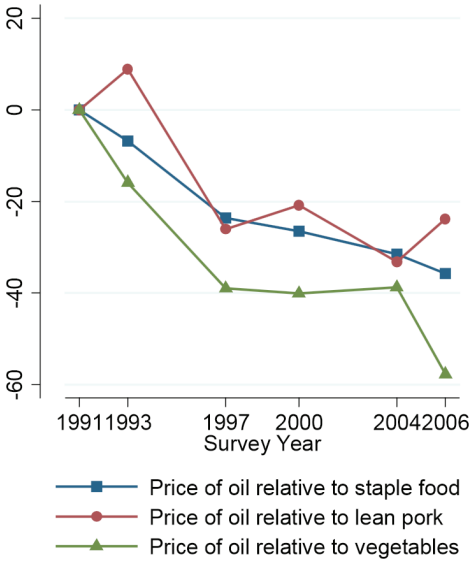
James (2008) sees the long-term fall in prices of fats and oils compared to more expensive products like fish, meat, dairy, and fruit and vegetables, as contributor to growing obesity in China.

3.6 Republic of Korea

3.6.1 Consumption trends

So far, the Republic of Korea has taken what some describe as a unique trajectory through the 'nutrition transition' (see Popkin et al. 2012), as a result of strong efforts to maintain a traditional Korean diet low in fat and high in vegetables in the midst of rapid economic growth and Westernisation (Lee et al. 2002). Though large shifts can be seen over the past decade, driven by an increasing openness to importing food, very high vegetable and modest fat consumption seem to have persisted (Lee et al. 2012). Estimates of vegetable consumption per person, particularly kimchi, have remained in most years between 260 and 290 grams a day since 1969 (see Figure 3.12).

Figure 3.11: Cooking oil prices, China, 1991–2006



Source: Figure 1 in Lu and Goldman 2010

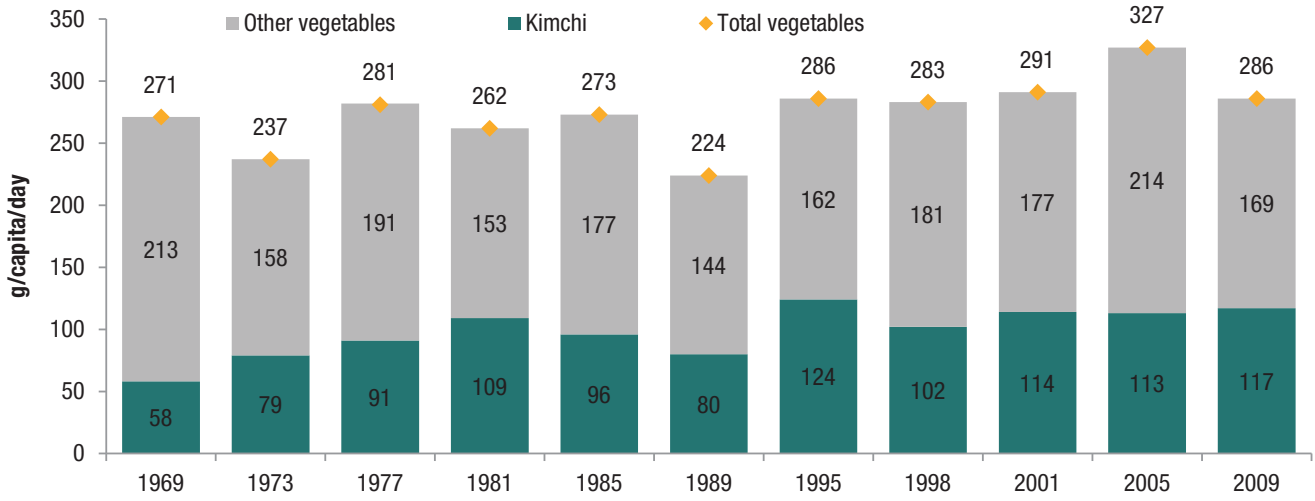
Some less positive trends have been spotted, however, with average daily alcohol intake rising from 39 kcal to 82 kcal per person between 1998 and 2009, as well as energy intake from SSB rising among teenagers (Lee et al. 2012). Han et al. (2013) documented rising prevalence of SSB consumption among adolescents and all older age groups between 2001 and 2009:

> SSB consumption prevalence increased to 38%, 69%, 70%, and 50% by 2009 up from 31%, 66%, 63%, and 32% in 2001 among adolescents, young adults, adults, and the elderly, respectively.

The prevalence of SSB consumption was higher among individuals of relatively high socio-economic status, particularly in the case of fruit drinks and miscellaneous SSBs – sports/energy drinks, coffee/tea products and flavoured milk – rather than soda.

A study of child and adolescent consumption for 2008–2011 found that on average, children aged seven to 12 drank around 65ml of SSBs a day, while children aged 13–18 drank 120ml a day. Some 12% of children and adolescents, however, were drinking more than 300ml of SSB a day. Lee et al. (2013) found higher consumption was associated with high overall energy intake, but low consumption of milk, fruit and vegetables (not meeting the 400g a day recommendation for the latter). Furthermore, they found that being overweight and obese was significantly associated with greater odds of high SSB consumption among boys aged 7–12 years.

Figure 3.12: Vegetable consumption in Republic of Korea, 1969–2009, grams per person per day



Source: Figure 2 in Lee et al. 2012 Note: Values are presented as three-year or four-year moving averages. Kimchi intake is presented as a mean from age>=1 between 1969 and 1995, and from age>=2 from 1998 to 2002.

3.7 Mexico

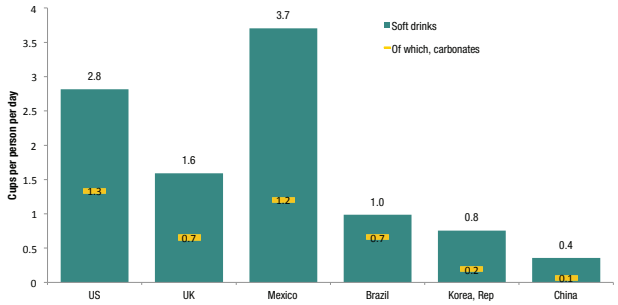
3.7.1 Consumption of ultra-processed food and drink

Mexico's consumption of processed, often unhealthy, food has skyrocketed (see Figure 3.13). Mexico has led Latin America in per capita consumption of ultra-processed food and drinks.

Mexican consumption of soft drinks per person is much higher than might be predicted by its per capita GDP (Basu et al. 2013) (see Figure 3.14): in 2008, daily consumption was almost one third more than in the USA.

Stern et al. (2014), using 24-hour diet recall studies from 1999 and 2012 with nationally representative samples, found that total daily energy from beverages increased by about 45kcal for children aged five to 11, by 57kcal for girls and young women aged 12 to 19, and by 96kcal for adult women aged 20 to 49.

Figure 3.14: Consumption of soft drinks per person per day, USA, UK, Mexico, Brazil, Korea and China, 2008

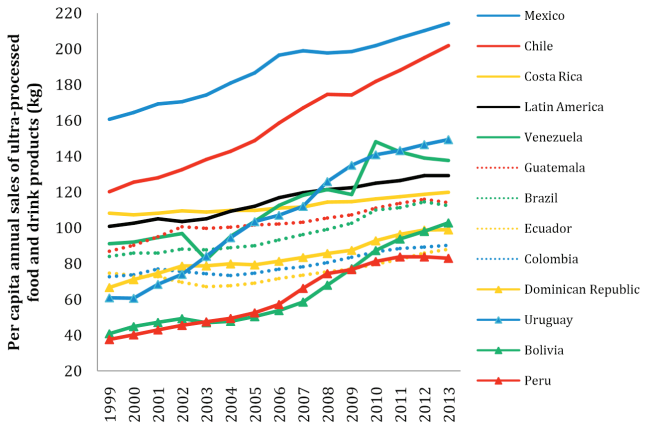


Source: Constructed from USDA data and population estimates from FAOSTAT. Original source: Euromonitor 2009

3.7.2 Food prices in Mexico

The real price of many beverages decreased over time in Mexico, corresponding to large increases in Mexican consumption of energy-containing beverages – whole milk, carbonated and non-carbonated SSBs, fruit juice with various sugar and water combinations added, and alcohol – between 1999 and 2006, so that by 2006, adults and adolescents obtained 22% and 20% respectively of their energy intake from these beverages (Barquera et al. 2008).

Figure 3.13: Annual sales of selected ultra-processed foods and drinks, 12 Latin American countries, 1999–2013



Source: Figure 1 in Moubarac 2014 (based on Euromonitor Passport Global Market Information Database (2014) and WHO Global Burden of Disease)

Note: Ultra-processed food and drink products include: carbonated drinks, fruit and vegetable juices, 'sports' and 'energy' drinks, breakfast cereals, sweet and savoury snacks, confectionery, ice creams, biscuits, spreads, sauces and ready meals. Quantity in litres was converted into kilograms.

3.7.3 Food and drink taxes in Mexico

In December 2013, after much debate, the legislature in Mexico approved two taxes: a peso (about US$0.07) per litre on sugary drinks and a 5% tax on energy-dense foods with more than 275 kcal per 100 grams (see Box 2A for an illustration of foods above this threshold).

The tax on SSBs alone could help prevent 515,000 new cases of diabetes by 2030 and lead to US$14 billion in savings for the health system (Arantxa Colchero, National Institute of Public Health, reported in Martin and Cattan (2013)).

Early reports suggest the tax may be helping to stem purchases of some SSBs and snack foods. According to the National Obesity Survey of 1,500 adults in Mexico in August 2014, 52% of Mexicans reduced intake of SSBs in 2014 (EFE 2014). Moreover, 'some 98 percent of respondents said consuming soft drinks contributed to obesity and caused people to get diseases like diabetes, the survey'. PepsiCo snack sales volume dropped by 3%, while Coca-Cola also reported a decline in sales over the first half of 2014 – though Mexico still has the world's highest consumption of Coca-Cola per capita (RT.com 2014).

3.8 Summary of literature from emerging economies

- Some reports link changes in diets, above all those involving more consumption of processed foods, to processed food and cooking oil becoming cheaper than other foods.
- In Latin America, the rising consumption ultra-processed foods and SSBs is coming under the spotlight. Some see this consumption as the consequence of heavy marketing by the large corporations that manufacture much of this food and drink.
- The possibility of using taxes to reduce consumption of processed food and SSBs is actively being studied, with most authors seeing the potential to significantly reduce consumption. Mexico has introduced taxes on both SSBs and energy-dense food. These, which came into effect in January 2014, will be the focus of intense scrutiny to see what effects they have.

4. Data and methods

Key data for this report are series for food prices from 1990 to recent years. The aim was to compile comparable series of retail prices for representative foods across a sample of countries over time from at least 1990 onwards, and where possible from 1980. *Retail prices were sought for representative foods* from the food groups set out in Section 2, namely: staples, fruits and vegetables; meat, seafood, and dairy; oils, fats, and sugar; and highly processed foods.

Table 4.1 lists the foods chosen in the four countries plus the UK. The aim was to select at least one representative from each food group, preferably one with large consumption, and – other than for the items in the processed category – foods that were minimally processed if at all. In practice, choice was limited to the range of price series already collected in each country. In some countries, most notably China, prices were available only for groups of foods, such as 'cake, biscuit and bread' rather than the individual products.

Ideally we would have liked to have the retail prices for the same foods across the four countries, but published data did not allow that. In any case, the aim was to have at least one food from each food group, choosing those that are most typically consumed. Since diets vary by country, relevant foods also differ: for example, the staple food in Korea is rice, while in Mexico it is maize.

Just one price for each food has been used, either national averages or the prices paid in a major city. It was not possible to obtain more detail on how prices vary within countries between, for example, urban and rural areas, or by food.

For the four country studies, through our collaborative group, data were taken from publicly available databases, as set out in Table 4.2.

Table 4.1: Food prices analysed for each food group and country

	Brazil	China	Korea, Rep	Mexico	UK
Staple	Rice	Grain	Rice	Tortilla and maize flour	Flour (wheat)
Fruit or vegetables	Oranges Tomatoes	Vegetables Dried and fresh fruits	Cabbage	Tomato Fresh vegetables	Fresh green vegetables
Fats or sugar	Sugar Soy oil	Oil and fat	Vegetable oil Sugar	Oils and edible fats Sugar	Sugar
Meat or dairy	Beef	Meat, poultry and products	Fish Chicken	Chicken	Chicken
Highly processed	Regular sausage Sweet biscuit	Cake, biscuit and bread	Ramen (noodles)	Chocolate and snacks Ready meals	Ice cream tub/block

Table 4.2: Data sources and deflators used for country cases

Country	Deflator	Data source
Brazil	CPI	• Food price data collected by the Instituto de Economia Agrícola (Institute of Agricultural Economics) of São Paulo State for the metropolitan area of São Paulo, Brazil's largest city [2010 population of 12.5 million in the municipality – the metropolitan area contains more], from 1980 to 2009. • CPI data from Fundação Instituto de Pesquisas Econômicas/Universidade de São Paulo, from 1980 to 2009. Owing to hyper-inflation in the 1980s and early 1990s, significant currency changes took place in March 1986, January 1989, August 1993 and July 1994 and hence appropriate corrections had to be made to compare prices across currency regimes, using information from Fundação Instituto de Pesquisas Econômicas/Universidade de São Paulo (Institute of Economic Research/University of São Paulo).
China	GDP	• Food price data from China Health and Nutrition Survey, and food price index data from China Statistical Yearbooks. • GDP deflator from IMF
Korea, Republic	CPI	• Food price index data from the Consumer Price Index for Korea (Statistics Korea). Price-level data from the monthly Report of Cost of Living in Korea for January 2006. • CPI deflator from Statistics Korea. CPI by Item (Commodities & Services) http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1J0A112&conn_path=I3
Mexico	CPI	• Food price index data from INEGI (Mexico). Price-level data for Mexico City from Procuraduría Federal del Consumidor (Mexico) • CPI deflator from World Bank WDI
UK	GDP	• Unit food price data (national average) imputed from survey data on spending and consumption from the Adjusted National Food Survey data 1974 to 2000, Expenditure and Food Survey 2001–02 to 2007 and Living Costs and Food Survey 2008 onwards. • GDP deflator from World Bank WDI

In most cases, directly observed retail prices were used. For Mexico, however, a food price index was used and calibrated to price levels from observed prices in Mexico City. In the UK, household surveys reported both spending and quantity for 330 foods. Hence it was possible to create unit prices by dividing spending by the quantity. Arguably this produces a better measure of price, since unit prices capture the effects of the frequent price promotions seen in UK food retailing, and not just the recommended price.

Price series have been deflated by either the CPI or the GDP deflator to remove the effect of inflation and allow comparison over time. In some cases, such as the UK, the CPI and the GDP give almost identical results. In three cases, however, the GDP deflator is significantly stronger than the CPI: between 1990 and 2012 the GDP deflator exceeded the CPI account of inflation by 21% for China, by 25% for Mexico, and by 59% for Brazil. Those differences make no difference to comparison of changes in relative prices within country, but clearly affect cross-country comparisons, or an interpretation of comparable price levels over time.

Once prices were deflated, indices of theses deflated prices were constructed to see how much prices of different foods in each country had changed over time from the same base year.

More formal testing of price changes was carried out by regressing time on deflated and logged prices from 1990 to a recent year, in most cases 2012. That allowed a test of whether a significant (log-linear) trend can be inferred, and if so, what the average annual price change has been. The key findings from the analysis here come from these estimated annual price changes.

5. Results of analysis: price movements

This section reports what the data show for the four emerging economies and the UK, then compares these insights to derive broader insights. Annex III has more details for each of the countries. For each country, prices are presented in two ways. One, as constant prices per unit weight. Two, as indices of these prices with a base set to the early 1980s; except for China where the mid-1990s had to be used since the series for the only processed food in the sample began then, and for Korea where it was possible to take the index back to the late 1970s. Graphs of indices make it easier to compare the size of changes between foods when they have very different absolute costs per unit weight.

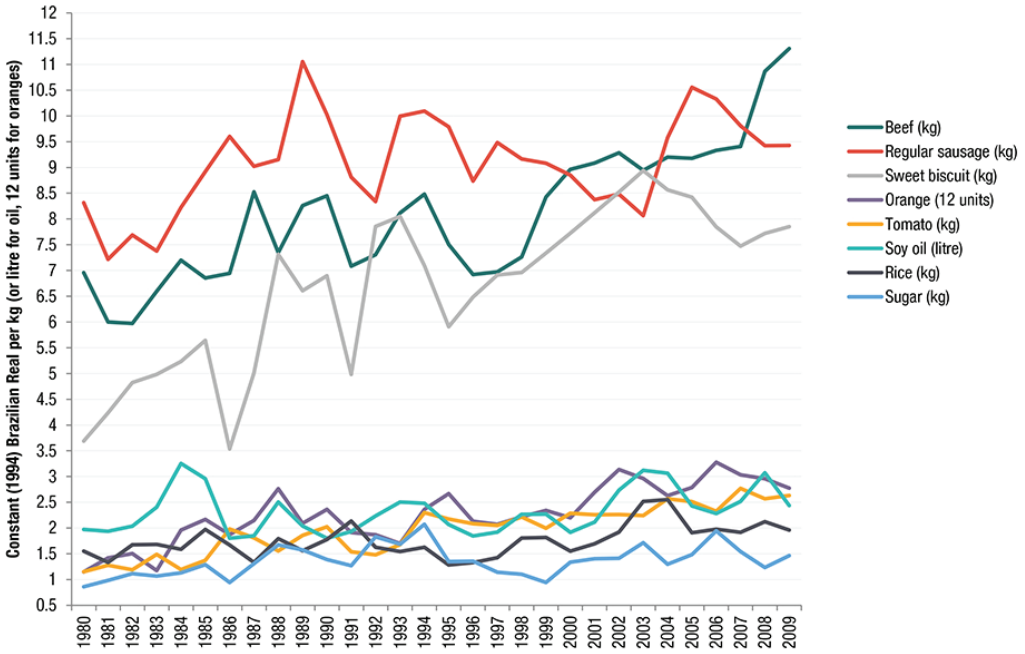
5.1 Brazil

Prices of key foods in São Paulo from 1980 to 2009 appear in Figure 5.1, first in constant 2009 values, second in constant values but indexed to a common 1980/82 base.

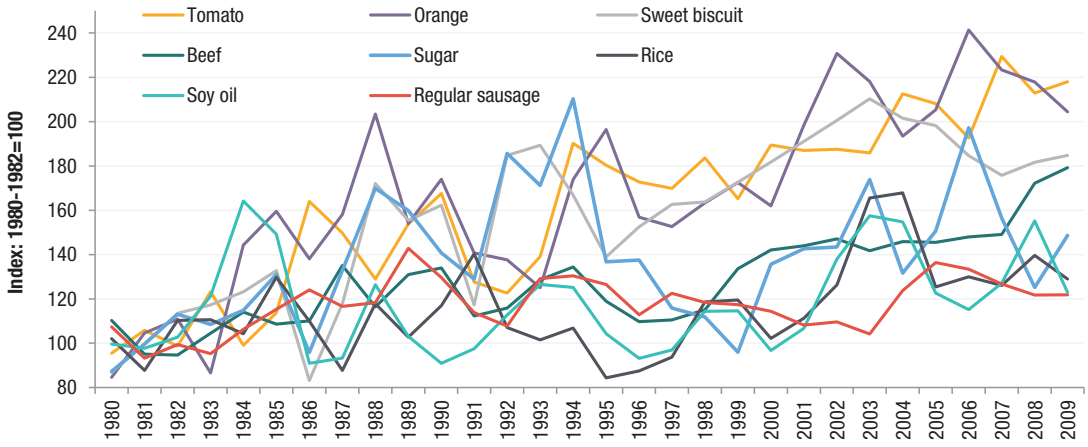
Brazilian prices are quite volatile over time, especially during the 1980s. In part the sharp movements in prices reflect times of high inflation that ended only in the mid-1990s. Despite the variance, some trends can be seen. Prices of fruit and vegetables[16] have gained the most. The lowest increases seen were for rice, sausage and soy oil. Sweet biscuits, which along with sausage are a processed food, also gained quite a lot.

Figure 5.1: Price of selected foods, São Paulo, Brazil, 1980–2009

(a) Constant 2009 prices



(b) Price indices, 1980/82 = 100



Source: Data from Rafael Claro (Original source: data collected by the Instituto de Economia Agrícola (Institute of Agricultural Economics) of São Paulo State for the metropolitan area of São Paulo, deflated to 2009 levels with CPI data and corrected for currency changes.

All prices rise in these series. That may partly reflect the choice of deflator, taken as the CPI. Had the GDP deflator been used, some prices would have fallen, because it registers a full 60% more inflation between 1990 and 2012 than the CPI. While this affects the strength of trends, it does not affect the relative changes in prices between foods.

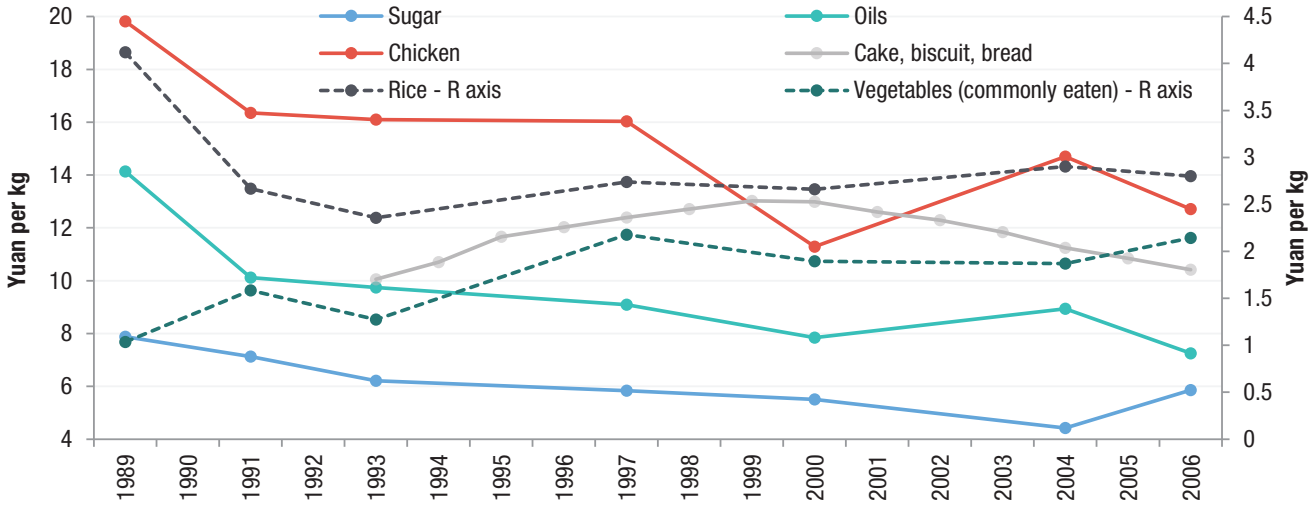
5.2 China

Prices of selected foods in China from 1989 to 2006 appear in Figure 5.2, first in constant 2006 values, second in constant values but indexed to a common 1993 base.

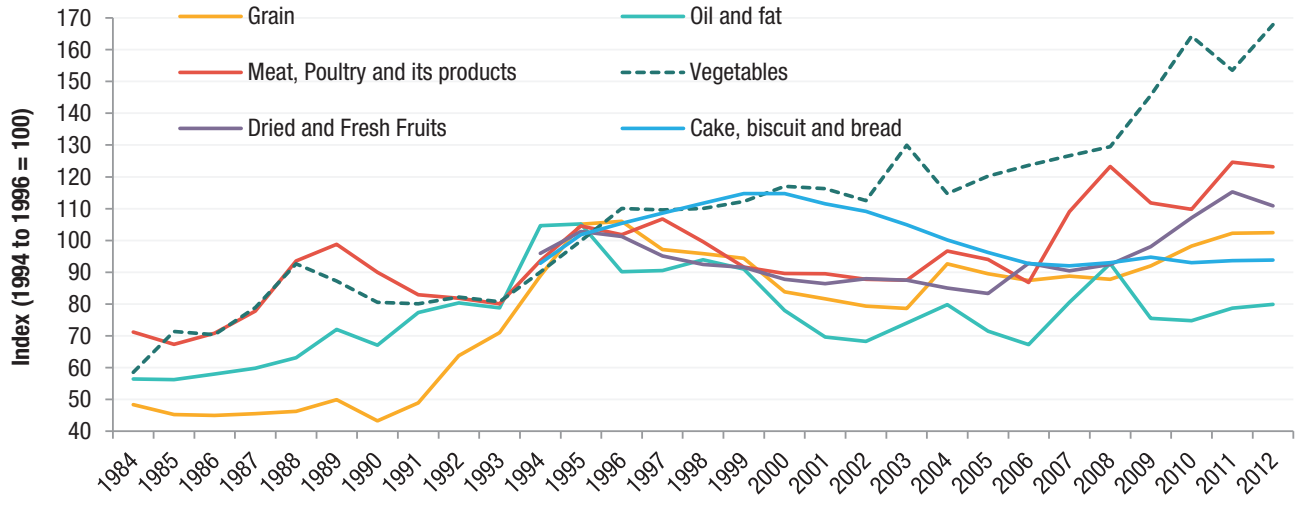
Food prices in China have been notably less variable from year to year than in Brazil. Since 1993, the prices of rice and vegetables have risen; those for cake, biscuit and bread have remained almost the same; while those for chicken, oils and sugar have fallen.

Figure 5.2: Price of selected foods, China, urban areas, 1989–2006

(a) Constant 2006 prices



(b) Price indices, urban China 1984–2012, 1994/96 = 100



Source: Data from Satoru Shimokawa, based on China Statistical Yearbooks. Indices were adjusted to constant 2012 levels by China's GDP deflator from the IMF.

16 Oranges and tomatoes were chosen as these were the most commonly consumed of the fruit and vegetables in terms of grams per capita in a recent consumption survey (data from Rafael Claro).

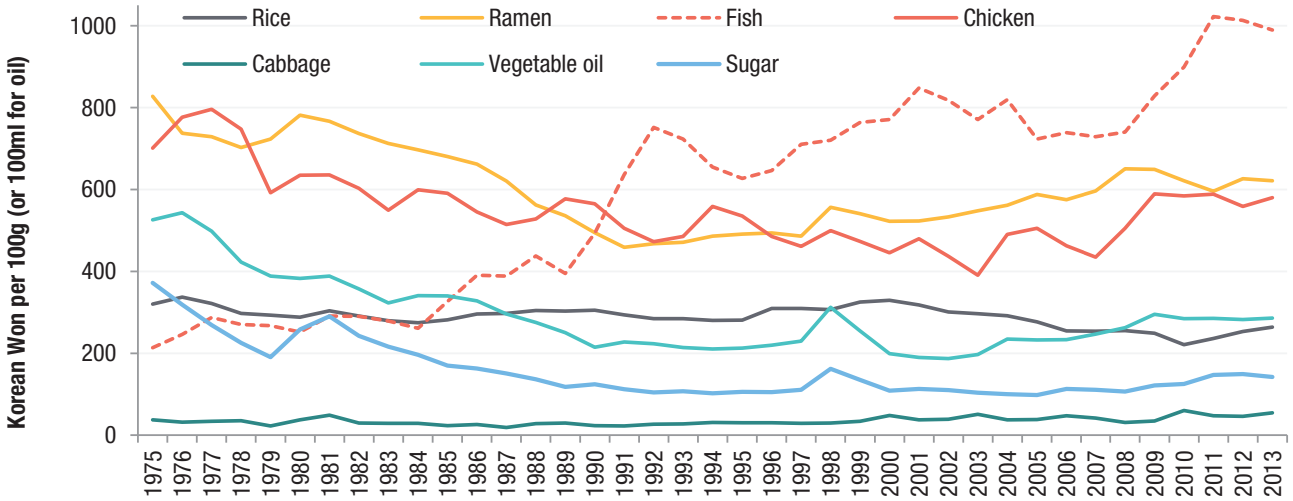
5.3 Republic of Korea

Prices of selected foods in Korea from 1975 to 2013 appear in Figure 5.3, first in constant 2006 values, second in constant values but indexed to a common 1975–77 base.

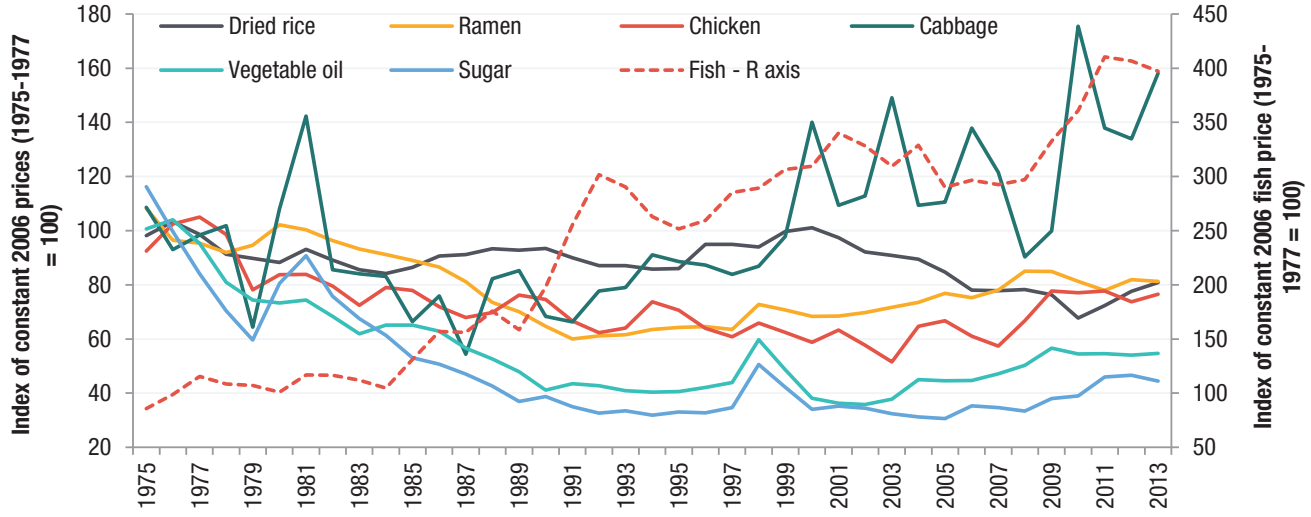
Only two of the selected foods rose in constant price from 1975–77: fish, the most consumed animal product,[17] by almost four times, and cabbage – the key ingredient of kimchi, Korea's national dish, by 60%. All other foods became cheaper, above all sugar and vegetable oil.

Figure 5.3: Prices of selected foods, Republic of Korea, 1975–2013

(a) Constant 2006 prices



(b) Prices indexed to 1975/77=100



Source: Data from Euna Han based on the Monthly Report of Cost of Living in Korea for January 2006 and the CPI for individual food items between 1975 and 2013, deflated to 2006 values using the CPI.

17 In 2011, average per capita supply of demersal and pelagic fish in the Republic of Korea was around 37kg/capita. In comparison, around 16kg/capita of poultry meat was supplied (FAOSTAT).

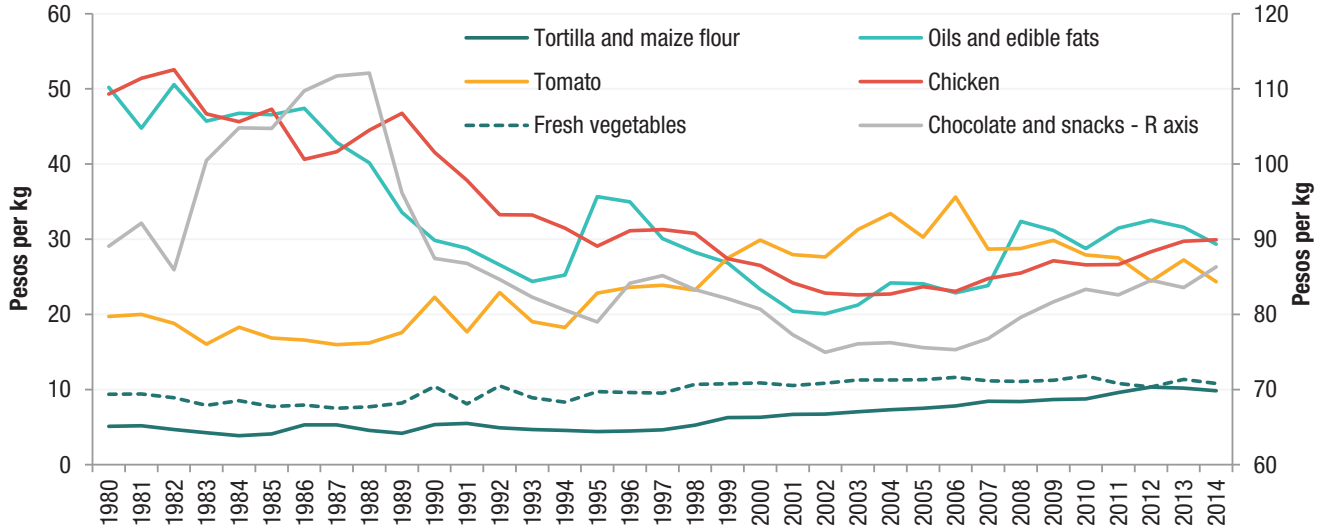
5.4 Mexico

Prices of key foods in Mexico from 1980 to 2014 appear in Figure 5.4, first in constant 2010 values, second in constant values but indexed to a common 1980–82 base.

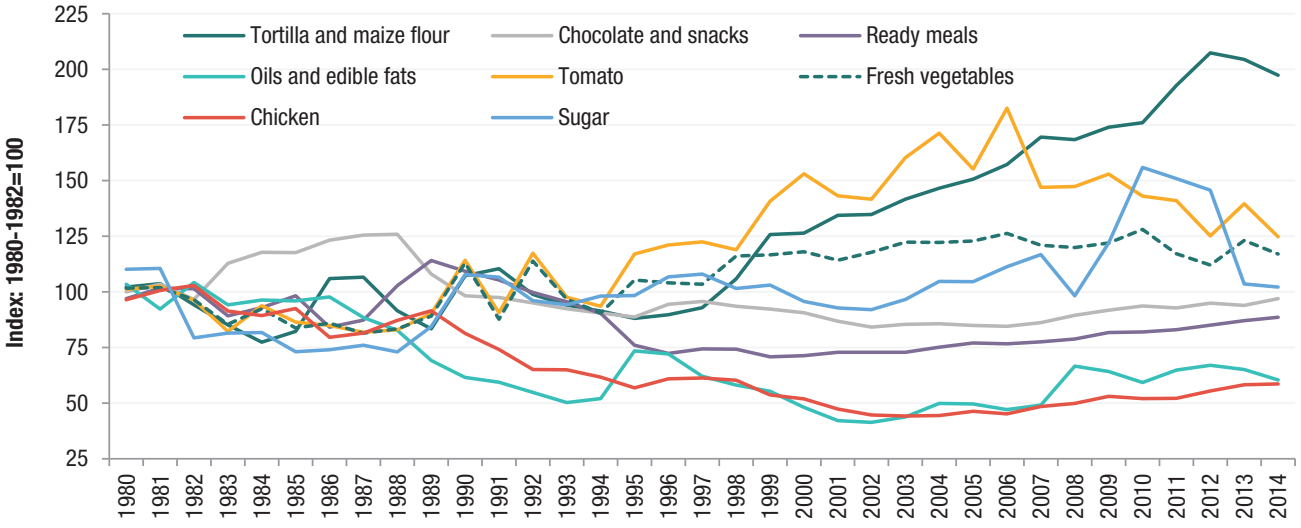
Despite considerable short-term variability in food prices, significant trends can be seen. Some food costs have risen significantly. By 2014, maize flour and tortilla cost almost twice what they did in the early 1980s. Policy change explains much of this since until 1998 tortilla prices were controlled. As Figure 5.4 shows, before that year, prices had not risen since the early 1980s but once prices were liberalised, they doubled within a decade. Tomatoes and other fresh vegetables also rose in cost. Significant falls in price by around 40% can be seen for chicken, oils and fats. Ready meals, chocolate and snacks have seen smaller prices falls. Sugar prices have barely changed.

Figure 5.4: Prices of selected foods, Mexico, 1980–2014

(a) Constant 2010 prices



(b) Priced indexed to 1980–82=100



Source: Data from Joel Alberto Vargas Hernández, 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 February 2015.

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

5.5 United Kingdom

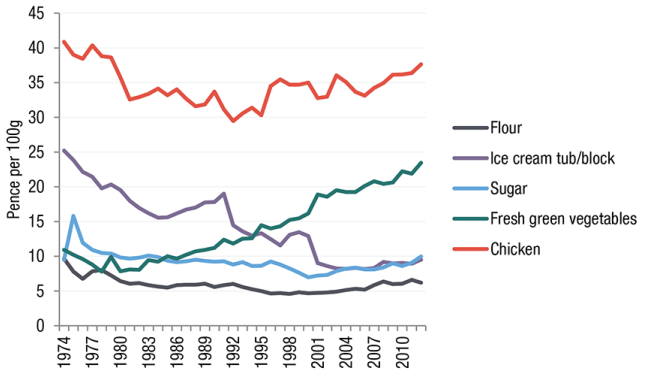
Prices of selected foods in the UK from 1974 to 2012 appear in Figure 5.5, first in constant 2005–06 values, then as price indices; followed by indices for food groups, weighted according to relative weight of consumption, indexed to a common 1984–86 base.

Panels (a) and (b) show that the price of fresh green vegetables has been rising in constant terms since the 1980s, while that of ice cream has fallen significantly. Prices for the other three products saw only small changes.

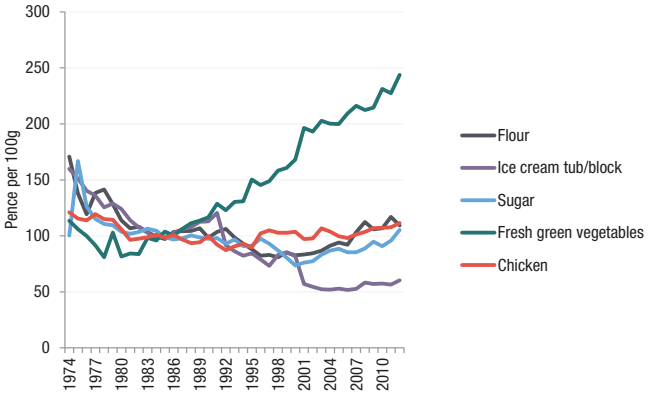
For the food groups in panel (c), prices of staples have risen in constant terms by 50% since the 1980s – largely due to the rising cost of potatoes – while those of fruit and vegetables have risen by 30%. Prices for fats and sugars have come down slightly; while those for meat and dairy and processed foods have fallen by 25% since the 1980s.

Figure 5.5: Prices of selected foods, United Kingdom, 1974–2012

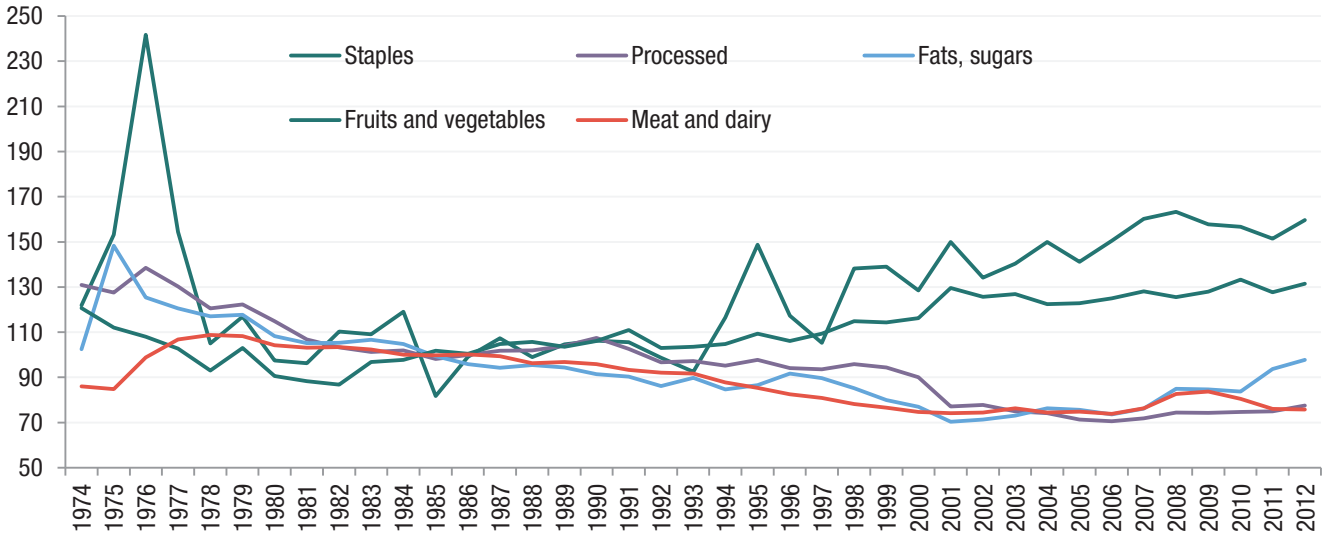
(a) Constant 2010 prices



(b) Prices indexed to 1984–86=100



(c) Prices by food group, weighted and indexed to 1984–86=100



Source: Constructed from data from DEFRA

Note: Staples index includes flour, fresh potatoes, dried rice, and oatmeal/oat products. Processed index includes ice cream tub/block, chocolate biscuits, chips (frozen or not), 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, oranges and bananas. Meat and dairy index includes eggs, chicken (uncooked, whole or in pieces), and whole milk.

5.6 Comparative analysis

To compare across the five countries, prices have been analysed for 1990 to 2012 as far as possible: for China, two food series begin only in 1993, while all the Brazilian price series end in 2009. For this period a simple regression of time on logged prices – it makes little difference if the prices are not logged – was carried out. This allowed the series to be checked to see if there was indeed a significant trend through time, or whether the variations seen were stochastic. It also allowed an estimate to be made of the direction and magnitude of the trend in prices, averaged as a log-linear relation. Table 5.1 sets out the results.

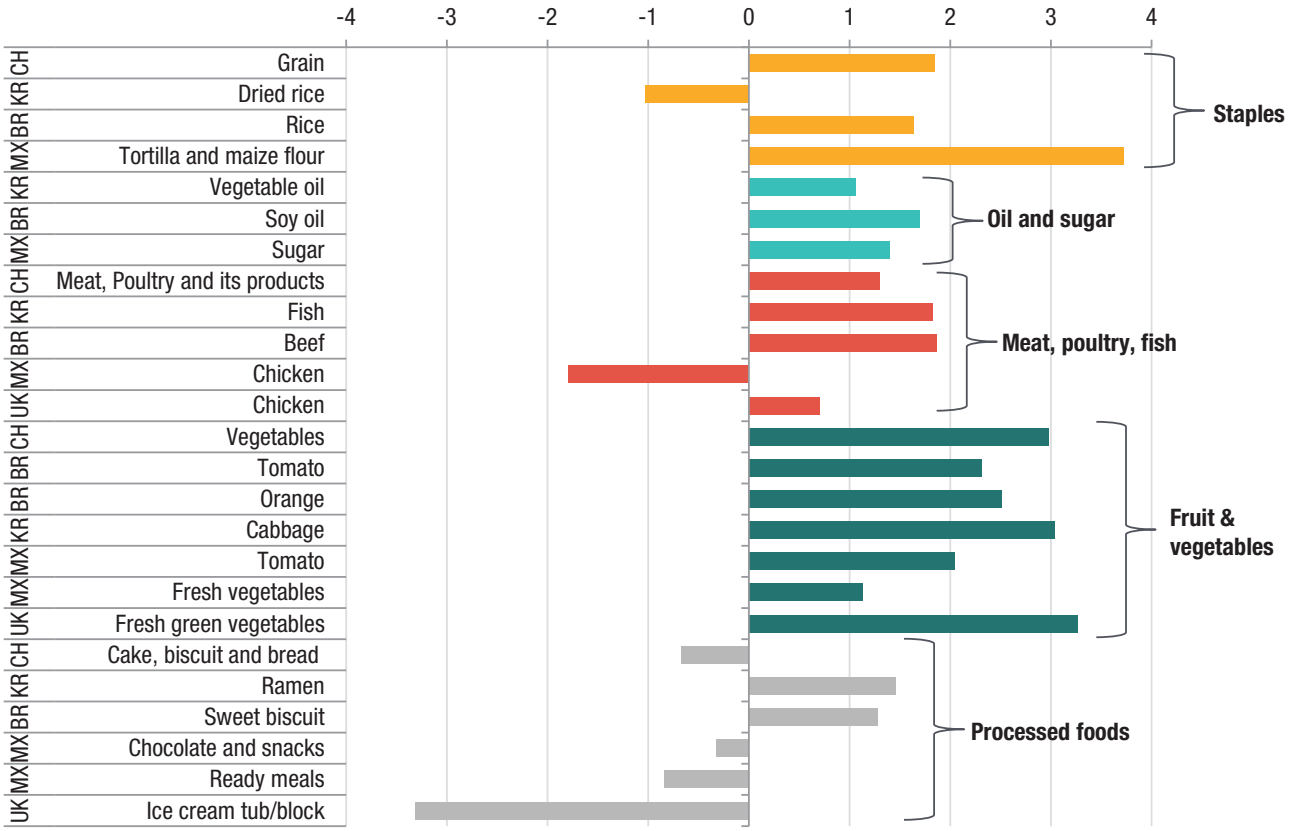
Table 5.1: Results of log-linear regression of time on prices

Country	Product	Period	R-square	F-stat	Sig	Slope	t-stat
BRA	Rice	1990-2009	0.39	11.39	0.0034	1.64%	3.37
BRA	Sugar	1990-2009	0.00	0.07	0.8001	-0.15%	- 0.26
BRA	Soy oil	1990-2009	0.56	22.55	0.0002	1.70%	4.75
BRA	Beef	1990-2009	0.75	54.75	< 0.0001	1.86%	7.40
BRA	Regular sausage	1990-2009	0.01	0.11	0.7474	0.07%	0.33
BRA	Sweet biscuit	1990-2009	0.54	20.94	0.0002	1.28%	4.58
BRA	Tomato	1990-2009	0.87	122.82	< 0.0001	2.31%	11.08
BRA	Orange	1990-2009	0.83	88.70	< 0.0001	2.51%	9.42
CHN	Grain	1990-2012	0.37	12.49	0.0020	1.85%	3.53
CHN	Oil and fat	1990-2012	0.11	2.64	0.1192	-0.51%	- 1.62
CHN	Meat, Poultry & products	1990-2012	0.55	25.80	< 0.0001	1.30%	5.08
CHN	Vegetables	1990-2012	0.94	319.45	< 0.0001	2.98%	17.87
CHN	Dried and Fresh Fruits	1993-2012	0.08	1.51	0.2357	0.39%	1.23
CHN	Cake, biscuit and bread	1993-2012	0.26	6.29	0.0219	-0.67%	-2.51
KOR	Dried rice	1990-2012	0.49	19.99	0.0002	-1.02%	- 4.47
KOR	Ramen	1990-2012	0.92	254.11	< 0.0001	1.46%	15.94
KOR	Chicken	1990-2012	0.04	0.92	0.3481	0.26%	0.96
KOR	Fish	1990-2012	0.70	49.64	< 0.0001	1.83%	7.05
KOR	Cabbage	1990-2012	0.85	114.55	< 0.0001	3.04%	10.70
KOR	Vegetable oil	1990-2012	0.33	10.36	0.0041	1.06%	3.22
KOR	Sugar	1990-2012	0.12	2.98	0.0988	0.57%	1.73
MEX	Tortilla and maize flour	1990-2012	0.90	196.30	< 0.0001	3.73%	14.01
MEX	Chocolate and snacks	1990-2012	0.21	5.68	0.0266	-0.32%	-2.38
MEX	Ready meals	1990-2012	0.21	5.62	0.0274	-0.84%	-2.37
MEX	Oils and edible fats	1990-2012	0.00	0.04	0.8408	-0.09%	- 0.20
MEX	Tomato	1990-2012	0.64	37.59	< 0.0001	2.04%	6.13
MEX	Fresh vegetables	1990-2012	0.77	69.61	< 0.0001	1.13%	8.34
MEX	Chicken	1990-2012	0.54	24.66	< 0.0001	-1.79%	- 4.97
MEX	Sugar	1990-2012	0.52	22.84	0.0001	1.39%	4.78
UK	Flour	1990-2012	0.16	3.97	0.0594	0.65%	1.99
UK	Ice cream tub/block	1990-2012	0.79	78.22	< 0.0001	-3.31%	- 8.84
UK	Sugar	1990-2012	0.01	0.25	0.6209	-0.13%	- 0.50
UK	Fresh green vegetables	1990-2012	0.97	694.18	< 0.0001	3.26%	26.35
UK	Chicken	1990-2012	0.71	51.73	< 0.0001	0.71%	7.19

Source: Regressions of time on logged prices. Data from sources in Section 4.

Note: Cells in grey are insignificant estimates. Cells in italics are marginally significant estimates. Slope estimates expressed as percentages.

Figure 5.6: Estimated average annual price change from 1990



Source: Table 5.1

Nine of the 34 estimates (shown in grey in Table 5.1) were not significant at the 5% level, while another three (shown in italics) were not significant at the 1% level. Removing the nine insignificant estimates and rearranging the statistics by food group, presenting the slope estimates in a chart gives Figure 5.6.

Two things are readily apparent. One is that prices of fruit and vegetables have risen substantially since 1990, mainly by between 2% and 3% a year on average – or by 55–91% between 1990 and 2012. The other is that four of the six processed products for which estimates are significant show price falls since 1990.[18] Most of the other foods have seen their prices rise by 1–2% a year, with the exceptions of the price falls seen for rice in Korea and chicken in Mexico.

18 While ramen prices have risen in Korea since the early 1990s, they had fallen considerably from the mid-1970s to 1991, so that by 2013 they were still cheaper than 40 years ago.

6. Conclusion and discussion

6.1 Changing prices

The single most striking finding is that in emerging economies the prices of fruit and vegetables have risen since 1990 (and in some cases for longer than that) and more rapidly than those of most other foods. This replicates what can be seen for both USA and UK prices of fruit and vegetables.

Limited evidence also suggests that prices of processed foods have either fallen or have increased slowly in the emerging economies, a result that again reflects what can be seen for the USA and the UK.

Two qualifications apply, however. First, price trends seen are uneven, varying over time, between countries and between similar foods within countries. While trends can be seen, other factors must be at work – including the disconcerting possibility that prices are not carefully observed and reported.

Second, the quality and nature of the observed foods may change over time, a point well documented for the USA where most fruit and vegetables have more added value on the supermarket shelf than they had 30 or more years ago – cut and trimmed, bagged, washed, and available all year round, no matter what the season. Might this also be the case in the emerging economies? This would require more study.

If the trends detected are real, something other than illusions seen in noisy data distorted by hedonic changes, they prompt questions about the reasons for them. If, for example, technical progress in farming were uniform so that unit costs of production were falling for all agricultural output, and if advances in the logistics of food wholesaling and retailing were similarly uniform, then we might expect the costs of most foods to move roughly in line with one another. But that is not the case.

So why have fruit and vegetables become more costly compared to other items? It is not as though there have not been technical advances in horticulture: on the contrary some of the most sophisticated seeds, soil nutrition, water control, and prevention of pests and diseases are seen precisely in the gardens and glasshouses in which so many fruit and vegetables are gro. While there is a world of difference between Dutch heated glasshouses and the tiny plots of green beans of central Kenya, in both cases, compared to other agriculture in their neighbourhoods, these systems are both more intensive and use more sophisticated technology than most other local farm enterprises. Moreover, advances in transport mean that fruit and vegetables are traded more than in the past, so that retail managers should be able to source from low-cost suppliers no matter where they may be.

Hypotheses can be imagined: horticulture may well have a stepped supply function, so that while small quantities of fruit and vegetables can be supplied at low unit cost, once a particular volume is reached, costs rapidly escalate to a significantly higher level. It may also be that the changes in quality noted explain the increased relative prices. Or, it may not be a matter of cost but of increased demand from those consumers who appreciate the health benefits of fruit and vegetables. These hypotheses merit a separate study.

Why does not the same apply to some processed foods? One possibility is that much processed food does not rely on costly farm ingredients, but rather is manufactured from relatively cheap ingredients, the added value being largely in factory processes of combining the ingredients and enhancing their flavour. Advances in manufacturing and flavouring probably help reduce unit costs in factory. That said, processed foods are not uniform in quality and pricing, since for any sub-category, there are usually products that are branded, sold on their special characteristics, usually with a price premium – as applies, for example, to soft drinks that compete with cheaper, unbranded options. This may explain why not all the processed foods considered in Table 5.8 show declining constant prices. Once again, additional studies might shed light on this.

6.2 Do prices matter … and might taxes work?

Evidence presented in the literature review suggests that prices do affect consumption, especially for people on low incomes. Own-price elasticity of demand for food may be relatively inelastic, but not that inelastic – US estimates of own-price elasticity for most foods are above (minus) 0.45. Hence price changes do influence diets. Moreover, it is striking to see that in the USA, where many consumers can afford most food they wish, consumption is sensitive to price, especially for SSBs – presumably because there are plenty of alternative soft drinks if one becomes more expensive than the rest.

Hence it is no surprise to see much study of the potential of taxes on less healthy options to reduce their consumption, perhaps even with subsidies on more healthy options to raise theirs. Most such studies indicate that imposing taxes would reduce consumption. But two qualifications apply.

One is that there may be cross-price effects, whereby when taxes raise the cost of a particular food, not only does its consumption fall, but so too does that of complements (foods which are typically consumed together, such as bread and butter). When those complements contain valued nutrients it is thus possible for taxes to reduce the quality of diet. In theory this problem can readily be tackled by placing a subsidy on the valued complement to offset the cross-price effect. In practice, learning which foods really are complements, to what extent, and then determining an optimal level of subsidy, could lead to a thicket of regulations that have to be adjusted in the light of emerging evidence, creating high administrative costs and giving the impression that such fiscal measures are just too difficult to contemplate. The question is how strong cross-price effects are and whether they may be remedied by other measures to encourage healthier diets.

The second is the apparently seductive argument that small taxes would create only small effects: that considerable change in consumption would require high taxes that would look disproportionate and unfair – say, more than the rate of VAT of 20% in the UK case. But a logical flaw applies here. The policy question is not so much, 'how large a tax would be necessary to bring down consumption of less healthy food X to recommended or insignificant levels', but 'how much benefit would be derived from imposing a politically acceptable tax on less healthy food X?' The answer to the former question may be a number so high as to be dismissed from the debate; but the answer to the latter question may be as striking as that provided by Nnoaham et al. (2009) for the UK: that taxes and subsidies of less than 20% could save no fewer than 6,400 premature deaths a year from coronary heart disease and cancers. If 6,400 people were to die in a catastrophic accident, massive resources would be deployed to prevent a repetition. Road deaths in the UK are far fewer than this number (less than 2,000 a year), to avoid which all manner of regulations apply to road users. The argument about small taxes, small gains is tantamount to arguments that condemn doing good because perfection is unattainable – '*le mieux est l'ennemi du bien*', as Voltaire put it.

In terms of what might be taxed and subsidised, this report suggests that energy-dense foods might be taxed, while fruit and vegetables whose prices often rise compared to other foods, might be subsidised.

Much comes down to the political appetite to contemplate taxing foods (see Box 6A). Events in Mexico suggest that some emerging economies may steal a march on HICs in this respect. The evidence presented in this report suggests that the Mexican taxes should do considerable good, thereby providing valuable lessons for other developing and emerging economies.

Box 6A: How feasible are taxes on foods?

> Sugar, rum, and tobacco, are commodities which are nowhere necessaries of life, which are become objects of almost universal consumption, and which are therefore extremely proper subjects of taxation. Adam Smith, *The Wealth of Nations*

In both the USA and the UK, although rates of overweight and obesity have long been recognised in healthcare circles as having reached epidemic proportions, policy-makers have been slow to recognise the severity of the issue. Lang and Rayner (2007) suggested this may stem from slow or ineffective advocacy work by public health proponents; from evidence that is not easily translated into policy; or from a lack of political champions. Some of these factors are changing, though progress is slow. In the USA in particular political champions have emerged in recent years: Michelle Obama's campaign against child obesity 'Let's Move' was launched in 2010, alongside the related Partnership for a Healthier America (PHA);[19] while the then mayor of New York, Michael Bloomberg, attempted, unsuccessfully,[20] to get tougher regulations on the size of fizzy drink to take effect in 2013. Champions are less visible in the UK, most of those being celebrity cooks such as Jamie Oliver rather than politicians. By and large, economic measures to control obesity are not common in food debates in the UK:

> … beyond the widely debated food taxes, the use of financial mechanisms to encourage healthier diets has not been a visible part of the policy debate about healthy eating and obesity in the United Kingdom. (Hawkes 2009b)

To which Lang and Rayner (2009) add:

> There is a powerful temptation in Government to limit actions to a choice-based, personalization approach, in part because this style of intervention is aligned to the commercial sector's own customer management and marketing methods, but also because a cross-society approach appears so big in conception that failure is assumed.

Yet this may be changing:

> Once dispatched to the bottom draw of policy options to address unhealthy eating, food taxes now seem back in the out tray of European policy makers. Even David Cameron made an offhand quip recently suggesting that this is something the British Government might explore. (Hawkes 2012)

In the USA the Dietary Guidelines Advisory Committee's report to the Secretary of Health and Human Services and the Secretary of Agriculture (USDA, 2015) has just been released, which recommends tax and tax-subsidy policies:

> Align nutritional and agricultural policies with Dietary Guidelines recommendations and make broad policy changes to transform the food system so as to promote population health, *including the use of economic and taxing policies* to encourage the production and consumption of healthy foods and to reduce unhealthy foods. For example, *earmark tax revenues from sugar-sweetened beverages, snack foods and desserts high in calories, added sugars, or sodium, and other less healthy foods for nutrition education initiatives and obesity prevention* programs. (USDA 2015; emphasis added)

Although industry lobbies may campaign hard against taxes – the American Beverage Association spent US$7.7 million opposing a proposed tax on SSBs in San Francisco (Rt.com 2014) – the public may be more behind tax/subsidy initiatives than politicians realise. A poll of New York residents found that:

> … 52% supported a 'soda tax,' but the number rose to 72% when respondents were told that the revenue would be used for obesity prevention. (Brownell and Frieden 2009)

Monteiro and Cannon (2012) argue that taxes may be more acceptable socially and politically in Brazil and other developing countries, compared to some HICs:

> '… the views of many commentators and policy-makers in the South are in sharp contrast with their counterparts in the North. In countries like the US, the general tendency is to deal with food, nutrition, and public health in isolation as matters largely of information, education, and "individual lifestyle adjustments" designed to reduce the risk of various disabilities and diseases. But in Brazil and other countries in the South, food is seen by most independent scholars and policy-makers as part of a much broader discourse that involves general well-being, the family, friendship, commensality, culture, sustainable livelihoods, environmental preservation, national identity and sovereignty, as well as personal and public health. (Monteiro and Cannon 2012)

They are not alone in seeing the governments of emerging economies as more prepared to act for better health, as James (2008) argues for China:

> China has traditionally been far more responsive to the value of policies which limit inequalities and establish standards of care than many western governments, who have yet to recognize that the individualistic free-market approach to obesity prevention is guaranteed to fail. China could therefore lead the way: if it follows western approaches, the health and economic burden will become unsustainable.

19 Recent initiatives linked to this include the PHA's (For info on PHA see http://ahealthieramerica.org/about/about-the-partnership/) 'Drink Up' campaign (see http://www.youarewhatyoudrink.org/about/) to encourage people to drink more water, and the planned FNV (Fruit and Vegetables – see http://www.fnv.com/) celebrity-backed marketing campaign to promote consumption of FNV as a brand, using sophisticated advertising techniques.

20 Ultimately this plan failed: see http://en.wikipedia.org/wiki/Sugary_Drinks_Portion_Cap_Rule/.

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ISSN: 2052-7209

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