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# Economic Perspectives on Obesity:

# Identifying Determinants and Evaluating Policies*

by

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*This discussion paper is a slightly modified version of Chapter 2 of the author's doctoral thesis "Obesity, Food Demand, and Models of Rational Consumer Behaviour – Econometric Analyses and Challenges to Theory".

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**Abstract:**

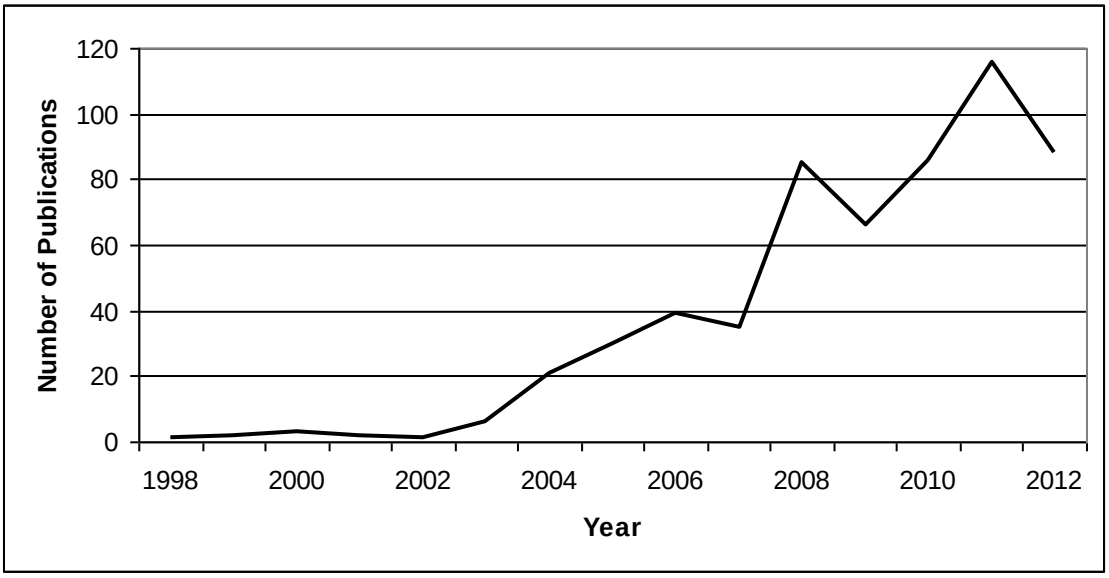
This paper reviews the recent economic literature on issues of health and nutrition with a special focus on obesity. Statistics show substantial variation in obesity rates both across countries and along socio-economic lines within countries indicating a need for a greater engagement by social sciences and economics. Various economic models emphasise different aspects of consumer behaviour related to obesity. The neoclassical approach stresses that overweight and obesity can be the outcome of rational decision making as a result of changes in relative prices. Household production theory adds components of education, abilities and time allocation and models of intertemporal choice assume a dynamic perspective. The field of behavioural economics points to deviations from rational behaviour that commonly occur in eating decisions. Potential market failures discussed as rationales for policy interventions are externalities, lack of information, and irrational behaviour. However, the empirical basis for the existence of these market failures is rather weak as is the empirical evidence on effectiveness and efficiency of specific policies such as fat taxes.

**Keywords:**
*Obesity; economic theory; economic policy; market failure; empirical evidence*

## 1 Introduction

Almost one and a half decades ago the first papers dealing with economic aspects of obesity appeared in literature. They were both reactions to claims from the public health sector for financial measures to combat obesity as well as fundamental papers that set out the importance of economic research related to the topic (PHILIPSON, 2001). These articles inspired numerous economists to engage in research on obesity. A new branch titled as "Obesity Economics" emerged with an increasing output from year to year. The rise of this area is mirrored by the growing publications and papers over the years depicted in Figure 1.

**Figure 1: Number of economic publications on obesity (EconLit), 1998-2012**




*Notes*: The number of publications in each year refers to the results of an EconLit-search for the keywords "Overweight", "Obese", and "Obesity".

***Source*: Own composition inspired by CAWLEY (2011).**

What is fascinating about "Obesity Economics" is the broadness of its contributions that enhance the general scientific and public discussion on the drivers of the global obesity epidemic and possible solutions to it. On a theoretical basis, economists stress that overweight or obesity can be a rational choice that maximises individual utility. At the same time they investigate possible deviations from rational behaviour or the existence of market failures that lead to welfare-decreasing outcomes. On the empirical side a strong focus lies on the investigation of causal relationships between economic and environmental factors, human behaviour and health outcomes. The instruments of modern econometrics and the increasing availability of large household data sets provide the basis for important insights into the structural pathways.

The objective of this paper is to provide a broad overview of the economic literature related to obesity. The structure of this review is as follows. Section 2 presents some stylised facts characterising the development and the current structure of obesity across and within countries. Section 3 sketches the basic theory and the various extensions established by economists to explain the patterns shown by the data. These theories provide the basis for the discussion about the appropriateness of government interventions in Section 4. Section 5 is devoted to the special case of fiscal measures aimed at reducing obesity and presents theoretical considerations and empirical evidence about the effect of food prices on body weight and obesity prevalence. A concluding discussion highlights some avenues for further research.

## 2 Stylised facts on structure and development of obesity

This section provides some stylised facts about the development of obesity and its distribution across countries and within populations. The observed patterns – especially the gradients along variables such as income, education or gender – clearly point to an important role of socioeconomic factors in the determination of obesity. Hence, an engagement of social sciences is necessary to explain trends and variation in the data that cannot be explained by genes or environmental toxins alone. However, prior to a closer look at the statistics, it deems appropriate to elaborate on the basic indicators of overweight and obesity in more detail.

The World Health Organization (WHO) defines overweight and obesity as "abnormal or excessive fat accumulation that may impair health" (WHO, 2012). The most common indicator of excess body weight and fat is the Body Mass Index (BMI). It is calculated as an individual's weight in kg divided by its height squared in $m^2$. According to the WHO classification, a person is overweight, when her BMI is greater than or equal to 25. At a BMI greater than or equal to 30, she will be classified as obese.

However, the use of BMI as a measure of fatness is not free from critique (see, e.g. BURKHAUSER and CAWLEY, 2008). Firstly, the cut-off values that define overweight and obesity are often claimed to be set arbitrarily. Secondly, BMI should be considered "a rough guide" (WHO, 2012), because two persons that have the same BMI may have a completely different level or distribution of body fat. Despite these drawbacks, BMI refers to the easily measurable anthropometric variables height and weight and is widely available for many

countries and over time. Hence, it is useful for epidemiological research but it may not be appropriate in the individual case (SASSI, 2010). In any case, the general patterns of rising obesity rates across and within countries and over time are highly relevant and pose interesting questions to (economic) research.

*Patterns of overweight and obesity across countries*

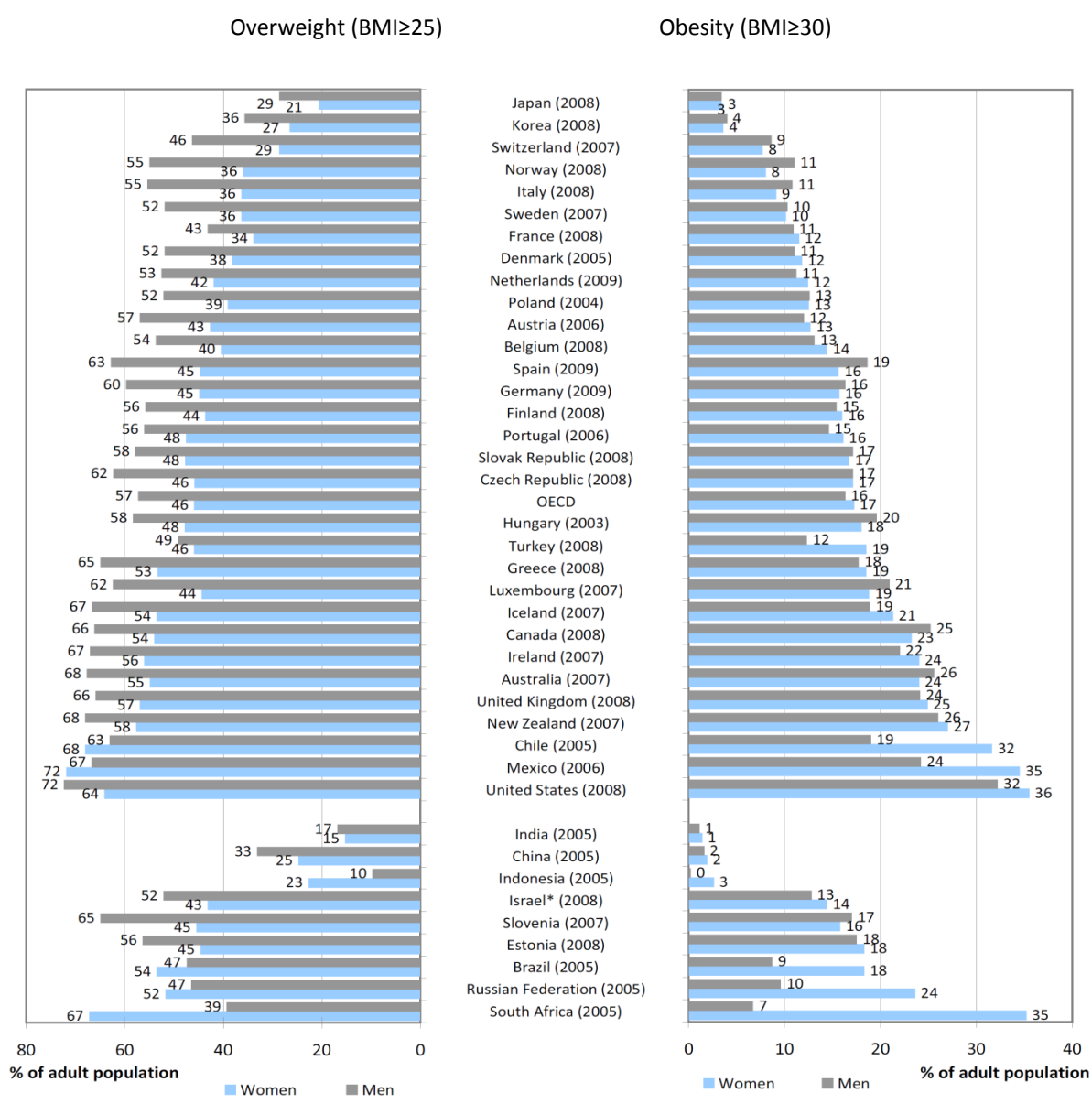
Figure 2 shows the percentage of adult populations that is overweight (including the obese) and obese for OECD countries as well as selected non-OECD countries. As revealed by the left panel, a considerable proportion (and often the majority) of people have a BMI larger than 25 in many countries. In the whole OECD, about one half of all people are overweight, while in the USA and Mexico more than two thirds are overweight. The Asian members, Korea and Japan, exhibit the lowest rates. Here, one third or less are overweight and obese.

However, overweight and obesity are not an exclusive problem of developed countries. Transition and developing countries show high prevalence of people with excess weight, too. In South Africa, the Russian Federation, and Brazil the proportion is around 50 %. Furthermore, the left panel indicates that overweight is more pronounced among men compared to women.

The figures for the obesity rates in the right panel show an almost identical ranking for the different countries, however, the cross-county differences are more pronounced. Whereas the USA have an about 2.5 times higher overweight prevalence than Japan the ratio is larger than ten with respect to the proportion of obese people. Remarkably, the gap between men and women that is present on the left-hand side disappears or is reversed in some countries when looking at the right-hand side.

Figure 3 illustrates the development of obesity over time in selected countries. Although all countries experience rising rates of obesity there is substantial variation in the pace of this growth as well as in the initial and current levels. The gap between countries has widened over time with the USA consolidating its position as the country with by far the globally highest rates of obesity (SASSI, 2010). Additionally, the figure points out a fundamental obstacle to obesity research: for most countries except the US, robust data on measures of overweight and obesity do not go back further than the mid-1980s.

**Figure 2: Overweight and obesity rates in OECD and selected non-OECD countries**

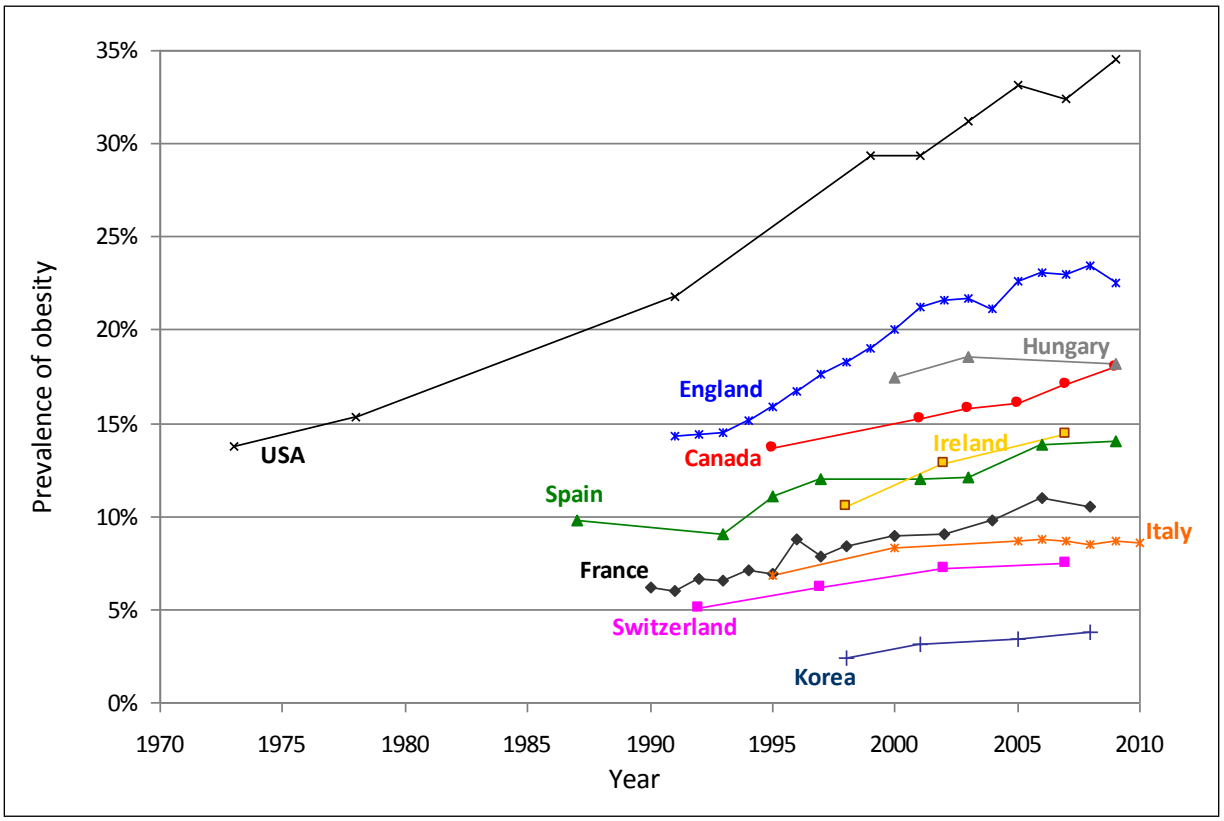



*Note:* For Australia, Canada, Czech Republic, Ireland, Japan, Korea, Luxembourg, Mexico, New Zealand, Slovak Republic, United Kingdom and United States, rates are based on measured, rather than self-reported, body mass index (BMI).

(*) The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

***Source*: SASSI (2010) based on OECD Health Data 2010, and WHO Infobase for Brazil, Chile, China, India, Indonesia, Russian Federation and South Africa.**

**Figure 3: Prevalence of obesity over time for selected countries**



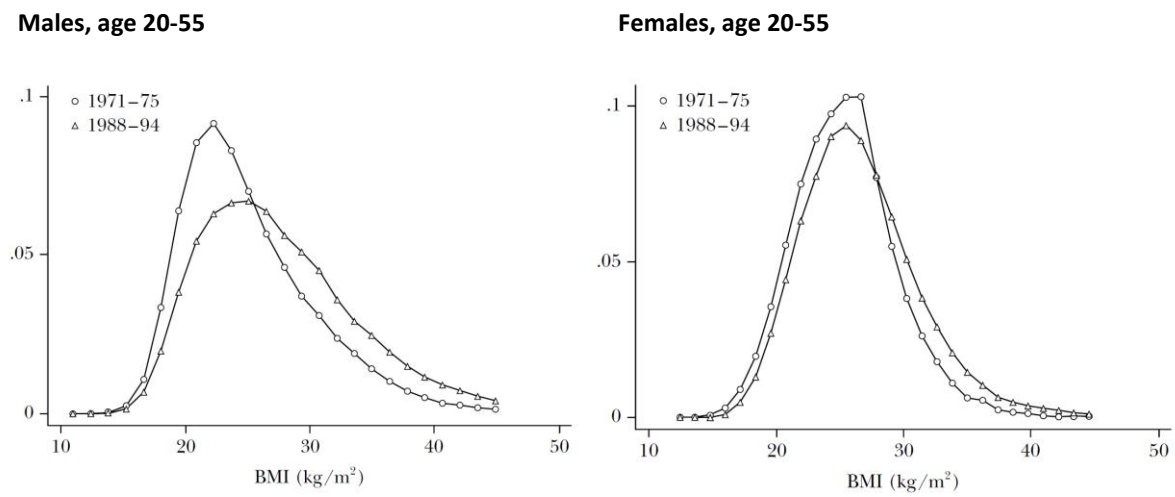

***Source*: OECD (2012).**

MAZZOCCHI et al. (2009) discuss possible reasons for the considerable variation in obesity rates across OECD countries. Higher obesity prevalence occurs in societies where "individualism" and "reliance on free markets" (like the US or Great Britain) is important compared to countries where "community involvement and regulation" are more strongly accepted (like in Japan, Korea, and Scandinavia)(ibid., p.14). A second aspect put forward by MAZZOCCHI et al. (2009) is that countries with a "strong food tradition" like France, Italy, Korea, or Japan, where "fewer dietary adjustments" have been made, show less obese populations. ALSTON et al. (2008) assess whether differences in agricultural policies can explain some of the cross-country variation but do not find a clear pattern. Generally, in the presence of multiple possible confounders, such an analysis stays at a more or less speculative level. A closer look at the patterns and dynamics within populations seems more promising, especially, when large and informative data sets are at hand. For the study of obesity and the design of policies, it is also important whether weight gain is a phenomenon that concerns the whole population or whether there are subgroups that are particularly affected.

*Within-country distribution of body weights*

A closer look at micro data reveals that body weights do not shift uniformly within populations. Long-term time series document a general increase in average height-adjusted body weights during the whole 20th century (COSTA and STECKEL, 1995). Recently, the extreme weights at the right tail of the distribution show dynamics, in particular (PHILIPSON, 2001). Figure 4 shows the frequency distribution of BMI for males and females in the USA and how they have changed over time.

**Figure 4: Distribution of BMI in the US population, 1971-1975 and 1988-1994**



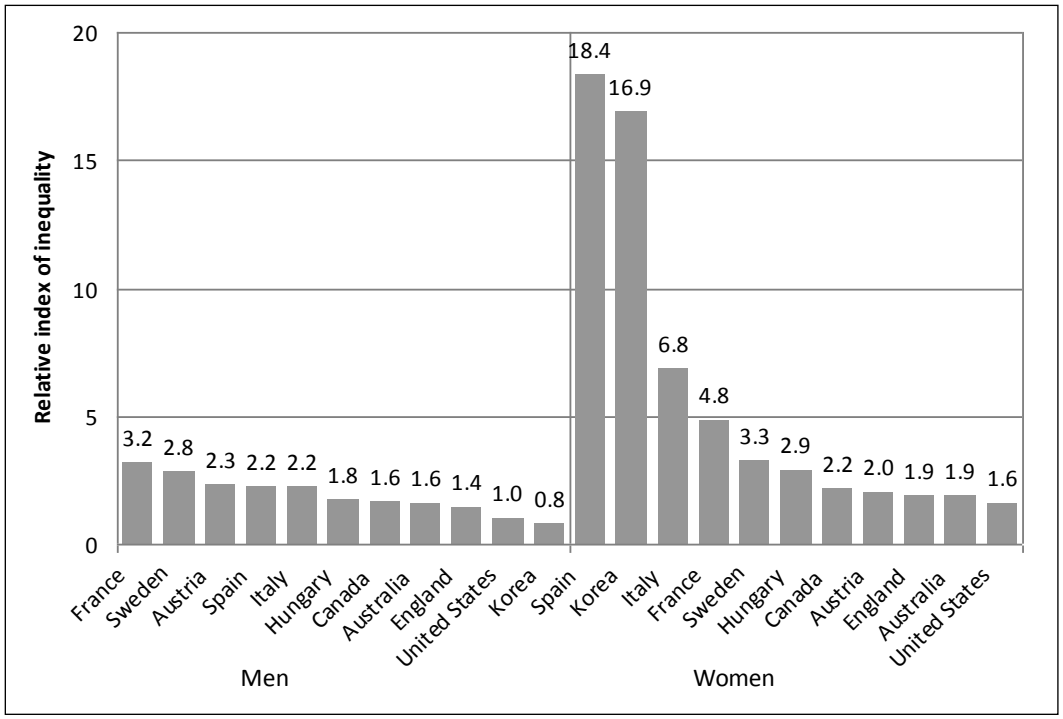

***Source*: CUTLER et al. (2003) based on NHANES-Data.**

Obviously, some population groups have put on more weight than others. Otherwise the curve would not have changed its shape but would just have shifted to the right. The right tails are more strongly pronounced today than in the past indicating that the weights of susceptible groups and thus the percentage of obese individuals have risen much more sharply than the weight of the average person (MAZZOCCHI et al., 2009). Based on data from the National Health and Nutrition Examination Survey (NHANES), CHOU et al. (2004) report that between 1978 and 1991 the percentage of obese people in the US rose by over one half from 14 % to 22 %. In the same period, the mean BMI rose by 1.24 kg/m² which is only an increase by 5 %. Similar patterns can be found in other industrialised countries like England (see Figure A1 in the appendix) and to a lower degree also for transition countries like Russia (see Figure A2 in the appendix).

Statistics that link obesity to socio-demographic variables strengthen the picture of obesity as a phenomenon that varies strongly across population subgroups. Thereby, both levels as

well as growth rates are subject to substantial heterogeneity. SASSI (2010) provides evidence on the social disparities of obesity prevalence that exist along age, socio-economic status (education, income), gender, and ethnicity. Again, higher obesity rates can be observed for women in most countries but pre-obesity (i.e. overweight) is much more common in men. Nevertheless, obesity is growing faster among males. Age and BMI show an inverse U-shaped relationship: BMI increases with age up to a certain level and then declines again slightly. Although the decline at higher ages could be explained by a loss of muscle tissue and general degradation processes (see e.g. ELMADFA and LEITZMANN, 2004, p.496), this finding should be interpreted with care. Cohort effects as well as higher mortality of obese people could also be possible reasons.

**Figure 5: Disparities in obesity in consideration of educational level, selected OECD countries**

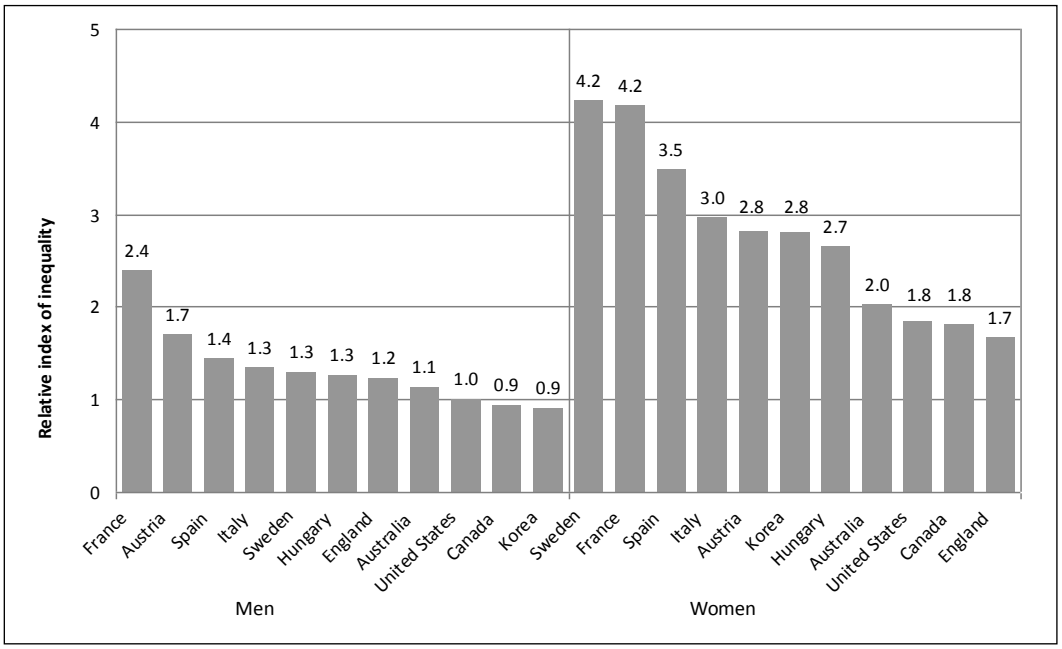



***Source*: SASSI (2010).**

Obesity rates differ considerably for groups with different educational levels, too. Figure 5 depicts calculations of a relative index of inequality that show the relative probability to be obese for persons with the lowest education compared to the highest educated group (OECD, 2012). Better educated individuals are less often obese than persons with lower education. The spread in obesity prevalence between both groups varies across gender and different countries. For men, educational differences are less pronounced than for women. The left panel of Figure 5 shows factors around three at the maximum and an index of equal

to or smaller than one for the United States and Korea (indicating that the higher educated that are equally or even more obese) for males. For women, the differences are huge. In Spain and Korea the least educated women are 18.4 times, respective, 16.9 times more likely to be obese compared to the highest educated. The ratios for income or social class, depicted in Figure 6, are less pronounced than for education but show a similar pattern.

**Figure 6: Disparities in obesity in consideration of household income or occupation - based social class, selected OECD countries**




***Source*: SASSI (2010).**

While an analysis of the OECD found that the social disparities "remained remarkably stable over time" (SASSI, 2010), CUTLER et al. (2003) draw a more complex picture. They present data on the BMI and obesity prevalence in the US across population groups for 1971-75 and 1988-94 (see Table 1). Many subgroups have different levels of obesity with the case of education being particularly interesting. For the period 1971-75 there is a strong gradient for women with 24 % obese in the lowest educated group and only 7 % obese in the highest educated. Similarly, 15 % of the lowest educated men are obese and only 8 % in the highest educated group. Over time, the absolute differences for women have almost prevailed. Only the medium group experienced a higher increase of 20 % (versus 13 % to 14 % in the higher and lower groups). In contrast, the figures for men have nearly converged over time implying that the growth rates for the better educated (college or more) were considerably higher than for the lower educated.

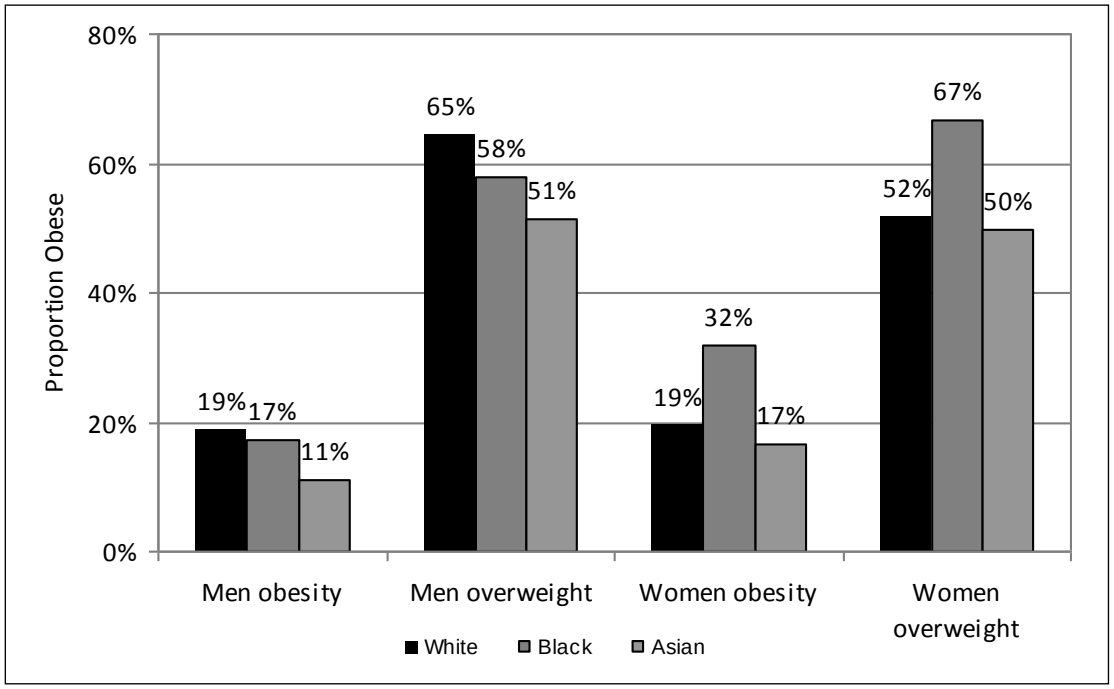
**Table 1: Weight increase in different population groups, USA, 1971-1994**

| | *Average BMI (kg/m²)* | | *Percentage Obese (BMI ≥ 30)* | |
|---|---|---|---|---|
| | *1971-75* | *1988-94* | *1971-75* | *1988-94* |
| Average | 25.4 | 27.3 | 16 | 30 |
| Adults | | | | |
| All | 25.0 | 27.1 | 15 | 28 |
| Single male | 24.4 | 25.5 | 9 | 18 |
| Married male, nonworking spouse | 25.6 | 27.1 | 13 | 26 |
| Married male, working spouse | 25.7 | 27.3 | 11 | 24 |
| Single female | 24.9 | 27.4 | 18 | 32 |
| Married female, working | 24.3 | 27.4 | 13 | 33 |
| Married female, not working | 24.9 | 28.0 | 16 | 36 |
| Elderly | | | | |
| All | 26.1 | 27.6 | 19 | 32 |
| Male | 25.4 | 27.0 | 13 | 28 |
| Female | 26.7 | 25.4 | 25 | 36 |
| Women aged 20+, by education group | | | | |
| <High school | 26.3 | 28.4 | 24 | 28 |
| High School | 24.2 | 27.5 | 13 | 33 |
| College or more | 22.8 | 25.4 | 7 | 20 |
| Men aged 20+, by education group | | | | |
| <High school | 25.6 | 26.5 | 15 | 23 |
| High School | 25.7 | 26.7 | 13 | 24 |
| College or more | 25.2 | 26.4 | 8 | 21 |

*Notes:* Data are from the National Health and Nutrition Examination Survey (NHANES); the BMI is measured in kg/m².

***Source*: CUTLER et al. (2003).**

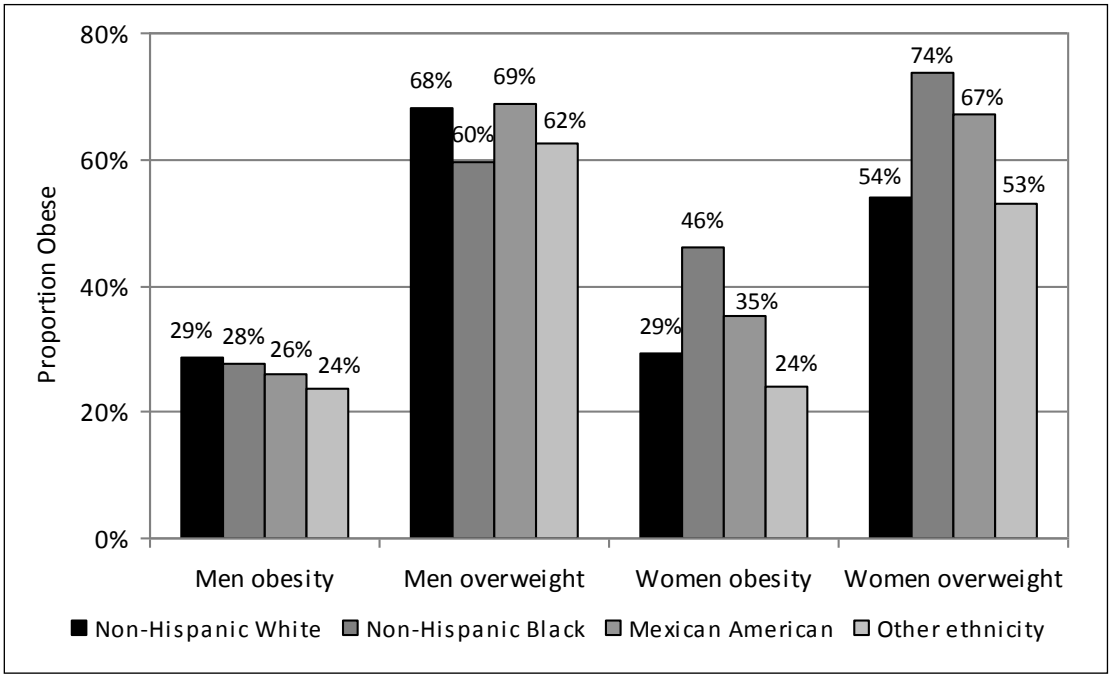
**Figure 7: Obesity and overweight in different ethnic groups in England (adults)**




***Source*: SASSI (2010), OECD analysis of Health Survey for England (HSE) data 1995-2007.**

Disparities across ethnic groups are shown for England and the USA in Figures 7 and 8. In both countries, white men show the highest prevalence of obesity and overweight. Among females, it is the Black and Mexican American groups that have the highest rates. These differences prevail even after accounting for possible socio-economic correlates (SASSI, 2010). However, the BMI thresholds that define obesity in white/Caucasian men and women may not apply equally well to other ethnicities.

**Figure 8: Obesity and overweight in different ethnic groups in the United States (adults)**




***Source*: SASSI (2010), OECD analysis of National Health and Nutrition Examination Survey (NHANES) data 1999-2008.**

## 3 Economic approaches to explain increasing obesity rates

Around the year 2000, economists took up the issue of rising obesity rates and set out an "economic research agenda" to identify determinants and possible avenues to address it (PHILIPSON, 2001). As the guiding principle, economists perceive the determination of body weight as the outcome of multiple individual choices. All decisions people make about what and how much to eat and drink or how active to be in their leisure time or at their working place affect their energy balance and, thus, their body weight. The numerous economic contributions presented below deal with the question whether these choices and obesity as a possible outcome are to be regarded as the result of rational decisions, irrational behaviour, or something in between.

In this regard, economists do not get tired of pointing out that the optimal body weight from an economic point of view may well differ from the optimal one proposed by medicines and public health specialists. Whereas the former is characterised as the state where the underlying behaviours maximise utility subject to the restrictions people face, the latter is concerned with the strict maximisation of health.

Given the shifts in obesity and overweight over time and between populations as sketched in Section 2, the natural reaction of economists is to look which conditions and incentives have changed that led people to alter their optimal behaviour in a weight-increasing way. The following review will first present the benchmark scenario of a rational individual that decides freely and autonomously on his or her body weight under given restrictions. Later on, possible deviations and irrationalities will find their way into the discussion.

### 3.1 Neoclassical interpretation: Technological change and shifts in relative prices

Researchers from a branch termed as "neoclassical theory of obesity" (PHILIPSON and POSNER, 2008, p.975) see welfare-enhancing technological change as the primary reason for the long-term increase in overweight and obesity within the last 150 years. Accordingly, both supply and demand side changes have contributed to increasing costs of physical activity and to decreasing costs of energy intake (LAKDAWALLA and PHILIPSON, 2009). Innovations in agriculture and food processing lowered the price of food while technological progress made work on the job and in the household less strenuous and energy-demanding. While workers in former societies "were paid to exercise", people are now considered to "pay to exercise"

(LAKDAWALLA et al., 2005, p.253), firstly in a direct way by, for instance, joining fitness clubs but also indirectly by investing their leisure time in physical activities. Additionally, modern entertainment technologies lowered the prices for sedentary leisure activities.

The proponents of the neoclassical view credit their interpretation to do "surprisingly well in explaining the observed trends" (LAKDAWALLA et al., 2005, p.253). By means of a simple model, they offer some interesting implications on offsetting effects of price changes for calorie intake and expenditure and the relationship of income and body weight. A more detailed presentation of the basic model below will illustrate both the unique contributions that economics provides to the analysis of obesity but also some weaknesses that arise from too-strict mathematical economic models.

As a basic feature of the neoclassical model of obesity, body weight *W* enters the utility function besides food intake *F* and alternative consumption *C* (PHILIPSON and POSNER, 1999):

(1) $U = U(W(F,S),F,C)$

Body weight, in turn, increases with energy intake from food *F* and decreases with strenuous energy expenditure *S*. For a growth in weight, *F* needs to exceed *S*. Furthermore, the marginal effects of *F* and *S* diminish with rising levels (i.e. $\partial^2 W/\partial F^2 \leq 0$ and $\partial^2 W/\partial S^2 \geq 0$). Also *F* and *S* are complementary, i.e. when an individual spends more energy the effect of energy intake gains in importance ($\partial^2 W/\partial F \partial S \geq 0$) (PHILIPSON and POSNER, 1999).

The crucial assumption of eq. (1) is that weight affects utility in a non-monotonic way. PHILIPSON and POSNER (1999) argue that every person has an ideal weight $W_0$ that may be either determined by 'objective' medical guidelines or subjective social norms or personal aesthetic values. Deviations from $W_0$ decrease utility at an increasing rate (i.e. $(\partial U/\partial|W_0 - W|) \leq 0$ and $(\partial^2 U/\partial|W_0 - W|^2) \leq 0$).

The main claim of economics in this context is that "neither subjective nor any objective weight $W_0$ is the preferred weight in the economic sense" (PHILIPSON and POSNER, 1999, p.8). To see this, consider the maximisation of *U* subject to an income constraint where the level of physical activity *S* is exogenously given:

(2) $max\ \ U = U(W(F,S),F,C) \qquad s.t.\ C + pF \leq I,$

where $p$ is the price of energy from food and $I$ is income. The first-order conditions of maximisation lead to:

$$(3) \qquad \frac{\frac{\partial U}{\partial W}\frac{\partial W}{\partial F}+\frac{\partial U}{\partial F}}{\frac{\partial U}{\partial C}} = p$$

In the optimum, the ratio of the marginal utility of food intake (that occurs directly via "joy of eating" and indirectly via the weight effect) and the marginal utility of alternative consumption have to equal the price ratio (where the alternative price is the numeraire).

Alternatively, equation (3') illustrates the trade-offs that emerge between weight, food and other consumption.

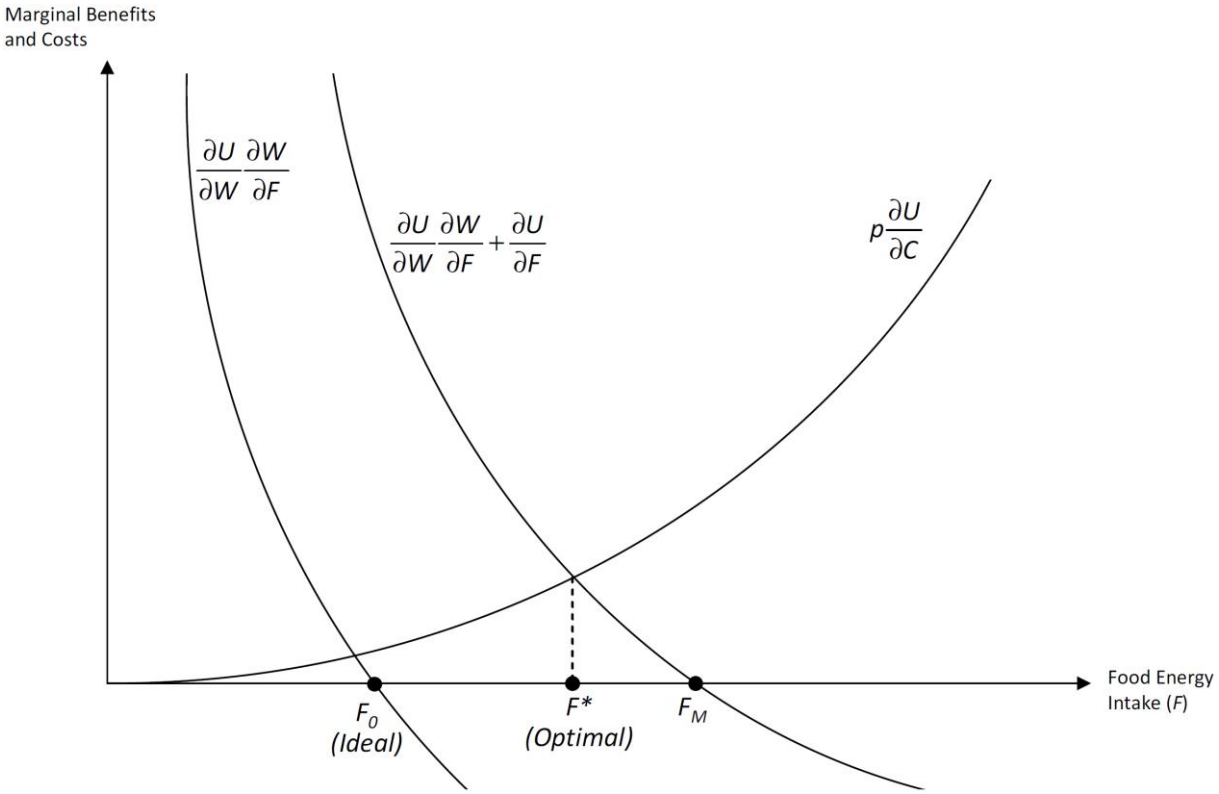
$$(3') \qquad \frac{\partial U}{\partial W}\frac{\partial W}{\partial F}+\frac{\partial U}{\partial F} = p\frac{\partial U}{\partial C}.$$

The relevant relationships are shown in Figure 9 that plots energy intake against the marginal benefits and costs from it. For a given $S$, the indirect marginal benefit of food via weight $(\partial U/\partial W)(\partial W/\partial F)$ is positive as long as a person is below her ideal weight ($W_0$) and gets negative when her weight exceeds $W_0$. While food intake $F_0$ would maximise utility derived just by weight, the total marginal benefit of food intake $(\partial U/\partial W)(\partial W/\partial F)+(\partial U/\partial F)$ is larger since utility increases with food intake. Thus, a person's optimal level of food consumption lies at $F^*$ where the total marginal benefit of food intake equals marginal costs of food consumption $p(\partial U/\partial C)$ that arise from the foregone consumption of alternative goods. This point also determines the optimal weight $W^*$ that may or may not differ from $W_0$. How strong both weight points differ from each other depends on the food prices and the marginal utilities of food consumption, of deviation from ideal body weight, and of alternative consumption.

An increase (a decrease) in the price of food energy shifts $p(\partial U/\partial C)$ to the left (to the right) and causes body weight to decline (to rise), i.e. $(\partial W/\partial p)<0$. Also an increase in income would cause a rightward shift and higher body weight (i.e. $(\partial W/\partial I)>0$). Moreover, the more

important other consumption $C$ is to a person, the steeper is $p(\partial U/\partial C)$ which lowers body weight, too. A further important aspect is the marginal utility of direct food consumption. The larger $(\partial U/\partial F)$ the higher is the optimal body weight.[1]

**Figure 9: Ideal, optimal, and maximum weight**




***Source*: PHILIPSON and POSNER (1999).**

Finally, PHILIPSON and POSNER (1999) emphasize that the model predicts the rise in body weight to be "self-containing". When the price of food energy approaches zero or income gains go to infinity food intake reaches an upper limit $F_M$. Here, the negative impact of weighing much more than $W_0$ would compensate the positive utility from eating.

PHILIPSON and POSNER (1999) as well as other authors provide further extensions and implications of the neoclassical model. LAKDAWALLA and PHILIPSON (2002; 2009) provide a dynamic version of the neoclassical theory. Additional features, for example non-monotonic effects of income, emerge from assuming that health is a normal good or as PHILIPSON and POSNER (1999) put it: "Wealthier or educated individuals care more about their weight for

[1] However, this is not a sufficient condition for a higher deviation of $W^*$ from $W_0$. At low incomes or very high food prices, that is, when the optimal body weight may be to the left of the ideal body weight, $W^*$ and $W_0$ may be even more closely to each other.

health or other reasons, and so they limit their weight more" (p.12). The result, an inverted U-shaped relationship of income and weight, matches the observation that weight rises with income in poorer countries whereas it declines with higher incomes in richer nations.

However, it is likely that many factors correlated to income explain large parts of its weight effect. The work of SCHMEISER (2009) for instance shows that the negative effect of income on weight, which is especially pronounced for women, turns positive once the variation in income is controlled by instrumental variables. Thus, exogenous increases in income cause body weights to rise in wealthy countries, too. Among the factors that are linked to income (and certainly mask its positive effect) are education, motivation, abilities, but also social norms and competition for appearance that people in better-paying jobs have to face. Some of these effects will be discussed in the following sections.

*Energy expenditure as endogenous choice*

The model is also extended by introducing strenuousness *S* as a choice variable which acts through its impacts on weight and income. PHILIPSON and POSNER see a shift in the effect on income *I(S)* as crucial for the rise in obesity. They argue that in agrarian societies physical effort has raised income (i.e. $\partial I/\partial S > 0$), whereas in post-industrial societies physical effort lowers income ($\partial I/\partial S < 0$) and causes weight to rise. A further extension of the model would be to introduce recreational exercise *E*, that may mirror the jogging and gym "revolution" which is likely to offset the effects of less strenuous work at the job (PHILIPSON and POSNER, 1999, pp.16). PHILIPSON and POSNER (2008) regard this complementarity of energy intake and energy expenditure as the reason for the observed steady growth in body weight despite periods of falling energy consumption in the 20$^{th}$ century.

The framework of PHILIPSON and POSNER is more applicable to the general increase of weight observed over the last 100 years. However, the recent changes in the shape of the BMI distribution are the results of the likely interaction of declining food prices and increases in wealth with many other factors. Models based on the household production theory point to aspects of reduced time costs in cooking, increased labour force participation of women, or changes in skills and abilities connected to nutrition and food preparation. Alternatively, behavioural economics stress the role that exogenous cues and decision heuristics play in a

changing food environment and emphasise irrational behaviours such as time inconsistencies. The next section discusses these arguments in more detail.

### 3.2 Household production theory

#### *3.2.1 Basic concept*

A very important stream of the economic literature on obesity relies on the household production theory that originates from BECKER (1965). This framework allows researchers to include the time that consumers have at their disposal as well as their knowledge and their abilities into the economic analysis of behaviour.

BECKER (1965) enhanced the neoclassic consumer theory by the notion that it is not the market goods which generate a person's utility in the first place but rather more elementary commodities, also called Z-goods (eq. 4). Examples of such Z-goods are health, love, or prestige.

(4) $U = u(Z_1,...,Z_n)$.

Household production theory treats households as small factories that produce these elementary commodities by combining market goods $x_i$ and their non-market time $t_i$, as depicted in equation (5). The vector $E$ describes the „state of the art of production" or the „level of technology of the production process" (MICHAEL and BECKER, 1973). It includes households' assets, their knowledge, and their abilities.

(5) $Z_i = f_i(x_i, t_i; E)$.

Hence, households are producers and maximise their utility at the same time. Consumers' demand for market goods is thus a derived demand analogous to a firm's demand for production factors (MICHAEL and BECKER, 1973).

A third innovation of household production theory is the extension of the narrow budget constraint in the conventional framework to a "full-income constraint". By allowing time to be freely convertible between direct use and income generation, the final restriction of the Becker model is the total time available ($T$).

(6) $S = wT + V = \sum_i (wt_i + p_i x_i)$.

Equation (6) shows the composition of a household's full income *S*. It can be described as the monetary value of *T* at the (constant) wage rate *w* plus non-labour income *V*. The income that is spent on each elementary commodity $Z_i$ consists of the opportunity cost of time necessary for its production ($wt_i$) plus the value of the market goods that are used ($p_i x_i$) (BECKER, 1965).

When households maximise their utility with respect to the full-income constraint and their production functions, they reach the following equilibrium:

$$(7) \qquad \frac{MU_i}{MU_j} = \frac{w\frac{dt_i}{dZ_i} + p_i\frac{dx_i}{dZ_i}}{w\frac{dt_j}{dZ_j} + p_j\frac{dx_j}{dZ_j}} \equiv \frac{\pi_i}{\pi_j}$$

The ratio of the marginal utilities, $MU_i$ and $MU_j$, of two commodities $Z_i$ and $Z_j$, must be equal to the ratio of their marginal costs, $\pi_i$ and $\pi_j$. The marginal costs (i.e., $dC/dZ_i$) are the shadow prices of the Z-goods that depend on the wage rate w, the price vectors $p_i$ and $p_j$ of the market goods as well as the input-output relations of time and goods present in the production of the commodities (BECKER, 1965).

This framework allows the restrictions of human behaviour to be modelled more explicitly. It emphasises more general goals of households and separates the preferences for these from restrictions of time, knowledge and abilities, as well as the state of the consumption environment (MICHAEL and BECKER, 1973; POLLAK and WACHTER, 1975; SEEL, 2006).

GROSSMAN (1972) established the application of household production theory to health research. He considered health as an investment good that depreciates over time but can be recovered through health production processes. The concept of health capital is a basic concept in the field of health economics (see e.g. LEIBOWITZ, 2004; GROSSMAN, 1972). At the same time the development literature used it to analyse hunger and malnutrition in developing countries (STRAUSS and THOMAS, 1998). Also the emerging field of obesity economics has increasingly applied household production theory to research on overnutrition and body weight. The next section presents a concise overview of the aspects that have been discussed in that area.

*3.2.2 Applications in literature*

The literature that uses household production theory as a framework for analysing nutrition and obesity emphasises four main aspects. These are, analogous to the extensions of the theory, a) market-goods inputs and b) time inputs in the production of health as well as c) productivity issues related to education or knowledge. A final point is d) the structure and relation of different variables within the process of modelling and empirical analysis.

CUTLER et al. (2003) see the main contribution of technological change to rising obesity in that it *reduced the time costs of food preparation*. This could especially explain the stronger shift at the right tail of the distribution, whereas the theory of PHILIPSON and POSNER (1999) is more applicable to the general increase in weight that occurred over the last hundred years. According to CUTLER et al., the time that women spend on preparing food and cleaning up after meals decreased by about 50 % between 1965 and 1995 (p.106). A further indication in favour of this view is that the growth of energy intake from 1977/8 to 1994/6, of men by 268 kcal and of women by 143 kcal, can be attributed in large parts to additional snacking. The share of additional energy intake attributable to snacks is 90 % for men and 112 % for women. Hence, the rise in food consumption was mainly driven by the number of meals rather than the energy intake per meal.

CHOU et al. (2004) focus on the effects that the availability of fast-food and full-service restaurants have on BMI and the prevalence of obesity. They argue that the rising number of such outlets dramatically reduced search and travel costs. Moreover, their analysis includes prices of meals in different types of restaurants and for food that is consumed at home, as well as prices for cigarettes and alcohol. These products are considered as inputs into the production of meals and health. The study of POWELL (2009) investigates the impact of fast-food prices and fast-food availability on adolescent BMI. Fast-food, other food items and time inputs are regarded as inputs into health production as well as a direct source of utility.

DRESCHER et al. (2009) examine the demand for healthy eating considering diversity of the consumed food products. Their innovative idea is that the combination of food inputs in the production of health, expressed as “healthy food diversity”, is an important aspect. HUFFMAN et al. (2010) analyse the impact of food prices on the aggregate demand for calories and the supply of health. They employ a broad range of variables, like prices for food and non-food,

as well as of time. Additionally, they include indicators for education, the child dependency ratio, labour force participation, and for the performance of public health systems.

HAMERMESH (2007) assesses how the relation of time and goods inputs into the commodity "eating" has been affected by income and time prices over time. He finds increasing goods intensity, where both goods and time inputs increased with income but higher time prices reduced time inputs. FERTIG et al. (2009) investigate how maternal employment affects childhood obesity. They find small positive effects of mothers' time inputs into the production of child health (like cooking or leisure time spent together). HAMERMESH (2009) examines the time spent on grazing (i.e. eating or drinking while pursuing another activity) in relation to the time that is spent on eating and drinking as the primary activity. He shows that the time spent on both is nearly equal, and that increasing wage rates imply increasing grazing.

NAYGA (2000) contributes to a better understanding of the role that education plays in the health production process. He finds that the effects of schooling on weight and risk of obesity are mediated by health knowledge that raises the allocative efficiency of health production. The study of VARIYAM et al. (1999) emphasises the potential endogeneity of health information variables assumed to impact productivity of health production. They reject the exogeneity of such variables statistically in most cases.

BEHRMAN and DEOLALIKAR (1988) and CHEN et al. (2002) contributed to structural issues related to household production of health. BEHRMAN and DEOLALIKAR present a comprehensive discussion of possibly endogenous and likely exogenous variables within a health production framework. CHEN et al. stress that variables collected in large-scale medical surveys like nutritional intakes are choice variables and, thus, endogenous. To receive unbiased estimates of their effect on health indicators, they should be instrumented by exogenous variables like prices of food and drugs.

### 3.3 Intertemporal choice

A growing number of authors examine the role that time preferences play in relation to the rise in obesity. The concept of time preferences refers to "decisions involving tradeoffs among costs and benefits occurring at different times" (FREDERICK et al., 2002, p.351). Intertemporal choice is not only important for questions such as how much money to save

today to be able to spend it tomorrow but also for the trade-off between the benefits of eating today and the costs of overweight and lower health in the future.

The analysis of intertemporal choice in traditional economics is based on the discounted utility model by SAMUELSON (1937)[2]. The central parameter in this model is the discount rate that is considered to represent "all of the disparate motives underlying intertemporal choice" (FREDERICK et al., 2002, p.351). A discrete version of a person's intertemporal utility function is shown by equation (8):

$$(8) \qquad U^t(c_t,...,c_T)=\sum_{k=0}^{T-t} D(k)\cdot u(c_{t+k}), \qquad \text{where} \quad D(k)=\left(\frac{1}{1+\rho}\right)^k.$$

Equation (8) can be interpreted as the utility a person derives from consumption at time *t+k* and *D(k)* as her discount function that shows how she weighs the utility gained in every period. The discount rate *ρ* "represents the individual's pure rate of time preference […] which is meant to reflect the collective effects of the 'psychological' motives" (FREDERICK et al., 2002, p.355) for the choice over time. Utility over a continuous time spectrum is expressed by equation (9):

$$(9) \qquad U^t(\{c_\tau\}_{\tau\in[t,T]})=\int_{\tau=t}^{T} e^{-\rho(\tau-t)}u(c_\tau).$$

The concept of intertemporal choice was adapted to the economics of health by GROSSMAN (1972) who analysed investments in health capital over an individual's life time. In his model, a households' utility function includes the commodity "health" which is produced by the households themselves.

The literature discusses several ways by which heterogeneous intertemporal choice behaviour has played a role in the rise of obesity. KOMLOS et al. (2004) argue for instance that individuals have become more impatient over time, i.e. *the rate of time preference* has increased. They propose a model where people's food consumption in each period provides

[2] FREDERICK et al. (2002, p.351) report that SAMUELSON had „manifest reservations about the normative and descriptive validity of the formulation", however, "the discounted utility model was accepted almost instantly".

immediate gratification whereas the benefits from investments in health affect utility in later periods. Hence, “as a population’s rate of time preferences rises, so will expenditure on non-health-related consumption, whereas expenditure on health investments [including investments in a healthier weight] decreases” (ibid., p.212). To support their hypothesis, they provide some descriptive statistics relating obesity rates to saving rates over time and across countries showing some correlations. However, the authors admit that this evidence based on “simple proxies” is not strong enough to establish causal relationships.

COURTEMANCHE et al. (2011, p.4) provide a short review of studies that do not support the hypothesis of a systematical change of time preferences in the course of time. ZHANG and RASHAD (2008) find a statistically significant relationship of BMI and time preference expressed by “willpower to lose weight”. However, their analysis is cross-sectional and the proxy that is used may be confounded with many other variables.

COURTEMANCHE et al. (2011) discuss a second way how time preferences could have influenced obesity prevalence. They take up the perception of lower food prices as a main driver of weight gain and augment it with the notion of a heterogeneous discount rate across the population. Since food prices affect the costs occurring in the present, those individuals with higher discount rates (i.e. for which the present has a relatively higher value) are expected to react more strongly to falling food prices and gain more weight. Such an effect could explain why especially the right tails of the BMI distribution have expanded overproportionally (see Section 2).

So far, these arguments do not contradict the neoclassical notion of rational reactions to changing economic incentives. The only difference is that people also shift consumption patterns over time. Many authors, however, claim that preferences over time are not fully consistent and preference relations change over time. Imagine a person thinking today about what to eat tomorrow. She may be not quite happy with her weight and decides to eat some salad, because she feels that she must do something for her health. When tomorrow then arrives and she actually has to choose what to eat, she may change her decision preferring a steak with French fries. Hence, her preferences of salad (“health”) over steak (“pleasure”) have changed, which is not consistent with the classical theory of discounted utility (FREDERICK et al., 2002). Such forms of behaviour where the discount rate

depends on the time span between the evaluated event and the present are commonly termed “hyperbolic discounting” (LAIBSON, 1997, p.445).

CUTLER et al. (2003) argue that lower time costs of food preparation have an especially disastrous effect on people who show such hyperbolic discounting behaviour. While those persons derive immediate gratification from the consumption of food, the effects on health and body weight from eating too much will occur later. Reduced time costs of food preparation affects those individuals the most who possess so called hyperbolic discount rates, i.e. those who have self-control problems and overrate immediate pleasure irrationally. This has important implications for welfare assessment. The welfare of rational consumers increases, when prices fall. However, for people with hyperbolic discounting, the welfare effect may be negative when the following relation holds true:

(10) $(\rho_S - \rho_H) \cdot \Delta W \cdot C_W > \Delta C_F$.

Here, $\rho_S$ and $\rho_H$ are the standard and hyperbolic discount rates, $\Delta W$ is the change in weight, $C_W$ are the costs of weight and $\Delta C_F$ is the change in food costs (CUTLER et al., 2003). Equation (11) expresses the welfare effects in time units:

(11) $(\rho_S - \rho_H) \cdot T_{\Delta W} > T_{\Delta F}$,

where $T_{\Delta W}$ and $T_{\Delta F}$ are the time costs of losing the weight gained and the reduction in time costs of food preparation, respectively. If people act rationally, the first term becomes zero, the condition is not met and welfare increases (despite rising weights). Individuals with hyperbolic discount rates underestimate the weight change and its associated costs and put on more weight than rational persons would have done (CUTLER et al., 2003).

IKEDA et al. (2010) analyse the relationship between differences in time discounting and the BMI for a large Japanese household survey. Besides pure impatience (higher and lower discount rates), they also test for significant effects of hyperbolic discounting as well as for an asymmetric discounting behaviour (i.e. benefits are discounted more heavily than costs). Again, their data are cross-sectional and the analysis only explains the distribution at one point in time (if at all) and not the trends that have occurred. Moreover, discount rates stem from experiments using money values.

SCHARFF (2009) also examines hyperbolic discounting as a “possible reason for the *persistence*” of obesity. He highlights that certain situational influences (e.g. smoking

colleagues at work who offer cigarettes or vending machines that sell donuts at work) may raise or lower the effective discount rate. Likewise, he argues (following CUTLER et al., 2003) that reductions in consumption time costs have "increased the effective discount rate of time preference used in food consumption decisions by hyperbolic agents" (p.8)[3]. SCHARFF also runs cross-sectional regressions of proxy variables on calorie intake stratified by body weight and gender and finds "that obese dieters display behaviour consistent with hyperbolic discounting". However, the proxies do not seem to really express the pure time preference. COURTEMANCHE et al. (2011) examine hyperbolic discounting, too. Their results suggest that obesity levels are partly due to rational intertemporal tradeoffs but also partly to time inconsistency.

RICHARDS and HAMILTON (2012) collect data on individual discount schedules for different amounts of money in an experimental setting. They conduct econometric tests for time-consistent behaviour of their respondents and for heterogeneous behaviour with respect to patterns of risky behaviour. Their results indicate "that discount functions are quasi-hyperbolic in shape, and that obesity and drinking are positively related to the discount rate" (p.181).

ETILÉ (2011) concludes that individuals who show hyperbolic discounting "do not receive in the long run the utility they would have received if they were to have been consistent" (p.729). Hence, the presence of hyperbolic discounting is said to justify interventions that help people overcome their self-control problems (BRUNELLO et al., 2009; SASSI, 2010; ETILÉ, 2011). One means to do so is a "sin tax" suggested by O'DONOGHUE and RABIN (2006). However, ETILÉ also warns to be "cautious, however, in labeling behaviors as 'irrational'" (p.728) and states that "absent good measures of time preferences in a large-scale food survey, hyperbolic discounting models are not yet testable." Also CUTLER and GLAESER (2005) argue that time preferences provide no consistent explanation for health behaviour. Time in-consistent behaviour as a rationale for policy interventions is also discussed in Section 4.3.

[3] One should be careful with the notion that the rate of time preference has increased, see also FREDERICK et al. (2002) for the issue of mixing up time preference, discount rate, discount factors etc.

### 3.4 Rational addiction

Another branch of the literature utilises the "rational addiction approach" by BECKER and MURPHY (1988) to explain why persons stick to harmful behaviours like overeating or alcohol and drug abuse over time. BECKER and MURPHY claim that an addiction can be the result of "a consistent plan to maximize utility over time" (p.675). Central to their model is the concept of "consumption capital" *S* which can be regarded as a capital stock built by past consumption of the addictive good. This addictive stock affects utility directly as well as indirectly by altering the marginal utility derived from the addictive good's current consumption *C*.

The indirect property ($\partial^2 U/(\partial C \cdot \partial S) > 0$) implies under certain conditions a so called "adjacent complementarity" between consumption levels at different points in time. Adjacent complementarity entails *reinforcement*, which means increasing current consumption of the addictive good increases future consumption of it (BECKER and MURPHY, 1988).

The stock's direct effect on utility is related to the aspect of *tolerance* which is often observed for harmful addictions. Here, "the marginal utility of the addictive stock is negative [$\partial U/\partial S < 0$]" (CHALOUPKA and WARNER, 2000). Tolerance implies for harmful addictions that "higher past consumption lowers the present utility from the same consumption level" (BECKER and MURPHY, 1988, p.682). For beneficial addictions (to music, sports etc.), tolerance occurs when $\partial U/\partial S > 0$ (CAWLEY and RUHM, 2011).

The difference to traditional models of habit formation is that BECKER and MURPHY allow for forward-looking agents that maximise their lifetime utility (CAWLEY and RUHM, 2011). CAWLEY and RUHM point out that rational addicts might freely choose to become addicts because they have a high adjacent complementarity.

BECKER and MURPHY link their theory to overeating and obesity themselves. They point out that "people get addicted not only to alcohol, cocaine, and cigarettes but also to work, eating, music, television, news…" (pp.675) and later on also claim that their theory can explain binge eating and cycles of overeating and dieting. Also CAWLEY (1999) argues that people can get addicted to calories from food resulting in obesity.

Some empirical applications can be found in literature. RICHARDS et al. (2007) test whether rational addiction applies to consumption of macronutrients (fat, proteins, and carbohydrates) from snack foods and find "broad support for the rational addiction hypothesis" (p.322) with an especially "strong addiction to carbohydrates" (p.309). MILJKOVIC et al. (2008) examine whether rational addiction to sugar is a possible cause of rising obesity rates. They find that an "increase in future sweet prices leads to increased sugar consumption at [the] current period by overweight and obese people" (p.59) which contradicts the predictions of the rational addicts hypothesis. Only the results for normal-weight people are in line with rational addiction behaviour. LIU and LOPEZ (2012) apply the rational addiction model to carbonated soft drinks and find "strong evidence" for a rational addiction based on significant effects from past and future consumption on current consumption.

### 3.5 Behavioural economics

The concepts of neoclassics and household production theory as outlined in Sections 3.1 and 3.2 assume that individuals always behave rationally and are fully aware of any factors that influence their decision processes. However, experimental studies from psychology and behavioural economics have shown that people often deviate from the behaviours we would expect from standard economic agents and make "choices that are demonstrably suboptimal" (JUST, 2011, p.99).

Several authors have pointed out such deviations from rational behaviour also occurring in the context of food consumption and obesity. A first aspect outlined is different *modes of decision making* where heuristics or simple rules are applied rather than complex, well-calculated optimisation processes. A second focus is on the *influence of situational factors* that affect the mode of decision making, the value of a decision's outcome as well as the monitoring of achieving the objective (WANSINK et al., 2009; JUST, 2011). The basic ideas will be briefly sketched on the following pages which are mainly based on JUST (2011) and WANSINK (2004) who provide more detailed reviews of behavioural (economics) aspects of food consumption.

*Decision mode*

The amount of cognitive resources available to a person at the moment he or she is making a decision is crucial for what that person's decision process looks like. In his Cognitive-Experiential Self Theory (CEST), EPSTEIN (1993) argues that people switch between modes of decision depending on those cognitive resources. When sufficient resources and time are available to individuals they evaluate stimuli via cognitive processes characterised by deliberative and rational thinking. Otherwise, people rely on an experiential system leading to faster decisions based on affect or emotion (JUST, 2011). Hence, individuals who are exposed to stress or face a number of other decisions at the same time are likely to show more impulsive behaviour. Then, their food decisions are not in accordance with their long-term objectives (e.g. concerning weight or health).

A second framework by LOEWENSTEIN (2004) highlights the impact of visceral factors like hunger or nervousness on time-inconsistent behaviour. While CEST assumes that people switch between modes of decision making, the visceral factors approach throughout regards humans as thinking rationally. However, the stronger the influence of visceral factors like hunger or thirst, the higher the utility that individuals get from the consumption of certain foods (JUST et al., 2007). Two propositions of LOEWENSTEIN's framework seem especially vicious. On the one hand, "people underestimate the effect of visceral factors on their own behavior", on the other hand, they "will forget the effect visceral factors played" after some time (JUST, 2011, p.105).

Also *prospect theory* (KAHNEMAN and TVERSKY, 1979) and *mental accounting* (THALER, 1980) have been used to explain food consumption decisions. These theories consider the findings that people relate their possible outcomes to a reference point and show a larger disutility from losses than utility from (equal-value) gains related to that reference point. Food marketers or policy makers could alter consumption behaviour by setting appropriate default options (JUST, 2011). However, defaults may be more or less successful as is shown by JUST and PRICE (2013). They examine the effect on consumption in cases where the standard offer of school lunches included vegetables and also in cases where not. Results indicated that "requiring a fruit or vegetable as part of the school lunch may increase waste substantially while only modestly increasing consumption of fruits and vegetables" (ibid., p.7).

JUST and WANSINK (2011) provide evidence that the behaviour of individuals in flat-rate price service contexts, also known as 'all-you-can-eat', is strongly related to the concept of *transaction utility* (i.e. "making a good deal"). The authors found that people who were randomly assigned to pay a higher price for the buffet consumed 38.6 % more pizza than those who had to pay lower prices. As the costs for eating are fixed and paid in advance, people should stop eating in both settings when their marginal utility of consumption is zero. However, the group with higher prices seemed to eat more to get their money's worth, as long as a positive 'transaction utility' from lowering the average cost per slice of pizza exceeds the negative utility from overeating and feeling full and uncomfortable. This kind of behaviour seems to suffer from the well-known *sunk cost fallacy* (JUST and WANSINK, 2011).[4] A further result of this study was that the quality of the food provided had an influence in flat-rate settings. When less tasty pizza was served, consumption increased, i.e. people ate more to justify the fixed price.

*Impact of eating and food environment*

When individuals switch between more cognitive and more affective or emotional modes of decision making, heuristics and reference points are of great importance. Then, environmental factors can considerably affect food choices. WANSINK and SOBAL (2007) argue that external factors can trigger in overserving and overeating when influencing *consumption norms* (i.e. what people think is the right amount to eat) and *consumption monitoring* (i.e. "how much they believe they eat" (ibid., p.109)). Typically, people are not aware that they are influenced in such ways, even when they are told (JUST, 2011). Environmental influences on food intakes can be categorised into the *eating environment* (e.g. atmosphere, lightning, effort to obtain the food, social interactions, secondary activities like TV and reading, other distractions) and the *food environment* (e.g. salience, structure, package or portion size, way of serving) (WANSINK and SOBAL, 2007; JUST, 2011).

Critics of the psychological or behavioural economical approach observe that the findings derived from controlled experiments in a closed setting may not be externally valid. MAZZOCCHI et al. (2009) address the example of increased portion sizes which are claimed to set higher reference points and lead to overeating (YOUNG and NESTLE, 2002). However,

[4] Interestingly, this kind of behaviour has already been described by the old Franconian saying: "Lieber'n Bauch verrenkt, als 'em Wirt was g'schenkt".

CUTLER et al. (2003) report a decrease in *average* calorie intake per meal that contradicts the small-scale findings on the macro level. Other findings from behavioural economics, though, might be better in line with the observational data. For instance, CUTLER et al. (2003) found that increased snacking is mainly responsible for larger calorie intakes. This would fit with the theory that the ubiquitous viewing of delicious food triggers impulsive eating behaviour. ANDERSON and MATSA (2011) analysed how the distance to fast-food outlets affects the BMI based on large-scale survey data. Controlling for possible reverse causality by using proximity to interstate highways as instrument, they found no significant effect on body weight.

## 4 Cases for policy interventions

The negative consequences of obesity for individuals and society have raised calls for political interventions to halt and reverse the rise in obesity (e.g. WHO, 2004; BROWNELL and FRIEDEN, 2009; POPKIN, 2009). Economists writing on this issue are mostly reluctant to support such measures without reservation even when they reduce obesity significantly. In the absence of market failures, most economists are convinced that the behaviour of rational and informed individuals acting on free markets maximises individual utility as well as social welfare (CAWLEY, 2011). Governments should not become active until a market failure is identified (CASH and LACANILAO, 2007). Even a high prevalence of obesity and its doubtlessly severe monetary and psychological consequences are not sufficient in their own right to justify interventions (KUCHLER and GOLAN, 2004).

As seen in Sections 3.1 and 3.2, the neoclassical and household production models of consumer behaviour explicitly include the possibility that a high proportion of overweight and obese people exists within a population. Rational and informed agents weigh the immediate as well as all future benefits and costs of their actions to reach the maximum achievable utility. “In such a setup, food-related chronic diseases are only private health problems and, a priori, the market will be efficient at supplying health inputs, be they junk foods or diets” (ETILÉ, 2011, p.727). Hence, when no market failures exist, any intervention by governments would draw the market result away from the socially optimal equilibrium.

However, if there is a market failure, “the equilibrium prices and quantities do not capture the total social costs and benefits” (MAZZOCCHI et al., 2009) and the government can improve the outcome. To be feasible, though, any intervention needs to pass a second criterion: Its

benefits have to outweigh its costs (CASH and LACANILAO, 2007). Thereby, the success of political interventions is not evaluated according to the reduction of obesity, but "by how well they fix the market failure they were designed to repair" (CAWLEY, 2011, p.133).

The economic literature concerned with obesity has identified some possible causes of market failure which will be reviewed and discussed in the following.

### 4.1 Externalities

A market failure often referred to in the context of obesity is the existence of *externalities*. Externalities occur when economic agents do not include the full costs or benefits of their actions into their decisions and deviate from the behaviour they would have shown had they taken all consequences into account. Inefficiencies in the allocation of resources and suboptimal social welfare will be the result (BRUNELLO et al., 2009; MAZZOCCHI et al., 2009). In particular, literature pays attention to two possible external effects, one related to health insurance and the other to labour markets (SASSI, 2010).

Central to the case of insurances are the medical costs that obesity and its co-morbidities impose on health care systems. The literature that attempts to estimate the costs of obesity for health care systems as well society in total has grown steadily over the last one and a half decades. Recent reviews of studies are provided by MÜLLER-RIEMENSCHNEIDER et al. (2008), VON LENGERKE and KRAUTH (2011), and WITHROW and ALTER (2011).

MÜLLER-RIEMENSCHNEIDER et al. (2008) conclude that "obesity appears to be responsible for a substantial economic burden in many European countries" (p.499) that ranges from 0.09-0.61 % of the respective countries' gross domestic product. WITHROW and ALTER's (2011) review of English language articles finds estimated shares of obesity in a country's total healthcare expenditures of 0.7-2.8 %. The authors report further that the relationship between the degree of obesity and health costs is non-linear with morbidly obese people (BMI ≥ 40 kg/m²) causing particularly high costs. For the case of Germany, VON LENGERKE et al. (2006) found that severely obese persons of classes II and III (BMI > 35) induce average annual costs of 2,572 €. These numbers are significantly higher than those for normal-weight (847 €), overweight (830 €) and moderately obese persons of class I (30 ≤ BMI < 35) with 1,080 €.

VON LENGERKE and KRAUTH (2011) stress that costs of obesity differ among groups of various socio-economic and demographic characteristics. Their review also includes one study that takes a lifetime approach and finds lower lifetime costs of obese people due to lower life expectancy and lesser need for long-term care (RAPPANGE et al., 2009). All reviews note the considerable heterogeneity in the methodology to estimate the costs of obesity and call for increased standardisation to improve the comparability across studies and countries.

**Table 2: Estimates of annual total and direct costs of obesity for different countries.**

| Authors | Country | Year | Cost estimates | Share in Health Care Expenditures |
|---|---|---|---|---|
| KATZMARZYK and JANSSEN (2004) | Canada | 2001 | 4.3 bn $ (total costs)<br>1.6 bn $ (direct costs) | 2.2 % of total health care costs |
| EMERY et al. (2007) | France | 2002 | 2.1-6.2 bn € (total) | 1.5-4.6 % of total health care costs |
| KNOLL (2010) | Germany | 2003/04 | 12.8-13.0 bn € (total)<br>11.4 bn € (direct) | n/a |
| SANDER and BERGEMANN (2003) | Germany | 2001 | 2.7-5.7 bn € (total)<br>1.3-2.7 bn € (direct) | 0.6-1.2 % of total health care costs |
| MCCORMICK, STONE and CAT (2007) | England | 2002 | 3.3-3.7 bn £ (total)<br>0.9-1.1 bn £ (direct) | 2.3-2.6 % of total health care costs |
| WOLF and COLDITZ (1998) | USA | 1995 | 99.2 bn $ (total)<br>51.6 bn $ (direct) | 5.7 % of total health care costs |
| FINKELSTEIN et al. (2003) | USA | 1998 | 78.5 bn $ (total) | 6.5 % of total health care costs |
| FINKELSTEIN et al. (2009) | USA | 2008 | 147 bn $ (total) | 9.1 % of total health care costs |

***Source*: Own composition.**

Table 2 summarises important results for selected studies on the annual total and direct costs of obesity. The term "direct costs" refers to the treatment of obesity and its attributable shares of associated co-morbidities like type-II diabetes, cardiovascular diseases arthrosis, cancer, hypertension, and psychosocial complications. Direct costs estimates typically include costs of hospitalisation and surgical interventions, medication, and visits to doctors. Total costs are the sum of direct costs and indirect costs. Indirect costs account for losses in value added caused by absence from work, morbidity and premature mortality (see e.g. KNOLL, 2010).

Most health care systems in developed countries are publicly funded and do not require the premium a person pays to be differentiated according to her weight. In a case of differing risks and corresponding costs in the population but equal premiums for individuals, a "positive subsidy for some individuals and a negative subsidy for others" emerges (BRUNELLO et al., 2009, p.572). However, the existence of such an insurance subsidy is only a necessary condition. Only when the subsidy induces a change in behaviour, i.e. there is a so- called *ex ante* moral hazard problem, is it suitable to speak of an insurance externality (BRUNELLO et al., 2009; ETILÉ, 2011). BRUNELLO et al. (2009) describe a scenario where body weight is determined during childhood and remains more or less fix during adulthood. Here, the characteristics of the health care systems would have no influence on efficiency but rather on equity.

The empirical evidence indicates that a possible health externality is rather small. BHATTACHARYA and SOOD (2007) also emphasise that both the subsidy to obese individuals *and* the sensitivity of body weight to this subsidy are relevant for the size of the welfare loss in the case of pooled insurance. They "estimate that the welfare loss due to the obesity externality in the US is about $ 150 per capita (in 1998 dollars)" and stress that "this estimate [..] is much smaller than the difference in medical expenditures between the obese and non-obese that is typically found in the literature" (p.281). Likewise, BRUNELLO et al. (2009) conclude that the obesity externality is likely to be small. However, their assessment is based on a simple comparison between the US and Europe with a lower degree of pooling but higher obesity rates in the former against a higher degree of pooling but lower obesity rates in the latter.

Apart from examining whether there actually is an insurance externality many authors discuss the question of the adequate policy reaction. "The generally accepted rule for achieving an optimal social outcome in the face of negative externality is to tax the damaging activity at a rate equal to the marginal external cost at the optimal level of provision" (CASH and LACANILAO, 2007, p.175). However, there is much controversy about the appropriate tax. Taxing unhealthy foods would be questionable, because of the difficulties to determine the marginal damage of one unit of "unhealthy" food, which may be zero for many consumers (CASH and LACANILAO, 2007). Other suggestions like taxing body weight (or adjusting insurance premiums according to weight) (ETILÉ, 2011) or taxing overall dietary composition (CASH and LACANILAO, 2007) would be similarly questionable. Such scenarios

would disregard the fact that the impact of the BMI on health can be very heterogeneous and also the effect of physical activity that plays a great role in determining health would not be considered.

A second branch of possible externalities of obesity is concerned with possible negative effects of a high BMI on employment, wages or schooling outcomes. ETILÉ (2011) emphasises that the empirical evidence on such relationships "may not reflect a causal effect" (p.725). Other factors (genetic and non-genetic) are most likely to affect labour market outcomes and obesity at the same time.

To sum up, externalities with respect to the health system may exist to a certain degree. However, their magnitude is most likely considerably lower than portrayed in the public discussion and the media. Another question in this respect is whether rising medical costs of obesity result from growing obesity prevalence or from the use of increasingly costly therapies to treat obesity and its related diseases.

### 4.2 Lack of information

Another market imperfection possibly arises from *insufficiently informed consumers*. The assumption of the standard model on buyers that "understand all their options and they understand the consequences of their actions" (MAZZOCCHI et al., 2009, p.68) may then no longer hold. The literature discusses four areas where individuals possibly lack information: 1) people are not aware of the health consequences that emerge from obesity, 2) it is unclear how lifestyles (eating and physical activity) affect body weight, 3) information on the characteristics of purchased foods such as calorie content and other ingredients is lacking, 4) the subjective perception of the healthiness of one's own weight differs from objective medical classifications (MAZZOCCHI et al., 2009; BRUNELLO et al., 2009).

The existence and the degree of these information problems are highly controversial. SASSI (2010) notes that "many would argue that most individuals today possess the basic knowledge required for them to broadly discriminate between more and less healthy options" (p.125). Also KUCHLER and GOLAN (2004) find it "difficult to believe that many Americans are not conscious of the relationship between a healthful diet and obesity" (p.42). They support their argument by referring to the omnipresence of diet and health topics in the media, government information programs, nutrition labels, and product health claims.

Empirical evidence is provided by BRUNELLO et al. (2009) based on data from the EUROBAROMETER survey. They find that in most European countries more than 80 % of the population knows that high body weight may have a deteriorating effect on health. Moreover, they find little evidence in favour of the argument that the information that reaches consumers is "fragmented or even conflicting" (CASH and LACANILAO, 2007, p.175). On average, less than 9 % of European adults feel that they lack information to follow a healthy diet (BRUNELLO et al., 2009).

VARIYAM and BLAYLOCK (1998) report that the majority of US citizens have basic nutrition knowledge. VARIYAM (2008) examines how the introduction of the Nutrition Labeling and Education Act (NLEA) in 1990 affected nutritional behaviour in the US. He finds an increasing effect on iron and fibre intakes but no changes in total fat, saturated fatty acids and cholesterol intakes. VARIYAM and CAWLEY (2006) present estimates that suggest a decreasing effect of the NLEA on obesity among white females by 2.36 %. There is some evidence that people fail to correctly evaluate their body weight as healthy or unhealthy (BRUNELLO et al., 2009). Moreover, KUCHLER and VARIYAM (2002) emphasise that information on food sold at restaurants and fast-food outlets may be insufficient. They call for targeted information to population subgroups that also takes into account the perceptions of people about their own weight status. SEIDERS and PETTY (2004) provide a more detailed overview of many points of criticism regarding marketing and information practices for food.

MAZZOCCHI et al. (2009) point out that "suppliers of healthy foods have incentives to provide verifiable information on the positive characteristics of their products" (p.71). The means of signalling healthy attributes enables them to differentiate their products.

### 4.3 Irrational behavior

A third important rationale for governments to intervene is *lack of rationality* in human beings. There are some areas where economists assume that individuals do not act fully rationally, such as in the presence of inconsistent time preferences or susceptibility to environmental cues. ETILÉ (2011) deems it "wise to be cautious, however, in labeling behaviors as 'irrational'" (p.728) and CAWLEY (2011) points out that "irrationality is in the eye of the beholder" (p.132).

Some authors like CAWLEY (2011) advance the view that "society may trust adults to accurately weigh the costs and benefits of a high-calorie diet or a sedentary lifestyle" (p.132). Paternalistic interventions may be justified though in the case of children who are "unable to take into account the future consequences of their actions" (CAWLEY, 2004, p.122).

However, many authors also regard time-inconsistent behaviour as an argument in favour of political intervention since "people overeat, despite substantial evidence that they want to lose weight" (CUTLER et al., 2003, p.112). Empirical support to this view is given by BRUNELLO et al. (2009) who find that a high proportion of adolescents fail in their attempts to lose weight. The economic theory behind time-inconsistency assumes quasi-hyperbolic discounting as the causal factor behind such behaviour. In that case, discount rates for events are lower, the further they are in the future (see Section 3.3). "People who suffer from lack of self-control do not make a rational choice which maximizes their overall lifetime welfare" and "their utility can be increased by their not being allowed to indulge in short-sighted behavior" (MAZZOCCHI et al., 2009, p.65). O'DONOGHUE and RABIN (2006) show that "sin taxes" may support people to stick to their long-term plans. Moreover, if individuals suffer from physical or psychological addiction, there clearly is a role for government (MAZZOCCHI et al., 2009).

Another area where non-rational behaviour is assumed is the case of environmental cues like the view or smell of tasty food that "trigger uncontrollable shifts in preferences" (ETILÉ, 2011, p.730). Hence, "cue-based strategies that firms use to encourage consumers' purchases have negative externalities: They lead to overconsumption and favour addiction" (ibid., p.730).

GLAESER (2006) perceives policies aimed at self-control problems as questionable because "paternalistic interventions always involve trading off the welfare of people at one point in time with people at some other point in time, and this requires tricky social welfare decisions. Second, the first-best response to self-control problems is always to increase the availability of technologies or contracts that facilitate private self control, which cannot really be called paternalism because these policies increase, rather than decrease, the choice set" (p.136).

### 4.4 Other welfare considerations

In addition to the three classical rationales described above, the literature discusses further reasons for government intervention such as opposition to the food industry and equity issues.

KUCHLER and GOLAN (2004) raise the question whether "producers are not responsive to consumer demand and do not supply the types of food desired by consumers" (p.41). They doubt, however, that "a business strategy that disregards consumer preferences could succeed for long" and conclude that the "wide variety of food products on grocery store shelves reflects the willingness and ability of the industry to adapt to consumer preferences" (p.41). They list multiple examples like the provision of 'low-carb' or 'low-fat' products, the existence of over 40.000 food products available and the multiple outlets that provide almost any food type one could think of. Also CAWLEY (2004) claims that it is the natural objective of the food industry to produce and sell "the goods or services that yield the highest profit. […] To the extent that consumers want to be more physically active, eat healthier foods, and weigh less, private industry has a profit incentive to help them do it" (p.123).

Based on the observation that obesity is more prevalent among groups of lower socioeconomic status, many authors see "a strong basis for intervention on equity grounds" (BRUNELLO et al., 2009, p.552). Obesity is associated with unemployment, low income, poor education or social isolation and "it is of particular concern to some governments that disadvantaged socioeconomic groups and ethnic minorities appear to take up less healthy lifestyles in increasing proportions, and they appear to be less responsive than other groups to interventions aimed at improving lifestyles" (SASSI, 2010, p.155). Whether socioeconomic status affects BMI or vice versa or whether both are simultaneously affected by underlying factors is difficult to determine (BRUNELLO et al., 2009; ETILÉ, 2011). With regard to socioeconomic differences, obesity would be one objective that would be tackled together with many others by a general policy that would enhance the opportunities of disadvantaged social groups. Specific inequities pointed out by CAWLEY (2004) are the existence of food deserts (grocery stores in African-American neighbourhoods sell less low-fat products or fruits and vegetables) or the lack of safe environments for physical activities in poor inner city neighbourhoods compared to wealthier suburbs. Further concerns related

to equity issues are possible regressive effects of fiscal measures to reduce obesity rates (ETILÉ, 2011). These will be discussed in Section 5.

## 5 Potential of fiscal measures to reduce obesity

While Section 4 deals with the question whether governments *should* intervene to reduce obesity, the present section discusses whether they actually *can* do something about it. Thereby, a clear focus lies on fiscal measures to alter relative market prices, since most of the other papers in this dissertation are concerned with price issues.

The initial proposal of price measures came from public health experts. Taxes on energy-rich foods or foods high in fat or sugar were supposed to reduce consumption of more "unhealthy" food items while subsidies on fruits and vegetables, for instance, would favour higher intakes of more "healthy" produce (BROWNELL, 1994; BATTLE and BROWNELL, 1997). However, only very high taxes could possibly reach such outcomes what lead some authors to doubt their political "feasibility and desirability" (JACOBSON and BROWNELL, 2000, p.854). Therefore, small taxes that do not necessarily change consumption behaviour but generate substantial revenues were regarded as an alternative. For example, JACOBSON and BROWNELL (2000, p.857) "suggest that public health professionals consider recommending snack taxes [on soft drinks, candy, gum, and snack foods] as a means of funding healthy eating and physical activity programs". According to their estimates, a national tax in the US of 1 cent per 12 ounces of soft drink would generate $ 1.5 billion per year.

The early debate on food taxes naturally drew the attention of (agricultural) economists and initiated an ever growing number of studies that investigated the relationship between food prices, consumption patterns, and body weight as well as possible outcomes of fiscal measures to promote healthier lifestyles.

### 5.1 Empirical evidence

There are already several reviews of empirical studies that assess relations between food prices and obesity and their implications for taxes and subsidies (POWELL and CHALOUPKA, 2009; POWELL et al., 2013; FAULKNER et al., 2011; POWELL and CHRIQUI, 2011; ANDREYEVA et al., 2010; THOW et al., 2010). Thus, the plan here is not to provide another review but present the essence of the research results. This leaves room to put more emphasis on methodological issues and policy implications.

*5.1.1 Price-BMI relationships*

One stream of the literature analyses reduced-form relationships between prices of selected food products and BMI and, respectively, the probability of being obese. POWELL et al. (2013) conclude that "overall, the evidence on the extent to which changes in food and beverage prices may significantly impact weight outcomes remains mixed" (p.122). Although some studies find significant price effects on body weight, the received elasticities are mostly smaller than 0.1 in absolute values.

The study of CHOU et al. (2004) finds an elasticity of BMI with respect to prices in fast-food restaurants of -0.05 and to food-at-home prices of -0.04. Moreover, they find that the prevalence of obesity falls by 0.6-0.7 percentage points when (any) food prices rise by 10 %. POWELL (2009) finds a similar fast-food price elasticity of BMI of -0.08 for adolescents. POWELL and BAO (2009) report price-weight elasticities for adolescents for fruit and vegetable prices of 0.07 (total population) and 0.14 (low-income households) as well as for fast-food prices of -0.26 (but only for low-income households). Estimations by subgroups suggest significantly higher elasticities of -0.31 for teenage children in middle-income households. Results of STURM and DATAR (2005; 2008) indicate that a difference of one standard deviation in prices for fruits and vegetables between two areas would cause a 0.11 points higher BMI in children by the third grade and a 0.2 points higher BMI by the fifth grade. HAN and POWELL (2011) found no significant effect of food prices on the prevalence of obesity among young women. They do report a significantly negative effect of fast-food prices on obesity for young men in a random-effects model that could not be confirmed, however, in a fixed-effects specification. HAN et al. (2012) found some unexpected positive coefficients of fast-food prices with respect to weight.

FLETCHER et al. (2010a; 2010b) analyse the effects of state-level soft drink taxes on BMI and find statistically significant coefficients. Their magnitude is however small: Increasing the tax rate by one percentage point lowers the BMI by 0.003 kg/m² and decreases the prevalence of obesity and overweight by 0.01 and 0.02 percentage points, respectively. SCHROETER and LUSK (2008) report a positive elasticity of food-at-home prices with respect to weight of 0.1, indicating that a decrease in the price of food at home would also decrease weight. However, the food-at-home-price elasticity with respect to BMI is negative, which is inconsistent. The conclusion that can be drawn from those studies is that there may be

significant effects of food prices on BMI. Of course, this is what one would expect, when acknowledging that prices have an impact on food consumption and food consumption, in turn, has an impact on body weight. However, the magnitude of the price effect on weight is very small due to many other variables and substitutive relationships.

### *5.1.2 Demand systems*

According to ETILÉ (2011), studies that just examine price-weight outcomes "cannot, however, inform the construction of price policies because they do not consider the whole pattern of substitution between products" (p.731). One could argue, of course, that all those substitution processes finally culminate in body weight. Hence, such analyses *can* inform policy makers to a certain degree. What they cannot achieve, however, is to provide a picture of the expectable consumption patterns after a policy change and their impact on budgets and nutrient patterns that have important implications for welfare and health aspects. To answer such questions, demand-system analyses are the preferable means because they give explicit information on own- and cross-price effects and substitutive relationships (ETILÉ, 2011).

Studies that examine effects of food taxes and subsidies via demand systems indeed reveal important insights into possible shifts regarding nutrient intakes. ALLAIS et al. (2009) estimate a complete demand system using scanner data for French households. Based on the resulting price elasticities they compute nutrient elasticities to assess the effect of price changes on nutrient intakes. They simulate higher value-added-taxes on cheese/butter/cream, sugar-fat-products, and/or prepared meals and conclude that "a fat-tax policy is unsuitable for substantially affecting the nutrients purchased by French households and leads to ambiguous effects" (p.243) such as lower intakes of important nutrients as several vitamins and minerals nutrients (ALLAIS et al., 2009). A further result is that such a fat tax would generate substantial revenues, but is also highly regressive.

CHOUINARD et al. (2007) examine likely effects of taxing the percentage of fat in food items and estimate a demand system for dairy products. They find that a 10 %-tax on fat content would reduce fat consumption by less than 1 %. The estimates of CHOUINARD et al. mark such a fat tax as extremely regressive with higher welfare losses for elderly and poor people.

NORDSTRÖM and THUNSTRÖM (2011) analyse the effects of targeted food taxes and subsidies "aimed at redirecting grain consumption to healthier levels" (p.267). Based on previous demand-system results they simulate revenue-neutral policy reforms for several population subgroups. Results indicate that, regarding tax payments, such reforms are progressive. The authors point out, however, that policies directed at other food groups may have different welfare effects. With respect to health effects, the authors find that it is the highest income group that benefits the most from the proposed reforms by increasing their fibre consumption by 38 %. At the same time, "the increase in fibre intake is accompanied by substantial increases in the intake of the unhealthy nutrients, though, making the net health effects difficult to evaluate" (p.9). This example mirrors an often pronounced view that policies aimed at altering the consumption of one target nutrient (e.g. saturated fats) or energy may have negative effects on intakes of other nutrients.

KUCHLER et al. (2005) estimate single demand equations for snack foods like chips and other salty snacks to assess likely effects of a tax on these food items. Their estimates suggest that taxes would have only minor effects on dietary quality but would generate large revenues.

In the course of the debate about food taxes, many researchers especially in the US identified soft drinks as a promising target for taxes. They are perceived as the single largest contributor to energy intake with low nutritional value (BROWNELL et al., 2009). Literature reports quite high own-price elasticities of around 0.8-1.0 in absolute values that promise substantial reductions in consumption when taxes raise prices (ANDREYEVA et al., 2010). However, other studies point out that possible shifts to energy-rich substitutes compensate for the decrease in soft-drink consumptions. FLETCHER et al. (2010b) show that there are possible counterintuitive effects of sin taxes on sugar-sweetened beverages. Analysing the effects of soft-drink taxes on child and adolescent soft drink consumption, they find that "moderate reductions in soft drink consumption from current soda tax rates" are "completely offset by increases in calories from other beverages" (p.968) mainly whole milk.[5] FLETCHER (2011) adds that although soda taxation may not be able to achieve its primary goal, i.e. reduction of obesity, it can have positive side effects on health through more nutritious substitutes. Juices and milk, for instance, contain comparable levels of energy but are in addition sources of valuable vitamins and minerals.

[5] The large effect of whole milk is quite surprising at first. However, these results were obtained for a sample of children and adolescents, where substitution of soft drinks by milk is surely more likely than in the case of adults.

SMITH et al. (2010) employ household scanner data to estimate a demand system for eight beverage categories. The received elasticities were applied to actual individual intake data to simulate energy-intake and body-weight effects of a tax on sugar-sweetened beverages (SSB). They found that a 20 % tax on SSB would reduce net daily energy intake from all beverages by 37 kcal for adults and 43 kcal for children. Translated into body weight these changes would result in a loss of 3.8 pounds and 4.5 pounds, respectively. The authors conclude that there is a certain potential of taxes on SSB to reduce the prevalence of obesity and overweight in the US. However, they also point out that much of the effect depends on the reactions of manufacturers and retailers and how much they allow the tax to be fully passed forward to consumers. From a methodological point of view the elasticities received from household scanner data should be treated with care. Since beverages often are subject to price promotions, received elasticities are likely to mirror short-term purchasing behaviour and, thus, are higher in absolute values than long-term elasticities.

**Table 3: Mean estimates of own-price elasticities of demand for selected beverages, fast food, and fruits and vegetables, 2007-2012**

| Food and beverage category | Mean price elasticity estimate | Range | No. of estimates |
|---|---|---|---|
| (a) Sugar-sweetened beverages (SSBs and soft drink beverages) | | | |
| SSBs overall | -1.21 | -0.71 to -3-87 | 12 |
| SSBs | -1.08 | -0.87 to -1.26 | 3 |
| Regular carbonated soft drinks | -1.25 | -0.71 to -2.26 | 4 |
| Sports drinks | -2.44 | -1.01 to -3.87 | 2 |
| Fruit drinks | -1.41 | -0.69 to -1.91 | 3 |
| Soft drinks | -0.86 | -0.41 to -1.86 | 4 |
| (b) Fast food | | | |
| Fast food | -0.52 | -0.47 to -0.57 | 2 |
| (c) Fruits and vegetables | | | |
| Fruits | -0.49 | -0.26 to -0.81 | 4 |
| Vegetables | -0.48 | -0.26 to -0.72 | 4 |

***Source*: POWELL et al. (2013, p.117).**

POWELL et al. (2013) provide a compilation of estimated own-price elasticities from studies that are related to food taxes to reduce obesity (see Table 3). Although the mean values are quite high, especially for beverages, the size of the estimated coefficients varies strongly.

*5.1.3 The role of substitution effects*

SCHROETER et al. (2008) provide a detailed discussion of substitution effects that can occur when certain food items are taxed. They derive theoretical conditions that have to be fulfilled, when a tax or a subsidy should have a weight-reducing effect. Starting from a simple utility function that includes weight W, a high-calorie food product $F^H$, a low-calorie food product $F^L$, physical exercise E, and other consumption goods, where weight depends on $F^H$, $F^L$, and $E$, they arrive at equation (12):

$$(12) \qquad \frac{\varepsilon_{WF^L}}{\varepsilon_{WF^H}} \cdot \varepsilon_{F^L p^H} < \left| \varepsilon_{F^H p^H} \right| .$$

Equation (12) needs to be fulfilled when a tax should reduce body weight. $\varepsilon_{WF^H}$ and $\varepsilon_{WF^L}$ are the elasticities of weight W with respect to the intakes of $F^H$ and $F^L$, respectively, $\varepsilon_{F^L p^H}$ is the cross-price elasticity of $F^L$ with respect to the price of $F^H$ and $\varepsilon_{F^H p^H}$ is the own-price elasticity of $F^H$. The ratio of the weight elasticities is by definition smaller than one. SCHROETER et al. (2008) now discuss the relationships between those products: When $F^L$ and $F^H$ are complements, the cross-price elasticity is smaller than one and weight will decrease. When $F^L$ and $F^H$ are substitutes the outcome is less clear and depends on the relative energy content of the two food items. The condition in eq. (12) holds, when the energy content of $F^H$ substantially exceeds that of FL and $\varepsilon_{WF^L} / \varepsilon_{WF^H}$ reaches zero. However, when both food products have quite similar energy contents, the ratio approaches unity. Additionally, when $\varepsilon_{F^L p^H} > \left| \varepsilon_{F^H p^H} \right|$, eq. (12) is no longer fulfilled and weight will increase. Analogous conditions can be derived for income, exercise and for the case of multiple products.

Using food-price elasticities from literature and calculating food-weight elasticities via energy accounting, SCHROETER et al. (2008) simulate different tax scenarios. They find a weight-reducing effect of soft-drink taxes, a smaller weight-decreasing effect of subsidies on diet soft drinks and weight-increasing effects of taxes on food consumed away from home and subsidies on food eaten at home.

The studies presented so far have assessed probable welfare effects of food price interventions only with respect to the changes of consumption and expenditure and classical welfare calculations. They found that taxes are highly regressive because individuals of lower

socioeconomic status consume relatively more of the products in question and experience higher welfare losses when these products are taxed. However, some authors argue that these groups are also likely to enjoy the highest health benefits from weight reduction as a result of an intervention.

LUSK and SCHROETER (2012) propose a simple way to explicitly include the weight loss into a welfare analysis and examine the net welfare effect of a food price measure. Their analysis builds on the model in SCHROETER et al. (2008) where weight is explicitly included in the utility function. They use the indirect utility function to model the welfare effect of a tax *t* on the basis of an individual consumer's equivalent variation *EV* and arrive at equation (13):

$$(13) \qquad EV = p^H t\left(F^{H*} + WTP^W\left(\frac{\partial W^*}{\partial p^H}\right)\right).$$

The welfare effect of a fat tax is expressed by means of the equivalent variation, the amount of money that must be given to or taken from the consumer to keep him on the same utility level as before the tax. The tax would increase his welfare when *EV* is negative and decrease his welfare when *EV* is positive. The welfare-decreasing effect would be higher the higher the tax *t* and the consumption level of the taxed food $F^{H*}$ are. A welfare-increasing effect arises from the inclusion of weight: $\partial W^* / \partial p^H$ measures the weight change resulting from an increase in the price of high-calorie food and is smaller than zero, and $WTP^W$ is the individual's willingness to pay to reduce weight by one pound. Hence, the consumer benefits from a tax, when $EV < 0$ or $F^{H*} < -WTP^W\left(\partial W^* / \partial p^H\right)$.

Based on actual consumption data and the price-weight elasticities calculated in SCHROETER et al. (2008), LUSK and SCHROETER (2012) estimate how large a person's willingness to pay for weight reduction should be to realise a welfare gain from a fat tax. The most optimistic scenario suggests that an individual should be willing to pay $760 per pound weight lost to benefit from a tax. This amount is far higher in comparison to empirical values for WTP to lose weight that range around $13/lb to $33/lb (NARBO and SJÖSTRÖM, 2000; CAWLEY, 2004).

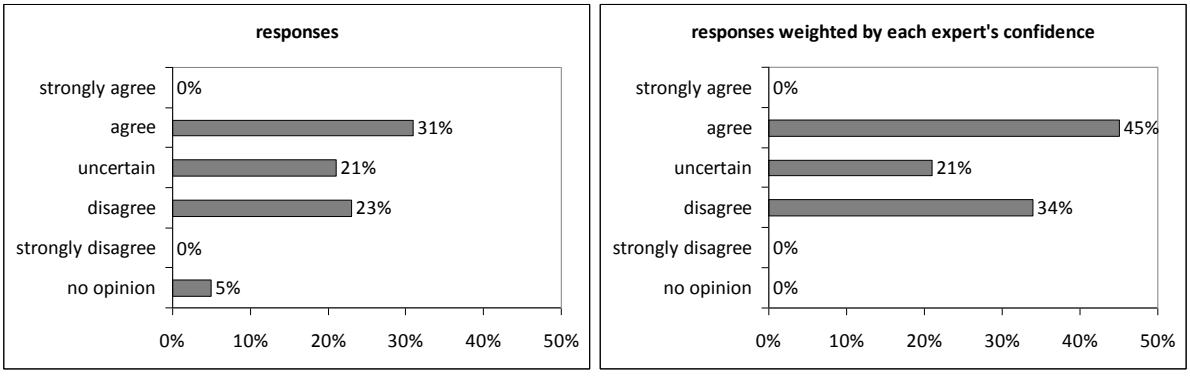
The effect of taxes on consumption and weight are likely to depend on food culture and the perception of what the relevant substitutes for consumers are. While in Europe the closest substitute to sugary soft drinks may be diet soft drinks, water or juice spritzer, consumers in the US will shift to sweetened milk drinks or gallons of juice.

*5.1.4 Divided opinions about the implications of the empirical results*

At this juncture the economic profession is divided whether fiscal measures significantly affect body weight and obesity prevalence. A poll of the IGM Economic Experts Panel among "distinguished experts with a keen interest in public policy from the major areas of economics" (IGM, 2013) revealed that a slight majority agrees to the statement: "Taxes or bans on large bottles of soft drinks containing sugar are not likely to have a significant effect on obesity rates because people will substitute towards consuming excessive calories in other ways". The explicit results are shown in Figure 10.

FAULKNER et al. (2011) conducted a Delphi survey among leading researchers in the field of obesity economics. These experts were asked to evaluate different policy measures according to several outcomes such as impact on consumption, physical activity, obesity, cost-effectiveness, unintended consequences, equity issues and political feasibility. The results of this Delphi survey are shown in Table 4.

**Figure 10: Results of IGM economic expert panel on soft drinks taxes**




Note: Responses (in %) to the statement „Taxes or bans on large bottles of soft drinks containing sugar are not likely to have a significant effect on obesity rates because people will substitute towards consuming excessive calories in other ways".

***Source*: IGM (2013).**

The participants evaluated the effectiveness of most interventions as "low" to "moderate". FAULKNER et al. (2011) report that three-quarters of the panel supported the introduction of a tax on sugar-sweetened beverages. This judgement seems to be based less on the moderate impacts on consumption or obesity but rather on the possible "powerful impact over time ", where the tax functions as a signal for other "tax, legislative, and educational initiatives to address obesity" (p.8) where certain food items are stigmatised. As these expectations are not really based on sound scientific evidence, the conclusions drawn by FAULKNER et al. (2011) are highly questionable:

*"Overall, the evidence is not sufficiently strong to provide clear policy direction. Additionally, the nature of the experiments needed to provide definitive evidence supporting certain policy directions is likely to be complex and potentially unfeasible. However, these are no reasons to take no action. It is likely that policies need to be implemented in the face of an incomplete evidence base" (ibid., p.1).*

**Table 4: Results of a delphi survey on likely effects of intervention to reduce obesity**

| | Impact on consumption | | Impact on PA | | Impact on obesity | | Cost-effective | | Unintended benefit | | Unintended harm | | Equitable | | Politically feasible | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Intervention** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** | **Mean** | **IQD** |
| Beverage tax | 2.9 | 0 | | | 2.1 | 0 | 2.9 | 0.5 | 2.5 | 1 | 2.4 | 1 | 2.3 | 1 | 2.5 | 1 |
| Food tax | 2.7 | 1 | | | 2.2 | 0.5 | 2.8 | 0.5 | 2.4 | 1 | 2.8 | 1 | 1.9 | 0 | 2.1 | 0 |
| Fruits & Vegetables subsidies | 2.9 | 0 | | | 2.1 | 0 | 2.3 | 1 | 2.9 | 0 | 2.1 | 1.5 | 2.5 | 1 | 2.5 | 1 |
| Child fitness tax credit | | | 2.3 | 1 | 2.1 | 0.5 | 2.1 | 0.5 | 2.8 | 0.5 | 2.0 | 0 | 2.1 | 1 | 3.2 | 1 |
| Adult fitness tax credit | | | 2.3 | 1 | 1.8 | 0 | 2.0 | 0 | 2.5 | 1 | 2.0 | 0 | 2.0 | 0.5 | 2.9 | 0.5 |
| Public transit tax credit | | | 2.1 | 0 | 2.0 | 0 | 2.2 | 0 | 3.1 | 0.5 | 1.9 | 0.5 | 2.7 | 1 | 3.2 | 1 |
| Sporting equipment tax credit | | | 1.9 | 0 | 1.7 | 1 | 1.7 | 1 | 2.3 | 0.5 | 1.9 | 0 | 2.1 | 0 | 2.6 | 1 |
| Subsidised PA programs | | | 2.5 | 1 | 2.0 | 0 | 2.1 | 0 | 2.6 | 1 | 2.1 | 0 | 2.3 | 0 | 2.5 | 1 |
| Road congestion tax | | | 2.1 | 0 | 1.7 | 1 | 2.5 | 1 | 3.4 | 1 | 1.9 | 0 | 2.4 | 1 | 2.3 | 1 |
| Income transfer unrestricted | 2.0 | 1.5 | 1.7 | 1 | 1.9 | 1 | 1.8 | 1.5 | 2.9 | 0.5 | 2.7 | 1 | 2.0 | 1.5 | 2.5 | 1 |
| Income transfer healthy food | 2.9 | 0.5 | | | 2.1 | 0 | 2.6 | 1 | 2.8 | 0.5 | 2.3 | 0.5 | 2.4 | 1 | 2.8 | 0.5 |
| Income transfer PA | | | 2.3 | 1 | 1.9 | 0 | 1.9 | 0 | 2.5 | 1 | 2.0 | 0 | 2.3 | 1 | 2.2 | 1 |
| Agricultural subsidies | 2.4 | 1 | | | 2.3 | 0.5 | 2.9 | 0.5 | 2.9 | 1.5 | 2.6 | 1 | 2.1 | 1 | 1.7 | 1 |
| Agricultural R&D rebalance | 2.4 | 1 | | | 2.2 | 0.5 | 2.5 | 1 | 2.9 | 0.5 | 2.3 | 1 | 2.8 | 0.5 | 2.7 | 1 |

Notes: Not at all/None = 1; Low = 2; Moderate = 3; High/A lot =4.
PA = Physical Activity; IQD = Inter Quartile Deviation; indicates the distance between the 25th and the 75th percentiles. A smaller IQD represents greater consensus.

***Source*: FAULKNER et al. (2011).**

*5.1.5 Econometric challenges for inference on food price effects*

Since many of the factors influencing and influenced by body weight "are usually not subject to experimental manipulation" (AULD and GROOTENDORST, 2011, p.237), research on relationships between economic variables and body weight mainly relies on observational data. The attempt to infer causal effects related to obesity and overweight, however, faces various challenges regarding estimation methods and data quality (AULD and GROOTENDORST, 2011). Especially "the exogeneity of food prices is an important identification challenge" (LAKDAWALLA and ZHENG, 2011, p.465).

A main concern is the problem of endogeneity causing bias in the parameters that should show the causal effects of one variable on another. Endogeneity exists when the independent variables in least-squares regressions are correlated with the error term and can have three different sources that most probably exist in many obesity research questions. 1) The relation between independent and dependent variable is not unidirectional but is rather characterised by reverse causality. 2) Important factors that affect the independent variable are not included in the regression equation (unobserved heterogeneity, omitted variables). When correlated with an independent variable, the coefficients will be biased. 3) Independent variables are measured with error (AULD and GROOTENDORST, 2011).

One example where endogeneity probably plays a role is the relationship between the prevalence of obesity in a certain area and the number of fast-food outlets there. Statistics show a very similar development of restaurant density and obesity over time, leading numerous researchers to establish a causal relationship. However, whether more restaurants cause higher obesity rates is questionable (ANDERSON and MATSA, 2011). We could as well suppose a reverse causality (people eat fast-food more often when the density of outlets is higher and gain weight but fast-food restaurants settle in areas with higher obesity prevalence) but also confounding factors like the tendency of obese people and fast-food outlets to locate in lower-income areas (AULD and GROOTENDORST, 2011). Another example would be obesity and schooling, where both variables can be assumed to be affected by other factors simultaneously (like motivation, abilities, family background, or discipline) (AULD and GROOTENDORST, 2011). Likewise, "food prices might be higher in areas with higher demand for food and during periods with higher demand for food" (LAKDAWALLA and ZHENG,

2011, p.465). Moreover, the measurement of food prices can be subject to substantial errors, especially, when aggregate food prices are employed (LAKDAWALLA and ZHENG, 2011).

Possible solutions to these problems are randomized controlled trials, adjustments of covariates, the use of instrumental variables and the application of panel data methods. However, LAKDAWALLA and ZHENG (2011) point out that all of the different approaches to identification "suffer from one or more key weaknesses" (p.466). The gold standard to identification are *randomized experiments*, where the influencing factor (*x*) can be controlled by the researcher independent to any other influencing factor on the dependent variable (*y*) (ANGRIST and PISCHKE, 2009). "Since controlled experiments are frequently costly or infeasible, obesity researchers commonly use observational data to infer causation" (AULD and GROOTENDORST, 2011, p.240). To reduce omitted-variable bias or confounding, the analyst should integrate as many possible variables that affect obesity as possible. However, some factors that lead to heterogeneous outcomes simply are not observed or cannot be observed. Additionally, "covariate adjustment does not correct for other types of endogeneity, i.e. measurement error and reverse causality" (AULD and GROOTENDORST, 2011, p.240).

A third approach to endogeneity is the use of Instrumental Variable (IV) techniques. Here, the researcher employs so-called instruments, one or more variables that affect *x*, are not correlated with the error term and their impact on *y* is exclusively through their impact on *x*. Thus, the part of the variation in *x* caused by the instruments is independent from any other source and of a "quasi-experimental" nature (AULD and GROOTENDORST, 2011). However, IV estimators are subject to strong reservations either because of weak instruments (they explain only little of the variation in *x*) or because they are correlated with the error term. A variable proposed to instrument food prices are relative food taxes (LAKDAWALLA and PHILIPSON, 2002) that, however, vary very little over time. Fast food availability is instrumented by proximity to interstate highways (ANDERSON and MATSA, 2011). A drawback here is the very small effect of interstate location on restaurant utilisation (LAKDAWALLA and ZHENG, 2011).

A fourth and frequently applied tool are panel data models. The use of longitudinal data that include several observations for the same individuals or households over time allows at least some potential endogeneity source to be avoided. It is assumed that important but usually immeasurable determinants on obesity (like culture, discipline, motivation) that are

correlated to regressors (like prices, age, and education) are constant over time. Hence, estimators considering only the varying factors (like fixed-effects models or differenced models) are not subject to this kind of endogeneity. Therefore, "the most common approach to identification is to control for area and time fixed-effects in panel data" (LAKDAWALLA and ZHENG, 2011, p.465). This allows avoiding endogeneity caused by unobserved regional factors (like eating habits, culture tradition, and infrastructure) that affect BMI and are correlated with food prices. Possible difficulties could arise when time trends are not homogeneous across all areas (LAKDAWALLA and ZHENG, 2011).

In their review of studies analysing the effect of food prices on BMI, POWELL et al. (2013) report that "longitudinal estimation methods" are increasingly used. "Studies that provided both cross-sectional and longitudinal estimates revealed that the associations mostly but not always remained statistically significant in the longitudinal models. However, the longitudinal fixed-effects estimates showed that the cross-sectional estimates often overestimated the associations highlighting the importance of controlling for individual-level unobserved heterogeneity" (ibid., p.124).

AULD and GROOTENDORST (2011) stress that most of the regressions that analyse the determinants of obesity have very low $R^2$ values - usually around 0.1. Many of the commonly included socioeconomic and environmental factors apparently explain only little of the total variation in body weight. It follows that those variables may be insufficient to influence body weight substantially. Moreover, the usefulness of IV techniques is limited in such a case.

A final challenge to the econometric analysis of obesity is the dynamic formation of body weight. From such a perspective, body weight is a stock variable determined by the flow of net energy intake/expenditures in the past (AULD and GROOTENDORST, 2011). Measuring all the possible economic and non-economic factors as well as incorporating them into a model is close to impossible. "An additional challenge in this line of research is that very small changes in behaviour can produce large changes in weight over time" (AULD and GROOTENDORST, 2011, p.249).

### *5.1.6 Issues of policy design*

POWELL and CHRIQUI (2011) discuss in which manner pricing policies should be designed to yield the best outcomes. With respect to the *size* of a tax, the obviously inelastic reactions of energy intake and body weight to price changes should be taken into account. High tax rates

would be necessary to induce a shift in behaviour that leads to a reduction in body weights. When the objective is to raise revenues, smaller taxes should be preferred since they "hold tremendous potential" (POWELL and CHRIQUI, 2011) for generating government revenues. This widely expressed view is, however, not necessarily consistent with the theory of an optimal tax. In the case of an inelastic demand, the revenue maximising tax rate actually may substantially reduce consumption *and* generate very high revenues. One remaining argument for small taxes is that they seem to be more feasible from a political perspective (e.g. JACOBSON and BROWNELL, 2000). Moreover, the public is more likely to accept such taxes, when the revenues are earmarked for other measures, like information campaigns, to reduce obesity (e.g. KUCHLER et al., 2005). Governments, however, are usually not obliged to exclusively use these revenues for targeted purposes.

Another issue regarding the design of taxes is finding a suitable *tax base*. POWELL and CHRIQUI (2011) argue that taxing specific groups of food would be easier with respect to legislative and administration efforts compared to taxing ingredients or nutrient content of food items. Public health experts target especially those food groups with low nutritional value like soft drinks (BROWNELL et al., 2009; CARAHER and COWBURN, 2005).

In contrast, CHOUINARD et al. (2007) compare taxing certain food groups such as soft drinks or snack foods to reduce sugar or fat intakes to "taxing electricity consumption – regardless of the source – to reduce air pollution" (p.1). Such a tax scheme would cause no substitutions away from products with high contents of the unhealthy nutrient to products with lower contents within the food groups. They advocate taxes on the proportion of fat or sugar in food items, analogous to taxing carbon to reduce greenhouse gas emissions because "such a tax would fall unequally on food according to their fat content" (p.1). MAZZOCCHI et al. (2009) point out that such "taxes on ingredients would trigger various repercussions" (p.139). Taxing ingredients rather than food groups would eventually cause food manufacturers to reformulate their products, e.g. decreasing the contents of the unhealthy ingredients. However, products that contain high levels of substances deemed as unhealthy often contain considerable amounts of healthy ones. Examples are dairy products that are rich fat *and* calcium or fruit juices rich in sugar *and* vitamins.

According to LEICESTER and WINDMEIJER (2004), taxes on nutritional content will cause high monitoring costs and may have unintended effects on other nutrients. High costs of administration, for instance, were one of the reasons to remove the fat tax in Denmark (see

also the Introduction). PHILIPSON and POSNER (2008) argue that "probably, any feasible tax response to obesity would cost more to enforce than it would be worth in reducing the social costs of obesity" (p.615).

US literature further discusses whether fat taxes should be levied on federal or state level. From a European perspective the question would be rather whether these apply within single countries or within the Union. The case of Denmark has shown for instance that people went increasingly shopping for their butter etc. in neighbouring countries, to the disadvantage of local producers and retailers.

Finally policy makers have to consider the appropriate form of the tax, i.e. whether sales or excise taxes should be favoured. POWELL and CHRIQUI (2011) argue that excise taxes have some advantages over sales taxes: 1) as a part of the shelf price, excise taxes are more obvious to consumers; 2) the location of purchase (stores, vending machines, restaurants) would not matter in case of an excise tax; 3) if an excise tax was applied, there would be no possibility to lower the tax rate per unit of the product compared to possible effects of volume discounts on sales taxes (e.g. by selling large containers). BROWNELL et al. (2009) add that sales taxes may lead consumers to switch to lower-priced brands. However, different views exist whether a higher visibility of a tax would be an advantage or a disadvantage. CASH et al. (2008) suggests that the act of taxation not only alters prices but conveys additional information and thereby puts a stigma on the taxed products that may trigger stronger consumer reaction.

CASH et al. (2005) emphasise that individuals can follow a healthy diet even if they consume snack foods or soft drinks sometimes because they like them. Such persons would be penalised by a tax without a reason. A more differentiated tax only on excessive consumption of certain foods, for instance, would, however, be impracticable.

CARAHER and COWBURN (2005) propose to draw the focus of fat taxes away from consumers. They argue that taxes and subsidies on raw materials at the manufacturer level may encourage the production of healthier food. Additionally, price measures in "closed systems such as schools and the workplace" (ibid., p.1242) may be more promising compared to a general intervention. BROWNELL et al. (2009) favour a threshold approach for sugar-sweetened beverages of 1 g of sugar per ounce (30 ml) to "encourage manufacturers to reformulate products" (p. 1602).

*5.1.7 Conditions of successful tax policies*

ALLAIS et al. (2009) expect reactions to taxes from the food industry such as product reformulations and discuss two possibilities. On the one hand, producers can lower the nutritional quality of their products to keep prices relatively constant. An opposite strategy would be to raise the value of the product by adding "more expensive ingredients and/or implementing new processes". The resulting product would be less affordable to low-income consumers. Hence, both strategies would decrease nutritional quality among households of lower socio-economic levels. Also ETILÉ (2011) points out that an important underlying assumption for the simulation of changes in nutrient intakes is that the "nutritional composition of products is unaffected by price changes" (p.733). When this condition holds true, researchers are able to simulate how prices affect demanded food quantities and, in turn, the nutrient intakes as for instance done by BEATTY and LAFRANCE (2005) (ETILÉ, 2011).

**5.2 Discussion about agricultural policies**

Some authors from the public health field have blamed the agricultural production system as well as agricultural policies for contributing to the obesity epidemic. In the US, for instance, POLLAN (2003) points out that "while one hand of the federal government is campaigning against the epidemic of obesity, the other hand is actually subsidizing it, by writing farmers a check for every bushel of corn they can grow" (p.2). Additionally, the race of farmers to increase yields and output by innovations in agricultural technology in order to hold up revenues in times of decreasing prices was a "sure-fire recipe for overproduction" (p.2). For the case of the EU, SCHÄFER ELINDER (2005) argues that it is "important to tackle the oversupply of food, driven by agricultural subsidies" (p.1333) provided by the Common Agricultural Policy (CAP) of the European Union (EU). To illustrate her arguments, she gives two examples from the milk sector where "production levels at 20 % above the domestic demand" are maintained, "at prices twice as high as on the world market" (p.1334). Some of the surplus milk is "sold with subsidies to the food industry, which turns it mainly into ice cream and cakes" another is used for the school milk program. The first case would result in additional 1.5 kg of butter per person and year; the second translates into 1.5 kg saturated fats per child and year, so the calculations of SCHÄFER ELINDER (2005).[6]

[6] This calculation, however, does not consider likely compensatory effects, e.g. drinking less milk at home.

Naturally, these reproaches have prompted agricultural economists to analyse the likely effects of agricultural policies on food prices and (over)consumption in more detail. ALSTON et al. (2008) acknowledge the possibility that "farm subsidies contribute to lower relative prices and increased consumption of fattening foods by making certain farm commodities more abundant and therefore cheaper" (p.472). For this to happen, however, they formulate three preconditions that must be met: 1) subsidies must significantly decrease the prices of farm commodities that serve as inputs to "fattening" foods, 2) a decrease in the prices of those inputs must translate to lower prices of the final food products at the retail level, 3) lower prices of the end products must significantly increase the consumption of these foods.

The effect of subsidies on commodity prices is regarded as rather small. Prices of some commodities like food and feed grains (used for the production of cereals, pasta, bread or livestock) experienced a decreasing effect by subsidies. However, an increase in production and consumption has been restricted by "additional policies that restricted acreage or production" (ALSTON et al., 2008, p.472). Other commodities like sugar, dairy products, and orange juice are subject to import restrictions that increase the price and reduce consumption (ALSTON et al., 2008). Several authors have estimated the effects of eliminating US farm programs and conclude that commodity prices, except for corn and wheat, would decrease and, in turn, would trigger higher consumption (MCDONALD et al., 2006). Larger effects could be expected from eliminating subsidies for subsectors like crops or corn (ALSTON, 2007; SUMNER, 2005).

Examining the special case of sweetener crops, BEGHIN and JENSEN (2008) conclude that "the current link between US sweetener consumption and farm policy is weak" (p.480). Mainly the low farm value share in sweetened foods is responsible for the low influence of policies targeted at the farm sector on the final retail products. The situation may have been different in earlier times and especially public expenditures on research and development have substantially lowered the price of corn and feed costs in the production of meat, poultry and dairy products. Likewise, High Fructose Corn Syrup (HFCS) is obtained from corn which constitutes an input for most soft drinks and sweets.

In response to SCHÄFER ELINDER and others, SCHMIDHUBER and SHETTY (2010) asses how Europeans' diets have changed and what contribution the Common Agricultural Policy made to this change. From the 1960s to the 2000s energy supply increased and also the share of

lipids in diet increased. The share of sugar remained nearly constant, with declines in the North and rising intakes in the South. However, it is remarkable that simple carbohydrates like added sugar and refined flour "have not significantly replaced in large measures foods rich in complex carbohydrates" (p.133). The intake of refined carbohydrates is substantially higher in other countries, first and foremost the US (more than twice as much) but also Egypt, Lebanon and other countries in the Near East (SCHMIDHUBER and SHETTY, 2010).

The availability of fruits and vegetables is far more than the recommended 400 g per day and person though real intakes are much lower. The authors report that the CAP has "significantly raised primary food prices" (p.144), in particular of sugar, milk and dairy products, and meat. Thus, especially the "bad" nutrients like saturated fats, cholesterol and sugar have been taxed. High margins and low rates of vertical price transmission hindered a significant impact of the CAP on final consumer prices. "If anything, the main instruments of the CAP should even have curbed food consumption, rather than stimulated it, notably of saturated fats and sugar" (p.145). SCHMIDHUBER and SHETTY conclude that the CAP has not been and would not be an efficient tool for changing food consumption and point to other more relevant factors like increases in income and the availability of food, female labour-force participation and growing food-away-from-home (FAFH) consumption. However, the authors concede that the CAP may have substantially affected consumption patterns in countries outside the EU. Especially in the region of the Near East and North Africa, export subsidies and resulting lower prices combined with lower margins to the final product "may have stimulated over-consumption, and contributed to the region's growing overweight and obesity problem" (p.145).

The key piece in the empirical evidence is the share of farm products in the total production costs of food at the retail level. On average this share is about 20 % (ALSTON et al., 2008) and much lower for highly processed foods that are prominently blamed for overweight and obesity. According to BEGHIN and JENSEN (2008), the share of HFCS amounts to only 1.6 % of the value of soft drink sales. Hence, even large price changes at the farm-gate level would result in negligible changes in food prices faced by consumers. MILLER and COBLE (2007) compared direct payments to producers and total food expenditures of consumers. Between 1960 and 2003 the subsidies were on average 1.1 % of consumer expenditures implying a very low effect on consumption decisions.

While the impact of farm policies/programs on the change in food consumption patterns seems to be limited, public investments in research and development probably played a more important role (ALSTON et al., 2008; BEGHIN and JENSEN, 2008). ALSTON et al. provide figures according to which food prices have decreased substantially since the 1950s (for livestock by 54 %, field crops by 72 %, vegetables by 28 % and fruits and nuts by 23 %). They conclude that "these price changes are sufficient to have had meaningful impacts on the cost of food and the prices paid by consumers for food products" (p.477). A reversal of the technological change would increase the price of final food products by 20 %, which would trigger a significant demand response.

RICKARD et al. (2013) simulate effects of US agricultural policies on calorie intake based on a comprehensive model that takes into account both the market for primary commodities as well as for processed food products. They conduct their simulations for three different time periods as well as for different commodity categories. RICKARD et al. (2013) find that "holding all other policies constant - removing US subsidies on grains and oilseeds in the three periods would have caused caloric consumption to decrease minimally whereas removal of all US agricultural policies (including barriers against imports of sugar and dairy products) would have caused total caloric intake to increase" (p.316). Moreover, they report a decreasing policy impact on energy in the course of time that approaches zero.

BONNET and REQUILLART (2011) analyse how the EU sugar policy reform affects the consumption of sugar. Using the example of the soft drink market, they estimate that sugar prices will fall by 36 % which reduces soft drink prices by 3 %. These lower prices would cause higher soft drink consumption and an additional sugar intake of 124 g per person per year.

## 6 Some open questions

This paper provided a comprehensive review of the economic literature on obesity. It showed that economic research addresses many important and relevant aspects concerning our view of consumer behaviour, uses innovative econometric techniques to analyse behaviour related to health and nutrition and contributes to the public discussion on policies to halt and reduce the increasing prevalence of obesity worldwide. This review also revealed, however, that the case of obesity is very complex and that many research questions remain open.

First of all, *heterogeneity* plays an eminent role. The descriptive statistics in Section 2 clearly show large gradients of obesity prevalence based on age, sex, income, education and other socio-economic characteristics. The development of the BMI distribution further indicates that some groups are especially vulnerable to changed environments. Consequently, we would expect considerable variation in consumer behaviour such as different reactions to prices. Moreover, studies that analyse such behaviour urgently need to consider heterogeneity in order to facilitate targeted policy-making.

A second aspect that the existing literature neglects is a consideration of *food quality*. Theoretical discussions about effects of fat taxes or thin subsidies exclusively focus on the substitution of one product (group), for instance meat, by another, let's say vegetables. In the presence of increasing product differentiation and supply of various quality levels, however, it might well be that taxing a certain product results in consumers still buying that product but at a lower price and quality level.

A third challenge for analysing interrelationships between body weight or other health indicators and economic determinants concerns *econometric methodology and adequate data*. The discussion in Section 5.1.5 stressed that fixed-effects estimation methods based on longitudinal data is an important and widely used tool to control for other variables that are omitted or unobservable. It is also necessary to have access to exogenous and detailed price data.

A final aspect is the theoretical treatment of human behaviour related to health and nutrition. Here, the *emphasis on the trade-offs between different utility-generating objectives* subject to budget or other constraints is very appealing (see Sections 3.1 and 3.2). This is exactly the core of decisions that human beings face every day. However, many papers that use those theoretical concepts, especially of household production theory, neglected or deliberately leave out important aspects in order to get a smooth and simple theoretical model.

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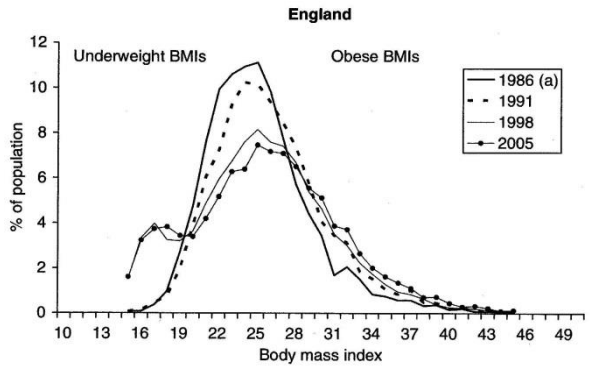
## Appendix

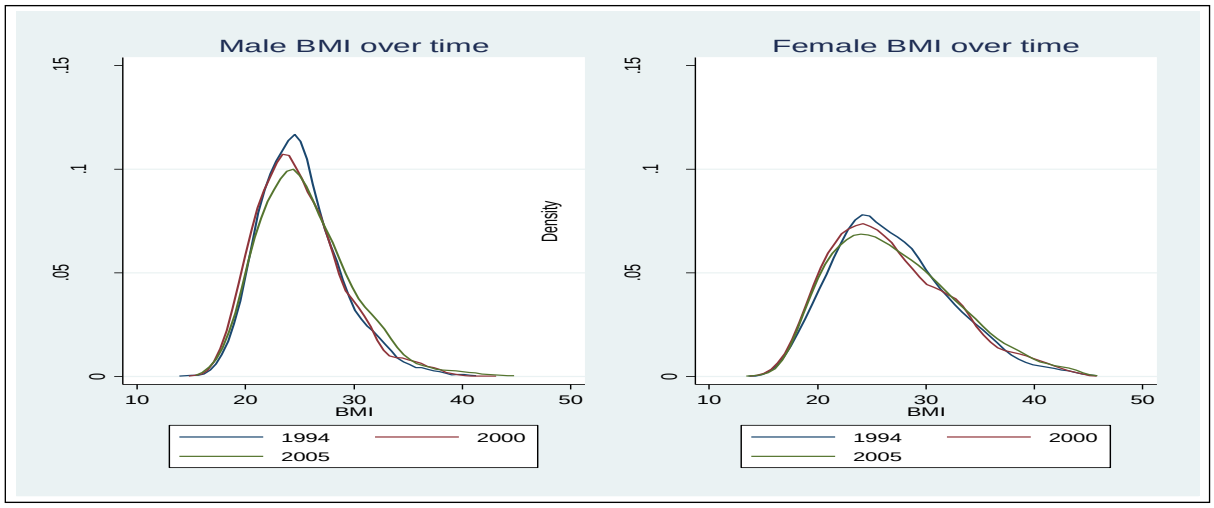
**Figure A1: Distribution of BMI in England, 1986-2005**




Data for 1986 refer to Britain and for 1991-2005 to England.

***Source*: MAZZOCCHI et al. (2009) based on data from the DNS Britain (1986/7) and from Health Survey of England.**

**Figure A2: Distribution of BMI in the Russian Federation, 1994-2005**




***Source*: Own presentation from RLMS data, 1994-2005.**

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