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Economics and Human Biology 4 (2006) 39–61

ECONOMICS AND HUMAN BIOLOGY

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Time discounting and the body mass index Evidence from the Netherlands

Lex Borghans, Bart H.H. Golsteyn *

Research Centre for Education and the Labour Market (ROA), Maastricht University, The Netherlands

Received 9 May 2005; accepted 6 October 2005

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. An increase in time discounting may be a contributing factor in the rise in BMI. Applying a large set of indicators for the individual discount rate from a Dutch survey, 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 in the Netherlands. 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 is more likely explained by shifts in other parameters that determine the intertemporal decisions regarding the trade-off of current and future health and satisfaction.

JEL classification: I1

Keywords: Body mass index (BMI); Risky behavior; Time discounting

* Corresponding author.
E-mail addresses: l.borghans@roa.unimaas.nl (L. Borghans), b.golsteyn@roa.unimaas.nl (Bart H.H. Golsteyn).

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doi:10.1016/j.ehb.2005.10.001

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. The utility one receives in a future period is weighted today by a discount factor that equals $1/(1 + \rho)$, where ρ is the discount rate. The higher the discount rate, the lower the discount factor and the less importance one assigns today to utility in that future period. Because of this, when the discount rate rises, the importance assigned to utility in the future period falls, and one is more likely to accept long-run decreases in health and appearance in exchange for the immediate gratification of eating. Among others, decreases in personal savings, rises in consumption (Parker, 1999) and rises in credit card debt (Blaylock et al., 1999) suggest that the average discount rate has increased over time. Along this argument, an increase in the average individual discount rate, could therefore help 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 point in 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 these questions we use data of the DNB household survey, a survey among a sample of the Dutch population, for the period 1995–2004. This data set contains information about weight and height, 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 questions for measuring the individual discount rate, which are standard in psychological literature. 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 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 significantly from 1995 to 2004. It is therefore unlikely that the upward trend in BMI can 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 et al. (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 et al. (1999) find only weak correlations between discount rates for money and for health. On the other hand, Bickel et al. (1999), Kirby et al. (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 (2005) 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 et al. (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 et al., 1990; Evans and Montgomery, 1994; Chevalier and Walker, 2001; Munasinghe and Sicherman, 2000; Fersterer and Winter-Ebmer, 2003). Frederick et al. (2002) give a more extensive overview of these findings.

The literature on changes in the discount rate over time is less extensive. Komlos et al. (2004) note that some evidence suggests that the average discount rate has increased, e.g. the National Gambling Impact Study Commission (1999) reports an increase in legal gambling in the US 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) shows that private savings have declined since 1980, while personal consumption as a percentage of GDP has increased.

Blaylock et al. (1999) and Levy (2002) provide theoretical models explaining obesity using individual differences in the discount rate. In a recent paper Komlos et al. (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. Smith et al. (2005) find that in an NLSY cross-section there is a significant relation between BMI and saving behavior, as a proxy for time preference, for black and Hispanic men and black women. 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. At the margin, in developed countries, 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 $\gamma_A > 0$ and $0 < \delta < 1$), 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 γ_A 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 P_A. An agent with an individual discount rate ρ, who maximizes the discounted utility for both periods, will maximize:

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

The optimal level of A equals:

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

This expression for A provides potential explanations for why people differ in calorie intake and consequently in BMI. Note that our model describes food intake A. This food intake will affect the BMI, so the change in BMI will be a function of A BMI = $f(A)$. When food consumption patterns are persistent BMI and food intake will be highly correlated, the first representing a stock and the second a flow. Assuming the technical parameter δ to be equal for all individuals, differences can be related to P_A, ρ, or γ_A. At a certain moment in time, all agents will face the same prices,[1] so cross-sectional variation in this model can only be related to differences in the discount rate and differences in γ_A, 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 γ_A increases, if prices decrease, or the discount rate increases. The same expression also provides a framework

[1] In the US, there is some evidence that the poor face higher food prices and/or lack physical access to healthier foods. An interesting extension of the model would be to relax the assumption of homogenous prices.

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.

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 et al. (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 people have a limited ability to foresee future consequences of their behavior (see Becker and Mulligan, 1997; 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 $U_1 = (\gamma_A A^\nu + \gamma_B B^\nu)^{\delta/\nu}$, $(\nu \leq 1)$ and utility in period 2 to $U_2 = -\mathrm{A} - \mathrm{B}$, with prices P_A and P_B, leads to the following optimal level of A:[2]

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

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 not 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. This model can also link health with labor market behavior. Suppose that A represents food intake and B represents leisure at the cost of investing in training or working hard to invest in a career. When leisure and food intake are substitutes, the model can explain that people who work or learn hard for their future benefits

[2] 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.

might neglect their health and face an increasing BMI. 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, 2000; Levine et al., 1997; Viscusi and Hersch, 2001). On the other hand, e.g. Gulliver (1995), Burton and Tiffany (1997) and Picone et al. (2004) provide evidence for the complementarity of smoking and drinking, while Cawley et al. (2004) 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 high, it will be especially low discounters who will choose low levels of *B*. 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 a high BMI. These extensions show that in a more general setting, the link between the individual discount rate and BMI becomes an empirical question, which we try to answer in this paper.[3]

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). DNB is a household survey, in which all members of the household are requested to fill out the questionnaire. The children are however excluded from most of the survey questions when they are below 16. The data are unique for our purposes, because they contain both questions about body height 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.

3.1. 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 to 2004. In 1995, the sample contained 4854 people. This decreased to 2059 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.

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 et al., 1991).

[3] While the model describes the different possible expectations one could have about the sign of the relation between BMI and the discount rate, we do not aim to estimate a structural variant of the model. This could be an interesting topic for future research.

Table 1
BMI levels men and women, 1995 and 2004

BMI[a]		1995			2004		
		Men	Women	Total	Men	Women	Total
<18.5	Undernourished	2.2	4.2	3.1	1.1	3.0	2.0
$18.5 \leq$ BMI < 25	Normal	57.5	65.5	61.3	47.3	50.6	48.9
$25 \leq$ 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

Source: DNB household survey.
[a] BMI is defined as weight in kg divided by height in meters.

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

3.2. BMI

Using the information on height and weight, we calculated the BMI as weight in kilograms over the square of height in meters. The data on height and weight are self-assessed, and may therefore be subject to some bias. Cawley (2004) shows that the self-reports of weight and height include some degree of reporting error.[4] This under- and overreporting hence transforms the scale of BMI and therefore self-assessed BMI data should be interpreted slightly different than BMI based on actual measures of height and weight. However, if the under- and overreporting is related to BMI levels only, relations between BMI and other variables will not be affected by this bias.[5] A more serious problem could arise if the degree of underreporting would be correlated with the individual discount rate. Regarding the extent of underreporting as reported by Cawley (2004) such biases are unlikely to change the results in this paper substantially. In addition, the data contains a small fraction of implausible answers. To reduce the impact of outliers, we leave out seven cases of 2059 for those claiming to weigh less than 35 or more than 135 kg. The average male respondent in our sample in 1995 is 180.6 cm tall and weighs 79.7 kg. 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 to 71.9 kg in 2004. Their BMI increased from 23.7 in 1995 to 25.4 in 2004. According to, e.g. the US Department of Health and Human Services, 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 1 shows that in 1995, 5.4% of the population was obese.

[4] Cawley (2000) shows the details of his estimation are shown in an appendix. Women, on average, underreport their weight by 1.5%, where underweight women overreport and overweight women underreport.
[5] This is under the assumption of approximately linear relationships between BMI and the variables.

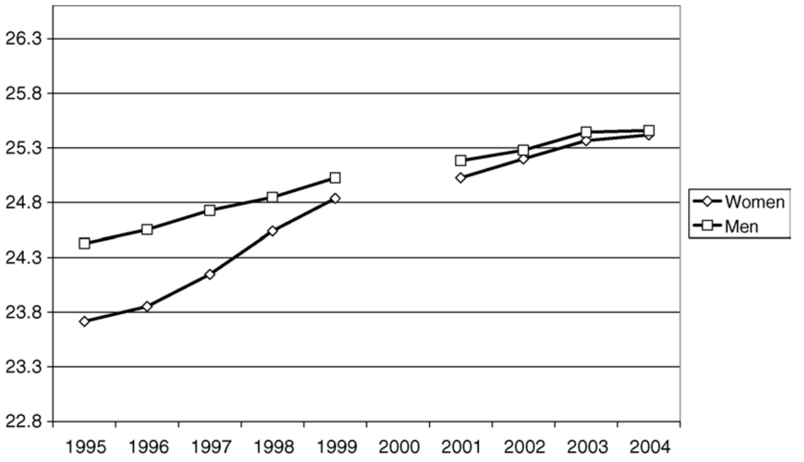

Fig. 1. The development of BMI, 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004. *Note*: the maximum of the scale of the vertical axis is determined by adding 0.5 times the standard deviation to the mean BMI score. Similarly, the minimum of the scale is determined by subtracting 0.5 times the standard deviation from the mean score. The mean and standard deviation are averages of these values over the years for men and women together.

In 2004, the percentage of obese people increased to 12.2%. The percentage of overweight people increased from 30.2 to 37.0%.

Fig. 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. Breaking down the development of BMI over time by age and sex, we find that the largest increase in BMI has taken place among women below 40. For women, the gaps in average BMI between age groups (25 to 39; 40 to 55; 55+) diminished considerably, while 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.

Interestingly, the standard deviation of BMI increased with the increase in BMI: for men the increase has been 0.303 (3.112–3.419) and for women 0.818 (3.875–4.694). Fig. 2 shows the increase in BMI between 1995 and 2004 for men and women across the percentiles of the BMI distribution. The figure shows that women in a high BMI-percentile became heavier over the years while women that were in a low BMI-percentile remained about equally heavy. For men the development is more equal between the percentiles. Men in all BMI-percentiles became heavier.

3.3. 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 discount rate questions, which are standard in psychological literature. 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

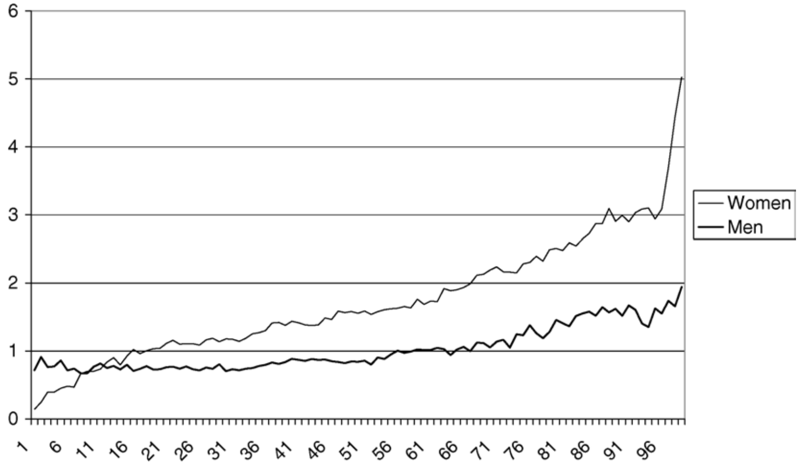

Fig. 2. Increase in BMI between 1995 and 2004 for different percentiles of the male and female BMI distribution. *Source*: DNB household survey 1995–1999, 2001–2004. *Note*: the vertical-axis is defined as the difference of the 2004 and the 1995 BMI score, the horizontal-axis is the percentile in the BMI-distribution.

between these proxies and BMI.[6] 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.

3.4. Measuring the discount rate

Following the psychological tradition (Rachlin et al., 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”.

Per question, the respondent has to choose one of these two options. 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.[7] Several papers show that this measure of the individual discount rate is 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

[6] We do not have measures of the actual eating behavior. The analyses therefore focus on the stock rather than on the flow of food intake.

[7] The discount rate is represented by the abbreviation “DR” in the tables.

Table 2
Percentages of the respondents choosing the option that gives them gratification sooner with the high and low monetary questions

Questions	Implicit discount rates	Percentage of respondents choosing gratification sooner	
		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 1 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.e. all monetary values in the questions were multiplied by 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.[8] People who are asked the set with the low money values score significantly higher on the discount rate (t-value = 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 2 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 enabling the use of non-monetary choices as a way to measure the discount rate, some authors apply survey questions based on more specific cases (see e.g. Frederick, forthcoming). To investigate the validity of our monetary measure of the individual discount rate, we asked the following additional question following this approach:

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

[8] This test is based on linear utility functions. The magnitude effect can in principle be explained also by non-linear utility functions.

$(((\text{days} + 10)/10)^{1/3} - 1)$. We find a very significant relationship between this measure and the discount rate based on the monetary questions (t-value = 5.141).

3.5. 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 3 contains the wordings of all these questions and provides some statistics for these proxy variables for the individual discount rate. 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 idea is that respondents with higher discount rates are more tempted to spend money immediately and will have more problems managing their money. Therefore, the expected correlation of these three variables with the discount rate and BMI is negative. 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) in the sense that people with high discount rates tend to be less risk averse, we included them in our set. The expected sign of the correlations with time discounting and BMI are negative for SAVE1, SAVE2, SAVE3 and SAVE4 and positive for the other variables. 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.[9] For instance people that agree to a large extent with the statement "I am only concerned about the present, because I trust that things will work out in the future" will generally have a higher discount rate. FUTURE01, FUTURE02 and FUTURE06 to FUTURE08 have negative expected correlations with time discounting/BMI, the others have positive expected correlations. The questions SPEND (negative expected correlations with time discounting/BMI) and PLAN (positive expected correlation) 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 (negative expected correlation with time discounting/BMI) is the total value of the accounts and different kinds of savings, while LIABILITIES (positive expected correlation) reflects the aggregate value of loans and credits, excluding the mortgage on the first house.[10] We apply these two financial summary statistics in euros and as a ratio to yearly net income.

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.

[9] 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.

[10] The mortgage is excluded because it is for most people an investment and therefore incomparable with depths for consumption reasons. Including mortgages would also bias the comparison between people who own or rent a house.

Table 3
Questions that are used as proxies for the individual discount rate

Name	Question	Answers	Mean	S.E.
MANAGE	How well can you manage with the total income of your household?	1 very hard, 2 hard, 3 neither hard nor easy, 4 easy, 5 very easy	3.495	0.854
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	2.188	0.735
HOWMUCH	Approximately 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	2.233	0.953
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	5.173	1.690
SAVE2	I would never consider investments in shares because I find this too risky	1 totally disagree, . . ., 7 totally agree	4.473	2.054
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	2.234	1.539
SAVE4	I want to be certain that my investments are safe	1 totally disagree, . . ., 7 totally agree	5.469	1.351
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	2.738	1.622
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	2.610	1.529

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 risks, 6[a] not applicable, 0[a] don't know	2.370	1.020
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	4.162	1.467
FUTURE02	I often work on things that will only pay off in a couple of years	1 totally disagree, . . ., 7 totally agree	3.590	1.533
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	3.657	1.525
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	3.721	1.594
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	4.519	1.353
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	3.410	1.459
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	5.160	1.255
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	4.241	1.333
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	3.255	1.375
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	3.867	1.420
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	3.719	1.469

Table 3 (*Continued*)

Name	Question	Answers	Mean	S.E.
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[a] I don't know	4.966	1.245
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 yes, very difficult, 0[a] I don't know	2.933	1.568
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 € (/100,000)	0.272	0.676
ASSETS/ (net income per year)[b]		Fraction of net income per year	1.077	1.665
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 € (/100,000)	0.030	0.260
LIABILITIES/ (net income per year)[c]		Fraction of net income per year	0.155	0.655

Source: DNB household survey 2004.

[a] Answers have been coded as missing values in the analyses.

[b] People who reported to have more than 10 times more assets than their net income excluded.

[c] People who reported to have more than 10 times more liabilities than their net income were excluded.

Table 4
Relationship between the discount rate and BMI as dependent variables and proxies for the discount rate as independent variables

	DR[a]		BMI					
	All		All		Women		Men	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
DR[a]			0.096	0.060	0.066	0.106	0.123	0.066*
MANAGE	−0.331	0.047***	−0.785	0.116***	−0.953	0.189***	−0.612	0.137***
EXPENDITURES	−0.250	0.055***	−0.597	0.134***	−0.957	0.231***	−0.302	0.152**
HOWMUCH	−0.272	0.053***	−0.474	0.126***	−0.798	0.199***	−0.122	0.155
SAVE1	−0.087	0.025***	−0.041	0.061	−0.097	0.106	0.006	0.068
SAVE2	0.073	0.021***	0.159	0.051***	0.215	0.093**	0.120	0.055**
SAVE3	−0.016	0.028	0.091	0.069	−0.024	0.138	0.151	0.070**
SAVE4	−0.079	0.032**	−0.107	0.076	−0.082	0.130	−0.130	0.088
SAVE5	−0.013	0.026	0.015	0.063	0.027	0.117	0.006	0.068
SAVE6	−0.055	0.028*	0.053	0.069	−0.091	0.131	−0.026	0.074
RISK	−0.108	0.059*	−0.019	0.135	0.284	0.299	−0.162	0.136
FUTURE01	−0.115	0.028***	−0.048	0.069	−0.106	0.117	0.006	0.078
FUTURE02	−0.151	0.027***	0.018	0.067	0.072	0.117	−0.026	0.075
FUTURE03	0.183	0.026***	0.207	0.065***	0.196	0.116*	0.213	0.072***
FUTURE04	0.080	0.025***	0.123	0.063*	0.080	0.112	0.151	0.069**
FUTURE05	−0.012	0.030	0.093	0.074	0.086	0.128	0.100	0.084
FUTURE06	−0.084	0.029***	−0.064	0.071	−0.173	0.123	0.032	0.080
FUTURE07	−0.124	0.033***	−0.014	0.080	0.108	0.138	−0.116	0.090
FUTURE08	−0.155	0.031***	−0.148	0.076*	−0.205	0.134	−0.103	0.084
FUTURE09	0.089	0.030***	0.088	0.072	0.008	0.126	0.153	0.081*
FUTURE10	0.077	0.029***	−0.045	0.070	−0.130	0.123	0.021	0.078
FUTURE11	0.122	0.027***	0.073	0.068	0.030	0.120	0.107	0.075
SPEND	−0.153	0.033***	−0.116	0.081	−0.125	0.141	−0.117	0.091
PLAN	0.103	0.026***	0.489	0.063***	0.628	0.109***	0.378	0.071***
ASSETS/100,000	−0.395	0.062***	−0.280	0.146*	−0.370	0.333	−0.249	0.139*
LIABILITIES/100,000	−0.137	0.143	0.358	0.343	3.143	1.795*	0.211	0.289
ASSETS/(net income per year × 1000)[b]	−0.101	0.030***	−0.181	0.067***	−0.125	0.103	−0.254	0.086***
LIABILITIES/(net income per year × 1000)[c]	0.055	0.075	0.282	0.157*	0.286	0.227	0.277	0.221

Source: DNB household survey 2004 and supplementary survey 2004. *Notes*: The table contains the estimated coefficients for the proxies of the discount rate in OLS regressions with DR and BMI as regressand, further including a full set of unreported dummies for all combinations of age and sex. The regressions have been run separately with one proxy at the time. The indicated significance levels are 1% (***), 5% (**) and 10% (*).

[a] 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.

[b] People who reported to have more than 10 times more assets than their net income excluded.

[c] People who reported to have more than 10 times more liabilities than their net income were excluded.

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 4 provides the estimates of the parameters for the proxies of the discount rate in relation with our measure of the discount rate based on the choices between two amounts of money (DR). With a few exceptions, we find a strong significant relationship between the proxies and the measure of the discount rate in the expected direction. SAVE2, SAVE6 and RISK have signs opposite to those expected. Apart from these variables, 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. The table shows that 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. Notably, we find that the DR variable does not correlate significantly with BMI. 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. There is some evidence that the discount rate for money and the discount rate for health might not be similar (see e.g. Cairns, 1994; Chapman and Elstein, 1995). The table shows also that in general, the link between time discounting and BMI is stronger for women than for men. 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.[11] 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.

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. For both proxies we find a significant negative parameter for university degree. The effect of the time discount proxies reduces slightly from −0.785 to −0.655 for MANAGE and from 0.489 to 0.468 for PLAN, but both parameters remain significant at the 1-percent level. Including interaction variables between income/education levels and PLAN, we find that the coefficient of the interaction between PLAN and education level 5 (bachelor degree) (coef.: −0.376, S.E.: 0.221) and the interaction of PLAN and income (coef.: −0.640, S.E.: 0.278) have a significant negative effect on BMI. Adding these interactions increases the effect of the relation between PLAN and BMI (coef.: 0.805, S.E.: 0.174). Similarly, the MANAGE-BMI relation remains significant if we include interactions and the coefficient increases (coef.: −1.113, S.E.: 0.312) with only the income-manage interaction significant (coef.: 1.448, S.E.: 0.711). These results indicate that when we control for education, the time discounting proxies have a significant impact on mean BMI in the predicted direction while this result seems to be somewhat stronger for people with lower incomes.

The size of the cross-sectional relationship between these proxies for time discounting and BMI will be downward biased due to measurement error in the explanatory variables. To get a

[11] The tables breaking the sample in different sex and age groups are available upon request. 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. This provides evidence for the implicit assumption in our analysis that the relation between the discount rate and BMI is constant with age.

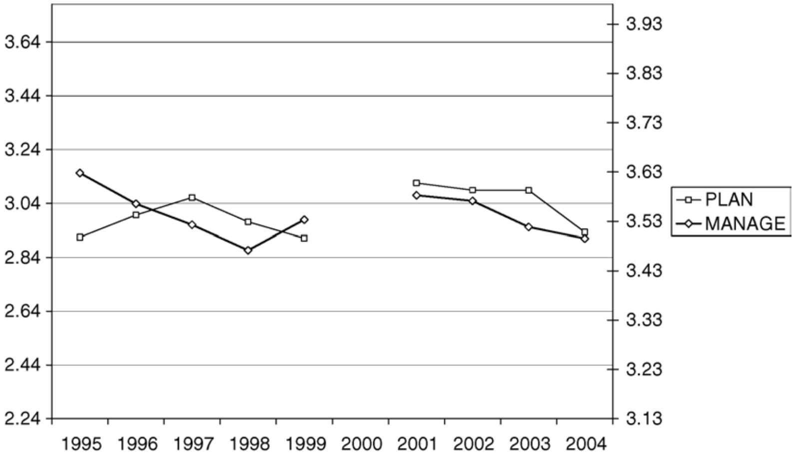

Fig. 3. Development of the scores on MANAGE-variable as a proxy for time discounting, 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004. *Note*: the left *y*-axis is related to the PLAN variable ('Many people find it difficult to plan or control their expenditures. Do you find it difficult to control your expenditures?' with 1 no, very easy, . . ., 7 yes, very difficult), the right *y*-axis is related to the MANAGE variable ('How well can you manage with the total income of your household?' with 1 very hard . . . 5 very easy). The maximum of the scale of the vertical axis is determined by adding 0.5 times the standard deviation to the mean PLAN/MANAGE score. Similarly, the minimum of the scale is determined by subtracting 0.5 times the standard deviation from the mean score. The mean and standard deviation are averages of these values over the years.

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 −0.785 to −2.006 (*t*-value: −7.462) and the effect of PLAN increases from 0.489 to 0.968 (*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 0.672 and an increase in the average of PLAN of 1.395 is needed.

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.[12]

Fig. 3 provides 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. 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 −0.008 (S.E. 0.006). This insignificant decrease implies a change of 8% over the whole period.

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

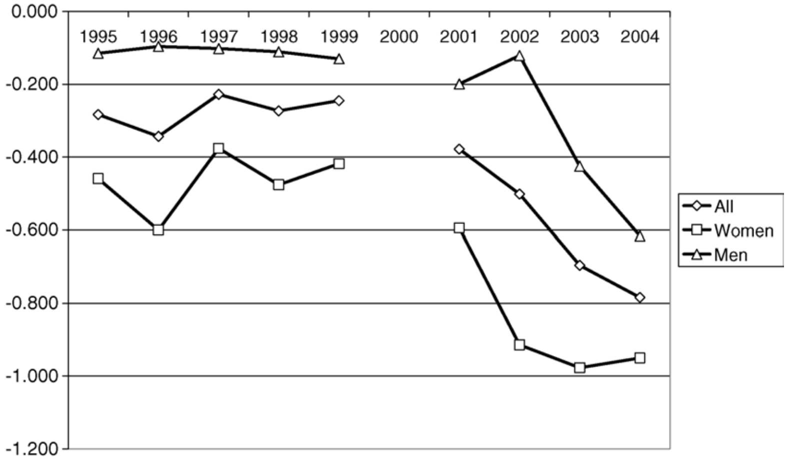

Fig. 4. Development of coefficients for MANAGE in annual regressions explaining BMI, 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004. *Note*: the graph depicts all estimated coefficients for MANAGE ('How well can you manage with the total income of your household?' with 1 very hard . . . 5 very easy) 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 is one tenth of the change that is needed to explain the increase in BMI. The largest difference between the averages in 2 years (1995 and 1998) is only 24% 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 0.009 (S.E. 0.011). This increase can explain only 6% of the increase in BMI. The largest difference in averages (1995 and 2001) explains 15% 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.

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. Figs. 4 and 5 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.[13] Figs. 6 and 7 depict this

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

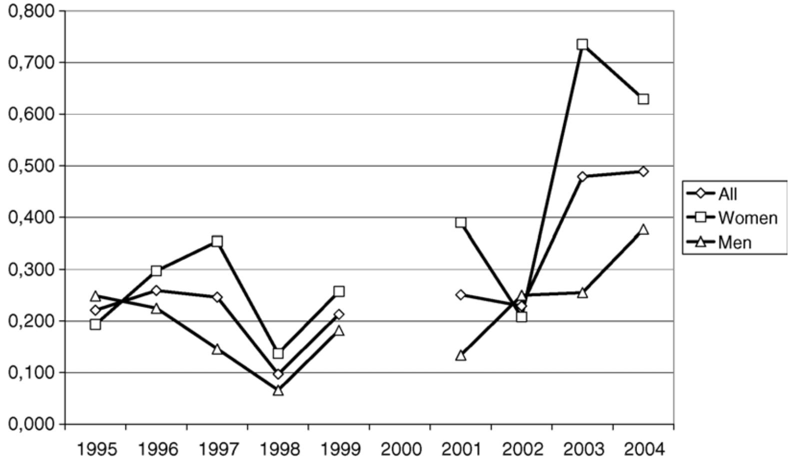

Fig. 5. Development of coefficients for PLAN in annual regressions explaining BMI, 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004. *Note*: the graph depicts all estimated coefficients for PLAN (‘Many people find it difficult to plan or control their expenditures. Do you find it difficult to control your expenditures?’ with 1 no, very easy, . . ., 7 yes, very difficult) 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.

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.

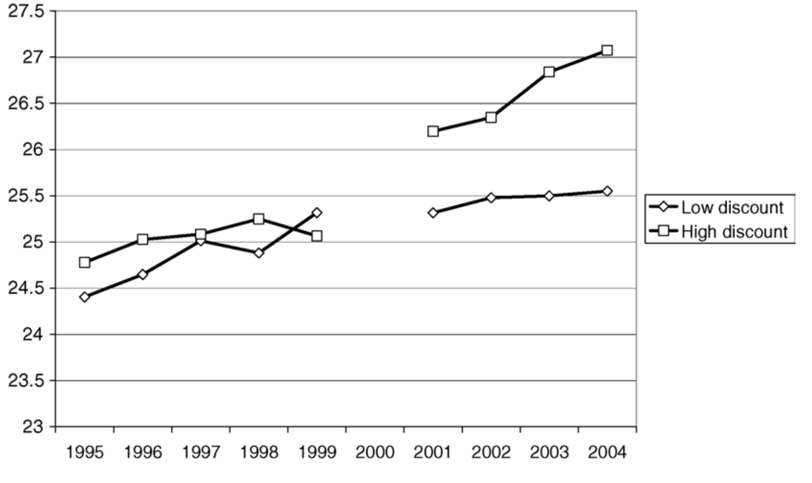

Fig. 6. BMI for high and low discounters (based on MANAGE variable), 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004, high discounters have been defined as values for MANAGE (‘How well can you manage with the total income of your household?’ with 1 very hard . . . 5 very easy) less than 3. *Note*: the maximum of the scale of the vertical axis is determined by adding 0.5 times the standard deviation to the mean BMI score. Similarly, the minimum of the scale is determined by subtracting 0.5 times the standard deviation from the mean score. The mean and standard deviation are averages of these values over the years.

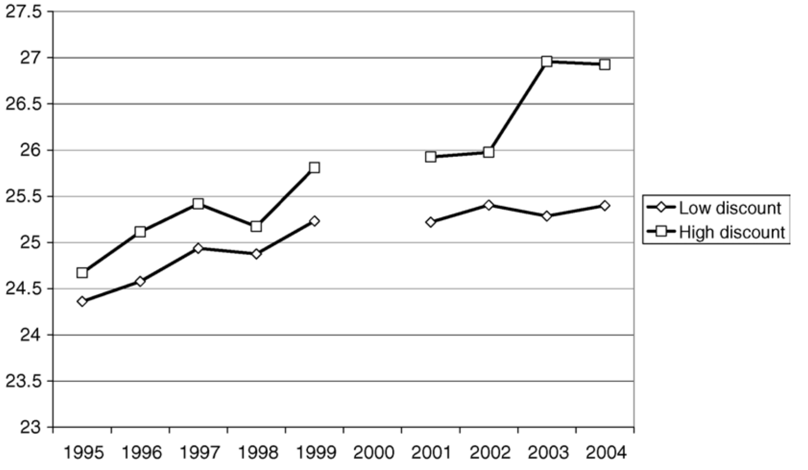

Fig. 7. BMI for high and low discounters (based on PLAN variable), 1995–2004. *Source*: DNB household survey 1995–1999, 2001–2004, High discounters have been defined as values for PLAN ('Many people find it difficult to plan or control their expenditures. Do you find it difficult to control your expenditures?' with 1 no, very easy, . . ., 7 yes, very difficult) larger than 4. *Note*: the maximum of the scale of the vertical axis is determined by adding 0.5 times the standard deviation to the mean BMI score. Similarly, the minimum of the scale is determined by subtracting 0.5 times the standard deviation from the mean score. The mean and standard deviation are averages of these values over the years.

6. Discussion and conclusions

In this paper we have analyzed (i) whether differences in BMI between people at a certain point in 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 height, 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 in the Netherlands.

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 to 2004. It is therefore unlikely that the upward trend in BMI can 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 et al. (2003) provide convincing evidence for this fall in the price. This price trend, however, does not 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 interactions between different forms of human capital can influence the discount rate-BMI relationship to a great extent. Both cross-sectional data and time series evidence provide examples to illustrate the interaction between food intake and other forms of risky behavior or investments in human capital. First, in the paper we indicated that people who invest in their career at school or work by learning might neglect their health, and eat more to increase mental concentration. In such a case leisure (not learning) and food intake are substitutes. 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 indeed a significant parameter of 0.197 (S.E. = 0.087).

A time-series example is provided by the data about smoking. Smoking rates have decreased considerably in the Netherlands in the past 10 years (our data indicate a decrease of about 9%). Developments in the discount rate alone cannot 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.

Acknowledgements

The authors thank Barry Bogin, associate editor John Cawley, Erik de Regt, Inge Sieben, Patricia Smith, Wendy Smits, Bas ter Weel and four anonymous referees for useful comments, John Komlos for his encouragement to write this study and CenterData for providing the data of the DNB household survey.

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