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Information Deficits and Overweight

Abstract

The prevalence of overweight has exploded across the world over the last 30 years. Sometimes known as *the obesity epidemic*, the steep increase in the number of overweight individuals comes at a large cost, both for the overweight individuals and society. Consequently, the causes of overweight are keenly debated.

In this thesis, we investigate one proposed factor behind overweight: incomplete information. In particular, we examine whether there is a correlation between people's perception of energy content of sugar-rich drinks and energy-dense food products (SDEF) relative to normal meals and their BMI. Through a quantitative study including 301 Swedish adults, we find no evidence that lack of information about energy content of SDEF is an important factor behind overweight. Consequently, we cannot support claims that increased information about energy content of food products (for instance through additional food nutrition labeling) is an essential part of a successful campaign against overweight.

Key Words: Obesity, overweight, food energy content, nutrition labeling, BMI, health economics

Authors: Niklas Engbom[*]
Lars Gezelius[†]
Tutor: Magnus Johannesson
Examiner: Örjan Sjöberg
Discussants: Petra Alestalo
Saana Kyröläinen
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[*] 21039@student.hhs.se.
[†] 20887@student.hhs.se.

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Table of Contents

Definitions

Body Mass Index (BMI)[1] – The most commonly used index to classify an individual's weight-related status: $BMI = \frac{weight(kg)}{(height(m))^2}$

Underweight – BMI< 18.5[2]

Normal weight – 18.5≤BMI<25[3]

Pre-obese[4] – 25≤BMI<30

Obese – 30≤BMI

Overweight[5] – 25≤BMI

SDEF – Sugar-rich drinks and energy-dense food products

[1] Throughout this thesis, all BMI values have the implicit unit kg/m^2.
[2] In some research defined as BMI<20.
[3] Admittedly, BMI values clearly are continuous. Nevertheless, we maintain the greater than *or equal to* sign as measurement errors make the measured variable discrete.
[4] Sometimes also referred to as overweight.
[5] Following the use of the World Health Organization (WHO 2010).

1. Introduction

"Obesity presents Europe with an unprecedented public health challenge that has been underestimated, poorly assessed and not fully accepted as a strategic governmental problem with substantial economic implications" concludes the World Health Organization (WHO) in a recent report (Branca, Lobstein and Nikogosian 2007, p. xiii). The rise in prevalence of overweight over the last three decades has indeed been remarkable, with obesity rates in Europe tripling or more since the 1980's (Branca, Lobstein and Nikogosian 2007). In Sweden approximately one half of men and one third of women are today considered overweight (Danielsson and Norberg 2009).

Consequently, the question what factors contribute to the rise is lively debated. Within medical research scientists examine, for example, what genes are associated with overweight, what food products are likely to cause overweight, and how overweight people are best treated from a medical point of view. Sociological studies show that race, gender and socioeconomic status, among others, are factors behind overweight (see for example Bray, et al. (2002), and French, Huang and Lin (2004)). Nevertheless, changes in such demographic factors are unlikely to solely explain the increased prevalence of overweight over the last decades (Cutler, Glaeser and Shapiro 2003). As a result, overweight is also a relevant field of study for economists. Basically, overweight is a consequence of an imbalance between energy intake and energy expenditure, with research today suggesting that changes in both have contributed to the increased prevalence of overweight around the world (Petersen, Schnohr and Sørensen 2004). Whatever the exact contribution of each channel is, overweight is (at least partly) a result of individual choice. Examining what forces affect these choices – and how the forces develop over time – is a task for economists.

Furthermore, overweight is clearly problematic from a medical point of view, but not necessarily from an economic. The energy imbalance causing overweight could in fact be utility maximizing for the individual, if some individuals prefer eating more and being overweight. However, if additional factors, such as incomplete information or self-control problems, prohibit the individual from maximizing his expected utility – or if there are negative externalities associated with overweight – overweight becomes an economic problem. By examining the factors behind overweight, economists can clarify whether public intervention to fight overweight is desirable.

If the government decides to intervene, one proposed way in which it could do it is through a "sugar tax" on particularly sugar-rich food products – currently debated in the US (Adamy 2009) – another through a clearer nutrition labeling policy as is currently discussed in the EU (Chaffin 2010). Another possibly effective policy would be to limit consumers' exposure to unhealthy products; for instance, advertising bans have been shown to have significant negative effects on tobacco consumption (Chaloupka and Saffer 2000). Eventually, the most efficient means in fighting overweight are likely to be those that target the roots of the problem. Thus, by examining the factors behind overweight, economics can simultaneously advice on how a potential public response to overweight is best designed.

1.1. Purpose of this Thesis

In this Master's thesis we focus on one potential factor behind overweight: incomplete information. Specifically, we aim to clarify whether information deficits regarding energy content of food products partly explain overweight. Simultaneously, we hope to draw conclusions about efficient policy responses to overweight.

1.2. Delimitation

We concentrate on perception of energy content in sugar-rich drinks and energy-dense food products (throughout this thesis SDEF) relative to normal meals because overconsumption of SDEF is regularly suggested by research as an important factor behind overweight (among others, Graubard and Kant (2005)). Furthermore, sources such as the WHO suggest that people might have particular difficulties correctly estimating the energy content of SDEF (Branca, Lobstein and Nikogosian 2007). Thus, if a lack of information regarding energy content is a factor behind overweight, this might be particularly applicable for SDEF. Also partly for the reasons mentioned above, many of the proposed policy options aiming at reducing overweight rates target SDEF. By focusing on these types of products, we hope to contribute to the debate surrounding them. We also limit our study to only focus on Swedish adults (18–85 years old).

1.3. Hypothesis

Suppose that some individuals categorically underestimate the relative energy content of SDEF: this might induce these individuals to consume more such products. Given that previous research has indicated precisely overconsumption of SDEF as an important factor behind overweight, such a misperception about relative energy content of SDEF might make these individuals prone to gain excessive weight. We evaluate such a scenario in this thesis.

Hypothesis: *a higher perception of relative energy content of SDEF contributes to a lower BMI among the Swedish adult population.*

1.4. Disposition

This paper consists of seven main chapters. In the next chapter, we give a background to the problem of overweight and discuss some of its economic consequences. In the third chapter, we use a model to briefly explain what might induce an individual to become overweight as well as discuss implications for public policy. In the fourth chapter, we introduce the methodology used in our quantitative study, the variables examined and discuss causality. In the fifth chapter, we present data and regression results, which we analyze in the sixth chapter. Finally, we summarize our findings in the seventh chapter. The inquisitive reader is referred to the appendices for supplementary data.

2. Background

Before we delve into the question of focus, we use the following three pages to give a quick overview of overweight. In the next section, we describe how overweight rates have grown over the last decades. Thereafter, we illustrate the costs associated with overweight, and finally we discuss the energy imbalance that causes weights to rise.

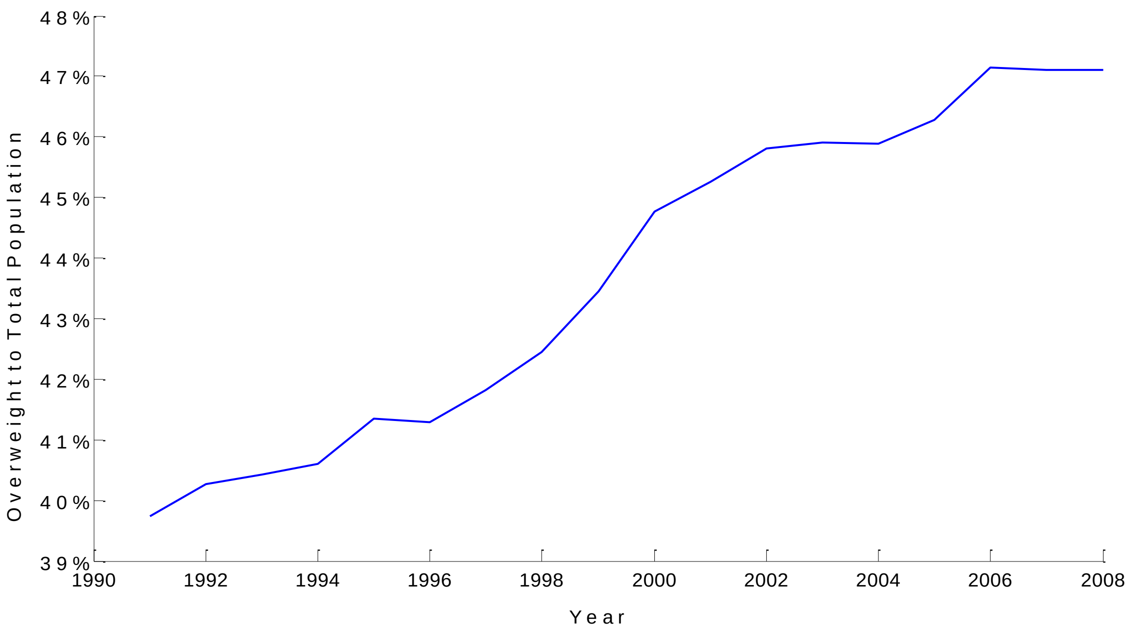
2.1. The Fattening of the World

Average obesity rates in the WHO European region[8] have increased threefold or more since the 1980's, see *Figure 1*. Today, overweight affects between 30 and 80 percent of adults in European countries, and up to one third of children (Branca, Lobstein and Nikogosian 2007). If the trend growth continues, 150 million adults are estimated to be overweight in Europe by 2010 (Branca, Lobstein and Nikogosian 2007). In the US, obesity rates more than doubled from 13 to 27 percent from 1960 to 2000 (Cutler, Glaeser and Shapiro 2003), and currently 73 percent of US adults are overweight (National Center for Health Statistics 2008). The scenario is similar in a large part of the developed world, and overweight is also a growing concern in many developing countries (Cecchini, et al. 2009). In Asia, the ratio of overweight Chinese men more than tripled from 4 to 15 percent in the period 1996–2004, while that of Chinese women doubled from 10 to 20 percent (Bell, Ge and Popkin 2001). Whereas in low-income countries, prevalence of overweight is higher in urban areas and with people of high socioeconomic status, high-income countries exhibit higher concentrations of overweight in lower socioeconomic groups, especially among women and in rural areas (Bacallao and Peña 2000) (Rissanen and Seidell 2004). The higher

[8] Including EU 25 and CIS countries – please refer to the WHO European Region office web site (http://www.euro.who.int/) for a full list of included countries.

prevalence of overweight among lower social strata in developed countries has been an additional source of concern in many OECD countries as it risks accentuating inequalities (Akdağ and Danzon 2006).

Figure 1: Development of the average overweight rate in selected OECD countries over the last two decades.



***Note*: Selection based on data availability. Unweighted average calculated for Austria, Canada, the Czech Republic, Finland, France, Italy, Japan, the Netherlands, Spain, Switzerland, the United Kingdom, and the United States.**
***Source:* OECD (2009).**

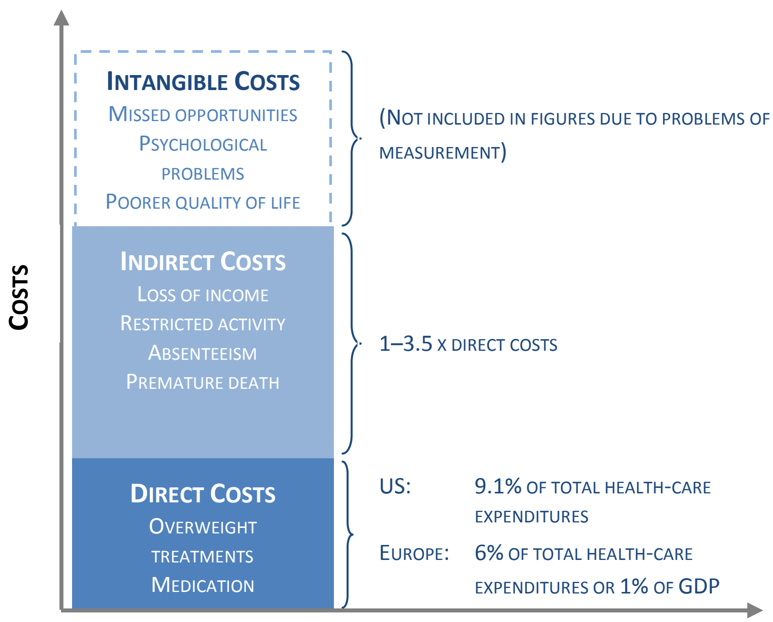
2.2. Overweight is No Free Lunch

Overweight increases the risks of coronary heart disease, hypertension, cancer at various sites, stroke, gallstone and asthma, as well as the use of long-term medication (Edelsberg, et al. 2000), just to mention some of its consequences. The risks associated with overweight increase gradually already from the upper part of the normal weight BMI span (Coakley, et al. 2001). In Europe, overweight is estimated to be a factor behind 80 percent of type-2 diabetes, to cause one million deaths per year and result in 12 million life-years of ill-health (Jackson-Leach, et al. 2004). Furthermore, overweight may reduce life quality and psychological well-being (Branca, Lobstein and Nikogosian 2007).

Costs of fighting overweight and its symptoms are referred to as direct costs of overweight, see *Figure 2*. Studies approximate such costs to 9.1 percent of total health-care expenditures in the US (Cox, Kortt and Langley 1998) (Fiebelkorn, Finkelstein and Wang 2003). Europe is not far behind; some estimates put direct overweight costs at up to six percent of total health-care costs or almost one percent of GDP (Branca, Lobstein and Nikogosian 2007).

Overweight also gives rise to indirect costs, such as loss of income from decreased productivity, restricted activity, absenteeism and premature death. For instance, obese individuals have an average life expectancy of six to seven years less than their normal weight peers (Haslam and James 2005).[9] It has been estimated that indirect costs of overweight are at least equal in size to direct costs, with the WHO estimating indirect costs to be at least twice as high (Akdağ and Danzon 2006). In Sweden, some estimates put direct costs of *only* obesity at around US$45 per capita per year, while indirect costs reach up to US$157 (Branca 2006). Moreover, these measures do not include intangible costs, such as missed opportunities, psychological problems and poorer quality of life, since they are difficult to measure.

Figure 2: Break-down of costs associated with overweight.



***Source:* Akdağ and Danzon (2006); Branca (2006); Branca, Lobstein and Nikogosian (2007); Cox, Kortt and Langley (1998); Fiebelkorn, Finkelstein and Wang (2003).**

2.3. Energy In Versus Energy Out

The arithmetic behind overweight is simple – an individual gains weight when he consumes more energy than he expends. However, it is difficult to clearly identify energy intake or energy expenditure as the sole responsible factor behind the growth in overweight in recent decades (Petersen, Schnohr and

[9] If the current trend growth in overweight continues, the UK Department of Health predicts that the *average* life expectancy for British men will be five years less in 2050 (Department of Health – Economic and Operational Research 2004).

Sørensen 2004). For instance, as a result of changing environments, including changes in transport, housing, workplaces and leisure-time settings, physical activity has decreased – today two thirds of adults in EU countries would benefit from being more physically active (Branca, Lobstein and Nikogosian 2007). On the other hand, much evidence points to increased energy intake as a more important factor behind the increase in overweight (Cutler, Glaeser and Shapiro 2003).[10]

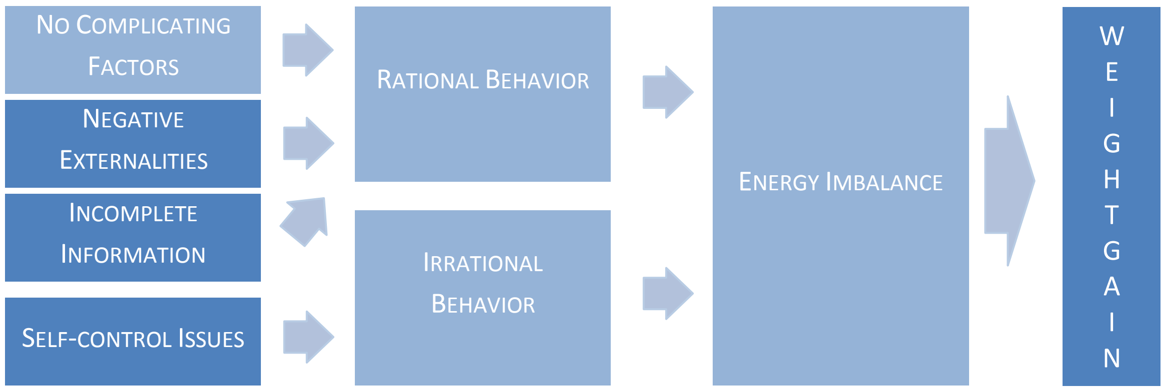
Changes in dietary behavior over the last decades might, for instance, be the result of higher general income levels, lower time-costs of food preparation (Cutler, Glaeser and Shapiro 2003), reductions in relative costs of food (Bhattacharya, Lakdawalla and Philipson 2005), changed attitudes (Peters 2003), or environmental changes (Just 2006). One way in which a change in attitudes has been proposed to affect caloric intake is through larger meals (Wansink 2004) (Nestle and Young 2002), another through more fast-food being consumed (Schlosser 2001). However, in the US, it has been shown that caloric intake has increased not mainly as a result of more calories consumed per meal but rather as a consequence of more meals consumed (Cutler, Glaeser and Shapiro 2003). We humans have a poor ability to register how much energy we consume, therefore we risk eating excessively. However, we have a much better ability to consume the right amounts based on volume (Drewnowski, Ledikwe and Rolls 2005). For this reason, products with high energy content relative to volume, such as SDEF, are considered to be particularly prone to be overconsumed (Ferres, Horgan and Stubbs 2000). Availability of SDEF has increased significantly over the last three decades (Branca, Lobstein and Nikogosian 2007), and thus SDEF are considered to be an important factor behind overweight (Prentice and Jebb 2003).

3. Modeling Overweight

Why would individuals choose – or happen – to become overweight? *Figure 3* displays the most commonly suggested mechanisms behind overweight. Overweight could be a consequence of rational choice, but the existence of externalities or incomplete information complicates the picture. Furthermore, self-control issues might make overweight a result of irrational decision-making. Understanding why people become overweight is not only interesting per se, it is also important in order to design an efficient policy response to counter it. Consequently, we devote this chapter to explaining potential mechanisms behind overweight and the implications for optimal policy response.

[10] For the curious, calories consumed have increased with four percent in Sweden since 1980 (Axelsen, et al. 2009), which might not seem very significant. However, given calculations by Cutler, Glaeser and Shapiro (2003) that the (US) increase in median weight over the last two decades required only an increase in energy intake of 100–150 calories per day (equivalent to approximately one can of Coca Cola), this increase is clearly not negligible.

Figure 3: Proposed mechanisms behind overweight. In the case of no complicating factors, overweight would be a utility maximizing choice. However, with the existence of negative externalities, incomplete information or self-control issues, the case is not that clear cut.



3.1. Happily Overweight

Overweight is clearly a medical problem: it reduces life expectancy, increases risks of a range of medical problems, etc. However, this does not in itself mean that being overweight is non-optimal; it might very well be a utility maximizing choice for the individual. In such a scenario, favoring public intervention to fight overweight could be a pitfall. Health economist Eric Finkelstein, visiting professor at Duke University, illustrates this point with the following example:

> My Uncle Al [is] a smart and successful attorney who also happens, not by accident, to be very overweight. In fact, he's overweight because instead of spending his time dieting and exercising, he has spent his time building a very successful law firm. I see no reason why the government should get Uncle Al to change his behavior if he does not want to. Even for low-income individuals, any effort to force people to change their behavior will only serve to make them worse off (even if they do become thinner) (Lafsky 2008)

If we trust people to know best themselves what makes them the most happy, why not let them do what they want?

Finkelstein continues by comparing overweight to motorcycle helmets: if someone wants to take the risk of riding a motorcycle without a helmet, why should we care? He concludes that we care because in case of an accident we do not want our tax money to be used to pay for this individual's poor judgment (Lafsky 2008).[11] This analogy is an example of externalities: some costs of riding a motorcycle without a helmet are not internalized, and this might also be the case for overweight (Cutler, Glaeser and Shapiro 2003). As has already been discussed, there are huge costs associated with overweight and not all of them might be carried by those that are overweight. For example, with a publicly funded welfare state –

[11] Another reason might be that we are paternalistic about other people's health, see Borgquist, Jacobsson and Johannesson (2007) for an interesting discussion.

such as that of many OECD countries – society might be forced to bear parts of the costs for overweight.[12] However, authors such as McCormick, Stone and Corporate Analytical Team (2007), put such claims in doubt, pointing out that if one considers cost savings arising from obese people's tendency to die prematurely, medical expenses associated with overweight might be exaggerated.

If the government decides to intervene because it believes there are significant externalities associated with overweight, an attempt to internalize externalities could employ taxes (Varian 1992). Critics, however, point both to a generally decreased welfare associated with taxes, as well as to the risk that taxes increase social inequalities (Branca, Lobstein and Nikogosian 2007).[13] Consider, for instance, a case where people are overweight because they excessively consume unhealthy food products, and suppose that, following the suggestion of Marshall (2000) and Brownell, Foster and Wadden (2002), an additional VAT is added on all such products (dubbed a "fat tax"). As previously stated, overweight is more common among low-income groups in developed countries, so one might fear that income effects associated with this tax would accentuate inequalities (such effects have been recognized in research regarding tobacco taxes (Reimler 2004)). However, in a scenario where externalities are the sole reason for intervention, a viable alternative in the form of increased information is missing (McCormick, Stone and Corporate Analytical Team 2007). Indeed, given that people already possess perfect information, there is no new information that could be provided.

3.2. A Rational Approach to Irrationality

Suppose that an individual understands the consequences of his consumption choices and believes the drawbacks of eating more outweigh the delights of that extra consumption. Could he still become overweight?

Although we are expected to eat only as much as we want to, research indicates that some overconsumption might not be a rational choice, but rather a result of poor self-control (Elfhag and Morey 2008). The individual has full information and does not desire to be overweight, but the temptation to eat more is simply too great to resist. Such a result could be the effect of hyperbolic discounting, where the individual attaches too much weight to present consumption (Scharff 2009). The

[12] For instance, for the US, Fiebelkorn, Finkelstein and Wang (2003) estimate that half of health-related obesity costs are borne by society, and in Australia, it has been estimated that the individual only carries 29.4 percent of the cost of being overweight (Access Economics Pty Limited 2008).
[13] Furthermore, although methods for calculating the optimal tax could be copied from the similar case of a tobacco tax (for which methods are presented by for instance Collins, et al. (2000) or Madden (2002)), determining the correct size of the tax might still be very difficult (Varian 1992).

consequence is time-inconsistent behavior (in a one-person model), i.e. suppose the individual choose yesterday how much to consume today – he would then have incentives today to change this consumption choice (in this case, he would decide to backtrack on a decision yesterday to consume healthy today). The result could be an unwanted overweight.

However, lack of self-control as an explanation behind the growth in overweight has received varied support. One might, for instance, question why our self-control would have become worse over the last decades (Mann 2008)? Cutler, Glaeser and Shapiro (2003), however, combine self-control problems with decreasing time-costs of food preparation and show that in such a scenario, self-control issues might very well be a factor behind the increase in overweight.

If self-control problems are a factor behind overweight, a combination of taxes and increased information could be considered (Scharff 2009). Public information campaigns might, for instance, make people aware of time-inconsistencies in their behavior. One example could be that the government advices people not to go shopping when hungry, as time-inconsistency problems are expected to be greater at such times (van Harreveld, Nordgren and van der Pligt 2009). Furthermore, if people do not rationally want to consume for instance SDEF but cannot resist buying them, targeted taxes might through price mechanisms provide incentives to restrain from buying the products.[14]

3.3. Information in Deficit, Calories in Surplus

In traditional economics, people are assumed to possess knowledge about everything – we know exactly the costs and benefits of all existing consumption choices in the world. Needless to say, this is quite a demanding assumption. Accordingly, contemporary economics has begun to admit how great impact incomplete information could have.[15] What if we base our choices on incorrect information?

In the following paragraphs, we construct a simple model to highlight how information deficits could lead to overweight being inefficiently common. Let

$$x = SDEF\ share\ of\ total\ energy, \qquad x \in [0,1]$$
$$f(x) = utility\ as\ a\ function\ of\ share\ x\ of\ energy\ from\ SDEF$$
$$v(x) = expected\ weight\ gain\ as\ a\ function\ of\ x$$
$$g(v) = utility\ of\ expected\ weight\ gain\ v$$

[14] A problem with the latter approach is a potentially very low price-elasticity in such a scenario, implying big income effects as well.

[15] For instance, in Harsanyi's (1967) game-theoretic models or in New Institutional Economics (for an overview see for instance Kasper and Streit (1999)).

Individual utility is thus given by:

$$U(x) = f(x) + g\big(v(x)\big) \quad \textbf{(1)}$$

Taking the derivative of this with respect to x and setting it equal to zero gives the optimum condition:

$$f'(x) = -g'\big(v(x)\big)v'(x) \quad \textbf{(2)}$$

The left hand side of *(2)* expresses the additional utility of consuming an extra share of SDEF; the right hand side expresses the marginal cost in terms of utility of that extra consumption (the expected additional weight gained times the marginal disutility of that extra weight). Basic economic theory says that without complicating factors, *(2)* is a utility maximizing condition, i.e. the case discussed earlier in *section 3.1*. Now, let

$$\alpha = perception\ of\ utility\ of\ additional\ weight\ gain\ (\alpha > 0)$$

$$\beta = perception\ of\ weight\ gain\ associated\ with\ a\ certain\ share\ of\ energy\ from\ SDEF\ (\beta > 0)$$

$$f(x) = \ln(x + 1)$$

$$v(x) = \beta(x + 1)$$

$$g(v) = -\alpha(\ln(v))^2$$

$$U(x) = \ln(x + 1) - \alpha(\ln(\beta(\mathrm{x} + 1)))^2 \quad \textbf{(3)}$$

Giving the optimal condition:

$$x^* = \frac{1}{\beta} * e^{\frac{1}{2\alpha}} - 1 \quad \textbf{(4)}$$

$$\frac{\partial x^*}{\partial \alpha} = -\frac{1}{\beta} * \frac{e^{\frac{1}{2\alpha}}}{2\alpha^2} < 0 \quad \textbf{(5)}$$

$$\frac{\partial x^*}{\partial \beta} = -\frac{1}{\beta^2} * e^{\frac{1}{2\alpha}} < 0 \quad \textbf{(6)}$$

From *(5)*, it is clear that if the individual has a too low idea about future disutility of a certain weight gain – a too low α – he will consume a higher share of SDEF and gain additional weight. However, given that the actual disutility suffered from overweight has not changed, this higher consumption of SDEF is inefficient. Given that the costs of overweight are large, long-term and often complex, it is not improbable that people have difficulties correctly assessing them.

A similar result arises if the individual associates a too low weight gain with a particular share of energy from SDEF. By *(6)*, a perceived lower weight gain associated with a particular consumption of SDEF – a lower β – results in a higher share of energy from SDEF. Assuming that the *actual* weight gain resulting from a particular share of SDEF has not changed, this higher share of SDEF would be inefficient. One way in which people could attain such a misperception about the weight gain associated with the consumption of a particular share of SDEF could be through a too low perception of relative energy content of SDEF.

If lack of information is deemed to be a factor behind overweight, taxes could technically force a consumption change. However, in order to target the root of the problem, existence of information deficits calls for increased information. Proposed ways in which this could be done include adequate nutrition labeling, favored by the WHO as a core action in fighting the growth in overweight rates (Branca, Lobstein and Nikogosian 2007). In the US, the US Food and Drug Administration launched an action plan against overweight in 2004 targeting better nutrition labeling as well as enhanced consumer awareness of harms of excess caloric intake (FDA 2004). In March, 2010, the European Parliament decided to create a common EU food labeling policy. Under the new rules, key nutrition information, including energy content, and amounts of fat, saturated fat, carbohydrates, sugar and salt, should be displayed on the front of the pack (energy content was considered particularly important to consumers and thus its display was subject to additional rules) (European Parliament 2010).[16]

It should be stressed, though, that although information campaigns have done well in earlier cases – for instance decreasing exposure to tobacco smoke and promoting the use of car seat belts (Branca, Lobstein and Nikogosian 2007) – they are no guaranteed success. Firstly, the success of an information campaign is dependent on incomplete information being an issue in the first place. Secondly, a successful information campaign targets precisely the areas where information deficits are believed to exist: there is no point in increasing knowledge about energy content if the problem really is a lack of information regarding the long-term costs of overweight. Finally, the design of the information campaign is vital because the public has to be perceptive to it.

Empirically, propositions that a lack of information is a factor behind overweight receive mixed support. Nayga (2000), for instance, finds that there is an inverse relationship between knowledge and the probability of an individual being obese. Philipson (2001), on the other hand, rejects the idea that a lack of information contributes to overweight – given increasing levels of information about overweight, prevalence of overweight should have been falling over the last decades, not increasing. Although this is

[16] However, proposals of a “traffic light” labeling system (green, amber and red labels on the front of packs to indicate healthiness) were turned down, provoking angry reactions from consumer organizations. The BEUC, the largest European consumer organization, said in relation to the EU decision that “when we clearly have an obesity epidemic spreading across Europe, and when consumers clearly want to make healthier choices about their diet, we really should give them the tools that work best.” According to the BEUC, the decision not to impose a “traffic light” labeling system constituted a severe blow to public health in general, and the fight against childhood obesity in particular (BEUC – the European Consumers' Organisation 2010).

a valid point, people might face special difficulties correctly estimating the energy content of some products, in particular SDEF (Branca, Lobstein and Nikogosian 2007). Given that SDEF have become increasingly more available over the last decades (Branca, Lobstein and Nikogosian 2007),[17] it might thus be that information deficits regarding energy content contribute to rising overweight levels. McCormick, Stone and Corporate Analytical Team (2007, p.163) admit that "there are, unfortunately, currently relatively few data available with which to test the extent to which imperfect information is a problem in the context of obesity."

3.4. Recent Research

Few studies have explored the relationship between overweight and perception of energy content. Some has been written about the effectiveness of additional food labeling, see for instance Aldrich (1999); Capps, Kim and Nayga (2001); Gracia, Loureiro and Nayga (2006); and Cawley and Variyam (2006). However, these studies do not actually examine the proposed potential root of overweight – incomplete information – but rather a means to fight it – increased nutrition labeling. Increased labeling might fail to have a significant effect on consumption behavior for other reasons than people not suffering from a lack of information regarding energy content, for instance poorly designed food labeling policies.

In a 2005 paper, Jackson, et al. (2005) examine whether the correlation between education and risk of being obese can be explained by knowledge of food energy content. Their survey includes 356 subjects from Aberdeen, Scotland, and asks the subjects to estimate the number of calories in 12 food and drink products. They find no correlation between probability of being obese and estimation of energy content of foods high in carbohydrates and low in fat and protein. However, products high in fat, independent of the other macronutrients present, are generally perceived to have significantly lower energy contents by obese people than non-obese subjects (although this is not the case for all high-fat foods). Particularly, this applies to fruit cake, confectionary and beer, i.e. the typical SDEF in their study. Furthermore, the correlation is only apparent in the lower social class group. They conclude that differences between individuals in perception of food energy contents possibly contribute to the development of obesity in lower social strata, but point out that more research is needed on the subject.

[17] As an example, Swedish consumption of soft drinks and bottled mineral water has increased with 230 percent since 1970 (OECD 2002).

4. Method

This thesis aims at examining whether there is a correlation between perception of relative energy content of SDEF and BMI among the Swedish adult population. For this purpose, we use a quantitative study. The relationship between the included variables is investigated using ordinary least squares regression models. Data are processed and analyzed using *Stata v.9.2* and *Matlab v.7.8.0*.

4.1. The Survey

We conducted a survey including 301 Swedish adults (aged 18–85) in the greater Stockholm area in November, 2009. The survey points were shopping malls and transit hubs because we believed people would be prepared to participate in the survey in such areas. Furthermore, we argued that such places could be expected to yield a relatively representative sample, since we anticipated a wide variety of people to be at such locations. With the aim of further increasing the representativeness of our sample, we did not randomly select our survey points but chose them to include what we thought were areas of different social strata.[18] The questionnaire was written in Swedish to exclude respondents not part of the Swedish population.[19, 20]

In the survey we aimed to recreate a decision moment for purchasing or consuming SDEF. Therefore, we showed subjects actual products and not photos of them.[21]

4.2. Investigated Variables

Subjects were asked to state their height and weight in order to calculate their BMI – the dependent variable in our analysis. The BMI is the most commonly used measure to classify people's weight-related status (see for instance WHO (2010)). Nevertheless, it is criticized for not accurately accounting for age and race, as well as an individual being an athlete, bodybuilder or adolescent (Jebb and Prentice 2001). Measuring the waist-hip ratio is often considered a more precise way to assess weight-related status for old people (Breeze, et al. 2006), and body fat percentage is generally deemed a superior measurement (Bouchard, et al. 2002). However, such methods were difficult to employ in our study. For instance, we ruled out measuring the waist-hip ratio since we anticipated that the response rate would significantly drop with such an invasive method. Moreover, even more advanced methods such as assessing body fat

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[18] The survey points were: Hässelby metro station, Nacka Shopping Mall, Odenplan (public square), Skärholmen metro station, Slussen (bus and commuter train transit hub), and Stockholm Central Station.

[19] For the questionnaire, please refer to *Appendix A*.

[20] If a respondent did not understand Swedish, we asked him whether he lived in Sweden or not. In case he did, we translated the questions (orally).

[21] Contrary to the method of Jackson, et al. (2005).

percentage had required a laboratory, ruling out our approach of targeting people at public places. It is also well established that the "normal" BMI differs around the globe, with cut-off points for overweight, obese, etcetera, being higher for large-framed Polynesians and lower for small-frame Chinese (Carmichael, et al. 1999) (Caterson, et al. 2000). We do not attempt to correct for any such effects when approximating a subject's weight-related status with his BMI.

Our analysis is thus based on self-reported BMI data, despite the fact that people tend to understate their weight and overstate their height (Beaglehole, et al. 1987). However, as has already been pointed out, we believed people would have objected to, e.g., step onto a scalar in a public place, ruling out other approaches. Furthermore, we argue that such self-reporting bias would only compress the BMI distribution, not render impossible an analysis based on self-reported data. Nevertheless, we attempt to adjust for such self-reporting bias when testing the robustness of our results. We conclude that for the purpose of this paper, the self-reported BMI is a good enough proxy for weight-related status.

The independent variable of interest to this study is perception of relative energy content of SDEF. Subjects were asked to state their perception of SDEF energy content as a percentage of a standard meal's. We use a relative scale because the study of Jackson, et al. (2005), indicated that the public had a poor perception of absolute energy contents, and we believed people tend to think about energy in relative terms.[22] Furthermore, we were particularly interested in comparing SDEF to other food products.[23]

A pilot study revealed a clear negative correlation between the number of products (and questions) and the response rate. Therefore, we limited the number of investigated products to six, five SDEF and one reference meal, see *Table 1*. We did not randomly select products among SDEF and "normal" meals, respectively, but handpicked some of the most commonly consumed products in Sweden (Coop 2008)

Table 1: Products examined in our survey.

Product	Size	Energy	% of meal
Coca Cola	330 ml	139 kcal	29
Cinnamon bun	10 cm in diameter	120 kcal	25
Crisps	25 g	132 kcal	28
Snickers	58 g	288 kcal	61
Beer (4.5% alcohol)	330 ml	165 kcal	35
Meal	100 g pasta, 75 g meat sauce	475 kcal	100

[22] The use of a relative scale was decided after consultations with Helén Lantz, head of the obesity clinic at Sahlgrenska University Hospital; Torbjörn Linde, head of the obesity clinic at Uppsala University Hospital; and Magnus Johannesson, Professor in Health Economics at Stockholm School of Economics.

[23] However, by using a relative scale, we forfeit the opportunity to comment on public absolute perception of energy content. The relative perception might be high because a subject believes the absolute energy content of SDEF to be high or the absolute energy content of the meal to be low.

(Lindblom 2009). The amounts of the products were chosen to represent a typical amount consumed at one occasion.[24]

Equation 1: Formula used to calculate individual *i*'s Sum. We define it as the sum of *i*'s perception of the relative energy content of product, *p*, (where p are the five SDEF surveyed) over the average estimation of the relative energy content of *p*, times a constant. A unit is defined as the mean Sum divided by a 100.

$$Sum_i = 20 * \sum_{p=1}^{5} \left(\frac{Estimation_{\;i,p}}{\sum_{n=1}^{301} \frac{(Estimation_{\;n,p})}{301}} \right)$$ By definition, $\overline{Sum} = 100$, and we define a unit as: $unit = \frac{\overline{sum}}{100}$

We define the sum of estimations (throughout this thesis referred to as Sum) for each individual *i* as the sum of *i*'s estimation of each product, *p*, over the average of estimations of *p*, times a constant, see *Equation 1*. By investigating some of the most common SDEF and by taking an average of estimations, we hope to create a reasonable proxy for perception of relative energy content of SDEF as a group. It should be pointed out that Sum is a weighted average of the estimated energy content of the separate products. We decide against using an unweighted average because we anticipate the mean perceived energy content of, for instance, Snickers to be higher than that of the other products, given that it has a far higher actual energy content. With an unweighted average, the estimation of Snickers would be expected to be more important in the Sum. Although one could claim that this is correct – Snickers is in a sense unhealthier than the other investigated products – we argue that a weighted average better suits our ambition to capture the SDEF as a group. The way Sum is defined by *Equation 1*, the estimation of every product on average carries an equal weight in the Sum.[25]

4.3. Control Variables

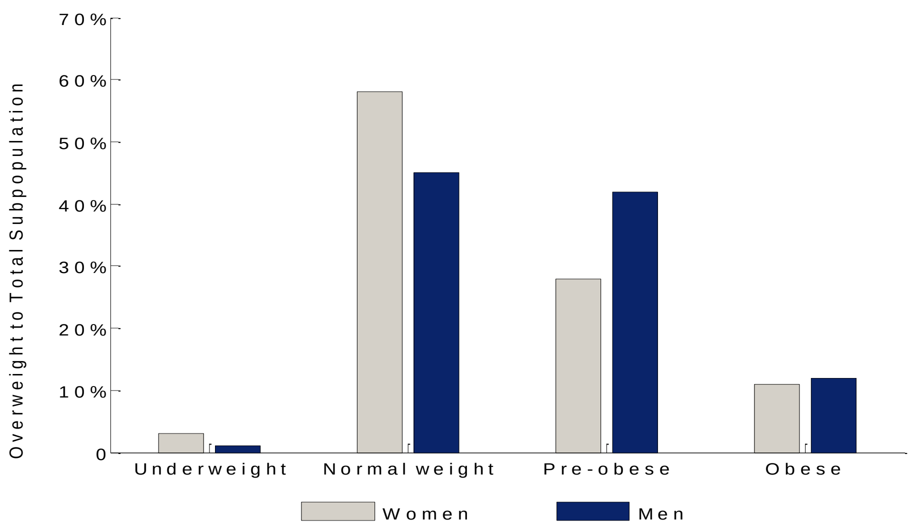
As control variables, we asked subjects to specify gender, age and level of education, since these factors are suggested to affect BMI (Wadman and ten Berg 2008). Gender has an ambiguous affect on overweight: whereas obesity is more common among women in many OECD countries, the percentage of pre-obese is higher among men throughout the OECD (Cecchini, et al. 2009). In Sweden, overweight is more common among men (Danielsson and Norberg 2009), see *Figure 4*.

[24] As stated by the producer for the spaghetti and meat sauce (the energy content was in line with the Recommended Daily Intake of the Swedish Ministry of Health (Livsmedelsverket 2008)).

[25] For this reason, we also rule out weighting the estimations of a product by the actual energy content of that product (if mean estimations of the separate products are not proportional to the actual energy content of the products, then on average, such a weighting method would make the estimations of some products more influential in the Sum).

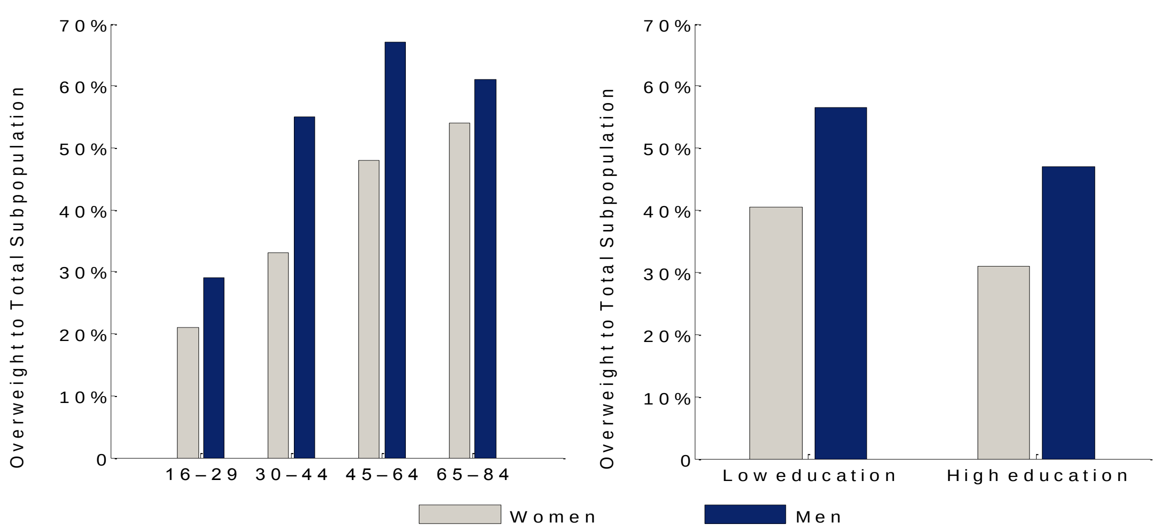
BMI and age have a bell-shaped relationship in many OECD countries (Cecchini, et al. 2009). *Figure 5* displays the percentage of Swedish overweight individuals in different ages (Statens folkhälsoinstitut 2009); the declining marginal effect of age on BMI can be inferred from it. For men, the relationship actually turns negative after a certain age. It should be stressed, though, that individuals' weights are observed at a particular point in time and thus people of a certain age belong to a certain cohort. It is difficult to determine whether observed effects are *truly* age effects or rather cohort effects (Cecchini, et al. 2009).

Figure 4: Percentage of the Swedish adult population (16–85 years old) in different BMI groups (underweight: BMI<18.5, normal weight: 18.5≤BMI<25, Pre-obese: 25≤BMI<30, Obese: 30≤BMI).



***Source:* Statens folkhälsoinstitut (2009).**

Figure 5: Percentage of overweight adult people in Sweden relative to the total subpopulation in subpopulations based on age and education, respectively.



***Source:* Statens folkhälsoinstitut (2009).**
***Note:* The high education group includes those with a university degree, the low education group includes everyone else.**

A relationship between education and overweight has been documented by several previous studies, for instance Borgonovi, et al. (2009).[26] In *Figure 5,* prevalence of overweight among high educated (defined as people with a university degree) and low educated (everyone else) is displayed. In our study, education was stated as the highest attained degree: upper secondary school, high-school or university. However, due to too few observations in the upper secondary school group, we grouped upper secondary and high-school observations into a low-education group.

Other factors that are regularly suggested to also affect BMI, such as genetics and social and physical environment, were not included in our survey due to difficulties in quantifying them. For instance, intergenerational influences have been shown to affect BMI (Branca, Lobstein and Nikogosian 2007), but we could not find a way to trustworthy measure such factors within the limits of our survey.

4.4. Regression Specification

In some earlier studies of overweight, a binary variable for overweight or obese has been used as dependent variable combined with logistic regression models (see, for instance, Jackson, et al. (2005) or Cecchini, et al. (2009)). Although Jackson, et al. (2005) fail to explain their choice of econometric approach when examining knowledge of energy content and risk of being obese, such an approach could perhaps be based on a belief that the question of interest is whether an individual is obese or not, not his exact BMI. Cecchini, et al. (2009) motivate their choice of a logistic model when examining obesity and its relationship with factors such as education level and socio-economic status (i.e. mostly discrete explanatory variables) by claiming that such an approach makes results easily interpretable as the impact of one specific characteristic by providing the relative odds of an event (being obese or overweight in this case) happening when comparing individuals for whom a given covariate takes different values.

Despite such arguments, we let BMI and Sum be continuous variables throughout most of our analysis. Admittedly, we could have defined discrete variables, such as a binary variable for being overweight or obese. However, in contrast to the case of Cecchini, et al. (2009), the independent variable of focus in this study is naturally continuous (Sum compared to e.g. education level). Therefore, we argue that employing a logistic regression approach would have left unused available information for no obvious reason. For instance, as has been pointed out, weight-related risks arise already from the upper part of the normal weight span (Coakley, et al. 2001), and therefore we do not want to overlook factors possibly

[26] Grossman (1972) explains theoretically the empirical fact that high-educated are generally healthier by demonstrating that a higher education increases the efficiency of health related investments, increasing demand for a higher stock of health.

resulting in only modest BMI increases (which a focus on a binary variable for "obese" or "overweight" might have meant). For the purpose of our study, we argue that a classic regression model is better suited. However, we employ such alternative methods to check the robustness of our results (see *section 5.2*).

Regression 1: BMI over perception of relative energy content.

$$BMI = \beta_0 + \beta_1 sum + \varepsilon$$

In *Regression 1*, we include Sum as the only explanatory variable. We consequently add controlling variables to *Regression 1* until we get *Regression 2*.

Regression 2: BMI over perception of relative energy content, age, age squared, gender and education.

$$BMI = \beta_0 + \beta_1 sum + \beta_2 age + \beta_3 (age^2) + \beta_4 female + \beta_5 high\ education + \varepsilon$$

Regression 2 includes Sum as an explanatory variable as well as our controlling variables. Gender and education both enter as binary variables. Following observations that overweight increases in age but at a lower marginal rate, we followed the approach of Cecchini, et al. (2009) and included both a linear and a quadratic term for age. Furthermore, it is plausible that there are interactive effects between factors; earlier studies have employed interaction terms for, for instance, gender and education to account for such potential effects (see for instance Borgonovi, et al. (2009)). However, we found it difficult to correctly include such interaction terms because we did not know the exact functional form of any such potential relationship. Therefore, to account for potential interactive effects we instead divided the sample into subgroups and ran *Regression 2* in these. Subgroups were defined based on all independent variables, i.e. Sum, gender, education group and age group,[27] as well as the dependent variable BMI. We created three age groups, young (aged 18–30), middle-aged (aged 31–60), and old (61–85);[28] two BMI groups, overweight (BMI≥25) and normal weight (BMI<25); and four groups based on Sum, a Sum in the first quartile, the second quartile, the third quartile and the fourth quartile.

Regression 3: BMI over perception of relative energy content of product *p*, age, age squared, gender and education.

$$BMI = \beta_0 + \beta_1 estimation_p + \beta_2 age + \beta_3 (age^2) + \beta_4 female + \beta_5 high\ education + \varepsilon$$

We use *Regression 3* when we focus on the investigated products separately.

[27] We attempted a further division of the sample into subgroups based on two or more of these parameters, e.g. a female old-age group, but were forced to abandon such efforts in the face of too few observations.
[28] We continued to control for age in subgroups based on age.

4.5. What Causes What?

Questions about causality are present in many economic analyses. In our study, concerning the relationship between age, gender and BMI, we argued that the proposed causality is the only plausible.[29] Whether education affects BMI or vice versa is debated (see for instance Borgonovi, et al. (2009)).[30] It is possible that a higher BMI compromises a student's ability to perform well in school, resulting in fewer formal years of schooling; for instance, Gortmaker, et al. (1993) show that women that are overweight in childhood complete fewer years of school. Odds are, however, that causality goes the other way, i.e. from education to BMI (Borgonovi, et al. 2009). Spasojevic (2003), for instance, uses a change in the 1950's in compulsory school length in Sweden that was not simultaneously implemented in all municipalities to investigate the causality in the relationship. She finds that 40 years later, an additional year of schooling decreases the risk of obesity by 12 percent among men, even after controlling for parents' social background. Consequently, we assume that causality indeed goes from education to BMI.

When we formulated the hypothesis that is the basis for this thesis, we anticipated that a potential relationship between perception of relative energy content of SDEF and BMI would take the form of the former affecting the latter. We found it hard to believe that variation in BMI could cause variation in an individual's perception of relative energy content. However, we will return to this discussion in *section 6.3*.

5. Data and Results

Of the 301 respondents, 152 were women and 149 had higher education (defined as an attained university degree). The sample BMI distribution and age distribution are presented in *Figure 6*. Estimates of relative energy contents of the surveyed products were very variable across individuals, see *Figure 7*.[31]

Average response values were remarkably higher than actual values, with the greatest difference from the true value on Coca Cola (337 percent of actual) and the smallest on Snickers (146 percent of actual), see *Table 2*. Low-educated on average estimated relative energy content of the surveyed products to be higher than high-educated, and the same was true for women as compared to men (see *Appendix B*). Variability (both measured in terms of standard deviation and interquartile range) is generally higher in the low-educated group, particularly among women.

[29] It is highly implausible that variations in BMI would cause variations in gender or age (or a change of cohort).
[30] It might also be that neither affects the other, but rather common traits (perhaps intelligence, self-control, individual discount rate) cause both to co-vary.
[31] Among individuals, though, there was a high level of consistency (see *Appendix C* for a graphical analysis).

Figure 6: Distribution of BMI and age, respectively, for the full sample including 301 Swedish adults.

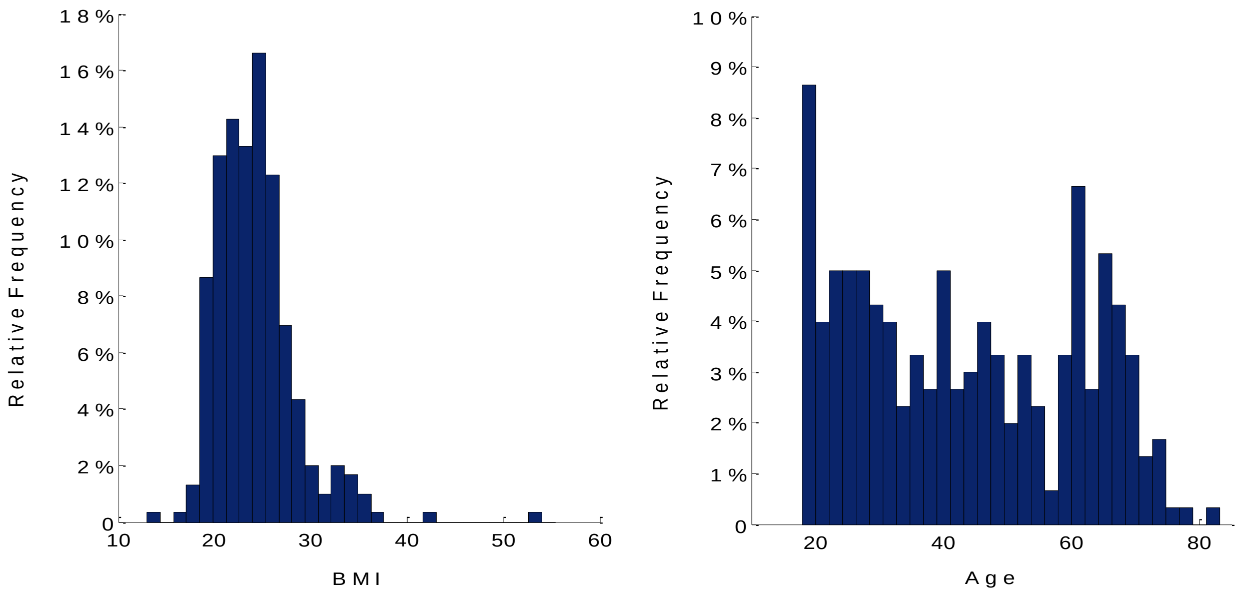


Figure 7: Distribution of the Sum of perceived relative energy contents of five SDEF relative to a normal meal for the full sample of 301 Swedish adults.

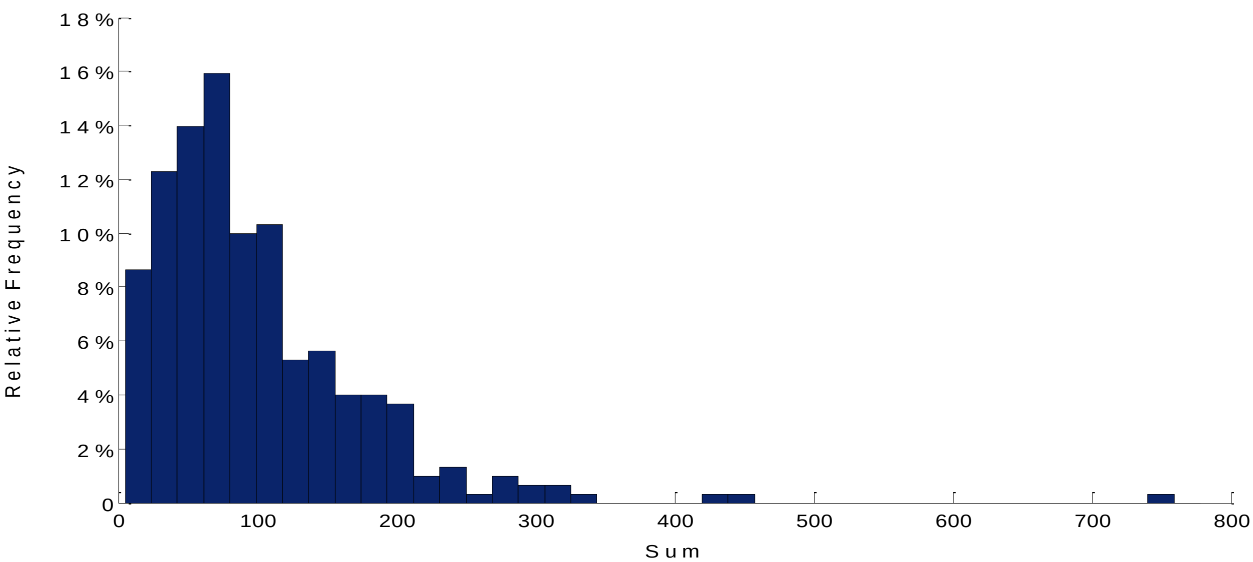


Table 2: Actual energy content and summary statistics for perceived relative energy content of five SDEF relative to a normal meal for the full sample.

			Estimated							
Product	**Actual**	**Obs**	**Mean**	**% of actual**	**Std. Dev.**	**Q1**	**Median**	**Q3**	**Min**	**Max**
Coca Cola	29	301	97.8	337%	96.3	35	80	120	1	1000
Cinnamon bun	25	301	52.2	209%	46.5	20	40	70	2	300
Crisps	28	301	75.8	271%	78.4	30	50	100	0	700
Snickers	61	301	89.3	146%	90.0	40	70	110	5	1000
Beer	35	301	80.2	229%	70.5	30	60	100	0	400
Sum		301	100		80	47	79	132	6	758

Note: **Obs refers to the number of observations, Std. Dev. to the standard deviation, and Q1 and Q3 to the 25th and 75th percentiles, respectively.**

Clearly, both the sample BMI distribution and the sample distribution of Sum include values very far from the median response. However, for instance regarding BMI, the target population also includes some extreme subjects – there are some very overweight people in Sweden (see for instance Neovius, Rasmussen and Teixeira-Pinto (2008)). Consequently, we argue that the extreme values in our sample correctly reflect the population we investigate and therefore should be included in the analysis. Nevertheless, such values might have a large effect on results (Alm and Britton 2008), and in that sense hide a potential correlation among the majority "normal" part of the population. For this reason, we also run controlling regressions excluding extreme observations, see *section 5.2*.

5.1. Regression Results

Base-case regression results are presented in *Table 3*.[32] Excluding all control variables, Sum is uncorrelated with BMI (at the five percent significance level, a level maintained throughout this thesis).[33] Adding one controlling variable at a time the coefficient on Sum generally remains positive but statistically insignificant.

Sum is statistically uncorrelated with BMI in subsamples based on gender, education, and BMI, as well as among the young and the middle-aged. In the old-age sample, the coefficient on Sum is positive and statistically significant, i.e. the *opposite* of what we had hypothesized. This is also true among those with an estimated Sum in the second quartile ($47<Sum\leq79$). For those with an estimated Sum in the third quartile ($79<Sum\leq132$), the correlation has the hypothesized negative sign and is statistically significant.

When looking at the surveyed products separately, no coefficient on any perception is statistically significant for the full sample (see *Appendix E*). In the low-educated group, the coefficient on cinnamon bun is positive and statistically significant. Among the old, the coefficients on crisps and beer are positive and statistically significant. Among the overweight, the coefficient on crisps is positive and statistically significant.

5.2. Robustness

The explanatory power of the models is generally low; however, this per se does not lead us to conclude that the models are poorly specified. Factors affecting BMI are likely to be diverse, and we expected many of them to be difficult to capture in our models. Moreover, error terms look normally distributed (see *Appendix F*) and we have found no indications of heteroskedasticity (see *Appendix G*).

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[32] All presented p-values are for the two-sided test.

[33] The distribution of BMI values relative to Sum is plotted in *Appendix D*.

Table 3: Results of classic regressions models (*Regressions 1–2*).

		Sum	age	age^2	female	high_ed	_cons	F-statistic	R^2	n
Sum only	Coefficient	0.0018	-	-	-	-	24.0691	0.36	0.0012	301
	(p-value)	*(0.547)*	-	-	-	-	*(0.000)*			
all variables		0.0028	0.2419	-0.0020	-2.0158	-0.3864	18.9883	10.35	0.1493	301
		(0.339)	*(0.005)*	*(0.034)*	*(0.000)*	*(0.409)*	*(0.000)*			
only overweight		0.0025	0.0973	-0.0009	0.0426	-1.3196	25.7711	0.97	0.0372	132
		(0.608)	*(0.494)*	*(0.539)*	*(0.953)*	*(0.067)*	*(0.000)*			
only normal weight		-0.0013	0.1316	-0.0013	-0.8665	0.5246	19.1928	6.39	0.1640	169
		(0.404)	*(0.008)*	*(0.020)*	*(0.002)*	*(0.051)*	*(0.000)*			
only Sums in Q1		-0.0341	0.3028	-0.0029	-1.1368	0.7411	18.0550	2.82	0.1717	74
		(0.344)	*(0.038)*	*(0.069)*	*(0.158)*	*(0.366)*	*(0.000)*			
only Sums in Q2		**0.1454**	0.2872	-0.0028	-4.1898	-1.4236	11.8153	5.23	0.2749	75
		(0.006)	*(0.148)*	*(0.190)*	*(0.000)*	*(0.163)*	*(0.023)*			
only Sums in Q3		**-0.0712**	0.3525	-0.0033	-2.3181	-0.3997	24.5662	6.92	0.3277	77
		(0.005)	*(0.352)*	*(0.027)*	*(0.002)*	*(0.601)*	*(0.000)*			
only Sums in Q4		-0.0065	0.0863	0.0006	-0.5062	-0.5285	21.7998	4.56	0.2486	75
		(0.262)	*(0.633)*	*(0.758)*	*(0.631)*	*(0.616)*	*(0.000)*			
only female		0.0029	0.3094	-0.0024	-	-0.4773	14.9848	8.98	0.1963	152
		(0.377)	*(0.007)*	*(0.062)*	-	*(0.440)*	*(0.000)*			
only male		0.0028	0.1500	-0.0013	-	-0.2716	21.4892	1.00	0.0269	149
		(0.593)	*(0.236)*	*(0.345)*	-	*(0.700)*	*(0.000)*			
only high educated		0.0048	0.3738	-0.0036	-2.0896	-	16.3114	7.67	0.1756	149
		(0.271)	*(0.002)*	*(0.004)*	*(0.000)*		*(0.000)*			
only low educated		0.0022	0.1549	-0.0008	-2.0889	-	20.2919	6.74	0.1550	152
		(0.590)	*(0.211)*	*(0.572)*	*(0.006)*		*(0.000)*			
only young		-0.0003	0.9218	-0.0176	-2.9146	0.2188	12.2880	6.24	0.2573	96
		(0.609)	*(0.381)*	*(0.419)*	*(0.000)*	*(0.732)*	*(0.321)*			
only middle		0.0005	0.1543	-0.0018	-1.7587	-0.1015	22.7273	1.07	0.0399	135
		(0.927)	*(0.754)*	*(0.736)*	*(0.025)*	*(0.898)*	*(0.040)*			
only old		**0.0172**	-4.2237	0.0306	-1.4962	-1.8028	170.6886	3.10	0.1949	70
		(0.007)	*(0.103)*	*(0.103)*	*(0.126)*	*(0.091)*	*(0.057)*			

Note 1: **Statistically significant Sum values in bold (at the five percent significance level and for the two-sided test).**
Note 2**: The high educated group includes all respondents with a university degree (as stated by the respondent), the low educated group includes everyone else. The young includes subjects 18–30 years old, middle-aged those 31–60 years old, and the old those 61–85 years old. The overweight includes all respondents with a BMI≥25, the normal weight all else. The category Sums in Q1 includes all Sums in the first quartile of the distribution of Sums (Sum≤47), Sums in Q2 all Sums in the second quartile (47<Sum≤79), Sums in Q3 those in the third quartile (79<Sum≤132), and Sums in Q4 those in the fourth quartile (132<Sum).**

In the above analysis, we include extreme observations, arguing that they correctly reflect the population we are investigating. Nevertheless, to check whether our results hold only among the great majority of observations, we define an outlier as an observation further than three standard deviations from the mean response. This excludes BMI values greater than 36 (three observations) and Sums greater than 340 units (three observations). Rerunning the regressions without the outliers, results are the same as when outliers are included (*Appendix H*).

Regression 4: Probability of being overweight over perception of relative energy content, age, age squared, gender and education.

$$Probability\ of\ Overweight = \beta_0 + \beta_1 sum + \beta_2 age + \beta_3 (age^2) + \beta_4 female + \beta_5 high\ education + \varepsilon$$

To further check the robustness of our results, we define a binary variable "overweight" for BMI≥25 and conduct logistic regression analysis, see *Regression 4* (this is similar to the approach of Jackson, et al. (2005)).[34] Results are in line with earlier findings, i.e. there is no statistically significant correlation between perception of relative energy content and probability of being overweight on the aggregate level (*Appendix I*).[35] In subsamples, statistically significant results exist in the same subsamples (and with the same sign on the coefficients) as with the classic regression models.

In *section 4.2* we argued that a potential self-reporting bias could be expected to compress the BMI distribution, but not render impossible an analysis based on self-reported data. Nevertheless, to check the robustness of this assumption and control for the fact that data are self-reported, we use the strategy outlined by Cawley (2000) and Lakdawalla and Philipson (2002). Based on US data containing both self-reported and actual weight as well as gender, we estimate the expected difference between the self-reported and the actual figure for a person of a certain gender in a certain weight group (unfortunately, there are no similar data for Sweden as far as we know).[36] Using recalculated BMI values (based on the US data set presented in Lakdawalla and Philipson (2002)), implications of our results do not change.

[34] As a further control, we also employed probit models but with the same results.
[35] Exchanging the binary variable for overweight with one for obese (30≤BMI) does not change results.
[36] Bound, Brown and Mathiowetz (2001) and Lee and Sepanski (1995) present the general strategy for correcting similar reporting errors.

6. Discussion

In the introduction, we stated that the aim of this paper was to clarify whether information deficits regarding energy content of food products partly explain overweight. We argued that if this is indeed the case, such information deficits might be particularly common for SDEF.[37] Consequently, we hypothesized that a lower perception of relative energy content of SDEF would be correlated with a higher BMI, as described by *Figure 8*. Perception of relative energy content of SDEF would affect an individual's inclination to consume SDEF. Since consumption of SDEF is believed to be an important factor behind weight gain, this would in turn affect the individual's BMI. In particular, a lower perception of relative energy content of SDEF would induce an individual to consume more of such products as compared to someone with a higher perception of the relative energy content, resulting in a higher weight.

However, we found weak support in data for such a mechanism. Admittedly, there was a negative correlation between Sum and BMI in one of the investigated subgroups (among those with an estimated Sum in the third quartile). But for the broad majority of subgroups there was no statistically significant relationship. Therefore, we abstain from reading too much into this single observation (the correlation between Sum and BMI statistically significantly had the *opposite* sign among those with an estimated Sum in the second quartile). Rather, given that one might expect one correlation in 20 to turn out statistically significant by coincidence at the 5 percent significance level, and the fact that we conducted analysis in quite many subsamples, we believe that pure coincidence is a likely explanation behind this result.[38, 39] Consequently, we devote the following chapter to firstly discussing why our hypothesis could not be supported by data. We subsequently draw conclusions about implications for public policy of our results. This chapter ends with a discussion of some critique to our methodology.

6.1. Unsupported Logic

One explanation behind why we could not observe the hypothesized relationship between perception of relative energy content and BMI could be that consumption of SDEF is not a driving force behind overweight, see *1* in *Figure 8*. For instance, overweight people might have gained excessive weight because they expended too few calories or because they consumed too great amounts of "normal"

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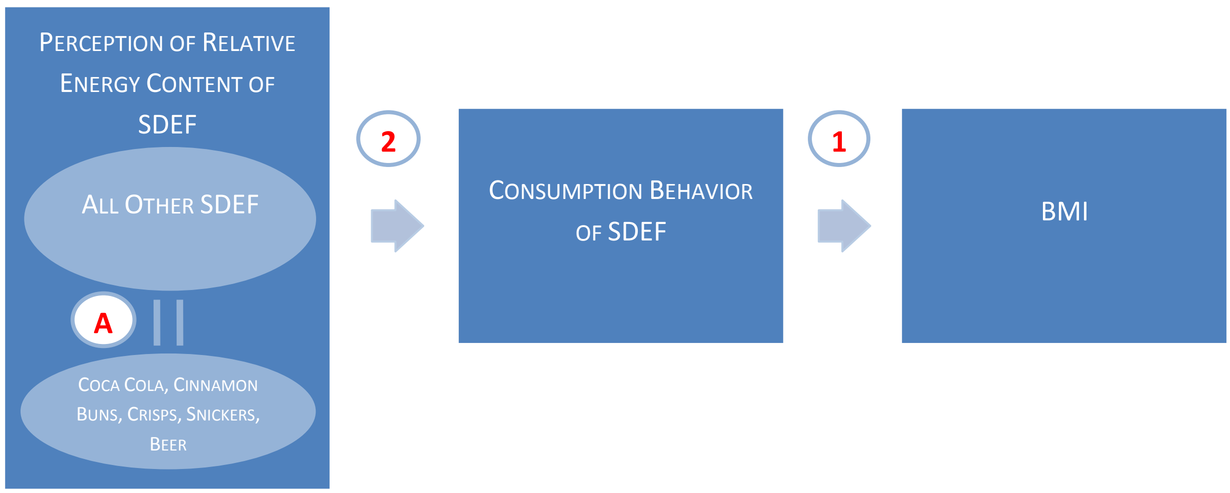
[37] And if this is the case, it will have an especially large impact for such products.

[38] To see this, let: $X = number\ of\ negative, statistically\ significant\ coefficients, \alpha = significance\ level$, and $n = number\ of\ subsamples$. Then under the assumption that there is no correlation between perception and BMI: $X \sim Bin\left(n, \frac{\alpha}{2}\right)$, and: $P(X \geq k) = 1 - P(X < k) \rightarrow P(X \geq 1) = 1 - P(X = 0) = 1 - (1 - \frac{\alpha}{2})^n = 1 - (1 - 0.025)^{15} = 0.316$. Thus, the probability of getting a result at least as extreme as the observed is large.

[39] We also believe that coincidence is the probable reason behind observations of a statistically significant, positive correlation between perception of relative energy content of SDEF and BMI in some subsamples.

food.[40] However, there is an overwhelming amount of research pointing to consumption of SDEF being an important factor behind gaining excessive weight (among others Drewnowski and Specter (2004); Prentice and Jebb (2003); Christakis, Drewnowski and Mendoza (2007); Faskunger and Schäfer (2006); and James, Leach and Rigby (2004)). As has already been pointed out, our intuitive perception about the correct amount to eat is based on volume rather than energy (Drewnowski, Ledikwe and Rolls 2005), and thus we are likely to fail to fully compensate for a higher consumption of SDEF with a lower consumption of normal foods (Horgan, et al. 2006). Consequently, we believe that this scenario is a less likely explanation behind the failure of our hypothesis to hold in data.

Figure 8: Hypothesized relationship between perception of relative energy content of SDEF, consumption behavior of SDEF and BMI.



We believe that a more plausible explanation is a failing link at *2* in *Figure 9*. If people fail to adjust behavior after what they know, a different perception of relative energy content of SDEF will fail to affect consumption behavior. As a result, a difference in perception will have no effect on BMI. That is, people might know that SDEF contain large amounts of energy, but this knowledge will not stop them from consuming the products. In such a scenario, lack of information is not a factor behind a high consumption of SDEF and a consequent high BMI. Thus, our results are in line with claims that a lack of information about energy content of food products cannot explain the increased prevalence of overweight over the last decades because it seems likely that such information has become more available over the last decades, at the same time as being overweight has become more common (for

[40] For instance, one could argue that a *lower* perception of relative energy content of SDEF implies a *higher* perception of relative energy content of "normal" foods. Suppose that a lower perception of relative energy content of SDEF indeed induces a subject to consume more SDEF but simultaneously to decrease consumption of normal food – this could lead to an unchanged BMI.

instance, Philipson (2001)). Although there were indications that such a general lack of relationship between knowledge of energy content and consumption behavior might not apply for SDEF (because of special characteristics of these products), we could not support this proposition in data.

6.2. Implications for Public Policy and Future Research

A further aim of this thesis was an aspiration to draw conclusions about efficient policy responses to overweight. In the background, we noted that increased information is commonly proposed as a means to fighting overweight. In particular recent discussions – for instance in relation to the design of a common EU food labeling policy (see for instance Chaffin (2010)) – focus on food nutrition labeling as a way to increase knowledge about energy content and in this way decrease prevalence of overweight. For example, consumer organizations, as well as the WHO, argue that adequate food nutrition labeling constitutes an essential part of a successful campaign against overweight (Branca, Lobstein and Nikogosian 2007) (BEUC – the European Consumers' Organisation 2010). However, based on our survey, we cannot support the rationale behind such propositions, that a lack of information about energy content contributes to a higher BMI. Consequently, we are forced to question the expected effectiveness of such measures as a means to fighting overweight.

Admittedly, though, the scope of this survey is limited – there are many more SDEF, other product groups, additional variables that affect BMI, more sophisticated methods to measure the included variables, etcetera (we discuss such shortcomings more thoroughly in the next section). For instance, Coca Cola, cinnamon buns, crisps, snickers and beer might not be representative of other SDEF (see *A* in *Figure 8*[41]). In such a scenario, the lack of support in data for our hypothesis might only apply for the surveyed products, not necessarily for SDEF in general. We tried to dissipate such risks by mainly analyzing an average of estimations of some of the most commonly consumed SDEF in Sweden. However, maybe people categorize products as plainly "healthy" or "unhealthy", and intuitively refrain from consuming "unhealthy" products, regardless of their perception of the exact energy content of such products. The surveyed SDEF are common and probably already categorized as "unhealthy",[42] while other less common SDEF might not have attained this status. Thus, the relationship between information and BMI might be different for other SDEF. This calls for additional research of less common SDEF.

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[41] We also measured all SDEF against *one* "normal" food: spaghetti and meat sauce, which need not be a good proxy for "normal" food (given limitations on the number of products we could investigate, we concluded that it was of higher relevance to examine as many SDEF as possible).

[42] Some respondents indeed commented that they never consumed some or any of the surveyed products, arguing that they were typical products that "one should avoid" because of their unhealthiness.

Furthermore, food nutrition labeling usually encompasses more than just additional information about energy content, for instance specification of different fats, salt, sugar etc. There might be a link behind deficits of such information and overweight.[43] Also in this area, we believe that there is a need for further research to better understand the relationship between information and overweight.

6.3. Sources of Concern

Our results clearly deviate from those of Jackson, et al. (2005), who found a negative correlation between estimation of energy content and risk of being obese among the Scottish population, although only among the lower social stratum and for some products. One explanation could be that the Swedish population is different from the Scottish; for instance, there might not be a social class in Sweden equivalent to the Scottish lower social stratum in terms of relationship between knowledge of energy content and weight-related status. Another reason might be differences in methodology between the two studies. Thirdly, information regarding energy content of SDEF might have increased over the last four years, for instance as a result of media attention on overweight and health-related issues, better nutrition labeling policies, etc. This might have cut an earlier link between information and overweight, and today only factors other than information deficits regarding relative energy content of SDEF affect BMI.[44]

Our sample also differs from earlier findings in the sense that there was no link between education level and BMI in our sample (compared to the findings of e.g. Wadman and ten Berg (2008)). One explanation could be that people overstated their level of education in our study.[45] We asked subjects to state their highest *attained* degree, and we suspect that some, especially young adults still in college/university, stated they had attained a university degree when they had in fact taken only some university courses. That is, measurement errors might have obscured the distinction between the two education classes, also blurring differences in prevalence of overweight between the two. Furthermore, our survey was conducted in the Stockholm area, making it highly likely that our sample is biased towards Stockholm. Stockholm is not necessarily representative of Sweden: it has more high-educated people (Statistics

[43] Moreover, additional information about such issues could potentially contribute to the fight against other health-related problems.

[44] If this is indeed the case, one might anticipate the growth in prevalence of overweight to have slowed down, because one factor that contributed to overweight no longer does so. As a matter of fact, the latest report from *The Swedish National Board of Health and Welfare* (*Socialstyrelsen)* claims that consumption behavior appears to have improved and that the prevalence of overweight increases at a slower rate than before in Sweden (Axelsen, et al. 2009). Obviously, there are many other potential reasons behind these observations.

[45] Such an inclination has, for instance, been proven in ethnic minorities (Graff-Radford, et al. 2007).

Sweden 2008) and a lower percentage of overweight women as well as obese women than any other region in Sweden (Wadman and ten Berg 2008). It could be that the earlier claimed benefits of higher education in terms of lower BMI only apply outside the capital.

Obviously, such differences between the Stockholm population and Sweden in general could also apply to the relationship between perception of relative energy content of SDEF and BMI, i.e. the relationship might differ in its nature between Stockholm and the rest of the country.[46] Nevertheless, we attempt to draw conclusions about a potential correlation for Sweden in general. We thus caution that our results are based on a sample population biased towards Stockholm, which might not be representative of Sweden. To be able to comfortably extent our conclusions to apply to Sweden in general, additional studies would be appreciated.

The survey locations were chosen to give what we believed would be a representative sample of the population. A majority of our survey points were metro and train stations, which clearly excludes the part of the population not using public transport. Possibly, high-income individuals are underrepresented in the survey because low-income individuals tend to use public transport to a greater extent in Sweden (Eliasson and Mattsson 2006). Furthermore, it might be the case that overweight people avoid public transport to a greater extent. Although this per se does not compromise our results (as long as the relationship between perception of relative energy content of SDEF and BMI does not differ between commuters and non-commuters, everything else the same), we caution that our sample cannot be expected to exactly match the target population. Furthermore, we approached people and asked them to participate in the survey. Some might have guessed that the survey was about knowledge of food energy content, and this suspicion could, for instance, have induced those that felt they had a worse idea about energy contents to refrain from participating to a larger extent than people that felt they had a good grasp of such issues.[47] We cannot rule out any systematic error among those that refrained from participating in the survey.

[46] Indeed, it might be the case that education is correlated with BMI if and only if perception of relative energy content of SDEF is correlated with BMI. The benefits of a higher education in terms of a lower BMI might apply through a greater access to and ability to handle health-related information (Borgonovi, et al. 2009). If such information fails to affect individual behavior – there is no causal link between perception of relative energy content of SDEF and BMI – a higher education will have no effect on BMI.

[47] Additionally, for this to compromise results, those that refrained from participating have to have a higher BMI, on average.

7. Conclusion

In this thesis, we evaluated information deficits regarding energy content of food products as a factor behind overweight. We argued that if a lack of information is a factor behind overweight, this might especially applicably for SDEF. In particular, we suggested that a too low perception of relative energy content SDEF might induce an individual to overconsume such products, resulting in a higher BMI. However, through a quantitative study including 301 Swedish adults, we could not support such a mechanism – we found no evidence that information deficits regarding energy contents of SDEF are correlated with a higher BMI. Our results could suggest that people do not base their consumption of SDEF on what they know about the energy content of such products, i.e. there is a failing link between knowledge of energy content and consumption behavior. Consequently, we cannot support claims that increased information about energy content of food products (for instance through additional food nutrition labeling) is an essential part of a successful campaign against overweight.

8. References

Access Economics Pty Limited (2008). The growing cost of obesity in 2008: three years on. Diabetes Australia.

Adamy, J (2009). Soda Tax Weighed to Pay for Health Care. the Wall Street Journal. May 12, 2009. http://online.wsj.com/article/SB124208505896608647.html (accessed January 5, 2010).

Akdağ, R., and M. Danzon (2006). "European Charter on counteracting obesity." WHO European Ministerial Conference on Counteracting Obesity. Istanbul, Turkey: WHO Regional Office for Europe. pp.1–5.

Aldrich, L. (1999) Consumer Use of Information – Implications for Food Policy. Washington, D.C.: U.S. Department of Agriculture.

Alm, S.E., and T. Britton (2008). Stokastik. Stockholm: Liber AB.

Axelsen, M., M. Danielsson, M. Norberg, and A. Sjöberg (2009). "Matvanor och fysisk aktivitet." In Folkhälsorapport 2009, by M. Danielsson, M. Berlin, I. Heimerson and M. Talbäck, pp.243–260. Västerås: Edita Västra Aros.

Bacallao, J., and M. Peña (2000). Obesity and poverty: A new public health challenge. Washington, D.C.: Pan American Health Organization.

Beaglehole, R., M.A. Ford, R.T. Jackson, and A.W. Stewart (1987). "Underestimation of relative weight by use of self-reported height and weight." American Journal of Epidemiology 125, no. 1: pp.122–126.

Bell, A.C., K. Ge, and B.M. Popkin (2001). "Weight gain and its predictors in Chinese adults." International Journal of Obesity 25, no. 7: pp.1079–1086.

BEUC – the European Consumers' Organisation (2010). "Food labelling: another missed opportunity for healthier choices." BEUC – the European Consumers' Organisation. March 16, 2010. http://www.beuc.org/BEUCNoFrame/Docs/2/CJJALOHAGNLPCLAEJLJFBFGNPDWD9DBYTY9DW3571KM/BEUC/docs/DLS/2010-00171-01-E.pdf (accessed April 5, 2010).

Bhattacharya, J., D. Lakdawalla, and T. Philipson (2005). "Welfare-enhancing technological change and the growth of obesity." American Economic Review 95, no. 2: pp.253–257.

Borgonovi, F., M. Cecchini, J. Church, M. Devaux, and F. Sassi (2009). Education and obesity in four OECD countries. OECD Health Working Paper No.46, Paris: OECD.

Borgquist, L., F. Jacobsson, and M. Johannesson (2007). "Is altruism paternalistic?" The Economic Journal 117, no. 520: pp.761–781.

Bouchard, C., et al. (2002) "The effect of sex, age and race on estimating percentage body fat from body mass index: The Heritage Family Stud." International Journal of Obesity 26, no. 6: pp.789–796.

Bound, J., C. Brown, and N. Mathiowetz (2001). Measurement Error in Survey Data. Vol. 4, chap. 59 in Handbook of Econometrics, by J. Heckman and E. Leamer, pp.3705–3843. Amsterdam: Elsevier.

Branca, F. (2006). World Health Organization Regional Office for Europe. WHO. November 2, 2006. http://www.euro.who.int/mediacentre/PR/2006/20061101_5 (accessed December 15, 2009).

Branca, F., T. Lobstein, and H. Nikogosian (2007). The challenge of obesity in the WHO European Region and the strategies for response: summary. Copenhagen: WHO.

Bray, G.A., J.C. Lovejoy, S. Paeratakul, and D.H. Ryan (2002). "The relation of gender, race and socioeconomic status to obesity and obesity comorbidities in a sample of US adults." International Journal of Obesity 26, no. 9: pp.1205–1210.

Breeze, E., C.J. Bulpitt, A.E. Fletcher, G.M. Price, and U. Ricardo (2006). "Weight, shape, and mortality risk in older persons: elevated waist-hip ratio, not high body mass index, is associated with a greater risk of death." American Journal of Clinical Nutrition 84, no. 2: pp.449–460.

Brownell, K.D., G.D. Foster, and T.A. Wadden (2002). "Obesity: responding to the global epidemic." Journal of Consulting and Clinical Psychology 70, no. 3: pp.510–525.

Capps, O., S. Kim, and R. Nayga (2001). "Food Label Use, Self-Selectivity, and Diet Quality." Journal of Consumer Affairs 35, no. 2: pp.346–363.

Carmichael, H.E., S.J. Lev, L.D. Plank, and B.A. Swinburn (1999). "Body size and composition in Polynesians." International Journal of Obesity 23, no. 11: pp.1178–1183.

Caterson, I.; Chunming, C.; Ikeda, Y.; Inoue, S.; Khalic, A.K.; Kim, Y.S.; Zimmet, P. (2000). The Asia-Pacific Perspective: Redefining obesity and its treatment. Manilla: WHO.

Cawley, J. (2000). Body Weight and Women's Labor Market Outcomes. Working Paper 7841, Cambridge, MA: National Bureau of Economic Research.

Cawley, J., and J. Variyam (2006). Nutrition Labels and Obesity. Working Paper 11956, Cambridge, MA: National Bureau of Economic Research.

Cecchini, M., M. Devaux, E. Rusticelli, and F. Sassi (2009). "The Obesity Epidemic: Analysis of past and projected future trends in selected OECD countries." OECD Health Working Papers.

Chaffin, J. (2010). "Nutrition labels give Brussels an awkward case of indigestion." the Financial Times, March 16, 2010.

Chaloupka, F., and H. Saffer (2000). "Tobacco Advertising: Economic Theory and International Evidence." Journal of Health Economics 19, no. 6: pp.1117–1137.

Christakis, D.A., A. Drewnowski, and J.A. Mendoza (2007). "Dietary Energy Density Is Associated With Obesity and the Metabolic Syndrome in U.S. Adults." Diabetes Care 30, no. 4: pp.974–979.

Coakley, E.H.; Colditz, G.A.; Dietz, W.H.; Field, A.E.; Laird, N.; Must, A.; Rimm, E.; Spadano, J.L. (2001). "Impact on overweight on the risk of developing common chronic diseases during a 10-year period." Archives of Internal Medicine 161, no. 13: pp.1581–1586.

Collins, D., H. Lapsley, J. Lightwood, and T.E. Novotny (2000). "Estimating the costs of tobacco use." In Tobacco Control in Developing Countries, by F. Chaloupka and P. Jha, pp.63–106. Oxford: Oxford Medical Publications for the World Bank and the World Health Organization.

Coop (2008). Sunda vanor 2008. Coop.

Cox, E.R., M.A. Kortt, and P.C. Langley (1998). "A review of cost-of-illness studies on obesity." Clinical Therapeutics 20, no. 4: pp.772–779.

Cutler, D.M., E.L. Glaeser, and J.M. Shapiro (2003). "Why Have Americans Become More Obese?" Journal of Economic Perspectives 17, no. 3: pp.93–118.

Danielsson, M., and M. Norberg (2009). "Övervikt, hjärt- och kärlsjukdomar och diabetes." In Folkhälsorapport 2009, by M. Danielsson, M. Berlin, I. Heimerson and M. Talbäck, pp.201–242. Västerås: Edita Västra Aros.

Department of Health – Economic and Operational Research (2004). Government Actuary's Department: estimated effects of obesity (based on straigt line extrapolation of trends). London: the Stationary Office.

Drewnowski, A., and S.E. Specter (2004). "Poverty and obesity: the role of energy density and energy costs." American Journal of Clinical Nutrition 79, no. 1: pp.6–16.

Drewnowski, A., J.H. Ledikwe, and B.J. Rolls (2005). "Changing the energy density of the diet as a strategy for weight management." Journal of American Diet Association 105, no. 5 Suppl 1: pp.S98–103.

Edelsberg, J., G. Oster, A.K. O'Sullivan, and D. Thompson (2000). "The clinical and economic burden of obesity in a managed care setting." The American Journal of Managed Care 6, no. 6: pp.681–689.

Elfhag, K., and L.C. Morey (2008). "Personality traits and eating behavior in the obese: Poor self-control in emotional and external eating but personality assets in restrained eating." Eating behaviors 9, no. 3: pp.285–293.

Eliasson, J., and L.G. Mattsson (2006). "Equity effects of congestion pricing: Quantitative methodology and a case study for Stockholm." Transportation Research Part A: Policy and Practice 40, no. 7: pp.602–620.

European Parliament (2010). Clearer and more informative food labeling rules. March 16, 2010. http://www.europarl.europa.eu/news/expert/infopress_page/067-70614-074-03-12-911-20100315IPR70613-15-03-2010-2010-false/default_en.htm (accessed April 5, 2010).

Faskunger, J., and E.L. Schäfer (2006). Fysiskt aktivitet och folkhälsa. Östersund: Statens folkhälsoinstitut.

FDA (2004). "Calories Count: Report of the Working Group on Obesity." U.S. Food and Drug Administration. http://www.fda.gov/Food/LabelingNutrition/ReportsResearch/ucm081696.htm#execsum (accessed January 26, 2010).

Ferres, S., G. Horgan, and J. Stubbs (2000). "Energy density of foods: effects on energy intake." Critical reviews in food science and nutrition 40, no. 6: pp.481–515.

Fiebelkorn, I.C., E.A. Finkelstein, and G. Wang (2003). "National medical spending attributable to overweight and obesity: How much, and who's paying?" Health Affairs W3: pp.219–226.

French, S.A., C.L. Huang, and B.H. Lin (2004). "Factors associated with women's and children's body mass indices by income status." International Journal of Obesity 28, no. 4: pp.536–542.

Gortmaker, S.L., A. Must, J.M. Perrin, A.M. Sobol, and H.W. Dietz (1993). "Social and Economic Consequences of Overweight in Adolescence and Young Adulthood." The New England Journal of Medicine 329, no. 14: pp.1008–1012.

Gracia, A., M. Loureiro, and R. Nayga (2006). "Do consumers value nutrition labels?" European Review of Agricultural Economics 33, no. 2: pp.249–268.

Graff-Radford, N.R., R.J Ivnik, J.A. Lucas, S.E. O'Bryant, F.B. Willis, and G.E. Smith (2007). "Discrepancies between self-reported years of education and estimated reading level among elderly community-dwelling African-Americans: Analysis of the MOAANS data." Archives of Clinical Neuropsychology 22, no. 3: pp.327–332.

Graubard, B.I., and A.K. Kant (2005). "Energy density of diets reported by American adults: association with food group intake, nutrient intake, and body weight." International Journal of Obesity 29, no. 8: pp.950–956.

Grossman, M. (1972)."On the concept of health capital and the demand for health." Journal of Political Economy 80, no. 2: pp.223–255.

van Harreveld, F., L.F. Nordgren, and J. van der Pligt (2009). "The Restraint Bias: How the Illusion of Self-Restraint Promotes Impulsive Behavior." Psychological Science 20, no. 12: pp.1523–1528.

Harsanyi, J.C. (1967). "Games with incomplete information played by Bayesian players: the basic model." Management Science 14, no. 3: pp.159–182.

Haslam, D.W., and W.P. James (2005). "Obesity." Lancet 366, no. 9492: pp.1197–1209.

Horgan, G., N. Mazlan, J. Stubbs, and S. Whybrow (2006). "Effects of increasing increments of fat- and sugar-rich snacks in the diet on energy and macronutrient intake in lean and overweight men." British Journal of Nutrition 96, no. 3: pp.596–606.

Jackson, D.M., H. Walker, L. Walker, and J.R. Speakman (2005). "Associations between BMI, social strata and the estimated energy content of foods." International Journal of Obesity 29: pp.1281–1288.

Jackson-Leach, R.; James, W.P.T.; Kalamara, E.; Mhurchu, C.N.; Nishida, C.; Rigby, N.J.; Rodgers, A.; Shayeghi, M. (2004). Overweight and obesity (high body mass index). Vol. 1, in Comparative quantification of health risks: global and regional burden of disease attribution to selected major risk factors, by M. Ezzati, A.D. Lopez, C.J.L. Murray and A. Rodgers, pp.497–597. Geneva: WHO.

James, P.T., R. Leach, and N. Rigby (2004). "The obesity epidemic, metabolic syndrome and future prevention strategies." European Journal of Cardiovascular Prevention & Rehabilitation 11, no. 1: pp.3–8.

Jebb, S.A., and A.M. Prentice (2001). "Beyond body mass index." Obesity Review 2, no. 3: pp.141–147.

Just, D.R. (2006) "Behavioral economics, food assistance and obesity." Agricultural and Resource Economics Review 35, no. 2: pp.209–220.

Kasper, W., and M. Streit (1999). Institutional Economics: social order and public policy. Cheltenham: Edward Elgar Publishing.

Lafsky, M. (2008). The Economics of Obesity: A Q&A With the Author of The Fattening of America. the New York Times. February 8, 2008. http://freakonomics.blogs.nytimes.com/2008/02/08/the-economics-of-obesity-a-qa-with-the-author-of-the-fattening-of-america/ (accessed January 4, 2010).

Lakdawalla, D., and T. Philipson (2002). The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination. Working Paper 8946, Cambridge, MA: National Bureau of Economic Research.

Lee, L., and J. Sepanski (1995). "Estimation of Linear and Nonlinear Errors-in-Variables Models Using Validation Data." Journal of the American Statistical Association 90, no. 429: pp.130–140.

Lindblom, K. (2009). Spagetti och köttfärssås vanligast på middagsbordet. Aftonbladet. February 23, 2009. http://www.aftonbladet.se/matvin/article4465204.ab (accessed January 5, 2010).

Livsmedelsverket (2008). Svenska näringsrekommendationer. March 5, 2008. http://www.slv.se/sv/grupp1/Mat-och-naring/Svenska-narings-rekommendationer/ (accessed March 1, 2010).

Madden, D. (2002). Setting the appropriate tax on cigarettes in Ireland. Working paper, Dublin: University College Dublin and Foundation for Fiscal Studies.

Mann, S. (2008). "Framing Obesity in Economic Theory and Policy." Review of Social Economy 66, no. 2: pp.163–179.

Marshall, T. (2000). "Exploring a fiscal food policy: the case of diet and ischaemic heart disease." British Medical Journal 320, no. 7230: pp.301–305.

McCormick, B., I. Stone, and Corporate Analytical Team (2007). "Economic costs of obesity and the case for government intervention." Obesity Reviews 8, no. 1: pp.161–164.

National Center for Health Statistics (2008). Prevalence of overweight, obesity and extreme obesity among adults: United States, trends 1976-80 through 2005-2006. Centers for Disease Control and Prevention.

Nayga, R.M. (2000) "Schooling, health knowledge and obesity." Applied Economics 32, no. 7: pp.815–822.

Neovius, M., F. Rasmussen, and A. Teixeira-Pinto (2008). "Shift in the composition of obesity in young adult men in Sweden over a third of a century." International Journal of Obesity 32, no. 5: pp.832–836.

Nestle, M., and L. Young (2002). "The contribution of expanding portion sizes to the US obesity epidemic." American Journal of Public Health 92, no. 2: pp.246–249.

OECD (2002). Towards Sustainable Household Consumption? Paris: OECD.

OECD (2009). OECD Health Data 2009: Statistics and Indicators for 30 Countries. November 2009. http://www.oecd.org/document/30/0,3343,en_2649_34631_12968734_1_1_1_37407,00.html (accessed January 15, 2010).

Peters, J.C. (2003). ”Combating Obesity: Challenges and Choices.” Obesity Research 11, nr 10S: pp.7S–11S.

Petersen, L., P. Schnohr, and T.I. Sørensen (2004). "Longitudinal study of the long-term relation between physical activity and obesity in adults." International Journal of Obesity 28, no. 1: pp.105–112.

Philipson, T. (2001). "The world-wide growth in obesity: an economic research agenda." Health Economics 10: pp.1–7.

Prentice, A.M., and S.A. Jebb (2003). "Fast foods, energy density and obesity: a possible mechanistic link." Obesity Reviews 4, no. 4: pp.187–195.

Reimler, D.K. (2004). "Poor Smokers, Poor Quitters, and Cigarette Tax Regressivity." American Journal of Public Health 94, no. 2: pp.225–229.

Rissanen, A., and J.C. Seidell (2004). "Prevalence of Obesity in Adults: The Global Epidemic." In Handbook of Obesity: Etiology and Pathophysiology, 2nd edition, by C. Bouchard and G.A. Bray, pp.93–108. New York, NY: Marcel Dekker.

Scharff, R.L. (2009). "Obesity and Hyperbolic Discounting: Evidence and Implications." Journal of Consumer Policy 32, no. 1: pp.3–21.

Schlosser, E. (2001). Fast Food Nation: the Dark Side of the All-American Meal. New York, NY: Houghton Mifflin Company.

Spasojevic, J. (2003). Effects of education on adult health in Sweden: Results from a natural experiment. PhD dissertation, New York, NY: City University of New York Graduate Center.

Statens folkhälsoinstitut (2009). "Resultat från Nationella folkhälsoenkäten – Hälsa på lika villkor, 2008." Statens folkhälsoinstitut. April 5, 2009. www.fhi.se/Documents/.../Resultat-2008/Overvikt-090405.pdf (accessed January 20, 2010).

Statistics Sweden (2008). Educational attainment of the population 2008. Statistiska meddelanden, Stockholm: Statistics Sweden.

Wadman, C., and H. ten Berg (2008). Livsstilsrapport 2008. Östersund: Statens Folkhälsoinstitut.

Wansink, B. (2004). "Environmental factors that increase the food intake and consumption volume of unknowing consumers." Annual Review of Nutrition 24: pp.455–479.

Varian, H.R. (1992). Microeconomic Analysis. 3rd ed. New York, NY: W.W. Norton & Company.

WHO (2010). World Health Organization Obesity. February 2010. http://www.who.int/topics/obesity/en/index.html (accessed February 23, 2010).

9. Appendices

9.1. Appendix A: Questionnaire

Bidra till hälsoforskningen i Sverige!

Jämför hur mycket **ENERGI** varje produkt innehåller **I FÖRHÅLLANDE** till normalportionen pasta och köttfärssås.

Du förväntas inte veta exakt rätt siffror. Skriv därför vad din intuition säger utan att fundera för länge.

A. _______% B. _______% C. _______% D. _______% E. _______%

Vi behöver också ditt svar på följande korta frågor

Kön	Kvinna ☐	Man ☐	
Högsta avslutad utbildning	Högstadium ☐	Gymnasium ☐	Högskola/universitet ☐
Ålder	_________ år		
Längd	_________ cm		
Vikt	_________ kg		

Vänligen vik lappen och lägg den i lådan när du besvarat alla frågor. Ditt svar behandlas naturligtvis helt anonymt.

Stort tack för din medverkan!

9.2. Appendix B: Additional Response Statistics

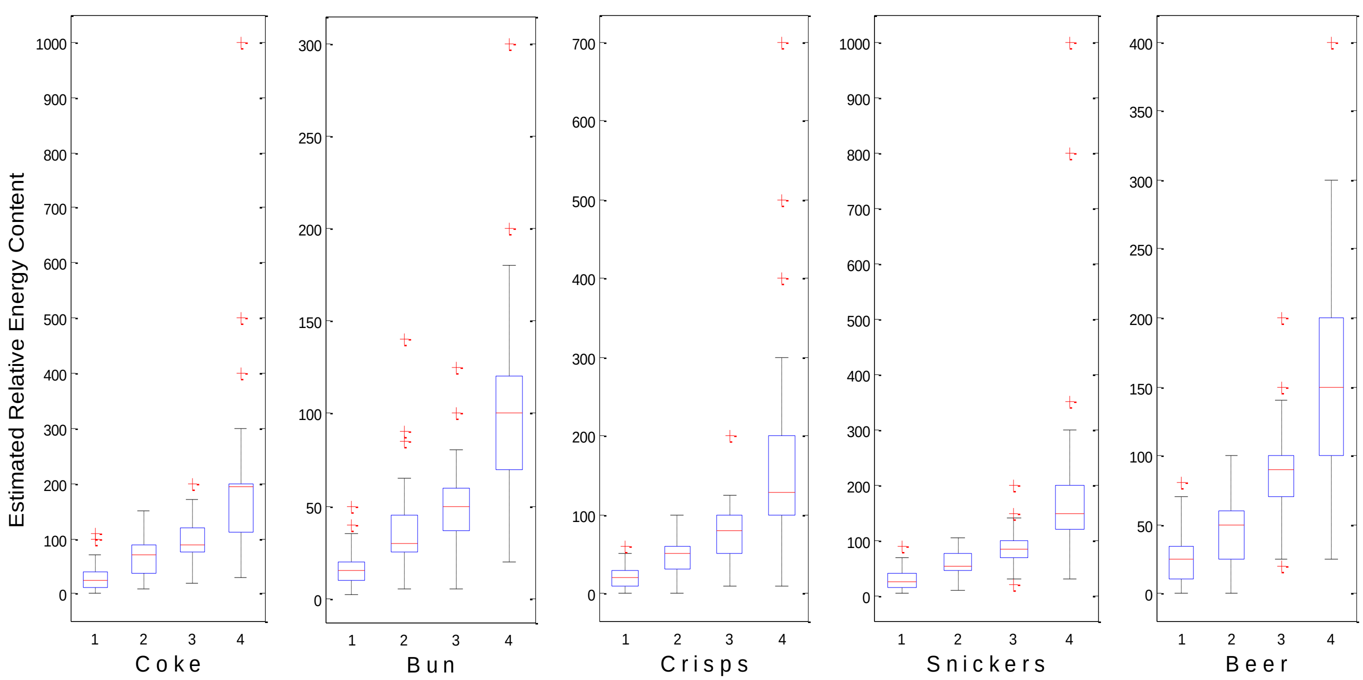
Table 5: Number of observations, mean perceived relative energy content, standard deviation, the 25th, 50th and 75th percentiles, and the min and max values in subsamples based on gender, education, age and weight-class.

Subsample	Obs	Mean	Std. Dev.	Q1	Median	Q3	Min	Max
Female	152	109.1	90.6	53	83	140	11	758
Male	149	90.7	66.9	41	77	118	6	329
High educated	149	90.9	59.9	45	79	123	11	315
Low educated	152	108.9	95.3	51	81	140	6	758
Young	96	101.4	95.1	48	74	132	11	758
Middle-aged	135	103.2	70.0	50	89	139	11	433
Old	70	91.8	76.6	41	76	104	6	445
Overweight	132	103.4	71.4	56	86	138	6	445
Normal weight	169	97.4	86.5	45	73	125	11	758

***Note*: The high educated group includes all respondents with a university degree (as stated by the respondent), the low educated group includes everyone else. The young include the subjects 18–30 years old, middle-aged those 31–60 years old, and the old those 61–85 years old. The overweight include all respondents with a BMI≥25, the normal weight all else.**

9.3. Appendix C: Additional Data on Relative Perception

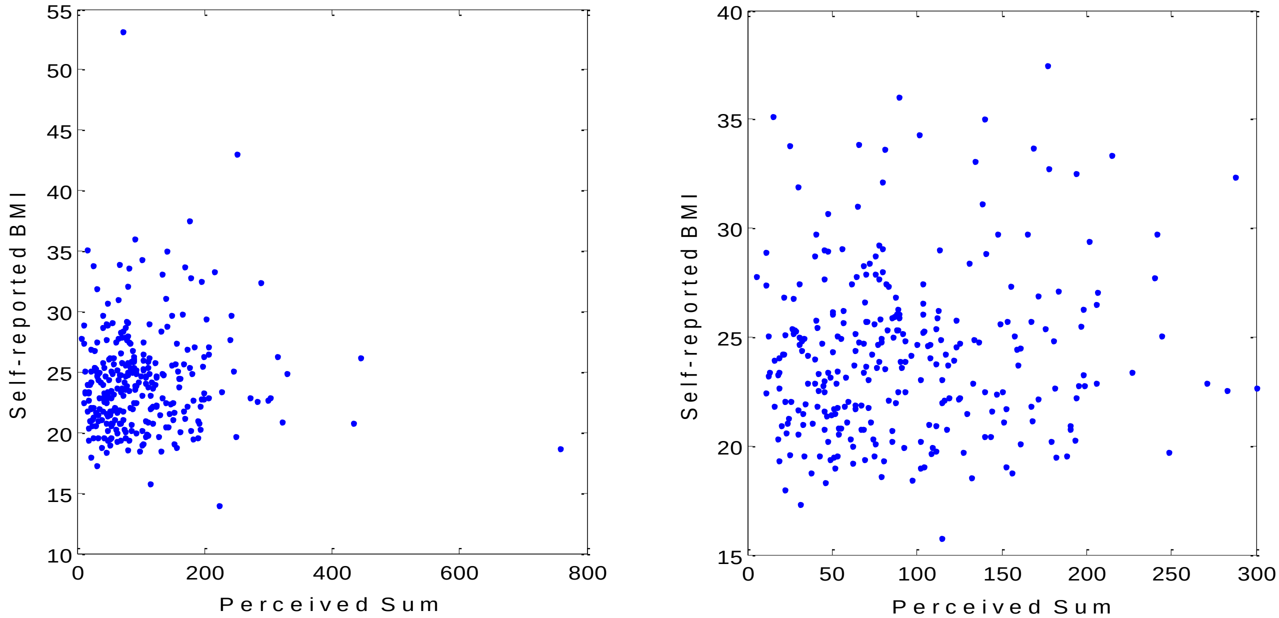
Figure 9: Distribution of perceived energy content of the separate products sorted by quartile of the Sum.



***Note 1*: The first box (from the left) in each subplot displays the distribution of the perceived relative energy content of a product for all individuals with an overall Sum in the first quartile, the second plot displays the distribution of the perceived relative energy content of a product for all individuals with an overall Sum in the second quartile, etc.**
***Note 2*: On each box, the central mark is the median, the edges of the box are Q1 and Q3 (the 25th and 75th percentiles, respectively), the whiskers extend to the most extreme datapoints that are not outliers, and the outliers are plotted individually. An observation is considered an outlier if it is smaller than Q1 - 1.5*(Q3 - Q1) or greater than Q3 + 1.5*(Q3 - Q1).**

9.4. Appendix D: Additional Data on Model Specification

Figure 10: Distribution of BMI values relative to Sum for the full sample (left) and for the majority part of observations (right).



9.5. Appendix E: Regression Results for the Separate Products

Table 6: Results of classic regression models for the separate products (*Regression 3*).

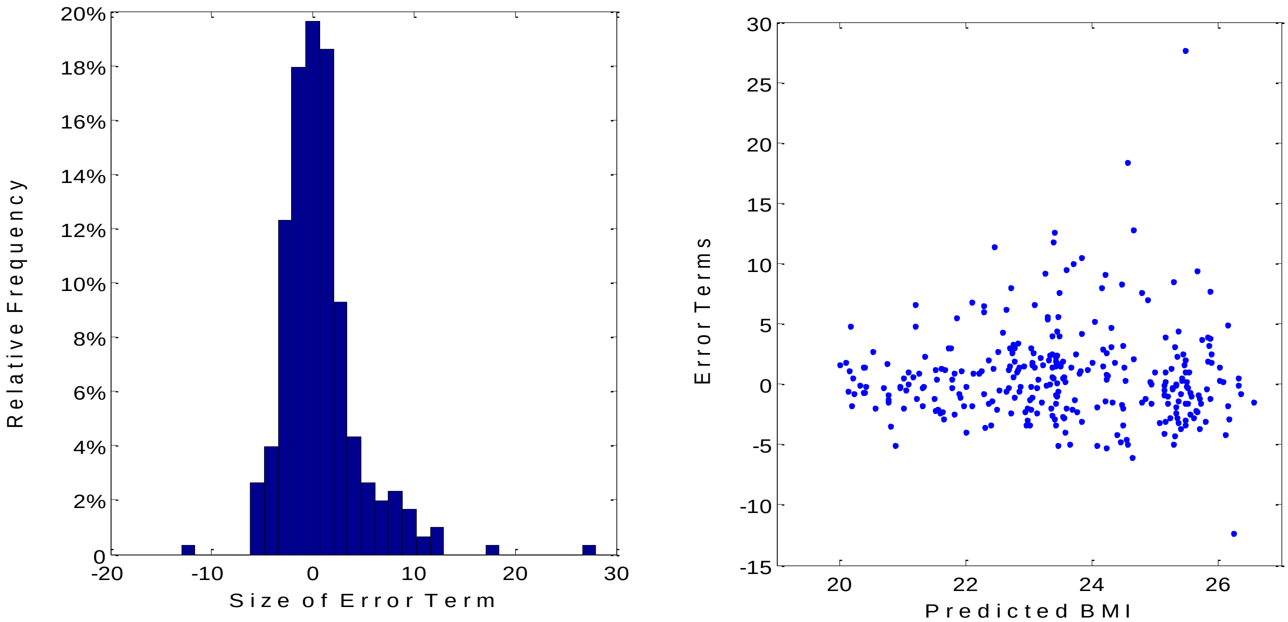
		coke	bun	crisps	snickers	beer
product only	Coefficient	0.0002	0.0040	0.0019	0.0001	0.0038
	(p-value)	*(0.942)*	*(0.451)*	*(0.533)*	*(0.962)*	*(0.266)*
all variables		0.0009	0.0046	0.0024	0.0010	0.0050
		(0.698)	*(0.351)*	*(0.419)*	*(0.683)*	*(0.123)*
only overweight		-0.0007	-0.0006	**0.0124**	-0.0015	0.0052
		(0.877)	*(0.938)*	***(0.032)***	*(0.668)*	*(0.325)*
only normal weight		-0.0009	-0.0044	-0.0016	-0.0012	0.0008
		(0.452)	*(0.136)*	*(0.275)*	*(0.479)*	*(0.634)*
only female		0.0000	0.0054	0.0028	0.0014	0.0056
		(0.999)	*(0.367)*	*(0.383)*	*(0.599)*	*(0.140)*
only male		0.0029	0.0024	0.0020	-0.0008	0.0053
		(0.473)	*(0.773)*	*(0.729)*	*(0.889)*	*(0.340)*
only high educated		0.0044	0.0080	0.0041	0.0026	0.0024
		(0.192)	*(0.268)*	*(0.348)*	*(0.577)*	*(0.573)*
only low educated		-0.0003	**0.0039**	0.0018	0.0005	0.0065
		(0.934)	***(0.004)***	*(0.667)*	*(0.872)*	*(0.176)*
only young		-0.0009	0.0002	-0.0015	-0.0032	-0.0009
		(0.700)	*(0.973)*	*(0.600)*	*(0.298)*	*(0.826)*
only middle		0.0032	-0.0003	-0.0036	-0.0015	0.0031
		(0.498)	*(0.969)*	*(0.542)*	*(0.815)*	*(0.589)*
only old		0.0068	0.0187	**0.0286**	0.0055	**0.0201**
		(0.381)	*(0.092)*	***(0.000)***	*(0.169)*	***(0.003)***

Note 1: **Significant values in bold.**

Note**: The high educated group includes all respondents with a university degree (as stated by the respondent), the low educated group includes everyone else. The young include subjects 18–30 years old, middle-aged those 31–60 years old, and the old those 61–85 years old. The overweight include all respondents with a BMI≥25, the normal weight all else.**

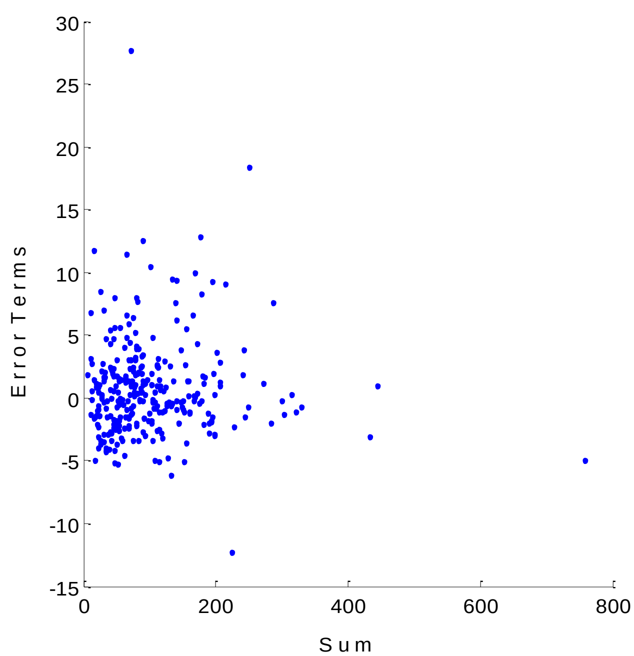
9.6. Appendix F: Additional Data on Error Terms

Figure 11: Histogram of error terms (left) and error terms plotted against predicted BMI values (right).



9.7. Appendix G: Additional Data on Heteroskedasticity

Figure 12: Error terms plotted against Sum.



9.8. Appendix H: Regression Results Excluding Outliers

Table 7: Results of classic regression models (*Regressions 1–2*) excluding outliers.

		Sum	age	age^2	female	high_ed	_cons	F-statistic	R^2	n
sum only	Coefficient	0.0034	-	-	-	-	23.7446	1.09	0.0037	295
	(p-value)	*(0.298)*	-	-	-	-	*(0.000)*			
all variables		0.0041	0.2058	-0.0017	-1.8417	-0.1228	19.3620	11.30	0.1635	295
		(0.183)	*(0.006)*	*(0.041)*	*(0.000)*	*(0.762)*	*(0.000)*			
only overweight		0.0020	0.0009	0.0001	0.3141	-0.7654	27.2633	0.72	0.0285	128
		(0.623)	*(0.993)*	*(0.962)*	*(0.558)*	*(0.147)*	*(0.000)*			
only normal weight		-0.0003	0.1302	-0.0013	-0.8728	0.5086	19.1367	5.99	0.1568	167
		(0.896)	*(0.009)*	*(0.023)*	*(0.002)*	*(0.061)*	*(0.000)*			
only Sums in Q1		-0.0341	0.3028	-0.0029	-1.1368	0.7411	18.0550	2.82	0.1717	74
		(0.344)	*(0.038)*	*(0.069)*	*(0.158)*	*(0.366)*	*(0.000)*			
only Sums in Q2		**0.1002**	0.0607	-0.0004	-3.2129	-0.3828	17.8796	5.39	0.2838	74
		(0.007)	*(0.666)*	*(0.771)*	*(0.000)*	*(0.595)*	*(0.000)*			
only Sums in Q3		**-0.0712**	0.3525	-0.0033	-2.3181	-0.3997	24.5662	6.92	0.3277	77
		(0.005)	*(0.011)*	*(0.027)*	*(0.002)*	*(0.601)*	*(0.000)*			
only Sums in Q4		-0.0055	0.1239	0.0000	-0.4984	-0.6484	21.0050	4.01	0.2387	70
		(0.564)	*(0.447)*	*(0.993)*	*(0.609)*	*(0.489)*	*(0.000)*			
only female		0.0063	0.3646	-0.0031	-	-0.3551	13.8039	9.24	0.2055	148
		(0.158)	*(0.001)*	*(0.008)*	-	*(0.531)*	*(0.000)*			
only male		0.0028	0.0362	-0.0001	-	0.0252	23.2997	1.09	0.0297	147
		(0.506)	*(0.726)*	*(0.959)*	-	*(0.965)*	*(0.000)*			
only high educated		0.0028	0.3351	-0.0032	-1.8945	-	17.0523	7.28	0.1692	148
		(0.504)	*(0.003)*	*(0.009)*	*(0.000)*	-	*(0.000)*			
only low educated		0.0059	0.1140	-0.0005	-1.8947	-	20.7016	7.31	0.1707	147
		(0.202)	*(0.273)*	*(0.657)*	*(0.003)*	-	*(0.000)*			
only young		0.0003	0.9352	-0.0178	-2.9397	0.1521	11.9629	5.97	0.2513	95
		(0.938)	*(0.375)*	*(0.416)*	*(0.000)*	*(0.815)*	*(0.336)*			
only middle		0.0030	-0.1304	0.0013	-1.1354	0.0985	28.0786	0.72	0.0278	132
		(0.555)	*(0.748)*	*(0.770)*	*(0.079)*	*(0.881)*	*(0.002)*			
only old		**0.0145**	-5.0444	0.0364	-1.8546	-1.5685	199.8976	3.34	0.2123	68
		(0.036)	*(0.029)*	*(0.029)*	*(0.031)*	*(0.090)*	*(0.013)*			

Note 1: **Statistically significant Sum values in bold (at the five percent significance level and for the two-sided test).**
Note 2**: The high educated group includes all respondents with a university degree (as stated by the respondent), the low educated group includes everyone else. The young include subjects 18–30 years old, middle-aged those 31–60 years old, and the old those 61–85 years old. The overweight include all respondents with a BMI≥25, the normal weight all else. The category Sums in Q1 includes all Sums in the first quartile of the distribution of Sum (Sum≤47), Sums in Q2 all Sums in the second quartile (47<Sum≤79), Sums in Q3 those in the third quartile (79<Sum≤132), and Sums in Q4 those in the fourth quartile (132<Sum).**

9.9. Appendix I: Logit Regression Results

Table 8: Results of Logit regression model (*Regression 4*).

		Sum	age	age^2	female	high_ed	_cons	n
Sum only	Coefficient	0.0009	-	-	-	-	-0.3412	301
	(p-value)	*(0.518)*	-	-	-	-	*(0.067)*	
all variables		0.0020	0.1094	-0.0008	-1.2375	-0.0098	-2.8056	301
		(0.214)	*(0.025)*	*(0.116)*	*(0.000)*	*(0.970)*	*(0.005)*	
only Sums in Q1		-0.0098	0.1003	-0.0008	-0.5578	0.6991	-3.0600	74
		(0.678)	*(0.315)*	*(0.436)*	*(0.304)*	*(0.201)*	*(0.141)*	
only Sums in Q2		**0.0880**	0.0915	-0.0008	-2.1347	0.0317	-7.0367	75
		(0.007)	*(0.433)*	*(0.527)*	*(0.001)*	*(0.955)*	*(0.030)*	
only Sums in Q3		**-0.0393**	0.1180	-0.0009	-1.8177	-0.2457	1.7870	77
		(0.040)	*(0.264)*	*(0.419)*	*(0.001)*	*(0.672)*	*(0.495)*	
only Sums in Q4		-0.0047	0.1633	-0.0010	-1.2124	-0.7878	-3.0718	75
		(0.285)	*(0.159)*	*(0.442)*	*(0.039)*	*(0.188)*	*(0.240)*	
only female		0.0008	0.1538	-0.0010	-	-0.2923	-5.4665	152
		(0.712)	*(0.070)*	*(0.263)*	-	*(0.474)*	*(0.004)*	
only male		0.0042	0.0961	-0.0009	-	0.2431	-2.3656	149
		(0.124)	*(0.125)*	*(0.181)*	-	*(0.486)*	*(0.064)*	
only high educated		0.0010	0.2245	-0.0022	-1.4557	-	-4.7518	149
		(0.757)	*(0.009)*	*(0.018)*	*(0.000)*	-	*(0.011)*	
only low educated		0.0025	0.0373	0.0001	-1.1652	-	-1.7166	152
		(0.176)	*(0.550)*	*(0.930)*	*(0.002)*	-	*(0.170)*	
only young		-0.0022	0.2321	-0.0030	-2.2469	0.0686	-3.9597	96
		(0.586)	*(0.834)*	*(0.895)*	*(0.000)*	*(0.914)*	*(0.766)*	
only middle		0.0031	-0.1155	0.0012	-1.2319	0.2237	2.8261	135
		(0.246)	*(0.617)*	*(0.628)*	*(0.001)*	*(0.548)*	*(2.826)*	
only old		**0.0087**	-0.0367	0.0003	-0.5980	-0.5109	1.4843	70
		(0.080)	*(0.981)*	*(0.979)*	*(0.264)*	*(0.387)*	*(0.978)*	

Note 1: **Statistically significant Sum values in bold (at the five percent significance level and for the two-sided test).**
Note 2**: The high educated group includes all respondents with a university degree (as stated by the respondent), the low educated group includes everyone else. The young include subjects 18–30 years old, middle-aged those 31–60 years old, and the old those 61–85 years old. The overweight include all respondents with a BMI≥25, the normal weight all else. The category Sums in Q1 includes all Sums in the first quartile (Sum≤47), Sums in Q2 all Sums in the second quartile (47<Sum≤79), Sums in Q3 those in the third quartile (79<Sum≤132), and Sums in Q4 those in the fourth quartile (132<Sum).**