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Time discounting and the body mass index

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Time Discounting and the Body Mass Index

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Abstract

In many Western countries, the relative weight of people – measured by the Body Mass Index (BMI) – has increased substantially in recent years, leading to an increasing incidence of overweight and related health problems. As with many forms of risky behavior, it is plausible that overweight is related to the individual discount rate. Increases in credit card debts, the rise in gambling and the development of a more hedonic life style, suggest that the average discount rate has increased over time. This increase may have been the cause of the increase in BMI. Applying a large set of indicators for the individual discount rate, this paper analyzes whether changes in time discounting can account for differences in body mass between individuals at a given point in time and whether changes in the average individual discount rate can explain the remarkable increase in BMI experienced in recent years. We find some evidence for a link between time discounting and differences in BMI between people, but this relationship depends strongly on the choice of the proxy for the discount rate. Giving our hypothesis the best chance, we analyze the development of the time discounting proxies that are most strongly related to BMI. We find no evidence for a change of these proxies over time. Our main conclusion therefore is that overweight might be related to the way people discount future health benefits, but the increase in BMI has to be explained by shifts in other parameters that determine the intertemporal decisions regarding the trade-off of current and future health and satisfaction.

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1 Introduction

In recent years, many Western countries have experienced a substantial increase in the average body mass of their population. This steady increase has serious consequences for life expectancy and health in general. It therefore raises the question why people take in more calories than recommended at the expense of future health, and why this behavior has changed so much in the past decade. Comparable to many other forms of risky behavior, it is plausible to assume a link between the individual discount rate and overweight. People who trade off current benefits against future costs at a high discount rate, put great weight on current pleasure and comfort obtained through eating, while giving relatively low weight to the potential future health problems related to this behavior. Increases in credit card debts, the rise in gambling and the development of a more hedonic life style, suggest that the average discount rate has increased over time. Along this argument, an increase in the average individual discount rate, could therefore explain the recent increase in the average Body Mass Index (BMI).

The aim of this paper is to investigate (i) whether differences in BMI between people at a certain moment of time are related to the individual discount rate, and (ii) whether a positive trend in time discounting can account for the increase of BMI over time. To analyze this question we use data of a survey among a sample of the Dutch population, for the period 1995-2004. This data set contains information about weight and length, and has a very large set of questions concerning the financial situation and attitude of the respondents. These questions offer ample opportunities for proxies to measure the individual discount rate. In 2004 we added a supplementary questionnaire to this survey with standard psychological questions for measuring the individual discount rate. On the basis of the 2004 data we are able to directly investigate the link between the discount rate and BMI, and to investigate the validity of a wide range of financial questions as proxies for the discount rate. Using the validated proxies we investigate the development of the individual discount rate and its link with BMI over time.

Our main findings are that differences in BMI between people in a specific year in the sample are related to some of our measures of the individual discount rate. Especially measures that are related to difficulties to manage expenditures are correlated with BMI. Comparing different years, however, it turns out that the average individual discount rate did not change from 1995 – 2004. The upward trend in BMI can therefore not be accounted for by an increase in the individual discount rate.

The cross-sectional correlation between the individual discount rate and BMI differs substantially between the sexes and age groups. On the basis of our theoretical model, we hypothesize that alternative possibilities to invest in human capital and to engage in risky behavior which are substitutes and/or complements to overconsumption of food could contribute to the explanation of these differences. Keeping in mind the broad character of human capital, these intervening alternatives could be related to health, but also to education and work. Consequently, the recent increase in BMI can also be related to price changes of these complements and substitutes.

This paper is related to the recent literature investigating the causes of the remarkable increase in BMI (Popkin and Doak, 1998; Flegal et al., 1998; Mokdad et al., 1999; Philipson, 2001; Komlos and Baur, 2004; Ogden et al., 2004). Technological change has been put forward as an explanation for increasing weights because it has simultaneously lowered the relative price of food and reduced the amount of physical activity required at work and in daily activity (Philipson and Posner, 1999; Lakdawalla and Philipson, 2002; Philipson, 2001). Cutler, Glaeser and Shapiro (2003) argue that the decrease in the price of calories is of the right magnitude to explain the increase in BMI, while the downward trend in physical activity is far too small to account for this development.

The paper is also related to the literature about differences in individual discount rates. On the basis of the human capital theory, which regards healthy behavior as an investment, as introduced by Becker (1964) and further developed by Grossman (1972), variations in health outcomes are often explained by differences in discount rates. Empirically, these relationships are not very robust however. Among others, Fuchs (1982) and Chapman and Coups (1999) find only minor relations between discount rates and health behavior, where the relations are not found for all measures of time preference or for all behaviors. Chapman and Elstein (1995) and Chapman, Nelson and Hier (1999) find only weak correlations between discount rates for money and for health. On the other hand, Bickel, Odum and Madden (1999), Kirby, Petry and Bickel (1999), Madden et al. (1997) and Vuchinich and Simpson (1998) find consistent relations between time preference and addictive behaviors. More in general, the individual discount rate is expected to play a crucial role in educational participation, and behavior in the labor market. Empirical evidence is scarce, however. Fersterer and Winter-Ebmer (2003) show that young people who stay in school longer tend to have a lower discount rate. DellaVigna and Paserman (2004) investigate job search behavior focusing on two opposing effects of time discounting. They find that more impatient workers search less intensively for a job, set a lower reservation wage and exit unemployment later, as predicted by a hyperbolic discounting model. Munasinghe and Sicherman (2000) find that workers with higher measured impatience select jobs with flatter wage profiles. Several other authors point at alleged contradictions with respect to time discounting. Komlos, Smith and Bogin (2004) put forward that while BMI increased, investments in fitness equipment also increased. Ruhm (2000) shows that in economic booms, health outcomes deteriorate, while health improves during recessions. Despite these ambiguous findings, many papers use risky behavior, e.g. smoking, as a proxy for time discounting (e.g. Sykes, Evans and McCrum, 1990; Evans and Montgomery, 1994; Chevalier and Walker, 1999; Munasinghe and Sicherman, 2000; Fersterer and Winter-Ebmer, 2003). Frederick, Loewenstein and O'Donoghue (2002) give a more extensive overview of these findings.

The literature on changes in the discount rate over time is less extensive. Some evidence seems to suggest that the average discount rate has increased. The National Gambling Impact Study Commission (1999) reports an increase in legal gambling in the U.S. over the past three decades. Blaylock et al. (1999) note that personal savings in America has decreased and that credit card debt has risen. Parker (1999) documents the decline in

personal savings since 1980, as well as the decline in private savings and the rise in personal consumption as a percentage of GDP.

Blaylock et al. (1999) and Levy (2002) provide theoretical models explaining obesity using individual differences in the discount rate. In a recent paper Komlos, Smith and Bogin (2004) are the first to hypothesize that the trend in obesity could be related to an increase in time preference. They provide evidence from a cross-country comparison of average BMI and saving rates, and time series evidence about these variables for the US, consistent with their hypothesis. However, as they acknowledge, these aggregate variables are probably poor proxies for the discount rate, which ask for more direct data about the discount rate at a micro level to investigate this hypothesis. Cutler and Glaeser (2005) investigate the link between time discounting and obesity by comparing BMI with other forms of risky behavior and conclude that time discounting cannot explain obesity. Allowing for substitutability or complementarity between investments and risky behaviors, we will show that the individual discount rate might have very different impacts on each form of behavior.

The remainder of this paper is organized as follows. Section 2 introduces the model. Section 3 is concerned with the description of the data. Section 4 investigates the cross-sectional relationship between time discounting and BMI. Section 5 analyzes the relationship between time discounting and BMI over time. Section 6 discusses the findings.

2 The Model

Theoretically, BMI and the individual discount rate are related because the immediate consequences of calorie intake differ from the future consequences. Excessive food intake leads to immediate pleasure or reduction of distress, while it reduces future health and physical appearance. This is a similar trade-off as in many other investment decisions regarding health, education, etc. In a two-period setting, assume that the utility of an agent in period 1 equals $U_1 = \gamma_A A^{\delta}$ (with γA > 0 and 0 < δ < 1), and utility in period 2 equals $U_2 = -A$, in which A represents a certain form of behavior that increases utility in period 1, but diminishes utility in period 2. The disutility of A in period 2 is used as unit of measurement. δ and γA are parameters regarding the diminishing marginal utility of A and the pleasure one derives of A, respectively. The price of A in period 1 – e.g. the price of food – equals PA. An agent with an individual discount rate ρ, who maximizes the discounted utility for both periods, will maximize:

(1) $$U = U_1 - P_A A + U_2 = \gamma_A A^{\delta} - P_A A - \frac{1}{1+\rho} A .$$

The optimal level of A equals:

$$(2) \qquad A = \left(\frac{\delta \gamma_A}{P_A + \frac{1}{1+\rho}} \right)^{\frac{1}{1-\delta}} .$$

This expression for A provides potential explanations for why people differ in calorie intake and consequently in BMI. Assuming the technical parameter δ to be equal for all individuals, differences can be related to PA, ρ, or γA. At a certain moment in time, all agents will face the same prices, so cross-sectional variation in this model can only be related to differences in the discount rate and differences in γA, reflecting differences in the relative importance of calorie intake compared to the future consequences of this behavior. Examples of this variation could be simple differences in the preferences for food, but also differences in the health risk of obesity to different people. The function shows that people will gain more weight if γA increases, if prices decrease, or the discount rate increases. The same expression also provides a framework for understanding shifts over time in the average BMI of the population. Since we are looking at averages, the increasing trend in BMI could be explained by an increase of the average individual discount rate, ρ, the average relative pleasure of people in food consumption γ_A, and of course changes in the average price of calorie-rich food. Note that when there are individual differences in the discount rate, such changes can shift the BMI of all people simultaneously, but can also affect high discounters more than low discounters. In the specification that has been chosen here, a change in the price of food would increase the BMI of all agents simultaneously, while a change in the average γ_A, would increase the average BMI by widening the gap between the BMI of high and low discounters.

When the individual discount rate is interpreted as a parameter of the utility function, an increase in BMI does not necessarily imply a fall in welfare. In that situation a fall in prices always implies improved welfare, with people apparently preferring to enjoy high levels of food consumption at the cost of future health problems. Cutler, Glaeser, and Shapiro (2003) argue that with hyperbolic discounting it is possible that lower prices lead to behavior associated with a loss of welfare. A more general interpretation of time discounting in which the discount rate also reflects a lack of power of imagination (see Becker and Mulligan, 1997, and Borghans and Golsteyn, 2005) leads to similar conclusions.

In the setting presented here, the absence of an empirical link between individual discount rates and BMI is almost equivalent to a rejection of the Discounted-Utility Model (Samuelson, 1937; Koopmans, 1960; Lancaster, 1963; Fishburn, 1970). Several authors have put forward arguments against this model. For example, Loewenstein (1992) argues that a utility function with one single parameter to describe intertemporal decisions is too restrictive, and proposes specifications with separate “discount rates” for each individual good. Mulligan (2005) argues that there can be no variation in individual discount rates, because people with discount rates that differ from the market discount rate would be exploited by profit maximizing firms.

In practice, however, overconsumption of food is not the only temptation in life. In a more general framework alternative possibilities to either invest in future benefits or enjoy life have to be considered simultaneously. Suppose, an agent has to decide about two forms of behavior, A and B, which both provide utility in period 1 and disutility in period 2. Generalizing the utility function in period 1 to $U_1 = \left(\gamma_A A^{\nu} + \gamma_B B^{\nu}\right)^{\frac{\delta}{\nu}}$, ($\nu \leq 1$) and utility in period 2 to $U_2 = -A - B$, with prices PA and PB, leads to the following optimal level of A.[1]

$$(3) \qquad A = \left(\frac{\delta \gamma_A^{\delta/\nu}}{P_A + \frac{1}{1+\rho}} \right)^{\frac{1}{1-\delta}} \left(1 + \left(\frac{\gamma_A}{\gamma_B} \right)^{\frac{1}{\nu-1}} \left(\frac{P_B + \frac{1}{1+\rho}}{P_A + \frac{1}{1+\rho}} \right)^{\frac{\delta}{\nu}-1} \right)^{\frac{1}{1-\delta}} .$$

The first part of this equation is almost identical to (2). The second part, however, reveals an interesting interaction between different forms of intertemporal trade-offs. When *A* and *B* are no perfect substitutes (so $\nu \neq 1$), differences between people in parameters with respect to aspect *B*, and changes of the price of *B* and the averages in the distribution, are also going to affect *A*. The impact of these differences depends on the degree of complementarity of *A* and *B*. The switching point is when $\delta/\nu = 1$. In practice, there are many applications of two aspects that can be substitutable or complementary. For example, when people need distraction to cope with stress, one could imagine smoking and eating to be substitutes. Also, when someone works long hours to invest in a career, food intake could substitute for what the rest the body is asking for. Empirical studies find negative relations between smoking and various outcomes that may be influenced by high discount rates, e.g. health, educational attainment, earnings levels, use of seatbelts, physical exercise, teeth brushing, and teeth flossing (Hersch and Viscusi, 1990; Hersch, 1996; Levine, Gustafson and Velenchik, 1997; Hersch, 2000; Viscusi and Hersch, 2001). On the other hand, e.g. Gulliver (1995), Burton and Tiffany (1997) and Picone, Sloan and Trogdon (2004) provide evidence for the complementarity of smoking and drinking, while Cawley, Markowitz and Tauras (2003) find that girls with higher BMI are on average more likely to start smoking.

It is very interesting to note that the impact of the interaction between two aspects A and B can be different for different values of the individual discount rate. So when the price of B is very low, and thus investing in low B's is beneficial, it will be especially low discounters who do so. When these aspects are substitutes, this will increase consumption of A, reversing the relationship between the discount rate and the form of behavior. An example is again the situation in which people who work hard to make a career, consume more food to keep on going. If the benefits from investing in the career exceed the costs of increased BMI, a low discount rate could in theory be related to high BMI. These extensions show that in a more

1. One could further generalize the model by introducing a CES utility function for the second period. In such a model, the future consequences of one type of behaviour also depend on other forms of behaviour.

general setting, the link between the individual discount rate and BMI becomes an empirical question, which we try to answer in this paper.

3 The data and empirical strategy

Our analyses are based on the DNB household Survey, formerly known as the CentER Savings Survey, collected by CentER (Tilburg, the Netherlands). The data are unique for our purposes, because they contain both questions about body length and weight and questions that seem to be very good proxies for time discounting for 1995-2004. In a supplementary survey in 2004, questions are asked that measure time discounting following the tradition in psychological literature.

The data

The survey is taken in March. The samples are representative for the Dutch population of 16 and older. From 1995, this annual survey contains a large number of questions about financial behavior and attitudes, with almost no change in the questions that are used. We use the data from 1995 – 2004. Table 1 provides information about the sample size per year. In 1995, the sample contained 4,854 people. This decreased to 2,059 respondents in 2004. In 2000, most of the questions that are relevant for our analyses have only been asked to respondents with a job. This was presumably due to an error in the routing of the questionnaire. Since the distribution of characteristics of the working population differs clearly from the characteristics of the population as a whole, we do not use the data for 2000 in the analyses.

Table 1
Sample size per year, 1995-2004

	Sample size
1995	4854
1996	4250
1997	3513
1998	2392
1999	2250
2000	1055
2001	2075
2002	2139
2003	2187
2004	2059

Source: DNB household survey

In October 2004, a supplementary survey has been carried out, targeted at the same respondents as the Basic DNB household Survey of 2004, including two questions that

measure the individual discount rate, following the tradition in psychology (Rachlin, Raineri and Cross, 1991).

Apart from the anthropometric measures, the questions about financial behavior and attitudes that provide many proxies for the individual discount rate and the two psychological questions, the survey provides information about sex, age, educational attainment, and income.

BMI

Using the information on length and weight, we calculated the BMI as weight in kilograms over the square of length in meters. The data on length and weight are self-assessed, and may therefore be subject to some bias. Cawley (2000) shows that women, on average, underreport their weight by 1.5%, where underweight women overreport and overweight women underreport. This under- and overreporting hence reduces the standard deviation of BMI and plausibly therefore self-assessed BMI data should be interpreted slightly different than true BMI measures. However, since the under- and overreporting is related to BMI levels only, relations between BMI and other variables will not be affected by this bias. In addition, the data contains a small fraction of implausible answers. To reduce the impact of outliers, we leave out 7 cases of 2,059 for those claiming to weigh less than 35 or more than 135 kilograms. The average male respondent in our sample in 1995 is 180.6 cm tall and weighs 79.7 kilograms. In 2004, these averages increased to 180.8 cm and 83.4 kg. Consequently, the average male BMI increased from 24.4 in 1995 to 25.5 in 2004. For females, the average height was stable from 168.3 cm in 1995 to 168.2 cm in 2004 while average weight increased from 67.2 kg to 71.9 kg in 2004. Their BMI increased from 23.7 in 1995 to 25.4 in 2004. A person with a BMI below 18.5 is considered undernourished. A BMI between 25 and 29.9 is overweight, while a BMI above 30 is obese. Table 2 shows that in 1995, 5.4 percent of the population was obese. In 2004, the percentage of obese people increased to 12.2 percent. The percentage of overweight people increased from 30.2 to 37.0 percent.

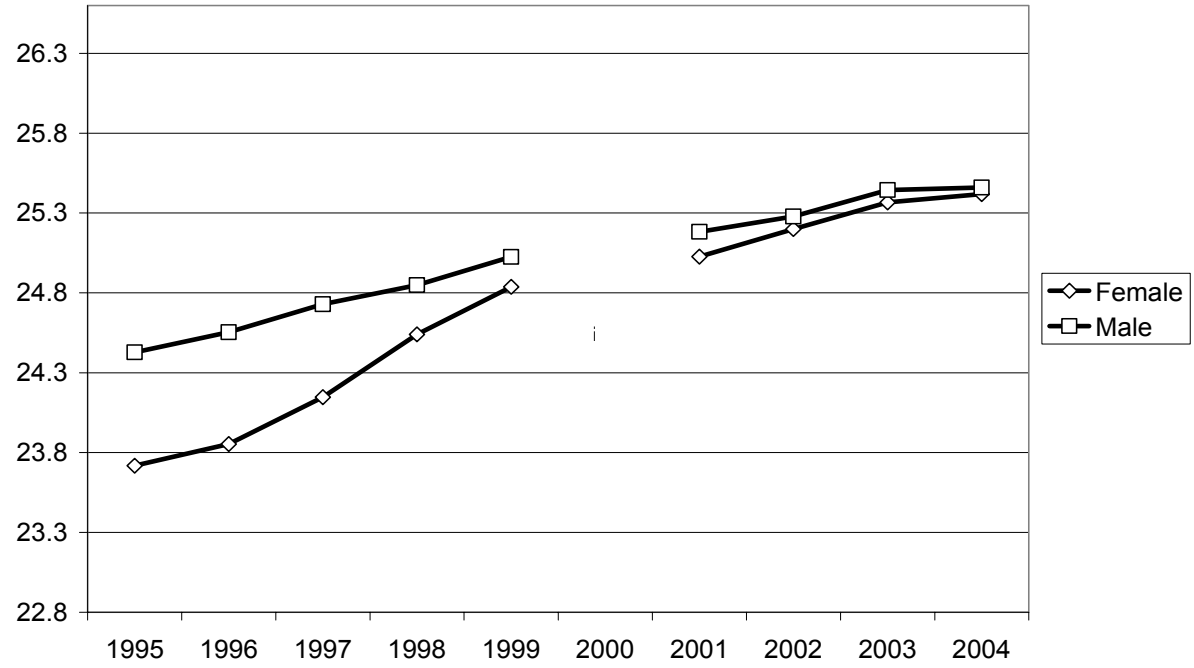
Table 2
BMI levels men and women, 2004

BMI*		1995			2004		
		Men	Women	Total	Men	Women	Total
<18.5	Undernourished	2.2	4.2	3.1	1.1	3.0	2.0
18.5<=BMI<25	Normal	57.5	65.5	61.3	47.3	50.6	48.9
25<=BMI<30	Overweight	36.0	23.6	30.2	42.1	31.1	37.0
BMI>=30	Obese	4.3	6.7	5.4	9.4	15.3	12.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0

* BMI is defined as weight in kg divided by length in meters.

Figure 1 gives the development of BMI in the population between 1995 and 2004. To facilitate visual comparison of the size of the developments in the graphs, the vertical axes in all graphs are scaled from the average value in the population in all years minus 0.5 standard deviation in this variable, to the same average plus 0.5 standard deviation. The figure clearly shows the large increase in BMI over this period, and shows that women experience a larger increase than men. Figure 2 provides more detailed information for women, breaking down the development of BMI over time by age group. The largest increase in BMI has taken place among the women below 40. The gaps in average BMI between the age groups diminished considerably. Figure 3 breaks down the development in BMI for men by age group. For men the increase has been similar in the three age groups, keeping the gap between men under 40 and the older two age groups intact.

Figure 1
The development of BMI, 1995-2004

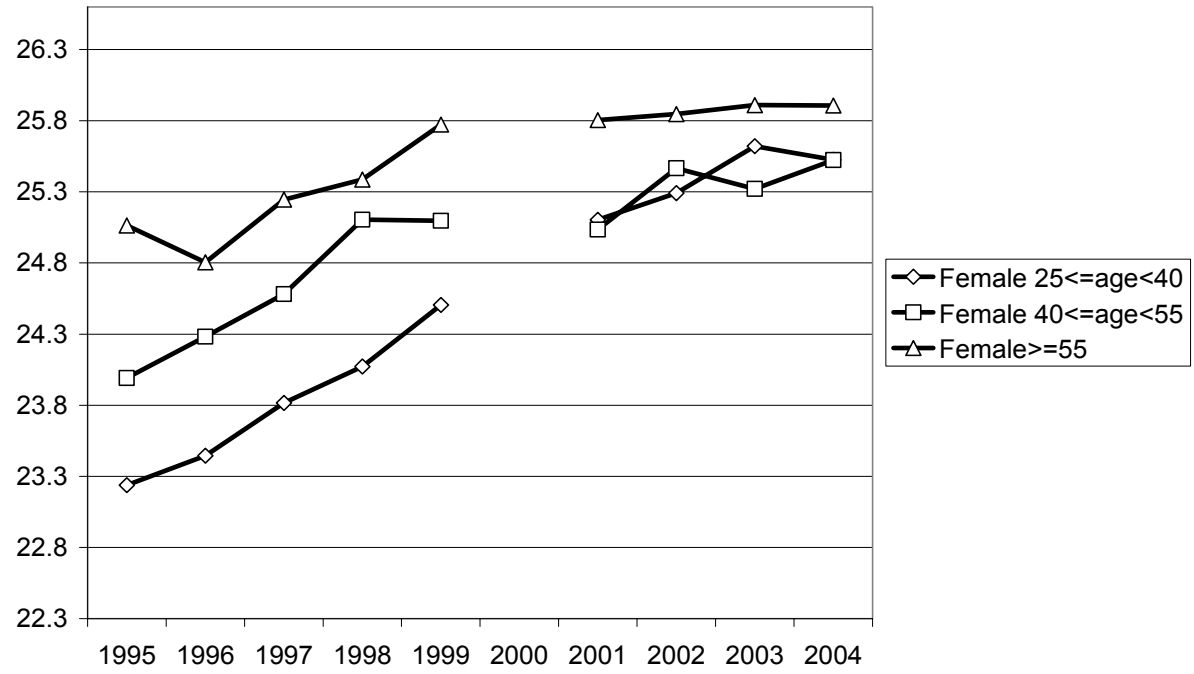


Source: DNB household survey 1995-1999, 2001-2004
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of men and women together ± 0.5 times its standard deviation.

Empirical strategy

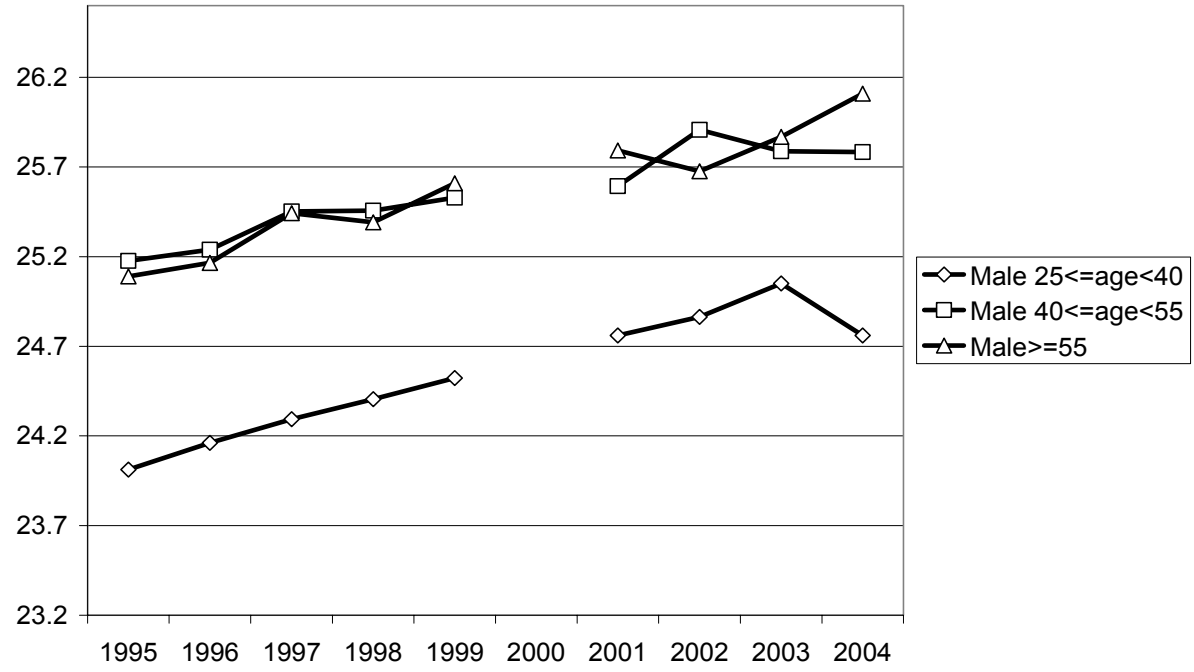
In the supplementary survey of 2004, we were able to include a few questions that aim at measuring the discount rate. Our empirical strategy is, first, to investigate the validity of these psychological discount questions. Second, we compare these measures of the discount rate with a list of potential proxies for the individual discount rate, which are available in the regular survey. Third, we investigate for 2004 the relationship between these proxies and BMI. Fourth, we select the proxies that are most successful in explaining BMI, check the robustness of these results and investigate whether this relationship between a proxy for time discounting and BMI can explain the rise in obesity that is observed in the past decade.

Figure 2
The development of BMI for females for three age groups, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

Figure 3
The development of BMI for men for three age groups, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

Measuring the discount rate

Following the psychological tradition (Rachlin, Raineri and Cross, 1991) we included a battery of six questions, like:

> "Please indicate, which alternative you would choose.
> 1 50 euro now
> 2 70 euro a year from now"

Varying the amount of money in alternative 1 and 2, and the timing of the first and second periods, makes it possible to vary an implicit discount rate and to determine the individual discount rate. Several papers show that the psychological measures to determine the discount rate are rather sensitive to the wording of the question, and to anchoring effects, i.e. imputed discount rates tend to be biased in the direction of the discount rate that equates the first pair of options to which the responds are exposed (Green et al, 1998). We checked the sensitivity of the answers to the level of the awarded money. For a random group of 50% of the respondents all questions have been asked using amounts that are a factor 10 larger (so "500 euro now" and "700 euro a year from now"). As found in several other papers (see e.g. Thaler, 1985), although the implicit discount rates are the same, the level of the results turns out to depend on the exact question. People who are asked the set with the low money values score significantly higher on the discount rate (t = 6.699). Verifying the correlation with a large set of other variables, however, we find no significant differences, which suggests that apart from this level effect, different wordings reflect similar differences between people in their trade-off between the present and the future. In all regressions, we include a dummy variable that equals 1 if the low amounts are asked, and 0 if the high amounts are asked, to control for the specific wordings of the question.

Table 3
Percentages of the respondents choosing the option that gives them gratification sooner with the high and low monetary questions

Questions*	% Respondents choosing gratification sooner		
	Implicit discount rates	Low amounts	High amounts
€50 now or €70 in 1 year	40	60.6	47.8
€100 in 1 year or €150 in 4 years	11	79.6	70.2
€100 now or €100 in 1 year	0	95.7	96.0
€50 in 1 year or €90 in 2 years	80	45.3	33.1
€50 now or €300 in 4 years	57	25.2	19.7
€100 in one year or €125 in 2 years	25	80.9	73.8

Source: DNB household survey, supplementary survey 2004
Note: A randomly selected group of the respondents were asked questions with the same implicit discount rates but higher amounts, i.c. all monetary values in the questions were multiplied by 10.

Table 3 provides information about the answers of the respondents on these discount rate questions. For the question mentioned above as an example, which has an implicit break-even discount rate of 40%, approximately 50% of the respondents prefer the money now, while 50% prefer to wait. As usually found, this median individual discount rate is much higher than typical interest rates at a bank. This may in part be due to the wording of the question and anchoring effects, but also reveals that many people tend to put high weight on immediate gratification compared to their future well-being. We use the number of answers in which a respondent prefers to get the money early as a measure for the discount rate.

As an alternative to the standard battery with monetary choices, some authors apply the idea to specific cases instead (see e.g. Frederick, 2005). To investigate the validity of this measure of the individual discount rate, we asked the following additional question following their methodology:

> "Suppose you win a 10-day holiday trip to an interesting destination. To spread participation, you are asked if you can delay your trip by three years in exchange for a longer vacation. How many days should you be offered in addition to accept the offer in 3 years' time?"

Answers varied from 0 to 365 days, with a mean of 13.8 days and a standard deviation of 33.2. This corresponds to a discount rate of 24.6%. 97.7% of the observations are in the 0-50 days interval. We truncate our measure at 50 days before calculating the implicit annual discount rate $\left(\left(\frac{days+10}{10}\right)^{1/3}-1\right)$. We find a very significant relationship between this measure and the discount rate based on the monetary questions (t-value =5.141).

Proxies for the discount rate

The basic questionnaire includes a wide variety of questions that are clearly related to the concept of an individual discount rate. We selected 25 questions which seemed to be most appropriate from a theoretical point of view. Table 4 contains the wordings of all these questions. The first three questions are related to the management of income and the question whether the respondent spent more money than he received in the past 12 months. The next group of seven questions concerns statements about saving behavior. In the six questions named SAVE1 to SAVE6 the respondent is asked to indicate to what extent he agrees with the statements on a 7-point scale. RISK asks how risky the investments of the respondent have been. These seven questions seem to be more related to risk aversion than to time discounting, but since risk aversion is known to be related to time discounting (e.g. Gafni and Torrance, 1984) we included them in our set. The next 11 questions (named FUTURE01 to FUTURE11) are again statements about the attitude referring to the trade-off between the present and the future. Based on the wordings of the statements one expects these

questions to be very good reflections of the individual discount rate.[2] The questions SPEND and PLAN ask whether the respondent tends to spend income immediately and whether it is difficult for him to plan expenditures. The survey monitors in great detail all different accounts, savings, and loans. ASSETS is the total value of the accounts and different kinds of savings, while LIABILITIES reflects the aggregate value of loans and credits, excluding the mortgage on the first house. We apply these two financial summary statistics in euros and as a ratio to yearly net income.

Table 4
Questions that are used as proxies for the individual discount rate

Name	Question	Answers
MANAGE	How well can you manage on the total income of your household?	1 very hard, 2 hard, 3 neither hard nor easy, 4 easy, 5 very easy
EXPENDITURES	Over the past 12 months, would you say the expenditures of your household were higher than the income of the household, about equal to the income of the household, or lower than the income of the household?	1 the expenditures were higher than the income, 2 the expenditures were about equal to the income, 3 the expenditures were lower than the income
HOWMUCH	About how much money has your household put aside IN THE PAST 12 MONTHS? If you really don't know, type 0 (zero)	1 less than Dfl. 3,000, 2 3,000 - 10,000, 3 10,000 - 25,000, 4 25,000 - 40,000, 5 40,000 - 75,000, 6 75,000 - 150,000, 7 150,000 or more
SAVE1	I think it is more important to have safe investments and guaranteed returns, than to take a risk to have a chance to get the highest possible returns	1 totally disagree , …, 7 totally agree
SAVE2	I would never consider investments in shares because I find this too risky	1 totally disagree , …, 7 totally agree
SAVE3	If I think an investment will be profitable, I am prepared to borrow money to make this investment	1 totally disagree , …, 7 totally agree
SAVE4	I want to be certain that my investments are safe	1 totally disagree , …, 7 totally agree
SAVE5	I get more and more convinced that I should take greater financial risks to improve my financial position	1 totally disagree , …, 7 totally agree
SAVE6	I am prepared to take the risk to lose money, when there is also a chance to gain money	1 totally disagree , …, 7 totally agree
RISK	What would you say was the risk factor that you have taken with investments over the past few years? If you haven't made any investments, select answer 6	1 I have taken no risk at all, 2 I have taken small risks every now and then , 3 I have taken some risks, 4 I have sometimes taken great risks, 5 I have often taken great, 6* not applicable, 0* don't know
FUTURE01	I think about how things can change in the future, and try to influence those things in my everyday life	1 totally disagree , …, 7 totally agree

2. Several proxies for time discounting could be combined to reduce measurement error. We prefer the analyses of the separate proxies since for most of them, the correlation with the psychological measure of the discount rate is sufficiently large, while furthermore this approach reveals the sensitivity of the results to the specific proxy used.

Table 4 (continued)
Questions that are used as proxies for the individual discount rate

Name	Question	Answers
FUTURE02	I often work on things that will only pay off in a couple of years	1 totally disagree , …, 7 totally agree
FUTURE03	I am only concerned about the present, because I trust that things will work themselves out in the future	1 totally disagree , …, 7 totally agree
FUTURE04	With everything I do, I am only concerned about the immediate consequences (say a period of a couple of days or weeks)	1 totally disagree , …, 7 totally agree
FUTURE05	Whether something is convenient for me or not, to a large extent determines the decisions that I take or the actions that I undertake	1 totally disagree , …, 7 totally agree
FUTURE06	I am ready to sacrifice my well-being in the present to achieve certain results in the future	1 totally disagree , …, 7 totally agree
FUTURE07	I think it is important to take warnings about negative consequences of my acts seriously, even if these negative consequences would only occur in the distant future	1 totally disagree , …, 7 totally agree
FUTURE08	I think it is more important to work on things that have important consequences in the future, than to work on things that have immediate but less important consequences	1 totally disagree , …, 7 totally agree
FUTURE09	In general, I ignore warnings about future problems because I think these problems will be solved before they get critical	1 totally disagree , …, 7 totally agree
FUTURE10	I think there is no need to sacrifice things now for problems that lie in the future, because it will always be possible to solve these future problems later	1 totally disagree , …, 7 totally agree
FUTURE11	I only respond to urgent problems, trusting that problems that come up later can be solved in a later stage	1 totally disagree , …, 7 totally agree
SPEND	Some people spend all their income immediately. Others save some money in order to have something to fall back on. Please indicate what you do with money that is left over after having paid for food, rent, and other necessities. Are you the sort of person that likes to spend his/her money immediately, or are you the sort of person that tries to save as much as possible, or are you somewhere in between those two extremes? If you really don't know, type 0 (zero)	1 I like to spend all my money immediately, …, 7 I want to save as much as possible, 0* I don't know
PLAN	Many people find it difficult to plan or control their expenditures. Do you find it difficult to control your expenditures? If you really don't know, type 0 (zero)	1 no, very easy, …, 7 yeas, very difficult, 0* I don't know
ASSETS	Aggregate variable including assets in: Checking accounts, Employer-sponsored savings plans, Savings arrangements, linked to a bank account, Deposit books, Savings certificates, Single-premium annuity insurance policies, Savings or endowment insurance policies, Growth funds, Mutual funds and/or mutual fund accounts, Bonds and/or mortgage bonds, Stocks and shares.	amount in € and fraction of net income per year
LIABILITIES	Aggregate variable including liabilities in: Private loans, Extended lines of credit, Outstanding debts on hire-purchase contracts, debts based on payment by installment and/or equity based loans, Outstanding debts with mail-order firms, shops or other sorts of retail business, Loans from family or friends, Study loans.	amount in € and fraction of net income per year

Note: Answers marked with *, have been coded as missing values in the analyses.

Table 5
Descriptive statistics of time discounting proxies

	Mean	Std. Deviation
MANAGE	3.495	0.854
EXPENDITURES	2.188	0.735
HOWMUCH	2.233	0.953
SAVE1	5.173	1.690
SAVE2	4.473	2.054
SAVE3	2.234	1.539
SAVE4	5.469	1.351
SAVE5	2.738	1.622
SAVE6	2.610	1.529
RISK	4.162	1.467
FUTURE01	3.590	1.533
FUTURE02	3.657	1.525
FUTURE03	3.721	1.594
FUTURE04	4.519	1.353
FUTURE05	3.410	1.459
FUTURE06	5.160	1.255
FUTURE07	4.241	1.333
FUTURE08	3.255	1.375
FUTURE09	3.867	1.420
FUTURE10	3.719	1.469
FUTURE11	4.070	1.959
SPEND	4.966	1.245
PLAN	2.933	1.568
ASSETS/100,000	0.272	0.676
LIABILITIES/100,000	0.030	0.260
ASSETS/(net income per year)	9.407	210.097
LIABILITIES/(net income per year)	0.258	2.201

Source: DNB household survey 2004

Table 5 provides some statistics for these proxy variables for the individual discount rate.

4 Cross-sectional relationship between time discounting and BMI

To investigate the link between time discounting and BMI, we analyze whether the proxies based on financial information and attitudes are indeed related to the individual discount rate. Using the data for 2004, we regress BMI on each of these proxies, saturating the model for age and sex (i.e. we included a full set of sex-age dummies, to ensure that all age and sex differentials are excluded from the analyses). The first column of Table 6 provides the estimates of the parameters for the proxy of the discount rate. With a few exceptions, we find a strong significant relationship between the proxies and the psychological measure of the discount rate. Very interesting exceptions are the assets and liabilities of the respondent. ASSETS is significantly related to the psychological measure of the discount rate, but when

Table 6
Relationship between the discount rate and BMI as dependent variables and proxies for the discount rate as independent variables

	DR*			BMI		
	Coef	St.Dev.	Sign	Coef	St.Dev.	Sign
DR*				0,096	0,060	
MANAGE	-0.331	0.047	***	-0.785	0.116	***
EXPENDITURES	-0.250	0.055	***	-0.597	0.134	***
HOWMUCH	-0.272	0.053	***	-0.474	0.126	***
SAVE1	-0.087	0.025	***	-0.041	0.061	
SAVE2	0.073	0.021	***	0.159	0.051	***
SAVE3	-0.016	0.028		0.091	0.069	
SAVE4	-0.079	0.032	**	-0.107	0.076	
SAVE5	-0.013	0.026		0.015	0.063	
SAVE6	-0.055	0.028	*	-0.053	0.069	
RISK	0.095	0.022	***	0.046	0.053	
FUTURE01	-0.115	0.028	***	-0.048	0.069	
FUTURE02	-0.151	0.027	***	0.018	0.067	
FUTURE03	0.183	0.026	***	0.207	0.065	***
FUTURE04	0.080	0.025	***	0.123	0.063	*
FUTURE05	-0.012	0.030		0.093	0.074	
FUTURE06	-0.084	0.029	***	-0.064	0.071	
FUTURE07	-0.124	0.033	***	-0.014	0.080	
FUTURE08	-0.155	0.031	***	-0.148	0.076	*
FUTURE09	0.089	0.030	***	0.088	0.072	
FUTURE10	0.077	0.029	***	-0.045	0.070	
FUTURE11	0.122	0.027	***	0.073	0.068	
SPEND	-0.153	0.033	***	-0.116	0.081	
PLAN	0.103	0.026	***	0.489	0.063	***
ASSETS/100,000	-0.395	0.062	***	-0.280	0.146	*
LIABILITIES/100,000	-0.137	0.143		0.358	0.343	
ASSETS/(net income per year*1000)	0.148	0.200		-0.026	0.465	
LIABILITIES/(net income per year*1000)	23.666	19.985		47.082	44.459	

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for the proxies of the discount rate in an OLS regression with DR and BMI as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).
* To control for the level differences in the discount rate, a dummy variable was included in all regressions with DR as dependent or independent variable, being 1 if the respondents answered the questions with low money amounts and 0 if the respondents answered questions in which the money amounts were multiplied by 10.

the assets for the income of the respondent is adjusted, this relationship disappears. These financial summaries are therefore no adequate proxies for the discount rate. For research purposes, this is unfortunate since such financial summary statistics are available for longer time periods in many countries. SAVE2 and SAVE6 have signs opposite to those expected.

Apart from these figures, most proxies however seem to be adequate measures for the discount rate. The next step in our analyses is to investigate whether these proxies of time discounting are related to BMI. For some proxies there is a significant relationship between time discounting and BMI, while for others this link is absent. Especially several questions related to the ability to manage expenditures have a significant parameter. It can be concluded therefore that there may be a relationship between time discounting and BMI, but this link is very sensitive to the exact variable that is chosen to proxy time discounting. An interesting topic for future research is to analyze the similarities in the proxies that are related to BMI in comparison with those that are not.

Table 7a-7d provide similar estimates for the relationship between time discounting and BMI, breaking the sample in different sex and age groups. In general, the link between time discounting and BMI is stronger for women than for men. For women, we find the strongest relationship in the age group 25-40. For men in this age group, however, the correlation between time discounting and BMI is almost absent. PLAN and MANAGE are the variables that have the highest level of significance in the overall relationship with BMI, and remain significant in most regressions for subgroups. Only for the age group 55+, MANAGE is not significantly related to BMI for men and women, while PLAN has no significant relationship with BMI for men in this age group. To give the hypothesis that the increase in BMI is related to a change in the average discount rate over time the best chance, we will use these two proxies for our further analyses.

Table 7a

Relationship between BMI and proxies for the discount rate by sex

	ALL			WOMEN			MEN		
	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign
DR*	0.096	0.060		0.066	0.106		0.123	0.066	*
MANAGE	-0.785	0.116	***	-0.953	0.189	***	-0.612	0.137	***
EXPENDITURES	-0.597	0.134	***	-0.957	0.231	***	-0.302	0.152	**
HOWMUCH	-0.474	0.126	***	-0.798	0.199	***	-0.122	0.155	
SAVE1	-0.152	0.078	*	-0.097	0.106		0.006	0.068	
SAVE2	0.150	0.069	**	0.215	0.093	**	0.120	0.055	**
SAVE3	0.100	0.074		-0.024	0.138		0.151	0.070	**
SAVE4	-0.207	0.102	**	-0.082	0.130		-0.130	0.088	
SAVE5	-0.001	0.068		0.027	0.117		0.006	0.068	
SAVE6	-0.053	0.069		-0.091	0.131		-0.026	0.074	
RISK	0.046	0.053		0.097	0.092		0.003	0.059	
FUTURE01	-0.019	0.075		-0.106	0.117		0.006	0.078	
FUTURE02	0.024	0.072		0.072	0.117		-0.026	0.075	
FUTURE03	0.197	0.071	***	0.196	0.116	*	0.213	0.072	***
FUTURE04	0.107	0.067		0.080	0.112		0.151	0.069	**
FUTURE05	0.082	0.083		0.086	0.128		0.100	0.084	
FUTURE06	-0.017	0.076		-0.173	0.123		0.032	0.080	
FUTURE07	-0.058	0.100		0.108	0.138		-0.116	0.090	
FUTURE08	-0.089	0.084		-0.205	0.134		-0.103	0.084	
FUTURE09	0.091	0.076		0.008	0.126		0.153	0.081	*
FUTURE10	-0.065	0.075		-0.130	0.123		0.021	0.078	
FUTURE11	0.107	0.073		0.030	0.120		0.107	0.075	
SPEND	-0.215	0.091	**	-0.125	0.141		-0.117	0.091	
PLAN	0.480	0.066	***	0.628	0.109	***	0.378	0.071	***
ASSETS/100,000	-0.280	0.146	*	-0.370	0.333		-0.249	0.139	*
LIABILITIES/100,000	0.358	0.343		3.143	1.795	*	0.211	0.289	
ASSETS/(net income per year*1000)	-0.026	0.465		2.970	13.775		-0.031	0.379	
LIABILITIES/(net income per year*1000)	47.082	44.459		38.446	58.484		75.599	78.498	

Source: DNB household survey 2004 and supplementary survey 2004

Notes: The table contains the estimated coefficients for the proxies of the discount rate in an OLS regression with BMI of all respondents and females and males separately as regressand, further including a full set of unreported dummies for all combinations of age and sex.

The indicated significance levels are 1% (***), 5% (**) and 10% (*).

* To control for the level differences in the discount rate, a dummy variable was included in all regressions with DR as regressor, being 1 if the respondents answered the questions with low money amounts and 0 if the respondents answered questions in which the money amounts were multiplied by 10.

Table 7b
Relationship between BMI and proxies for the discount rate for age groups 25-40 by sex

	ALL			WOMEN			MEN		
	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign
DR*	0.202	0.151		0.256	0.245		0.126	0.168	
MANAGE	-1.030	0.235	***	-1.412	0.366	***	-0.547	0.275	**
EXPENDITURES	-1.028	0.269	***	-1.580	0.432	***	-0.420	0.303	
HOWMUCH	-0.638	0.257	**	-1.215	0.365	***	0.307	0.339	
SAVE1	0.151	0.137		0.285	0.233		0.031	0.148	
SAVE2	0.384	0.111	***	0.599	0.179	***	0.157	0.125	
SAVE3	-0.101	0.140		-0.261	0.238		0.043	0.150	
SAVE4	0.102	0.162		0.423	0.261		-0.240	0.180	
SAVE5	-0.220	0.129	*	-0.229	0.211		-0.212	0.144	
SAVE6	-0.347	0.140	**	-0.484	0.233	**	-0.215	0.153	
RISK	0.051	0.113		0.121	0.181		-0.027	0.127	
FUTURE01	0.068	0.154		0.064	0.250		0.072	0.171	
FUTURE02	-0.054	0.150		0.114	0.244		-0.238	0.165	
FUTURE03	0.208	0.147		0.189	0.241		0.227	0.161	
FUTURE04	0.158	0.138		0.196	0.227		0.118	0.152	
FUTURE05	0.234	0.170		0.434	0.277		0.018	0.189	
FUTURE06	-0.001	0.161		-0.033	0.262		0.035	0.179	
FUTURE07	0.172	0.178		0.205	0.287		0.135	0.200	
FUTURE08	-0.073	0.178		-0.282	0.291		0.149	0.195	
FUTURE09	0.201	0.170		0.177	0.281		0.225	0.185	
FUTURE10	-0.079	0.163		-0.057	0.260		-0.105	0.186	
FUTURE11	0.160	0.157		0.365	0.256		-0.061	0.173	
SPEND	-0.471	0.155	***	-0.570	0.253	**	-0.365	0.171	**
PLAN	0.663	0.135	***	1.016	0.221	***	0.320	0.147	**
ASSETS/100,000	-2.434	1.006	**	-4.127	1.718	**	-0.898	1.030	
LIABILITIES/100,000	4.346	1.807	**	5.888	3.150	*	3.027	1.815	*
ASSETS/(net income per year*1000)	-219.363	164.132		-267.539	216.427		-23.011	275.838	
LIABILITIES/(net income per year*1000)	290.682	208.679		250.224	265.822		547.332	419.747	

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for the proxies of the discount rate in an OLS regression with BMI of all respondents between the age of 25 and 40 and females and males separately as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).
* To control for the level differences in the discount rate, a dummy variable was included in all regressions with DR as regressor, being 1 if the respondents answered the questions with low money amounts and 0 if the respondents answered questions in which the money amounts were multiplied by 10.

Table 7c
Relationship between BMI and proxies for the discount rate for age groups 40-55 by sex

	ALL			WOMEN			MEN		
	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign
DR*	0.146	0.109		0.079	0.193		0.205	0.119	*
MANAGE	-1.074	0.198	***	-1.199	0.332	***	-0.953	0.228	***
EXPENDITURES	-0.867	0.239	***	-1.186	0.414	***	-0.599	0.266	**
HOWMUCH	-0.483	0.207	**	-0.811	0.335	**	-0.129	0.250	
SAVE1	-0.075	0.107		-0.203	0.184		0.040	0.121	
SAVE2	0.196	0.090	**	0.217	0.164		0.180	0.097	*
SAVE3	0.234	0.121	*	0.199	0.243		0.253	0.123	**
SAVE4	-0.248	0.141	*	-0.273	0.239		-0.226	0.161	
SAVE5	0.125	0.117		0.241	0.212		0.039	0.126	
SAVE6	0.004	0.125		0.107	0.235		-0.063	0.132	
RISK	0.122	0.095		0.139	0.160		0.105	0.108	
FUTURE01	0.047	0.121		-0.045	0.202		0.136	0.139	
FUTURE02	0.325	0.120	***	0.399	0.211	*	0.266	0.132	**
FUTURE03	-0.011	0.119		-0.075	0.204		0.046	0.134	
FUTURE04	0.113	0.118		0.106	0.203		0.119	0.132	
FUTURE05	0.103	0.130		-0.033	0.218		0.237	0.150	
FUTURE06	-0.002	0.126		-0.089	0.212		0.079	0.143	
FUTURE07	-0.053	0.145		-0.021	0.249		-0.082	0.164	
FUTURE08	-0.031	0.141		0.052	0.239		-0.109	0.160	
FUTURE09	0.095	0.132		0.116	0.229		0.076	0.148	
FUTURE10	-0.141	0.129		-0.321	0.222		0.014	0.145	
FUTURE11	-0.071	0.126		-0.193	0.219		0.031	0.140	
SPEND	-0.004	0.146		0.140	0.250		-0.133	0.165	
PLAN	0.616	0.107	***	0.615	0.183	***	0.616	0.121	***
ASSETS/100,000	-0.963	0.384	**	-2.458	1.090	**	-0.648	0.336	*
LIABILITIES/100,000	0.077	0.394		-1.504	4.570		0.094	0.314	
ASSETS/(net income per year*1000)	-0.381	0.669		-28.148	138.974		-0.381	0.591	
LIABILITIES/(net income per year*1000)	340.782	215.059		335.842	265.154		364.589	459.535	

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for the proxies of the discount rate in an OLS regression with BMI of all respondents between the age of 40 and 55 and females and males separately as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).

- To control for the level differences in the discount rate, a dummy variable was included in all regressions with DR as regressor, being 1 if the respondents answered the questions with low money amounts and 0 if the respondents answered questions in which the money amounts were multiplied by 10.

Table 7d
Relationship between BMI and proxies for the discount rate for age groups 55+ by sex

	ALL			WOMEN			MEN		
	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign	BMI Coef	St.Dev.	Sign
DR*	0.021	0.083		-0.133	0.155		0.113	0.094	
MANAGE	-0.289	0.177		-0.327	0.291		-0.252	0.220	
EXPENDITURES	-0.081	0.199		-0.247	0.361		0.030	0.230	
HOWMUCH	-0.336	0.198		-0.288	0.329		-0.372	0.244	
SAVE1	-0.105	0.084		-0.221	0.149		-0.022	0.098	
SAVE2	0.010	0.071		-0.124	0.140		0.077	0.077	
SAVE3	0.086	0.101		-0.015	0.242		0.116	0.103	
SAVE4	-0.127	0.105		-0.286	0.180		0.002	0.127	
SAVE5	0.058	0.089		0.042	0.187		0.066	0.095	
SAVE6	0.083	0.100		0.116	0.209		0.069	0.107	
RISK	-0.012	0.074		-0.323	0.169		-0.042	0.084	
FUTURE01	-0.195	0.095	**	-0.305	0.195	*	-0.104	0.112	
FUTURE02	-0.186	0.090	**	-0.230	0.162		-0.156	0.105	
FUTURE03	0.402	0.087	***	0.522	0.167	***	0.335	0.098	***
FUTURE04	0.116	0.083		-0.014	0.161		0.186	0.092	**
FUTURE05	0.012	0.103		-0.005	0.184		0.023	0.119	
FUTURE06	-0.167	0.099	*	-0.416	0.181	**	-0.010	0.113	
FUTURE07	-0.105	0.108		0.149	0.195		-0.278	0.124	**
FUTURE08	-0.268	0.098	***	-0.398	0.181	**	-0.188	0.112	
FUTURE09	0.035	0.095		-0.167	0.168		0.182	0.111	
FUTURE10	0.045	0.092		-0.009	0.174		0.077	0.104	
FUTURE11	0.145	0.089		0.000	0.164		0.238	0.102	**
SPEND	0.075	0.124		0.085	0.234		0.069	0.139	
PLAN	0.211	0.094	**	0.290	0.169	*	0.157	0.109	
ASSETS/100,000	-0.076	0.141		0.089	0.303		-0.139	0.150	
LIABILITIES/100,000	1.481	1.167		2.632	2.349		0.955	1.281	
ASSETS/(net income per year*1000)	0.319	0.594		7.247	14.841		0.305	0.535	
LIABILITIES/(net income per year*1000)	15.197	42.924		7.024	56.325		40.693	78.348	

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for the proxies of the discount rate in an OLS regression with BMI of all respondents aged 55 or older and females and males separately as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).
* To control for the level differences in the discount rate, a dummy variable was included in all regressions with DR as regressor, being 1 if the respondents answered the questions with low money amounts and 0 if the respondents answered questions in which the money amounts were multiplied by 10.

The human capital theory predicts that the individual discount rate will be negatively related to educational investments and consequently to income. To investigate the robustness of the link between the proxies MANAGE and PLAN and BMI, we include dummies for educational

achievement and income in these regressions. As in previous regressions, a full set of age and sex dummies is included. Table 8a and 8b provide the estimates. For both proxies we find a significant negative parameter for university degree. The effect of the time discount proxies reduces slightly from -.785 to -.655 for MANAGE and from .489 to .468 for PLAN, but both parameters remain significant at the 1-percent level.

The size of the cross-sectional relationship between these proxies for time discounting and BMI will be downward biased due to measurement error. To get a more adequate estimation of the magnitude to the time discounting effects, we estimate parameters with 2SLS, using PLAN as instrument for MANAGE and vice versa, and again saturating the model with age and sex dummies. The 2SLS estimations exceed the OLS results, as expected. The negative coefficient for MANAGE increases from -.785 to -2.006 (t-value: -7.462) and the effect of PLAN increases from .489 to .968 (t-value: 6.704). This implies that to fully explain a 1.35-point increase in BMI for the period 1995-2004, a decrease in the average of MANAGE of .672 and an increase in the average of PLAN of 1.395 is needed.

So, although the cross-sectional relationship between time discounting and BMI is rather sensitive to the choice of a time discounting proxy, this relationship does not reflect pure effects of educational attainment or income.

Table 8a
Relationship between BMI and MANAGE as proxy for the discount rate, controlled for income and education levels

	B	Std. Error	
Constant	29.339	1.993	***
MANAGE	-0.655	0.123	***
Low vocational degree	0.423	0.336	
High school	-0.543	0.399	
Intermediate vocational degree	0.169	0.359	
High vocational degree	-0.104	0.342	
University degree	-0.925	0.417	**
Net income per year /100,000	-0.250	0.504	
Age + Sex dummies	Yes		

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for MANAGE, dummies for levels of education obtained and net annual income in an OLS regression with BMI of all respondents as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).

Table 8b
Relationship between BMI and PLAN as proxy for the discount rate, controlled for income and education levels

	B	Std. Error	
Constant	25.715	1.929	***
MANAGE	0.468	0.066	***
Low vocational degree	0.494	0.333	
High school	-0.536	0.396	
Intermediate vocational degree	0.179	0.356	
High vocational degree	-0.039	0.340	
University degree	-0.850	0.414	**
Net income per year /100,000	-0.575	0.494	
Age + Sex dummies	Yes		

Source: DNB household survey 2004 and supplementary survey 2004
Notes: The table contains the estimated coefficients for PLAN, dummies for levels of education obtained and net annual income in an OLS regression with BMI of all respondents as regressand, further including a full set of unreported dummies for all combinations of age and sex.
The indicated significance levels are 1% (***), 5% (**) and 10% (*).

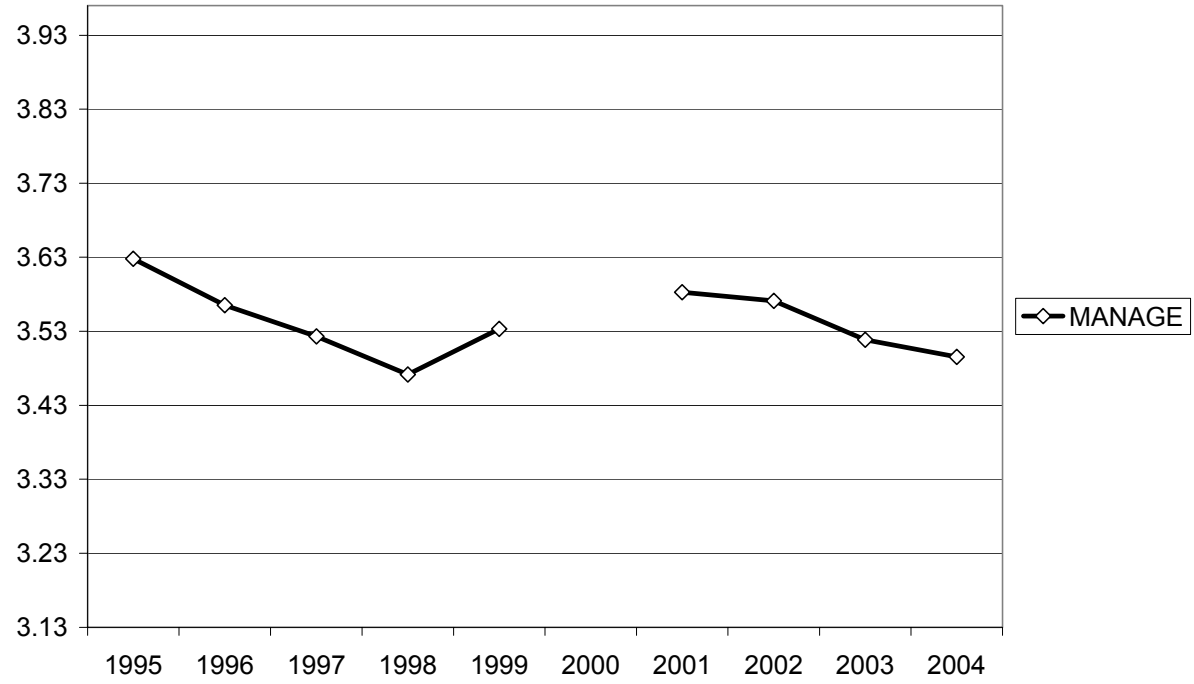
5 The relationship between time discounting and BMI over time

An important issue is whether this correlation between the discount rate and BMI is able to explain the rise in BMI that the Netherlands has experienced in the past decade. To give this hypothesis the best chance, we will discuss the development of the link between time discounting and BMI on the basis of the proxies PLAN, and MANAGE.[3]

Figure 4-5 provide the development of these proxies for time discounting over time. Again, the range at the vertical axis has been set equal to one standard deviation of the variable concerned, with the average for all years in the center of the graph. The figures reveal that the relationship between time discounting and BMI cannot explain the marked increase in body mass over the time period investigated. The small fluctuations in the discount proxies seem to be more related to business cycles. There is no clear downward trend in MANAGE. A linear regression analysis explaining the average value of MANAGE with a time trend gives a coefficient of -.008 (s.d. .006). This insignificant decrease implies a change of 8% over the whole period. This is one tenth of the change that is needed to explain the increase in BMI. The largest difference between the averages in two years (1995 and 1998) is only 24 percent of the size needed to explain the upward trend in BMI. Also PLAN does not have a clear upward pattern and the changes are of insufficient size to explain the trend in BMI. The time trend coefficient of a linear regression is .009 (s.d. .011). This increase can explain only

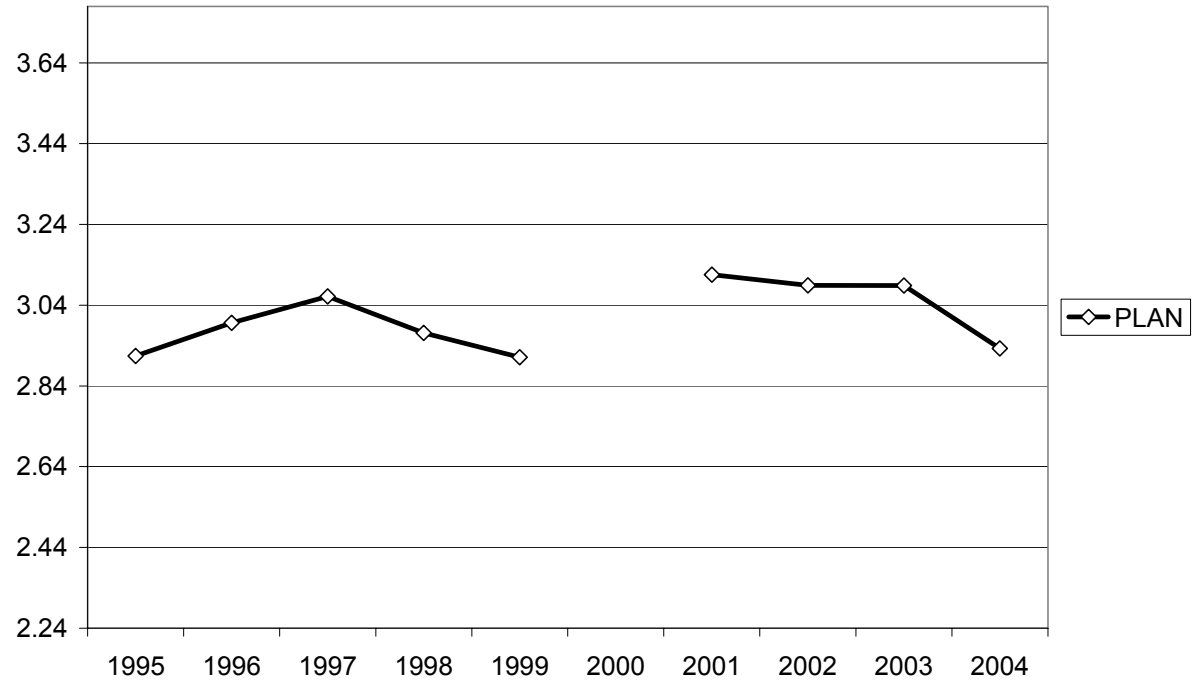
3. Analyses based on other proxies of time discounting related to BMI in the cross section, provide similar results.

Figure 4
Development of the scores on MANAGE-variable as a proxy for time discounting, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

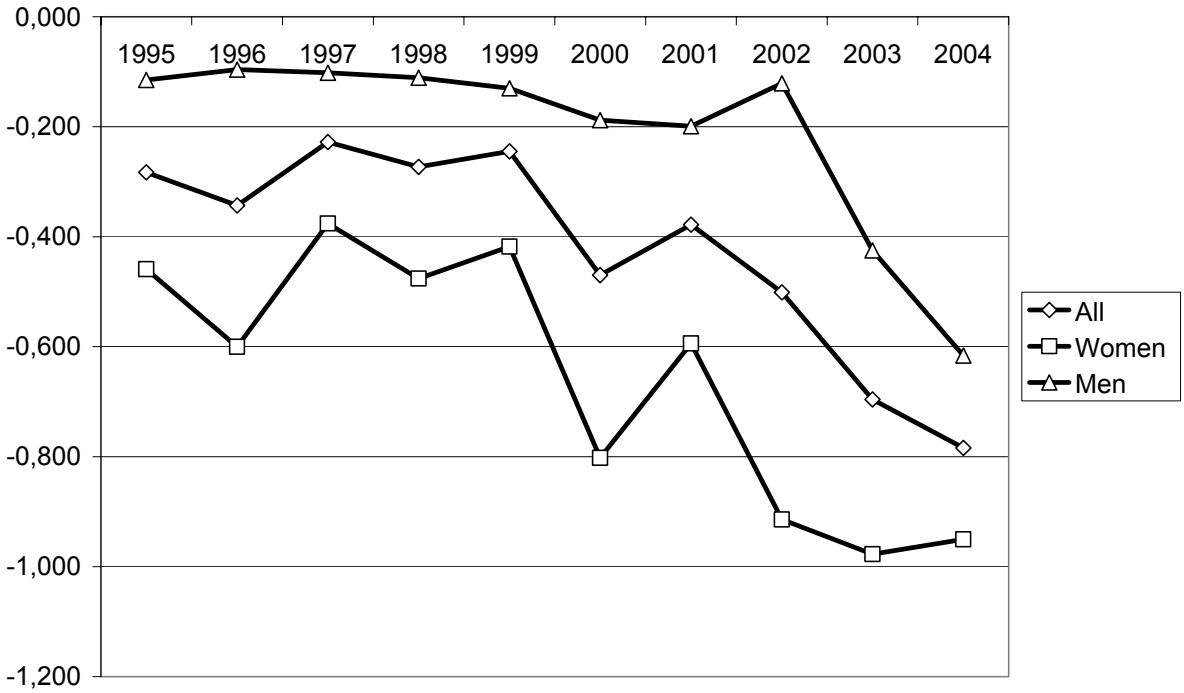
Figure 5
Development of the scores on PLAN-variable as a proxy for time discounting, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

6% of the increase in BMI. The largest difference in averages (1995 and 2001) explains 15 percent of the 1.35-point increase in BMI. Similar patterns are found when we investigate the proxies for specific age and sex groups in the data. There might of course be a delay between developments in the average individual discount rate and BMI. It is not very likely, however, that such a lag takes the full length of the 10 years for which we have data available.

Figure 6
Development of coefficients for MANAGE in annual regressions explaining BMI, 1995-2004

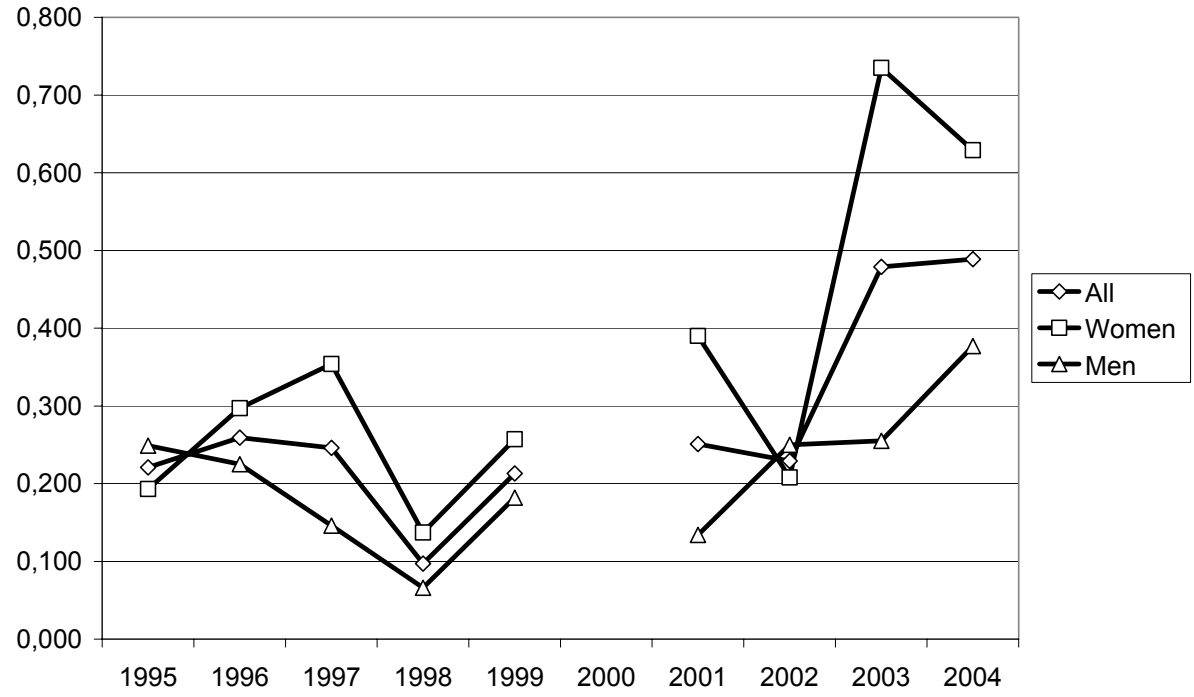


Source: DNB household survey 1995-1999, 2001-2004
Note: The graph depicts all estimated coefficients for MANAGE in an OLS regression with BMI for all respondents and males and females separately as regressand, further including a full set of dummies for all combinations of age and sex.

This leaves us with the question whether there has been a constant shift in BMI over time for people with different discount values, or whether the increase in BMI has been larger among high discounters than among low discounters. We estimate the relationship between the two proxies and BMI for all years. Figure 6 and 7 show the development of the estimated parameters for time discounting. Both figures reveal that the correlation between time discounting and BMI has increased over time: high discounters gained more weight than low discounters. This was more so for women than for men. This implies that whatever has been the cause of the increase in BMI, the change has not shifted the “optimal” BMI for all people with an equal amount. Potential explanations for the increase in average BMI are thus interacting with the individual discount rate. In the specification of the model in Section 2 changes in the price of calories would not generate such an interaction effect, but shifts in the relative price of substitutes and complements would increase the gap between the BMI

of low and high discounters.[4] Figure 8 and 9 depict this diverging trend in an alternative way. We split the sample in two parts: one group representing high discounters (PLAN larger than 4 and MANAGE less than 3) and the other group low discounters. The graphs clearly show a steady increase in the BMI of the high discounters, while the BMI of the low discounters remains more stable.

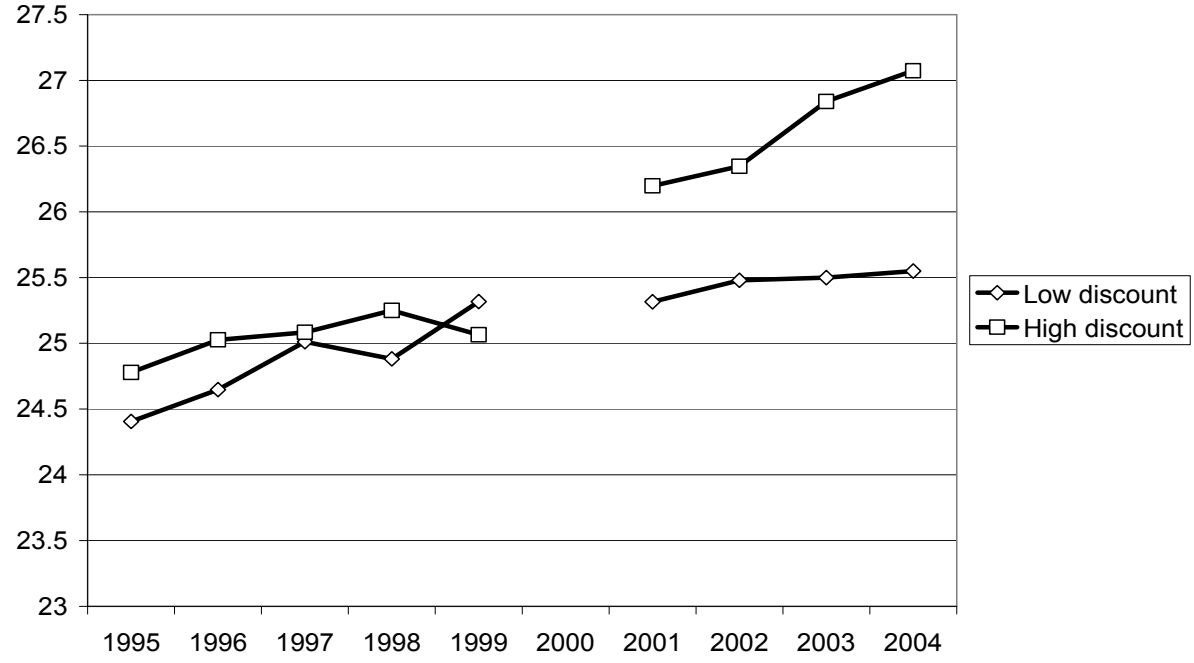
Figure 7
Development of coefficients for PLAN in annual regressions explaining BMI, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
Note: The graph depicts all estimated coefficients for PLAN in an OLS regression with BMI for all respondents and females and males separately as regressand, further including a full set of dummies for all combinations of age and sex.

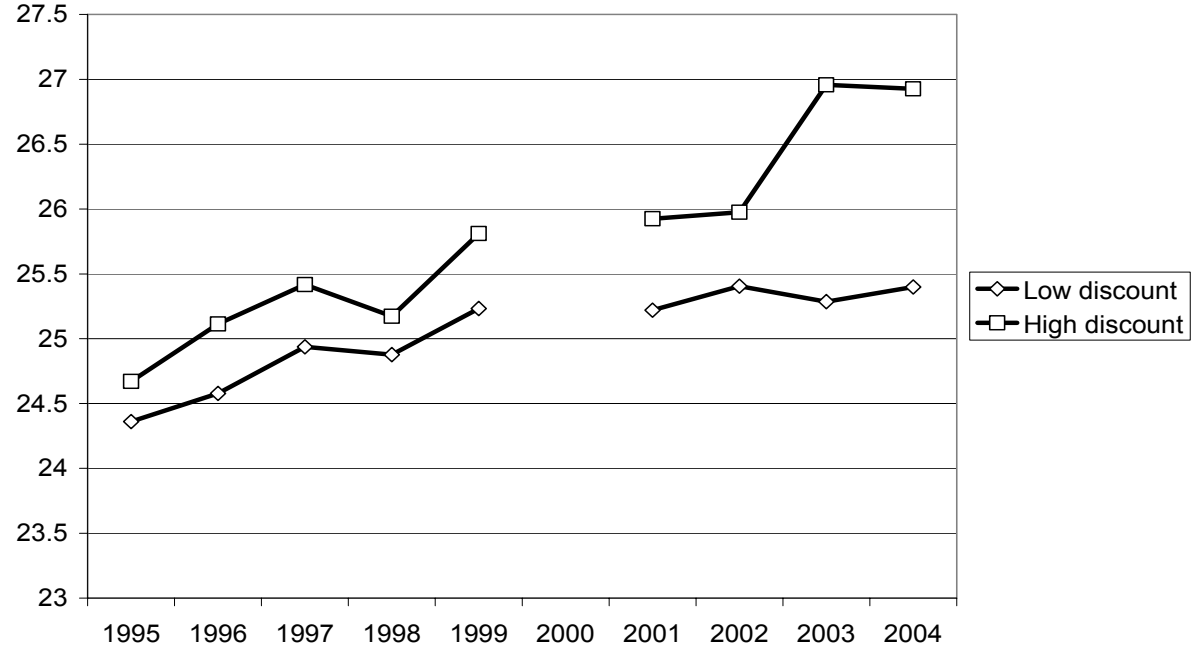
4. A model in which the utility in the second period is non-linearly related to *A*, could also generate such interaction effects.

Figure 8
BMI for high and low discounters (based on MANAGE variable), 1995-2004



Source: DNB household survey 1995-1999, 2001-2004
High discounters have been defined as values for MANAGE less than 3.
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

Figure 9
BMI for high and low discounters (based on PLAN variable), 1995-2004.



Source: DNB household survey 1995-1999, 2001-2004
High discounters have been defined as values for PLAN larger than 4.
Note: The scale of the vertical axis is determined by the mean total score over the years on BMI of women of all age groups together ± 0.5 times its standard deviation.

6 Discussion and conclusions

In this paper we have analyzed (i) whether differences in BMI between people at a certain moment of time are related to the individual discount rate, and (ii) whether a positive trend in time discounting can account for the increase of BMI over time. To analyze this question, we have used data from a survey among a sample of the Dutch population, for the period 1995-2004, which contains not only information about body weight and length, but also has a very large set of questions concerning the financial situation and attitude of the respondents. On the basis of the 2004 data, we have investigated the link between the discount rate and BMI, and the validity of a wide range of financial questions as proxies for the discount rate. Using the validated proxies, we have investigated the development of the discount rate and its link with BMI over time.

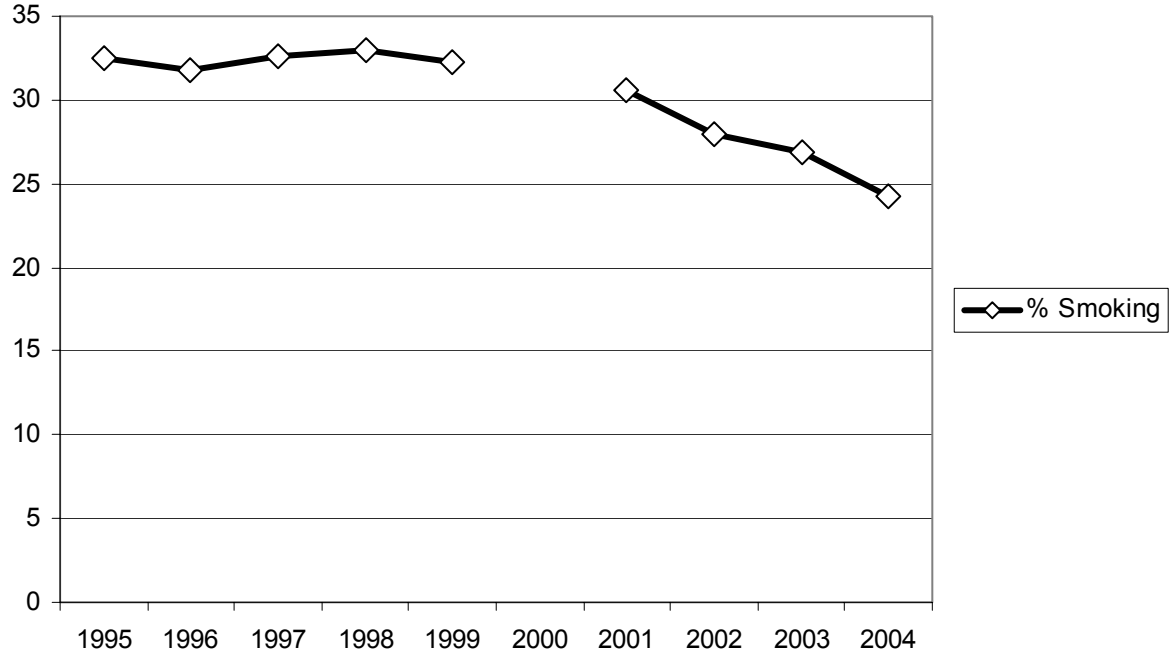
Our main findings are that differences in BMI between people in a specific year in the sample are related to some of our measures of the individual discount rate. Especially measures that are related to the ability to manage expenditures are correlated with BMI. Comparing different years, however, it turns out that the average individual discount rate did not change from 1995 – 2004. The upward trend in BMI can therefore not be accounted for by an increase in the individual discount rate. We find that with the increase of BMI the difference in BMI between low and high discounters has also increased, i.e. BMI may not have increased because the average discount rate increased but because high discounters gained more weight.

On the basis of the basic model in Section 2 the only alternative explanation left for a rise in BMI would be a fall in the price of calorie-rich food. Cutler, Glaeser and Shapiro (2003) provide convincing evidence for this fall in the price. This price trend, however, does not explain the growing dispersion in BMI between high and low discounters, nor is it able to explain the weak cross-sectional relationship between time discounting and BMI. It also leaves unexplained the remarkable differences between sex and age groups with respect to this link between time discounting and BMI.

We believe that for future research it is important to look in greater depth at the substitutability and complementarity between food consumption and other forms of risky behavior and investments in human capital. The extended model in Section 2 has shown that such interaction can influence the discount rate-BMI relationship to a great extent. Both cross-sectional data and time series evidence provide examples to illustrate such potential interactions. First, a regression explaining BMI with apart from the usual variables (age-sex dummies) also the answer to the question “In my work people take care I get tasks of which I can learn a lot”, gives a significant parameter of .197 (st.dev=.087). A potential explanation for this finding is that people who face good opportunities to work on their career, put less weight on future health, when the stress of working hard can be compensated by extra food consumption. A time-series example is provided by the data about smoking. Figure 10 depicts the development of smoking in the Netherlands in the past 10 years. Developments in the discount rate alone can never account for both this trend and the trend in BMI. Various policy measures to reduce smoking have clearly increased the price of smoking. Our

hypothesis is that reductions in smoking behavior could also have caused the increase in BMI when smoking and eating are substitutes in period's 1 utility function. Since both behaviors can help to reduce distress, such substitutability seems not to be unlikely. We therefore think that such interactions in behavior provide interesting avenues for further research concerning the developments of obesity.

Figure 10
The development of smoking rates, 1995-2004



Source: DNB household survey 1995-1999, 2001-2004

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