HAPPY HOUSE:

SPOUSAL WEIGHT AND INDIVIDUAL WELL-BEING

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FIRST DRAFT. DO NOT QUOTE.

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Abstract

We use life satisfaction (LS) and Body Mass Index (BMI) information from three waves of the GSOEP to examine well-being spillovers in body shape between spouses. Semi-parametric regressions reveal that individual well-being falls with partner's BMI, at least beyond some "ideal" level. Own BMI is positively correlated with LS in thin men, and then negatively correlated with LS, after some point defined as own ideal BMI. This own ideal BMI itself moves upward with partner's BMI in the range of overweight. As such, the marginal negative impact of own overweight and obesity is attenuated by having an overweight or obese partner. This fact is of interest for the identification of sub-populations that obesity policies should target. It is also consistent with contagion effects, whereby individuals follow their partner as the latter gains weight. These results are however difficult to validate with instrumental variable analysis.

Keywords: Obesity, subjective well-being, utility spillovers, social interactions.

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Happy House: Spousal Weight and Individual Well-Being

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1 Introduction

This paper analyses the relationship between well-being and BMI within couples. We have two reasons for doing so. First, the relationship between BMI and well-being pinpoints BMI distributions that produce similar levels of population welfare. In the spirit of Waaler's curve, we can describe BMI-related inequality between population subgroups beyond the sole medical impact of overweight and obesity. It may be the case that, for instance, thin women married to overweight men are less happy than couples of overweight individuals. Separating the welfare and the medical consequences of overweight and obesity will help inform public-health policy.

Second, as noted by Blanchflower *et al.* (2009), the increase in the prevalence of obesity and overweight has been so rapid over recent decades that the World Health Organisation declared in 2003 that "obesity has reached *epidemic* proportions".[1] The use of the word "epidemic", formerly reserved for diseases that are transmissible through identifiable pathogenic agents, is applied here in the context of health changes that are, *a priori*, under the sole control of the individual: "eat less, exercise more" is a common piece of advice to those who express concern over their body weight. We can however consider obesity as an epidemic if we can identify a causal effect of changes in some individuals' body weight on the body weight of another group of individuals. In this perspective, a lively debate has recently sprung up regarding the presence of such contagion effects in social networks (Christakis and Fowler, 2007 and 2008, *vs*. Cohen-Cole and Fletcher, 2008 and 2009).[2] This literature has tried to identify contagion effects from data on (arguably) choice variables, such as BMI or obesity: the choice of each individual is modelled as a function of that of members of her peer group; and the key question is whether the latter has a causal effect on the former. We here complement this empirical approach to contagion effects, by analysing the preferences of the married over their partner's body shape. A necessary condition for the existence of contagion in choices is that there be spillovers between individuals in the utility function: individual *i*'s utility from her choice is a function of both her own and her peer group's behaviour or attributes, here given by their body shape. "Utility spillovers" will produce contagion effects if, in addition, partners' body shapes are complements or substitutes in the production of individual utility: we will speak of cross-partial effects (CPE) in this context. In this case, although one's own body shape may be valued in and of itself, its effect on utility is tempered (or enhanced) by partner's body shape. As a consequence, changes in the latter will affect marginal utility and therefore decisions. Even in the absence of CPE, identifying "utility spillovers" is useful for the evaluation of the well-being effects of obesity policies.

We use life satisfaction as a proxy measure of utility with which to estimate the effect of both own and partner's BMI, and thus test for the existence of "utility spillovers" in body shape. The latter is measured by the Body Mass Index (Weight in kilograms divided by Height in meters squared). A significant correlation between LS and partner's BMI may reveal that the partner's body shape choice (via calorie-intake and physical-activity decisions) affect individual well-being. These equations are estimated using data on German couples from three waves of the German Socio Economic Panel (GSOEP 2003, 2004, 2006). Blanchflower *et al.* (2008) used the same data to analyse the impact of own BMI, relative to the average BMI by age, on life satisfaction. Our work expands theirs in two directions. First, we consider a much tighter reference group than the age cohort, the partner, who arguably is much more salient for everyday decisions (especially eating). Second, we take endogeneity concerns seriously.

We first identify the shape of the relationship between partner BMI and individual utility, for men and women separately. Well-being spillovers from one partner to the other are negative in couples where there is considerable disparity in partners' body shapes, or when both partners are obese; they are positive when both partners are thin or moderately obese. We identify ideal BMI levels, at which life satisfaction is maximised. When both partners are thin, ideal BMI is around 21-22 for women, and 24-25 for men.

However, own ideal BMI depends positively on partner's actual BMI, especially when the latter is overweight or obese. This is consistent with positive cross-partial effects, whereby partner BMI affects the marginal well-being effect of own BMI. Inequality in BMI within the couple reduces welfare, which may be of interest to policy-makers.

However, life satisfaction measures experienced rather than decision utility. BMI is likely endogenous, representing a choice outcome, and therefore picking up unobserved preference, technological and environmental factors which are common to the partners. These hidden common factors make it difficult to identify utility spillovers beyond simple well-being spillovers. We appeal to an instrumental variable strategy, which yields somewhat different results. BMI levels are instrumented by their past changes. Since the correlation between the former and the latter is significant (and positive) for overweight and obese individuals only, our estimator puts more weight on the preferences of individuals with high levels of BMI. The interaction effects then become insignificant, which is not surprising. In obese couples, the well-being effect of an increase in partner BMI is likely negative, as the health-related insurance effect of being in couple is reduced. Contagion effects are less likely to appear in couples of overweight or obese individuals. Obesity policies can not therefore appeal to the "household social multiplier" to amplify their effects, and should target both partners. Contagion effects are more likely to affect individuals who are potentially active on the marriage market rather than stable couples.

The remainder of the paper is organized as follows. Section 2 presents the concept of well-being/utility spillovers, and reviews predictions about the effect of partners BMI on own well-being. Section 3 then presents the data. Section 4 proposes linear and semi-parametric regression results, while Section 5 discusses how these may be affected by endogeneity. Last, Section 6 concludes.

2 Spousal interactions in body weight

Our aim in this paper is to evaluate the relationship between body shape and utility within couples. All of the analysis, and the adjective "married", will refer to men and women who report being together in a couple, regardless of the actual legal arrangement describing their relationship. There are a wide variety of body characteristics which go towards making individual body shape, many of which are likely valued by both the individual and their partner. The large-scale surveys on which empirical research in Economics relies will typically contain only few of these. Here we concentrate on one convenient summary measure of body shape, the Body Mass Index (BMI). BMI is defined as weight in kilograms divided by height in meters squared. While BMI is a good predictor of weight-related morbidity at the population level, it does not take into account the distribution of fat and muscle in the body, and may not be a very good predictor of body shape at the individual level (Burkhauser and Cawley, 2008). Although the correlation between BMI and body fat varies by age, sex, race and the level of physical activity, it does remain fairly strong (Garrow and Webster, 1985, and Prentice and Jebb, 2001).

We wish to identify the effect of an individual's own BMI on both their own and their partner's utility. The critical question is whether and how partner BMI affects the production of utility: are there "utility spillovers" in BMI, and might they produce contagion effects? The remainder of this section defines more formally what we mean by "utility spillovers", and appeals to the existing literature in economics and sociology to discuss the basis of such effects with respect to body weight.

2.1 "Utility spillovers": concept and illustration.

The underlying idea of utility spillovers can be assimilated to a simple situation in game theory. Consider two individuals $\{i,j\}$ and imagine that each individual k in $\{i,j\}$ has to choose an action a_k from a set of feasible actions Γ_k. The net well-being benefits from actions are represented by the indirect utility function $V_k(a_i,a_j)$: there are "utility spillovers" when the marginal effect of one's partner's action on the other's utility is non-zero:

Utility spillovers: $\partial V_i / \partial a_j \neq 0$ or $\partial V_j / \partial a_i \neq 0$.

This standard set-up defines a basic game situation between spouses. If we postulate that spouses behave strategically *à la* Nash, we can define best-response functions to the partner's choice from the first-order conditions of the utility-maximisation problem ($\partial V_i / \partial a_i = 0$ and $\partial V_j / \partial a_j = 0$): $a_i = r_i(a_j)$ and $a_j = r_j(a_i)$. Utility spillovers imply contagion effects in behaviours if the first-derivative of the best-response, $r_i(.)$, with respect to partner's behaviour, a_j, is non null. This occurs when the cross-partial derivatives of *V*, which we call cross-partial effects (CPE), are different from 0:

Contagion effects: $\partial^2 V_i / \partial a_i \partial a_j \neq 0$ or $\partial^2 V_j / \partial a_i \partial a_j \neq 0$.

Last, one or more equilibria can be defined by the intersection of the reaction functions in Γ_i x Γ_j space. Their existence and stability depends on the shape of the utility functions (and in particular on the local second-order derivatives). Clark and Oswald (1998) explore in detail the consequences of such utility spillovers, both from a normative point of view (they may generate multiple equilibria with no guarantee that the best equilibrium emerges), and from a positive point of view (they may explain following as well as deviant behaviours). While research in the domain of social interactions (SI) generally focuses on the identification of best-response functions,[3] we here borrow empirical tools from the economics of well-being to identify directly a primitive of SI phenomena – the marginal utility of others' body shape, where "others" here refers to the individual's partner.

A great deal of attention has recently been devoted to income spillovers, whereby the utility of individuals is considered to depend on both their own and their peer group's income. This is one reading of the Easterlin paradox: the positive effects on utility of my own higher income are offset by higher incomes in my reference group. This kind of spillover with CPE brings to the fore the possibility of multiple equilibria: different levels of income may produce the same levels of utility. The well-being literature has taken this general idea and applied it to non-income phenomena, for instance unemployment. The latter is a bad, so spillovers with CPE would imply that own unemployment has less of a negative effect on utility the higher is the level of reference-group unemployment. This phenomenon has now been shown in data from a number of different countries (see, Clark, 2003, Shields and Wheatley Price, 2005, Shields *et al*., 2008, and Powdthavee, 2007). Again multiple equilibria are possible: at a high enough level of regional or local unemployment, there is no utility loss from unemployment compared to employment. The utility spillover idea has also recently been applied to regional spillovers in religion (Clark and Lelkes, 2008). Last, recent work has uncovered some evidence of health spillovers with CPE within the household: my own health problems have less effect on my utility when I live with other people who share them (Powdthavee, 2008). Health spillovers within households are also considered from a theoretical point of view by Bolin *et al.* (2001, 2002), in order to predict the impact of changes in family policies on the distribution of health between spouses, and between parents and children. We contribute to this literature on utility spillovers, by looking at a particular health and aesthetic issue, BMI, as a proxy for body shape.

BMI is considered by epidemiologists and clinicians as a health indicator, rather than a choice variable. Health concerns with BMI are typically associated with both under- and over-weight, but we will focus on the latter. According to the World Health Organisation, individuals are underweight when their Body Mass Index (BMI) is under 18.5, overweight when it is over 25, and obese for a figure of over 30. Epidemiological studies show that mortality and morbidity risks increase significantly for BMI over 27-28 for most adults under the age of 85 (see for instance Stevens *et al*., 1998). For this reason alone, we imagine that, at least after a certain level, higher levels of both own and partner BMI reduce utility. However, from the economist's point of view, the story might be much more complex, as BMI does not only affect utility indirectly, through the production of health capital, but is also an aesthetic attribute and a choice variable.

Following the economic approach to obesity, we postulate that individuals have some degree of freedom in their choice of body shape. First, they can exercise more either to burn calories or to build up their muscles. Second, they can ingest fewer calories to lose weight. We are of course aware that powerful physiological mechanisms limit the individual ability to change body shape, at least in the short run (Cabanac, 2001). For instance, the basal metabolic rate (the calories the individual has to expend in order to stay alive) decreases when calorie intakes are brutally cut. Hypo-caloric slimming diets also have specific cognitive costs. During moments of high-awareness, dieters generally avoid answering their basic caloric needs (as signalled by the sensations of hunger and satiety). In this case, the body interprets calorie restrictions as a threat, protects its fat reserves, and sends signals that induce the loss of control, especially during moments of low awareness. Maintaining awareness has a cost, as well as lack of self-control as it damages self-esteem (Heatherton *et al.*, 1993, Basdevant, 1998, Herman and Polivy, 2003). However, since we will work on yearly observation periods, it seems reasonable to assume that the choice set Γ of most individuals is fairly wide over this period (several points of BMI), although its bounds may be affected by unobserved psychological traits.[4] The choice set may be more restricted when individuals face substantial economic constraints.[5]

2.2 The utility of body shape

A number of pieces of evidence from the social-psychology literature suggest that individuals have an ideal body shape, at which point their satisfaction with body size is maximized. Satisfaction with body size may be represented as an aggregate of satisfactions over several domains, amongst which probably figure health and beauty (Etilé, 2007). Ideal body shape is therefore likely related to both health concerns and aesthetic preferences.

Health is obviously linked to productivity in the labour market. As such we expect BMI to affect labour-market outcomes. Averett and Korenman (1996) and Cawley (2004) find evidence of significant wage penalties for medically-obese white women in America. Using French data, Paraponaris *et al*. (2005) suggest that unemployment duration in France is positively correlated with BMI. Controlling one's weight may be seen as a sign of self-responsibility, and research has shown that being overweight is considered by recruiters and supervisors as a signal of unobservable predispositions such as laziness or lack of self-control (Puhl and Brownell, 2001). If these failings are considered to be negatively correlated with productivity, overweight will reduce the chances of labour-market success, especially with respect to job positions that require self-control, dynamism, and leadership.[6] BMI may therefore affect utility through health-related labour-market outcomes.

Ideal body shape also depends on aesthetic preferences. The latter may be highly idiosyncratic. An extreme case here is anorexia nervosa, which has long been analysed through the lens of the psychological history of patients (Bruch, 1973). However, one important lesson from the empirical literature in sociology and history is that the aesthetic ideal is also influenced by social context. Ideals of beauty change across time and social classes, and the seemingly natural positive value attributed to thinness in Western societies reflects social norms describing what individuals "ought" to look like. The turn of the Twentieth century was marked by a change in ideals of beauty, especially for women.[7] Women's thinness became a status signal in societies typified by the Protestant ethic between 1890 and 1920: fatness was supposed to go hand-in-hand with gluttony and lack of self-control (Kersh and Morone, 2002). The ideal of thin women then spread from the upper to the middle classes after World War II, as women were able to take greater control of their body, especially via birth control (Fishler, 1990). This diffusion process did not however produce a uniform social norm regarding body size. Using individual French data on actual and ideal BMIs, Etilé (2007) shows that, for given levels of education, income and household structure, average ideal body size does not differ between employees, professionals and executives, while blue-collar workers have higher ideal BMIs. This finding might be interpreted as evidence that the diffusion of the thinness norm has been limited to white-collar workers, consistent with a certain separation between the lifestyles (foodways, body practices) of different social classes (Bourdieu, 1979). In particular, a strong body is a requisite for manual work.[8] Social norms of ideal body shape may therefore change both over time and between social groups. They will not necessarily correspond to any health threshold (*i.e.* neither the 27-28 BMI health threshold, nor the official WHO overweight threshold of 25). Social-norm effects may produce preference discrimination in labour-market outcomes. This differs from the statistical discrimination evoked above, whereby body weight is held by employers to be a predictor of productivity. Morris (2006) uncovered empirical evidence of a positive effect of BMI on occupational attainment for men, and a negative effect for females. Using ECHP data, D'Hombres and Brunello (2007) show that the wage-overweight relationship is significantly negative in southern European countries, and positive in northern countries.[9] Statistical discrimination on its own cannot account for these gender or cross-country differences.

Last, body weight can be seen as an adjustment variable in the energy-balance equation: when calorie intake exceeds calorie expenditure, excess calories are stocked in fat cells and body weight increases (and the opposite when calorie expenditure exceeds calorie intake). Then, assuming that physical activity is relatively constant (it is mainly determined by on-the-job activity), BMI will mostly reflect calorie intake, and therefore, in a well-being equation that does not control for food consumption, the taste for food.

The relationship between utility and own BMI then likely reflects several different phenomena, including ***health concerns***, ***aesthetic preferences*** and ***calorie intake***. Health concerns produce a BMI – utility relationship which is fairly flat up until the threshold of 27-28, and is negative and concave thereafter. Aesthetic preferences imply that any departure from the aesthetic ideal will reduce individual utility. Here we thus expect well-being to be hump-shaped in own weight. Calorie intake is positively related to BMI. If there is some exogenous satiation level of calorie intake, marginal utility will be positive to the right of it, and negative thereafter. The sum of these three effects will produce a BMI – utility relationship which is also hump-shaped, but with a peak, representing ideal body weight, that is likely to be different from the medical threshold of 27-28. The relationship will be asymmetric, being flatter to the left of this peak.

2.3 Partner's body shape and utility spillovers.

To evaluate the impact of partner's body shape on utility, we imagine that the household-decision process takes two steps. First, decisions over body shapes are taken. Second, conditional on body shapes, partners make their choices over leisure and the labour market, as well as consumption of private and public goods. Such a model can, in theory, be solved by backward induction. Although we are only interested in the first step, looking informally at what happens in the second step may help us to produce predictions regarding the impact of partner's BMI on the first-step objective function (*i.e.* V in section 2.1., and Life Satisfaction in the empirical analysis).[10]

In the following we are careful to distinguish the direct effects of partner's BMI (*i.e.* those that are independent of the individual's own BMI) from the cross-partial effect (CPE). Although both generate "utility spillovers", only the second is associated with contagion effects.

As noted above, BMI is a proxy for health, and individuals will likely have preferences over their partner's health (and therefore over their BMI) similar to their health-related preferences over their own BMI. An analogous argument applies for the labour-market effects of BMI. Individual preferences over partner's health are partly undoubtedly altruistic. A more self-interested argument is that individuals would like to have a healthy partner to look after them in case they become ill themselves. Conversely, if their partner's health deteriorates due to overweight-related illness, then they will have to take care of more of the household production (domestic tasks).

Aesthetic preferences will not only apply to oneself (wanting to look good), but also to one's partner, if there is an ostentatious element to being in a couple. Having a partner with desirable characteristics may signal one's own value or status. Marriage-market outcomes clearly reveal the value of partner's body weight. Averett and Korenman (1996) find evidence of an effect of body mass (overweight and obesity) on marriage-market outcomes for young white American women in the NSLY. This is not the case for black women, nor for men, which suggests that social norms may account for this result (see also Averett and Korenman, 1999). Conley and Glauber (2007) find similar results in PSID data covering all age categories. Their estimates confirm the results in Averett and Korenman: body mass is associated with a lower likelihood of marriage for women only, especially at young ages, and with lower spousal earnings. Health and aesthetic considerations imply that partner's body shape is likely to have a direct impact on utility.

We now consider the interactions between own and partner's body shapes in the production of utility. There are four different channels of influence.

First, there is ***household production***. Own and partner's weight may be complementary in the production of marital output within a couple. We can specifically imagine joint production of leisure, where a wide divergence in BMIs may prevent the couple from undertaking certain activities together (e.g. eating or climbing mountains). If being closer to the ideal body shape has a positive effect on marital output and is complementary across the couple, then more attractive individuals will tend to marry each other, as an increase in attractiveness increases the marginal return from partner's attractiveness. If the marriage market is characterised by optimal sorting of partners, whereby "*persons not married to each other could not marry and make one better-off without making the other worse off*" (Becker, 1973), we will see *positive assortative mating*. To our knowledge, this has not specifically been analysed in the empirical literature in economics, and more generally only little work has introduced aesthetic preferences into the marriage market. A historical illustration is provided by Sköld (2003), who shows that in Eighteenth- and Nineteenth-century Sweden, those who were pockmarked by smallpox married about two years later than those without disfigured faces. This effect was gender-neutral, and revealed positive assortative mating, as "healthy" individuals were more likely to marry each other, whereas pockmarked individuals were more likely to remain single or found only pockmarked partners.

Second, individuals may compare their body weights to each other. There is now a large literature in social science which details evidence of relative utility. This has often taken the form of income comparisons to a reference group, whereby individuals are happier if their own income rises, but less happy as that of their reference group rises (see Clark *et al*., 2008, for a survey). In the specific context of BMI, being overweight is likely to be associated with lower utility. ***Social comparisons*** then would imply that this negative impact is watered down if others in the reference group are overweight too. With a household-based reference group, an overweight individual should suffer less psychologically if their spouse is overweight as well.[11]

The social comparisons and household production arguments both imply that the CPE is positive when both partners' BMIs are both under or over some ideal levels, and negative when one of the partners' BMIs is under and the other is over the ideal level.

Third, partner's BMI also carries ***information*** about the health risks of being overweight or obese oneself. In this case, partner's BMI is likely to have a negative effect on marginal utility of own BMI, especially if the latter is above the official medical threshold for overweight (BMI=25). Further, individuals with overweight and ill partners presumably have to supply part of the ensuing health care and provide a greater part of household production. This might be easier if they are not themselves overweight or obese. Hence, ***health care needs*** and ***social learning*** about health risks may switch the complementarity of BMIs in the production of utility into substitutability when both partners' BMIs are high.

Fourth, there is a ***productivity and household bargaining*** argument. The relationship between body weight and income will have an effect on both the amount of household output, as discussed above, but also potentially on its division (occurring at the second stage of the decision process). An overweight spouse may earn less, reducing household resources. However, if individual bargaining power in the household depends on relative weight (via individuals' chances in the remarriage market), then those with an overweight spouse will see their bargaining power rise.[12] The overall CPE here is uncertain, as the individual gains a larger share of a smaller cake.

These four aspects of spousal relationship imply that partners' BMIs may be complements or substitutes in the production of utility. Only complementarity (a positive CPE) is consistent with contagion effects.

Testing for utility spillovers and contagion effects requires that not only the first-derivatives of the utility function be identified, but also the second-derivatives. From the above discussion, it is clear that own utility is likely to be hump-shaped in own and in partner's BMI, but that there are no clear-cut predictions regarding the sign of the second-order derivatives. Section 3 below presents the data that we will use to evaluate these correlations, and describes our key assumptions about the use of Life Satisfaction as a proxy measure of utility.

3 Data

Our empirical analysis is based on data from three waves of the German Socio-Economic Panel (GSOEP), 2002, 2004 and 2006, which contain data on height and body weight. The GSOEP is a long-run panel data set, starting in 1984, with data collected at the household and individual levels (see Wagner *et al.*, 2007). Information about the main variables is non-missing for 19899 individuals aged 18 or over (adults) living in private households. 14386 of these individuals (72.3%) were observed over all three years, 4028 over two years and 1485 for one year only. Of the 52699 individual-year observations, 73.4% represent individuals who are living in a couple ("married"). Our control variables include the number of waves over which the individual was observed, age, real equivalent after-tax and income transfers income (in 2004 Euros), the number of individuals in the household, labour-force status, years of schooling, and region. Table A1 in Appendix A presents the descriptive statistics for married and unmarried individuals in this initial sample (Sample 1). The main estimation sample, Sample 2, consists of the 6555 couples of men and women in Sample 1, of whom 66.0% are observed over all three years (see Table A1). Married couples tend to be observed less than are others, due to transitions in to and out of marriage between 2002 and 2006. These transitions are due to couple formation, divorce and the death of one of the partners. Married individuals in Sample 2 are slightly older and richer than are those in Sample 1 (see Table A2). They are more often *legally* married rather than simply living together. Occupation, education and body sizes (BMI and height) are similar in the two samples. There are however significant differences between the married and the unmarried in Sample 1. Single women are older and are more often retired, with less education, partly because they are more often widowed. Single men are on the contrary younger, less educated and are more often apprentices or unemployed than are married men. These statistics reflect the matching equilibrium of the marriage market, wherein older women and younger men are more likely to be single. Obviously, selection into and out of marriage is likely to affect our estimates: Section 5 considers this issue. We now present our key variables: life satisfaction and BMI.

3.1 Life satisfaction as a measure of utility

The dependent variable in the empirical analysis is Life Satisfaction (**LS**). This comes from the response to the question "*How satisfied are you with your life, all things considered*"? This question is asked of all respondents every year in the GSOEP. Responses are on a eleven-point scale from zero to ten, where 0 means completely dissatisfied and 10 means completely satisfied.

A recent literature has argued that utility can be usefully measured by questions about well-being (such as satisfaction, happiness or mental stress) in large-scale surveys. The empirical analysis therefore relies on the assumption that subjective well-being – as measured by life satisfaction – be a measure of utility.

In order to use life satisfaction to elicit individual preferences over body weight, we make two key assumptions (see Ferrer-i-Carbonell and Frijters, 2004):

H1: Life Satisfaction is a positive strictly monotonic transformation of utility: it preserves preference ordering.

H2. Life Satisfaction is interpersonally *ordinally* comparable.

We then suppose, for individual k in $\{i,j\}$, that $LS_k=\omega_k(V_k(W_i,W_j))$ where $\omega_k(.)$ is a (well-behaved) reporting device that translates utility into life satisfaction, and $V_k(W_i,W_j)$ is the utility of body shapes.[13] Then:

$$\partial LS_i / \partial W_j = \partial V_i / \partial W_j \, \omega_i'\left(V\left(W_i, W_j\right)\right). \qquad \textbf{(1)}$$

H1 implies that ω_i is strictly increasing, so that $\omega_i'(.)$ is strictly positive. As such, testing whether there are utility spillovers from j to i ($\partial V_i / \partial W_j \neq 0$) and identifying their sign amounts to testing whether W_j has a significant positive or negative effect on individual *i*'s satisfaction. **H2** is required to ensure that different levels of life satisfaction between individuals with different body shapes, which empirically identify the BMI-LS relationship, reflect only variations in underlying utility, and not reporting styles that might be correlated with body shape. In other words, individuals with similar answers enjoy similar levels of utility, and for all k, $\omega_k = \omega$.[14] Testing whether there are CPE in utility requires one additional assumption:

H3. The reporting device is linear.

Under **H3**, ω''(.)=0 and:

$$\partial^2 LS_i \big/ \partial W_i \partial W_j = \partial^2 V_i \big/ \partial W_i \partial W_j \, \omega'\left(V\left(W_i, W_j\right)\right) \quad \textbf{(2)}$$

If spouses act strategically (*à la* Nash), then the existence of contagion effects between spouses only requires that the cross-derivatives of life satisfaction with respect to spouses' body shapes be different from 0. Last, linearity in the reporting device is a natural consequence of cardinality, if we assume that life satisfaction is interpersonally *cardinally* comparable. Cardinality has one clear advantage over ordinality: life satisfaction can be used for policy evaluation, in particular in the cost-benefit analysis of obesity policies (van Praag, 2008).

Table A3 shows the cumulative distribution of this satisfaction score by gender, marital status (being in a couple or single), and sample (Sample 1 or Sample 2). The distributions of LS in single women and men clearly dominate the distributions of women and men in couples (compare Line 1 to Line 3, and Line 2 to Line 4). Married women are slightly happier than married men (Line 3 vs. Line 4), and the distributions of LS in married individuals do not seem to differ significantly between Sample 1 and Sample 2. Hence, if there is a selection bias, it is produced by marriage entries and exits, rather than from Sample 2 compared to Sample 1.

3.2 Body Mass Index

Table A2 reveals that single men and women have lower BMIs than do married men and women. Figures A1 to A3 show the nonparametric estimates of BMI in the different subsamples. The difference between married and single respondents appears strikingly in Figures A1 and A2. However, the BMI gap is smaller for women (Figure A1) than for Men (Figure A2). Age effects may explain this gender difference, as individuals generally gain weight up to a fairly advanced age, and single women are more likely to be old (widowed) than are single men. Last Figure A3 shows that, in Sample 2, men are more likely to be overweight or obese than are women.

Figure A4 shows a scatter plot of partner's BMI, with two nonparametric regression lines: the bold line represents the prediction of woman's BMI conditional on man's BMI; the thin line is the prediction of male BMI conditional on female BMI. Both lines are upward sloping. There is a mostly positive correlation between partners' BMI, except at low and high BMI values. This may reflect positive assortative matching on the marriage market (selection), endogenous influence within couples (contagion effects/following behaviours), or the consequences of common shocks and environmental constraints (contextual effects).

Figure A5 presents non-parametric regressions of life satisfaction on own BMI for women and men (the solid line), with the associated 95% confidence interval (the dotted lines). Women's LS is decreasing in own BMI, while men's BMI is concave, increasing until about 25 (the threshold for overweight), and then decreasing. Men with low BMI are more satisfied than men with BMI of over 35, and less satisfied than overweight men. This suggests that ideal BMI is relatively low for women, while it is close to the overweight level for men. This gender asymmetry is likely due to gender differences in aesthetic norms or taste for food, since medical norms are not gendered.

This section has argued that the identification of spillovers between partners in the BMI-LS relationship is a way to test for body-shape spillovers in decision utility. Descriptive statistics also suggests that selection in and out couples affects LS and BMI.

As a consequence, the estimation results we propose in the next section must not be over-interpreted: looking at the BMI-LS relationship within couples will not identify tastes for body shape in general (e.g. which BMI *ought* women to have in men's view?), but rather the tastes of married individuals. Contagion effects due to social interactions between men and women may also occur outside the couple, as a consequence of changes in social norms on the marriage market.

4 Well-being spillovers within couples

This section estimates life satisfaction equations by ordinary and semi-parametric least squares regressions, under assumption **H3**. The empirical model is then:

$$LS_{it} = f(W_{it}, W_{jt}) + \alpha X_{it} + \varepsilon_{it} \qquad \textbf{(3)}$$

where W_{it} and W_{jt} are the partners' BMIs at time *t*, X_{it} is a set of control variables, and ε_{it} captures the influence of unobserved factors. In the parametric regressions, f(.) will be a second-order polynomial function of W_{it} and W_{jt}, while it will be left unspecified in the semi-parametric regressions. We will also compare OLS and ordered probit regression results. The ordered probit model is very popular in the well-being literature, because it assumes only ordinal comparability (**H2**), which is less restrictive than cardinal comparability or **H3**. However, Ferrer-i-Carbonell and Frijters (2004) show that the choice of ordinality or cardinality actually makes only little difference to the results, while the assumptions retained regarding the correlation between the unobserved factors and the covariates are key. Throughout this section, we will assume that ε_{it} is orthogonal to the latter (X_{it}, W_{it} and W_{jt}). As a consequence, we are cautious in the interpretation of the estimates. Under **H3**, they will only identify values of BMI that are more desirable than others at a population level, not for any individual. This assumption is partially relaxed in the next section.

4.1 Parametric regressions

We first carry out a parametric analysis of the BMI-LS relationship by gender, assuming that the function f(.) in equation (3) is quadratic in partners' BMIs. These estimations control for a number of demographic variables: age, age squared, real income, height, years of schooling, labour market status, number of individuals in the household, "land" of residence, and year.

Table C1 in Appendix C presents results from pooled OLS regressions for various populations: single women and single men in Sample 1, and married women and married men in Sample 2. We focus here on the marginal well-being effect of own BMI only. Hence, for married individuals, partner's BMI is excluded from the equation. Figure C1 depicts the marginal effect of own BMI. There is striking gender asymmetry: while single and married women have similar marginal effects (the former being slightly higher), those of single and married men differ radically. There is no BMI-LS association for single men; that for married men starts as significantly positive, falls with BMI, and becomes negative after a BMI of 27-28. Last, own BMI has a greater impact on well-being for men than for women.

Table C2 then introduces partner's BMI, its square and the interaction between own BMI and partner's BMI. The OLS results are comparable to ordered probit estimates: the coefficients are of the same sign and significance. Figures C2 to C5 illustrate the OLS regression results. Figures C2 and C3 show the marginal effect on women's life satisfaction of own and partner's BMI respectively, as a function of partners' BMI. Figures C4 and C5 depict analogous figures for men's life satisfaction. The marginal effect of own BMI for women is small, decreasing, and becomes negative and significant for high BMI levels only. The interaction effect is significantly positive (see Column 2 of results in Table C2). As shown in Figure C2, the marginal effect of own BMI is higher as the man's BMI increases. A rise in BMI for a thin woman (BMI = 22.5) produces lower well-being if her partner is very thin (BMI = 20) or even a little overweight (BMI = 25), but rising well-being if he is obese (BMI = 30). The effect of the woman's BMI on the marginal effect of the man's own BMI follows the same pattern (see Figure C3). One important difference however, is that the marginal effect of man's BMI on woman's LS turns negative at an higher threshold (around 26 when woman is just overweight), while the marginal effect of woman's BMI on woman's LS becomes negative after 21 (when her partner is overweight). There are thus significant well-being spillovers in BMI from men to women, in the sense that married women are more satisfied when they are with a thin rather than overweight or obese partner. The converse is less true. Figure C5 represents the marginal effect of woman's BMI on man's life satisfaction. This is not significantly different from 0, essentially because the interaction effect is positive and counterbalances the direct negative effect of woman's BMI (seen Column 4, Line 4 in Table C2). Hence, there seems to be no spillovers from women to men. Otherwise, as in Table C1, the marginal effect of own BMI is higher for men than for women.

Last, Table C3 reproduces these results with discontinuous measures of body shapes: three dummies for whether the individual has a medically normal BMI (BMI<30), is overweight (25≤BMI<30) or obese (BMI≥30). The dummies for men and women are interacted, producing nine states. The category is "man normal: woman normal". Life satisfaction is estimated to be lower in all other situations. As in Table C2, women's life satisfaction is lower when their partner's BMI is higher. However, when they are obese, it matters little whether their partner is himself obese or only overweight (-0.25 points of LS in both cases). For both partners the "man overweight: woman overweight" situation is better than "man normal: woman overweight" or "man obese: woman overweight". This illustrates the possibility of cross-partial effects, whereby having a partner making similar choices is positively valued. Here, well-being spillovers from women to men are not significantly different from 0 for overweight or obese men: their life satisfaction is similar whatever their partner's body shape. However, this is not the case for thin men. For them, having an overweight spouse is associated with a loss of well-being of -0.22 points, and -0.35 if she is obese. This rough introduction of non-linearities does seem to change the results somewhat: we therefore check by turning to semi-parametric estimation.

4.2 Semi-parametric regressions

We now estimate equation **(3)** without explicitly specifying the shape of the relationship between partner BMI and own life satisfaction. We use a penalized spline approach, implemented using linear mixed models and bivariate basis functions of partner BMI (Ruppert *et al.*, 2003). Some technical details are provided in Appendix B. The results are given by a series of graphs in Appendix C. These represent maps of life satisfaction levels, first-derivatives and cross-derivatives, in the space of partner BMI. Male BMI is on the Y-axis of these graphs, female BMI on the X-axis.

Figures C6 and C7 show conditional mean life satisfaction levels for men and women respectively. The highest life satisfaction scores pertain, for men and women, when male BMI is between 24 and 25, and female BMI between 22 and 23. There is thus little gender differences in the "peak" values of BMI. Around this peak, women's satisfaction is on average higher than men's satisfaction. Iso-satisfaction lines, which are drawn for LS=6.7, 6.8, 6.9, 7.0 and 7.1, are approximately symmetric around the North-West/South-East axis. As can be seen, both high and low values of BMI are associated with lower well-being, as well as increasing divergence between partners' BMIs.

Figures C8 to C11 propose estimates of the marginal effects of own and partner's BMI for men. Figures C8 and C10 show the shape of these marginal effects, while Figures C9 and C11 add additional information about their sign and significance: the black area represent couples of BMIs for which the marginal effect is significantly positive, and the grey area couples of BMI for which it is significantly negative. White areas indicate insignificant effects. Male life satisfaction increases in own BMI up to a point, located in the white area of Figure C9, which represents, at a population level, "man's ideal BMI in men's view", conditional on their partner's BMI. Beyond this threshold, own BMI reduces life satisfaction. This ideal BMI is not correlated with female BMI when the latter is under 25, and but increases with female BMI beyond this point. The changes in male ideal BMI can be tracked in Figure C8, by looking at the iso-line 0. A man with a BMI of 25 married to a thin woman is better off than a man with BMI of 27 married to the same woman; this conclusion is reversed if the woman is obese. This is exactly the kind of interaction effect we were expecting in Section 2.3. Here, it seems to be positive. Figure C16 confirms this point. The interaction between partners' BMIs is positively correlated with man's life satisfaction, and the correlation is significant for levels of man's BMI lower than 30-32, and values of woman's BMI over 24-26. Figure C10 reveals that there are well-being spillovers in BMI from women to men. These spillovers are positive when women's BMI is below a threshold, which we may call "women's ideal BMI in men's view", and become negative beyond this threshold. Woman's ideal BMI in men's view is fairly stable, at around 22-23, for moderate values of man's BMI (under 26), and then increases rapidly as male BMI passes from 27 to 30 (see the iso-line 0 in Figure C10).

Figures C12 to C15 show the results for women's life satisfaction. There are striking similarities to those for men. For instance, the marginal change in life satisfaction associated with an increase in own BMI is positive up to some point (the woman's ideal BMI from women's point of view), but turns negative thereafter. Figures C14 and C15 show the well-being spillovers in BMI from men to women. These are significantly negative as long as the woman is thin and the man is severely overweight or obese, or if the woman is overweight and her partner is obese, or if both are obese. These spillovers are stronger for thin women than for overweight women, when their partner is obese. Obese women are better off when their partner is moderately overweight rather than thin. This modulation of spillovers is due to the interaction effect, which is significantly positive for most couples along the 45-degree line (see Figure C17), and positive but not significant almost everywhere else.[15] Last, it is interesting to note the similarity between man's ideal BMI in women's view and man's ideal BMI in women's view (compare the iso-lines 0 in figures C8 and C14), whilst there is a clear gender asymmetry regarding women's ideal BMI. Women's consideration of a woman's ideal BMI is lower than that from the male point of view, as long as male BMI is under 32-33.

Our results are thus consistent with well-being spillovers in BMI. These are negative when own BMI is low and partner's BMI is high; they are also attenuated in couples with similar body shapes. Dissimilar couples may have lower levels of well-being than couples where both partners are overweight. Public health policies should not only tackle the causes of weight gain, but also the determinants of BMI inequalities within couples.[16]

This section has presented results regarding spillovers in well-being between spouses, as a function of their BMI. A key question is then whether these results can be translated into marginal utilities which determine behaviour. If we have identified positive cross-partial effects, then contagion within the couple may result, whereby one partner's gain (or loss) in weight will be followed by their partner. If not, then within-couple contagion effects probably do not help to explain the spread of obesity.[17] The following section investigates these issues.

5 The identification of social interactions in behaviour

This section asks whether Section 4's results reflect utility spillovers and positive cross-partial effects between partners: in other words, do our results tell us about the effect of partner's BMI on own behaviour (via marginal utility), or only individual experienced utility?

5.1 Identification issues

It is commonly argued that subjective well-being measures, such as that used in this paper, reveal experienced utility, rather than decision utility (Clark *et al.*, 2008). We consider BMI as a choice, and therefore ask whether OLS estimates in equation (3) help us to understand how this choice is undertaken. To illustrate this point, consider, as in Section 2.1. a couple $\{i,j\}$ and imagine that each member k in $\{i,j\}$ chooses an action a_k in a set of feasible actions $\Gamma(Q_k, \eta_k)$, determined by observed variables Q_k and unobserved factors η_k. The factors η_i and η_j are potentially correlated. The well-being benefits from the choice of action are represented by the utility function $V(a_i,a_j;X_k,\varepsilon_k)$, where X_k and ε_k are respectively observed and unobserved preference factors. The ε_k's and η_k's may be correlated. Whatever the household decision process, and assuming that divorce is not a threat, the equilibrium actions chosen by the two partners, a_i* and a_j* depend on $\{Q_k, X_k,$

ε_k, η_k., k=i,j}: this yields individual utility of V(a_i*, a_j*; X_k, ε_k). This equilibrium utility is what the equations in Section 4 estimated. However, since a_k* depends on ε_k, there is an endogeneity bias. Section 4's estimates can therefore not be used directly to produce statements about contagion effects, or ex-ante evaluations of the welfare effect of changes in BMI.

One way to circumvent this problem is to instrument the two BMI levels, their squares and their interaction. As we do not have policy-based instruments, we appeal to more *ad hoc* instruments.[18] For expositional convenience, suppose that life satisfaction is a function of own BMI only, and assume that the data are generated as follows:

$$\begin{cases} LS_{it} = \alpha W_{it} + \eta_i + v_{it} \\ W_{it} = \gamma W_{it-1} + \rho \eta_i + f_i + \varepsilon_{it} \end{cases} \qquad \textbf{(5)}$$

Here η_i captures time-invariant unobserved factors that affect life satisfaction, f_i time-invariant factors that affect W_{it} only and are orthogonal to η_i, and v_{it} and ε_{it} time-varying shocks that are orthogonal to the fixed effects. Given that we have three periods, BMI at t = 3 can be instrumented by changes in BMI between t=1 and t=2, and t=2 and t=3 (Strategy 1). Alternatively, we can take the first difference of the life satisfaction equation:

$$\Delta LS_{it} = \alpha \Delta W_{it} + \Delta v_{it} \qquad \textbf{(6)}$$

and instrument BMI in first differences by BMI in level (Strategy 2). These identification strategies are valid, if we assume some restrictions on the distributions of the random shocks. First, the time-varying shocks that affect body weight and life satisfaction between two periods have to be uncorrelated. Second, and for Strategy 1 only, individuals' initial BMIs should be random conditional on the individual fixed effects. Appendix B2 discusses these restrictions using Blundell and Bond (1998).

These restrictions produce moment conditions, $E(W_{it}\Delta v_{i3})=0$ and $E(v_{i3}\Delta W_{it})=0$ for t=2 and t=3, that can be used to identify the marginal utility of BMI, α in equation **(5)**. To this end, we use a two-step efficient GMM procedure, and test the restrictions separately. The restrictions $E(W_{it}\Delta v_{i3})=0$ are first used to estimate the life satisfaction equation in level

(Level GMM estimator). Here, partners' BMIs, their squares and the interaction are instrumented using their first difference. We use observations in t=3 only, and the first differences between t=1 and t=2, and t=2 and t-3 as instruments. This provides five over-identifying restrictions (one for each instrumented variable). Hansen-Sargan statistics are used to test validity. The second set of restrictions is likely to be less informative, because there is a lack of variation in individual life satisfaction between t-2 and t-3. For 37.6% of the sample, life satisfaction reported in 2006 is the same as in 2004. For another 38.9%, the score changes by 1 point only. Hence, these are not used separately from the first set of restrictions, but in addition to them. Together, these produce the System GMM estimator originally proposed by Blundell and Bond (1998), with 10 over-identifying restrictions. Whatever the set of restrictions, we report Cragg-Donald statistics to test the weakness of the instrument set in the first-step regressions. This statistic is the equivalent of the usual F-statistic for the first-stage instrumental equation when there is more than one instrumented variable. A value over 10 indicates that the instruments are fairly strong. As we have one period only to estimate the model, it is not possible to check more directly whether $E(v_{it}\Delta\varepsilon_{it-s})=0$ and $E(\varepsilon_{it-s}\Delta v_{it})=0$.

Assuming the independence of contemporaneous shocks on BMI and life satisfaction is perhaps heroic. Hence, we also considered first differences between t=1 and t=2 only to instrument the variables in level observed at t=3. This condition exactly identifies model (5) and it was therefore impossible to test the validity of the restrictions. The main conclusion was that this set of instruments is weak, as indicated by a Cragg-Donald statistic of under 4.

5.2 Results

Table D1 in Appendix D shows the main results. Since the sample is reduced to the third period, we also propose OLS regression estimates to be compared to Section 4's findings. The over-identifying restrictions are accepted in Level GMM and System GMM estimations for men and for women. However, the p-value drops sharply in the System GMM results. Adding over-identifying restrictions increases the probability of rejection if they are not valid "in the true model". This fall in the p-value indicates that we must be cautious about the robustness of the results.

Nevertheless, Table D1 reveals that the interaction effect, which is again positive in the OLS regressions, becomes negative and insignificant after instrumentation. In the Level-GMM estimates, the Cragg-Donald statistics indicate that the set of instruments is fairly strong. The interaction effect is negative for both men and women. It remains negative, but only for women, in the System GMM regressions. It is worth noting that no significant utility spillovers between partners are detected, while own BMI still has a concave marginal effect. To illustrate, and compare the OLS and Level-GMM results, Tables D2-1 to D2-4 compute the marginal effects (with their standard errors) at various values of partner BMI.

The estimates in Table 2-1 reveal that, for men, the marginal effect of own BMI is decreasing. For thin men (BMI = 20, the first line), this is positive both in the OLS and Level GMM regressions. But, while the marginal effect on well-being (OLS results) is zero around the threshold of overweight, and becomes significantly negative thereafter in obese men (as in Section 4), the marginal utility is still positive in overweight men (Level GMM results), and becomes negative only for very high values of male BMI. The comparison of adjacent columns show that an increase in woman's BMI has little effect on the man's marginal utility of own BMI (Level GMM), while there is as in Section 4 a positive cross-partial effect on well-being (OLS). Table D2-2 estimates the marginal utility of woman's BMI for men. This is significant, and negative, in obese women only. Hence, there are negative utility spillovers, which are not attenuated by a rise in male BMI. A one-point increase in woman's BMI, when she is just obese (BMI=30), decreases utility by -0.032 satisfaction points for a just overweight man, and -0.047 when he is just obese (Level GMM, third Column in Table D2-2). On the contrary, marginal well-being spillovers from women to men are negative for obese women, but attenuated when the man is also obese. A marginal increase in women's BMI is associated with a (significant) loss of 0.047 well-being points for thin men, and a (not significant) fall of only 0.010 for obese men.

The pattern of results for the marginal effect of own BMI is similar for women: see Table D2-3. Marginal utility becomes negative in obese women, while it is positive, albeit insignificant, for just overweight women, and significantly positive for thin women married to thin or just overweight men (around +0.1 points of utility: see the Level GMM results). The marginal well-being effects are not well-identified, since the coefficients on own BMI and its square are insignificant in Table D1 (see the fourth Column of results). This may be due to the small sample size. As a consequence, we obtain the implausible result that an increase in woman's BMI around the threshold of obesity produces a rise in well-being (+0.195 satisfaction points). The marginal utility of partner's BMI is never significant, while a marginal increase in male BMI is associated with well-being benefits in thin women married to non-obese men, and a well-being loss for women in couples where both are obese.

To check how changes in sample size affect the results, we have re-estimated the model using a slightly different technique. Using three moment conditions $E(v_{i3}\Delta W_{i3})= E(v_{i3}\Delta W_{i2})= E(v_{i2}\Delta W_{i2})=0$, we are able to use two waves of observations instead of three. This is a Difference GMM estimator. The results are given in Table D3. The sample size increases from 4328 observations to 10128. For men, the OLS and Difference GMM estimates confirm the previous results. For women, once again, there are less significant effects, and no utility spillovers from men.

The estimates presented in this section show that there are cross-partial effects in well-being but not in behaviour. This implies that contagion effects are unlikely to pertain within couples. There are two reasons why the OLS and instrumental variable results are different. First, it is obvious that OLS regressions do not identify the direct impact of BMIs on utility, but also contextual effects that affect well-being and are correlated with BMI: some environments are more obesogenic than other. They are characterised in particular by a lack of food retail points (the food deserts), or a lack of public utilities (e.g. public transport). Couples living in deprived area are more likely to be obese and to face hard living conditions that lower well-being. Second, Figure D1 shows that the instrument used in the Level GMM regressions, changes in BMI, is correlated (positively) with BMI in levels only for overweight and obese individuals.[19] Hence, it remains possible that cross-partial effects in utility are positive, and therefore produce contagion effects, but only in relatively thin men and women.

6 Conclusion

[TO BE COMPLETED]

Bibliography

Appendix A: Descriptive Statistics

Table A1. Samples characteristics

		Sample 1	Sample 2
Number of individuals		19899	6555 couples (13110 individuals)
Individuals observed over…	…3 years	14386	4328
	…2 years	4028	1472
	…one year	1485	755
Number of individual-year observations		52699	16683 couple-year observation
% married individuals		73.4%	100%
% men		48.5%	50%

Table A2. Descriptive statistics (Sample 1 and Sample 2)

Sample	Sample 1				Sample 2	
Sub-sample	*Women not in couple N=7753*	*Men not in couple N=6259*	*Women in couple N=19380*	*Men in couple N=19307*	*Women N=16683*	*Men N=16683*
Variable						
BMI (Body Mass Index)	24.6 (4.4)	24.9 (3.6)	25.1 (4.2)	26.7 (3.5)	25.1 (4.1)	26.8 (3.5)
Height (in cm)	165.3 (6.8)	178.7 (7.4)	165.3 (6.3)	177.4 (7.1)	165.1 (6.2)	177.2 (7.1)
Age	49.2 (22.1)	38.4 (17.7)	48.9 (14.0)	51.8 (14.2)	50.1 (13.7)	52.8 (13.8)
Income: real equivalenced after tax and transfer, in 2004 Euros	16397.2 (11149.6)	21227.7 (27977.2)	22384.4 (23325.7)	22831.4 (23439.3)	23 368.4 (24630.9)	
Years of schooling minus seven	4.6 (2.5)	5.0 (2.5)	5.0 (2.6)	5.5 (2.9)	5.0 (2.6)	5.6 (2.9)
MARITAL STATUS						
Legally married	0.0%	0.0%	0.0%	0.0%	94.5%	
Cohabiting couples	0.0%	0.0%	12.5%	11.8%	5.5%	
OCCUPATION						
Full-time worker	27.4%	47.3%	25.1%	61.9%	22.9%	61.1%
Part-time worker	13.5%	6.6%	29.1%	3.6%	29.8%	3.5%
Apprenticeship	5.6%	11.7%	0.4%	0.3%	0.2%	0.2%
Retired	34.2%	13.4%	18.3%	24.9%	19.6%	26.4%
Unemployed	6.1%	9.5%	5.4%	5.9%	5.1%	5.5%
Housewife/husband	10.8%	1.8%	24.7%	1.8%	25.9%	1.8%
Other job status	9.8%	11.2%	2.6%	3.3%	2.4%	3.2%
Number of individuals in the household	2 (1.4)	2.2 (1.5)	3.0 (1.1)	3.0 (1.1)	3.0 (1.1)	
Year = 2002	31.7%	32.3%	33.6%	33.7%	34.0%	
Year = 2004	34.9%	35.5%	35.3%	35.2%	35.0%	
Year = 2006	33.4%	32.2%	31.1%	31.2%	31.0%	

Table A3. Cumulative distribution of Life Satisfaction levels by sex, marital status and sample

% LS level ≤	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Women not in couple (Sample 1)	0.67	1.37	3.25	6.99	11.97	27.16	40.18	62.22	87.63	96.26	100.00	**6.623**
Men not in couple (Sample 1)	0.77	1.31	3.21	6.92	11.62	24.96	37.27	61.21	88.00	96.69	100.00	**6.680**
Women in couple (Sample 1)	0.36	0.65	1.76	4.12	7.83	19.92	31.46	54.02	84.45	95.54	100.00	**6.760**
Men in couple (Sample 1)	0.28	0.63	1.68	4.31	7.90	19.12	31.19	54.61	86.17	96.28	100.00	**6.999**
Women in couple (Sample 2)	0.34	0.62	1.66	3.97	7.58	19.56	31.14	53.55	84.32	95.43	100.00	**7.018**
Men in couple (Sample 2)	0.29	0.62	1.59	4.17	7.70	18.88	31.00	54.28	86.00	96.25	100.00	**6.993**

Note: this table should be read as follows: 0.63% of those women in sample 1 who are not in couple declare a LS level of 0. 87.63% of them have a satisfaction score of 8 or less. The average life satisfaction level of these women is 6.623.

Figure A1. BMI distribution – Women – Sample 1.

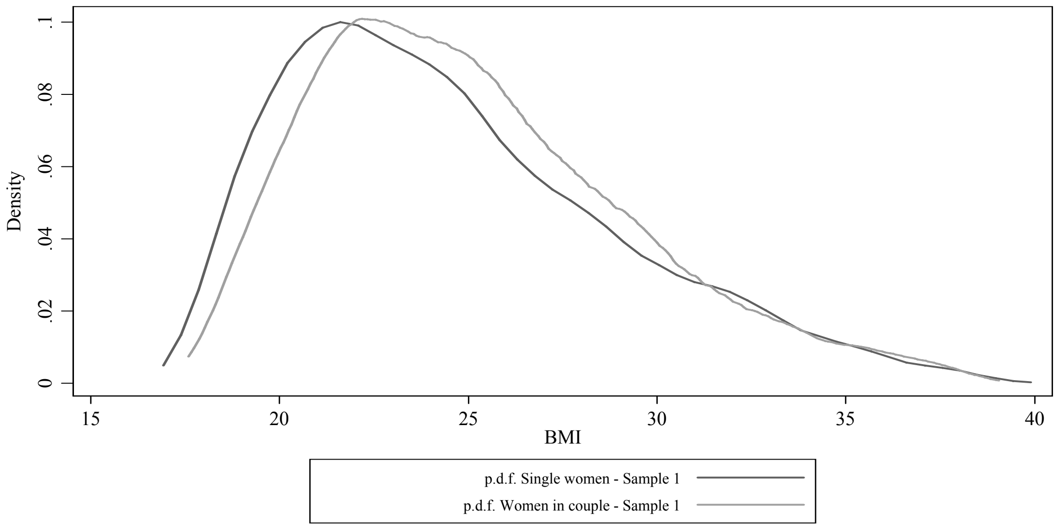


Figure A2. BMI distribution – Men – Sample 1.

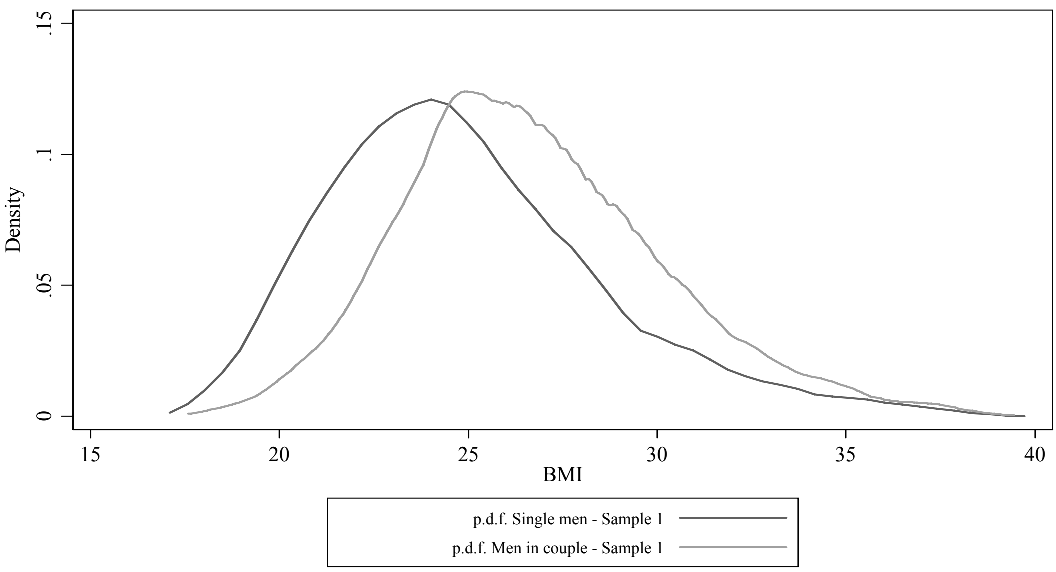


Figure A3. BMI distribution – Sample 2.

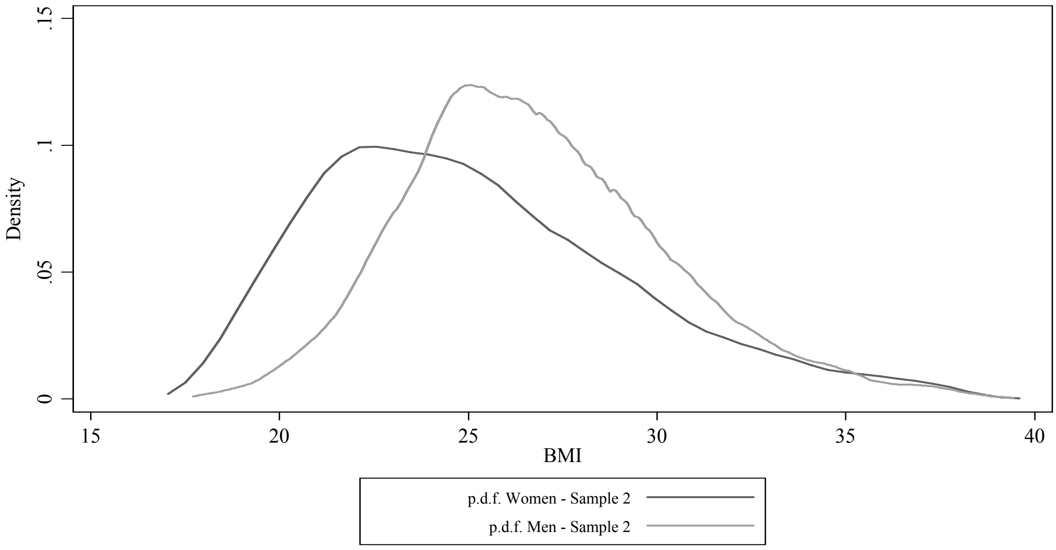


Figure A4. Woman's BMI vs. Man's BMI - Sample 2

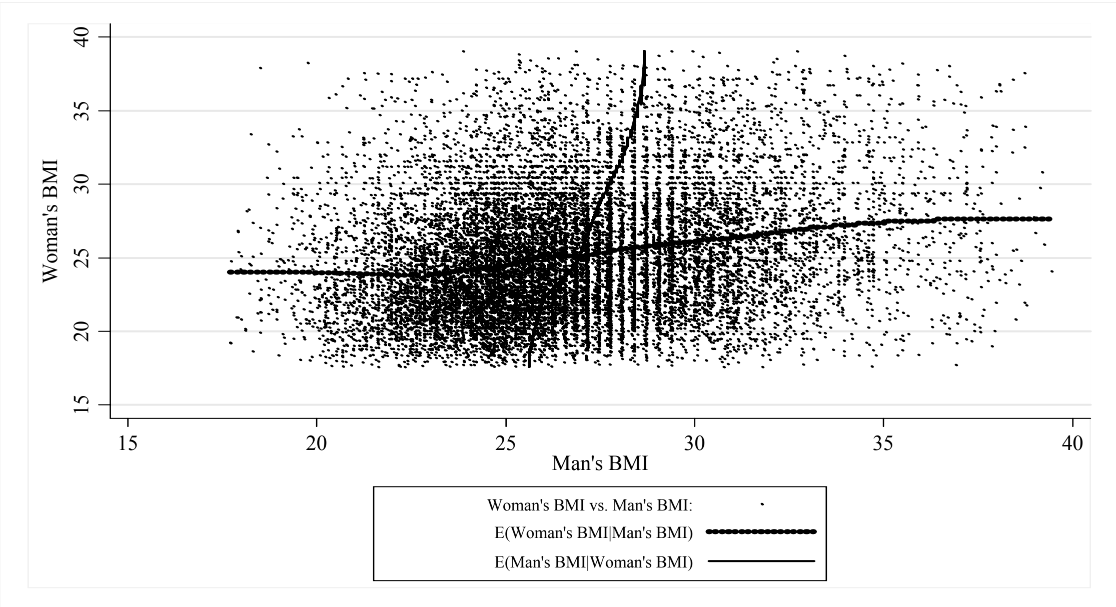
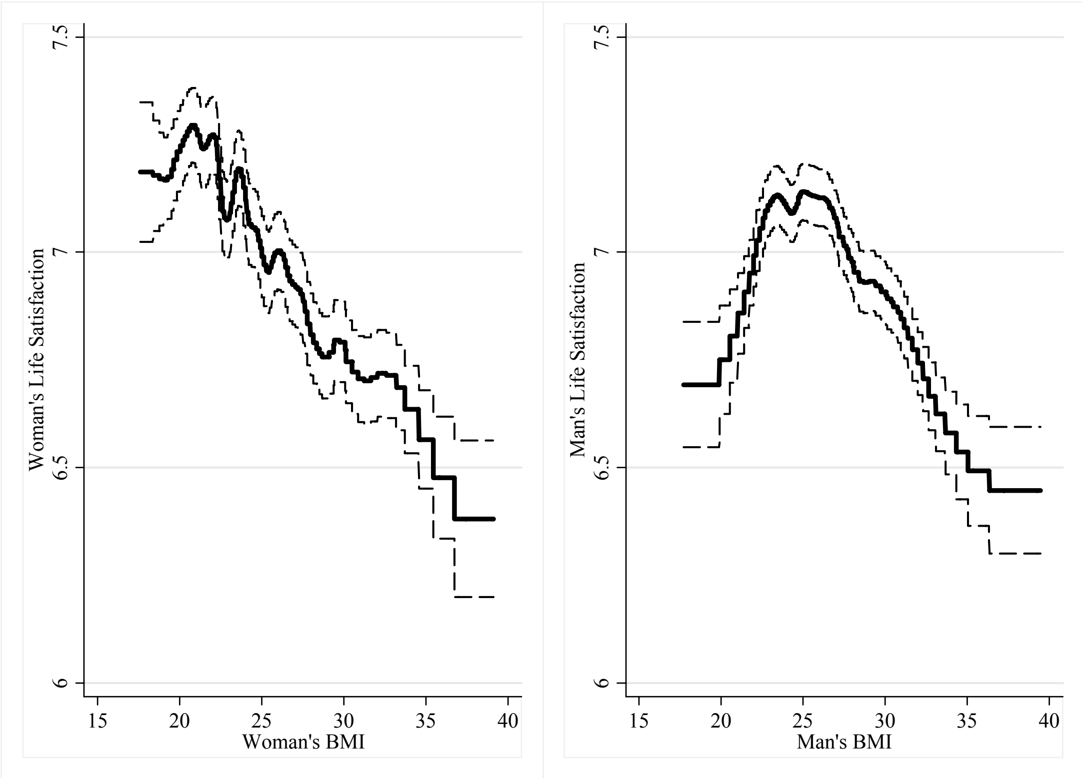


Figure A5. Life satisfaction vs. own BMI for men and women - Sample 2



Appendix B: Some technical issues

Appendix B1. Semi-parametric regressions

Consider model **(3)**:

$$LS_{it} = f(W_{it}, W_{jt}) + \alpha X_{it} + \varepsilon_{it} \qquad \textbf{(3)}$$

In Section 4.2., f(.) is left unspecified and the model is estimated by the semi-parametric regression method proposed by Ruppert, Wand and Caroll (2003). The idea is to approximate the bivariate function f(.) by a mixture of radial basis functions defined on the space of partners' body shapes:

$$LS_{it} = \beta_0 + \beta_o W_{it} + \beta_p W_{jt} + \mathbf{Z}_{it,K}\mathbf{u} + \alpha X_{it} + \varepsilon_{it} \qquad \textbf{(B1)}$$

where **u** is a K x 1 random vector, and $\mathbf{Z_{it,K}}$ is a 1 x K vector of radial basis functions with k^{th} element:

$$Z_{it,K}(1,k) = \left\| \begin{pmatrix} W_{it} \\ W_{jt} \end{pmatrix} - \begin{pmatrix} \kappa_{ok} \\ \kappa_{pk} \end{pmatrix} \right\|^2_{1 \le k \le K} \log\left(\left\| \begin{pmatrix} W_{it} \\ W_{jt} \end{pmatrix} - \begin{pmatrix} \kappa_{ok} \\ \kappa_{pk} \end{pmatrix} \right\| \right) \qquad \textbf{(B2)}$$

In **(B2)**, $\boldsymbol{\kappa}' = (\kappa_{ok}, \kappa_{pk})$ represents a knot in the $\mathbb{R}^2$ space, and ||.|| is the euclidean distance. Hence, the estimator approximates the shape of the relationship between the *W*s and *LS* by a weighted sum of functions centred on different knots. The weights in **u** are random variables with mean 0.

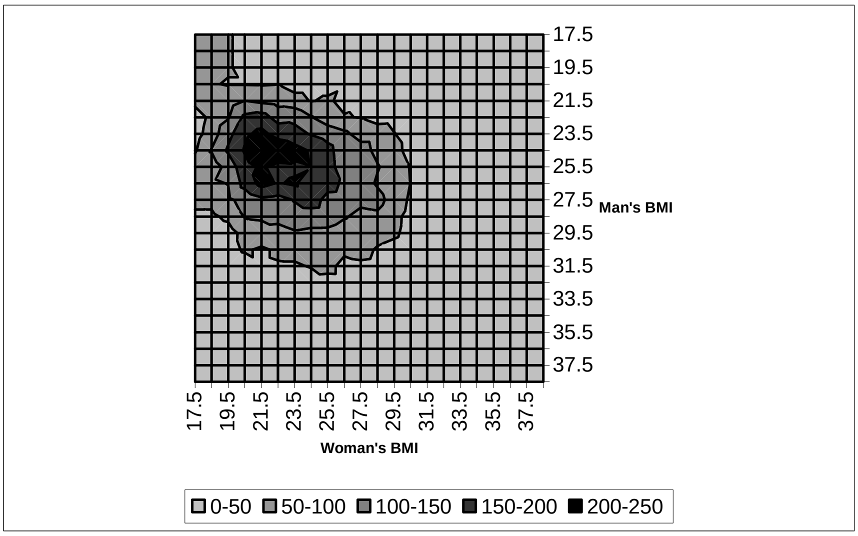
The choice of the knots is a key issue in bivariate smoothing. Here, we select them by a two stage procedure. First, we construct a rectangular lattice over $\mathbb{R}^2$ containing all $\{W_{it}, W_{jt}\}$ observations, with grid points located at each integer value of BMI. Second, adjacent cells of this grid are merged when they contain less than 20 observations. The intersection points of the grid eventually obtained are the knots we use in the estimates (see Figure B1). As there are less observations in the corners of the $\{W_{it}, W_{jt}\}$ space, there are also less knots in these regions, which limits the loss of information (the variance is lower compared to the case where there would have been many knots in sparse regions), but also the quality of the approximation (see Figure B2).

The model is then estimated following the algorithm proposed by Ruppert *et al.* in their chapter 13.5. Standard-errors and values of the derivatives are computed using formula in chapters 6.4. and 6.8..

Figure B1. Knots (Horizontal axis: woman's BMI; Vertical axis: Man's BMI)

	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5	31.5	32.5	33.5
17.5																	
18.5																	
19.5				o	o	o			o								
20.5		o	o	o	o	o	o	o	o	o							
21.5		o	o	o	o	o	o	o	o	o	o	o					
22.5	o	o	o	o	o	o	o	o	o	o	o	o	o		o		
23.5	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		
24.5	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
25.5		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
26.5		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
27.5		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
28.5		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
29.5		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
30.5		o	o	o	o	o	o	o	o	o	o	o	o		o		
31.5				o	o	o	o	o	o	o	o	o	o		o		
32.5						o	o	o	o	o	o	o	o				
33.5							o	o	o	o							
34.5								o		o		o					
35.5																	
36.5																	
37.5																	
38.5																	

Figure B2. Cell density



Appendix B2. IV strategies.

All the discussion here is inspired from Blundell and Bond (1998). Consider first Model (5).

$$\begin{cases} LS_{it} = \alpha W_{it} + \eta_i + v_{it} \\ W_{it} = \gamma W_{it-1} + \rho\eta_i + f_i + \varepsilon_{it} \end{cases} \quad \textbf{(5)}$$

Then:

$$\begin{aligned} &\forall i, t \geq 3, s \in \{0,...,t-3\},\ E\left(v_{it}\Delta\varepsilon_{it-s}\right) = E\left(v_{it}\Delta W_{i2}\right) = E\left(\eta_i \Delta W_{i2}\right) = E\left(\eta_i \Delta\varepsilon_{it-s}\right) = 0 \\ &\Rightarrow E\left((\eta_i + v_{it})\Delta W_{it}\right) = 0 \end{aligned} \quad \textbf{(B3)}$$

This is because the data generating process implies : $\Delta W_{it} = \gamma^{t-2} W_{i2} + \sum_{s=0}^{t-3} \gamma^s \Delta\varepsilon_{it-s}$. How plausible are these restrictions on the Data Generating Process? First, assuming that the time-varying shocks and time-invarying factors are orthogonal is natural in the context of panel data: $E(\eta_i \Delta\varepsilon_{is})=0$. Second, suppose that:

$$W_{i1} = \frac{\rho\eta_i + f_i}{1-\gamma} + u_{i1} \quad \textbf{(B4)}$$

where, for instance, $u_{i1}=\sum_{s=0}^{\infty}\gamma^{s}\varepsilon_{i1-s}$ under full stationarity (*i.e.* the model valid for the observation period is also valid for the entire process). Assume further that ε_{it-s} follows an antoregressive process (this assumption is all the more plausible that food price and quality are unobserved and highly auto-correlated.): $\varepsilon_{it-s}=\theta\varepsilon_{it-s-1}+r_{it-s}$ for $s<t-2$ and $\varepsilon_{i2}=\theta u_{i1}+r_{i2}$. Then $E(v_{it}\Delta\varepsilon_{it-s})=0$ holds if $E(v_{it}r_{it-s})=0$ for $t-s>1$ and $E(v_{it}u_{i1})=0$. When there are three periods, these restrictions amount to consider that random shocks r_{i2} and r_{i3} allocate individuals to various levels of BMI at each period: conditionally on the fixed effects, v_{i3} and ε_{i3} must be uncorrelated. If ε_{is} and v_{is} are correlated for s=2 and s=3, but ε_{i3} is unrelated to ε_{i2}, then changes between t=1 and t=2 can still be used to instrument BMI at t=3. Third, using **(B4)**, we have:

$$\begin{aligned}\Delta W_{i2} &= (\gamma-1)W_{i1}+\rho\eta_i+f_i+\varepsilon_{i2}\\ &= (\gamma-1)u_{i1}+\varepsilon_{i2}\end{aligned} \qquad \textbf{(B5)}$$

and, once again, $E(v_{it}\Delta W_{i2})=0$ is valid for t = 3 as long as $E(v_{i3}u_{i1})=0$ and $E(v_{i3}\varepsilon_{i2})=0$ (or $E(v_{i3}r_{i2})=0$). Fourth, using **(B5)** and the condition of orthogonality between the fixed effects and the time-varying shocks, $E(\eta_i\Delta Wi2)=0$ if $E(\eta_i u_{i1})=0$. Borrowing words from Blundell and Bond (1998), any "entry period disequilibrium" of BMI from the asymptotic convergence level $(\rho\eta_i+f_i)/(1-\gamma)$ that is randomly distributed across agents (hence independent from η_i) will preserve this condition. It is also naturally satisfied in the fully stationary model (since then $E(\varepsilon_{is}\eta_i)=0$ for all s).

To summarise, instrumenting BMI at t=3 by its changes between t=1 and t=2, and t=2 and t=3, amounts to impose two restrictions: one on the distribution of the time-varying shocks that affect body weight - they must be uncorrelated with the time-varying shocks in the life satisfaction equation; the other on the randomization of individuals at the entry in the observation period. The first restriction has still to be valid if $\gamma=0$. In our data there are a number of individuals, whose self-declared BMI is fairly stable from one period to another: the random shocks u_{i1}, r_{i2} and r_{i3} can be interpreted as a randomization mechanism who would assign individuals either to a control group – those whose BMI is left unchanged –, or to a treatment group with varying treatment intensity – those whose BMI changes -, from an initial level W_{i1} that has itself been randomised.

We also consider the first-difference of the life satisfaction equation:

$$\Delta LS_{it} = \alpha \Delta W_{it} + \Delta v_{it} \qquad \textbf{(6)}$$

and then, assuming that $E(W_{i2}\Delta v_{i3})= E(W_{i1}\Delta v_{i3})$, we instrument BMI in first-difference by BMI in level . This strategy will be valid if $E(\eta_i\Delta v_{it})= E(f_i\Delta v_{it})=0$ for t=2 and t=3, which was assumed *a priori*, and $E(\varepsilon_{i2}\Delta v_{it})=0$. The second restriction holds, once again, when random shocks on body weight are uncorrelated with shocks on life satisfaction. Hence, both types of instrumentation require the same kind of restrictions regarding the correlation of the residuals of the BMI and the life satisfaction equations.

Appendix C. Main results

Table C1 – Well-Being and BMI: Household Results. GSOEP – 2002, 2004 and 2006

Technique	**OLS**					
Sample	**1**	**1**	**1**	**1**	**2**	**2**
Sub-sample	**Single women**	**Single men**	**Married women**	**Married men**	**Married women**	**Married men**
Own BMI/10	1.068 (0.656)	0.421 (0.747)	0.566 (0.381)	2.752*** (0.530)	0.720* (0.409)	3.169*** (0.567)
(Own BMI/10) squared	-0.215* (0.125)	-0.087 (0.140)	-0.143** (0.071)	-0.515*** (0.095)	-0.166** (0.076)	-0.590*** (0.102)
HEIGHT	0.007 (0.004)	0.002 (0.004)	0.003 (0.003)	0.009*** (0.002)	-0.025 (0.059)	0.010 (0.060)
(AGE/10)	-0.464*** (0.092)	-1.168** (0.128)	-0.608*** (0.092)	-0.733*** (0.094)	-0.601*** (0.102)	-0.705*** (0.104)
(AGE/10) squared	0.035*** (0.010)	0.113*** (0.014)	0.059*** (0.010)	0.074*** (0.010)	0.059*** (0.011)	0.072*** (0.010)
LOG(INCOME)	0.289*** (0.055)	0.379*** (0.057)	0.532*** (0.033)	0.618*** (0.036)	0.672*** (0.039)	0.619*** (0.040)
YEARS OF SCHOOLING	0.061*** (0.012)	0.061*** (0.013)	0.049*** (0.007)	0.039*** (0.006)	0.033*** (0.007)	0.038*** (0.007)
Number of household individuals/10	-0.339 (0.271)	0.365 (0.254)	0.333* (0.170)	0.459*** (0.165)	0.464** (0.189)	0.520*** (0.185)
Not legally married			-0.082 (0.053)	-0.086* (0.051)	-0.115 (0.074)	-0.135* (0.069)
Part-time worker	-0.116 (0.080)	-0.344** (0.108)	0.095** (0.040)	-0.086 (0.077)	0.112*** (0.043)	-0.122 (0.085)
Apprenticeship	0.201** (0.101)	-0.146* (0.088)	-0.229 (0.183)	-0.215 (0.250)	-0.372 (0.235)	-0.288 (0.288)
Retired	0.229* (0.121)	-0.384** (0.167)	-0.072 (0.067)	-0.129* (0.066)	-0.046 (0.070)	-0.124* (0.069)
Unemployed	-1.048*** (0.116)	-1.340** (0.100)	-0.629*** (0.073)	-0.856*** (0.069)	-0.562*** (0.080)	-0.809*** (0.076)
Housewife/husband	0.050 (0.088)	0.664*** (0.187)	0.213*** (0.042)	-0.138 (0.115)	0.229*** (0.045)	-0.093 (0.119)
Other job status	0.140 (0.086)	-0.301** (0.091)	-0.101 (0.096)	-0.355*** (0.081)	-0.089 (0.109)	-0.376*** (0.087)
Other control variables: "Land" dummies, year dummies, constant.						
R-squared	*0.09*	*0.16*	*0.10*	*0.13*	*0.11*	*0.12*
N	7753	6259	19380	19307	16683	16683

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure C1. Marginal effect of own BMI (based on Table C1 estimates)

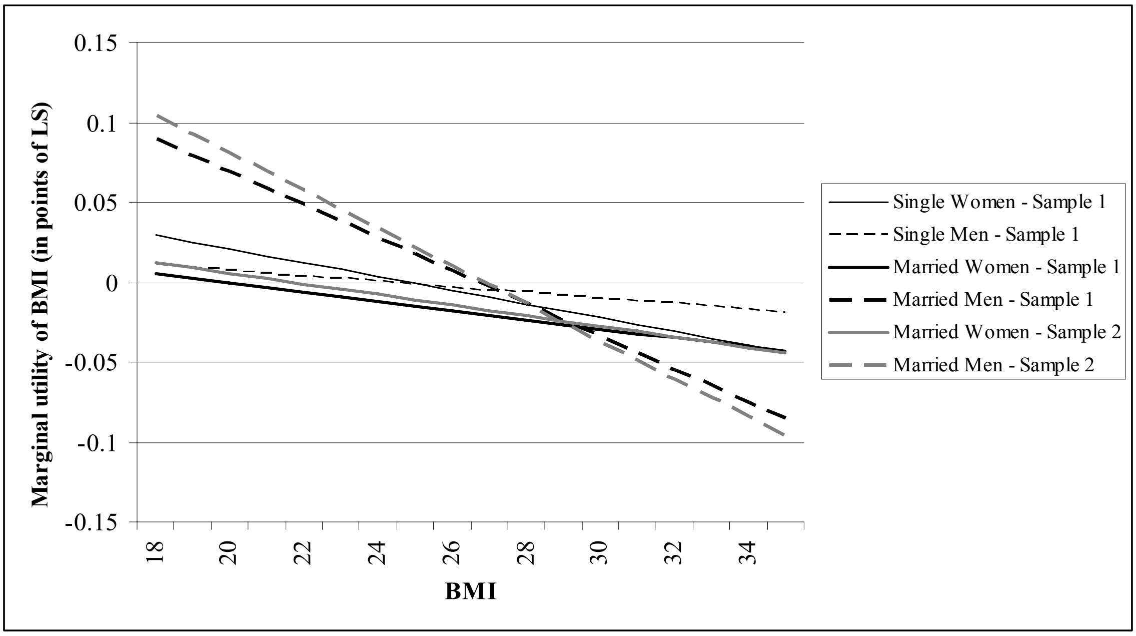


Table C2. Well-being and partners' BMIs in Sample 2 (N=16683)

Technique	**OPROBIT**	**OLS**	**OPROBIT**	**OLS**
	Women		**Men**	
Own BMI/10	-0.155 (0.285)	-0.082 (0.353)	1.474*** (0.366)	2.591*** (0.421)
(Own BMI/10) squared	-0.117** (0.048)	-0.220*** (0.060)	-0.386*** (0.065)	-0.670*** (0.075)
Own BMI/10 crossed with Partner's BMI/10	0.248*** (0.071)	0.403*** (0.089)	0.235*** (0.075)	0.403*** (0.086)
Partner's BMI/10	0.369 (0.370)	0.768* (0.434)	-0.616** (0.284)	-0.861** (0.343)
(Partner's BMI/10) squared	-0.193*** (0.064)	-0.341*** (0.077)	-0.016 (0.048)	-0.063 (0.059)

Note: Standard errors clustered at the household level in parentheses; * significant at 5%; ** significant at 1%. **Control variables as in Table C1**.

Figure C2. Women's marginal effect of own BMI (Table C2's OLS estimates).

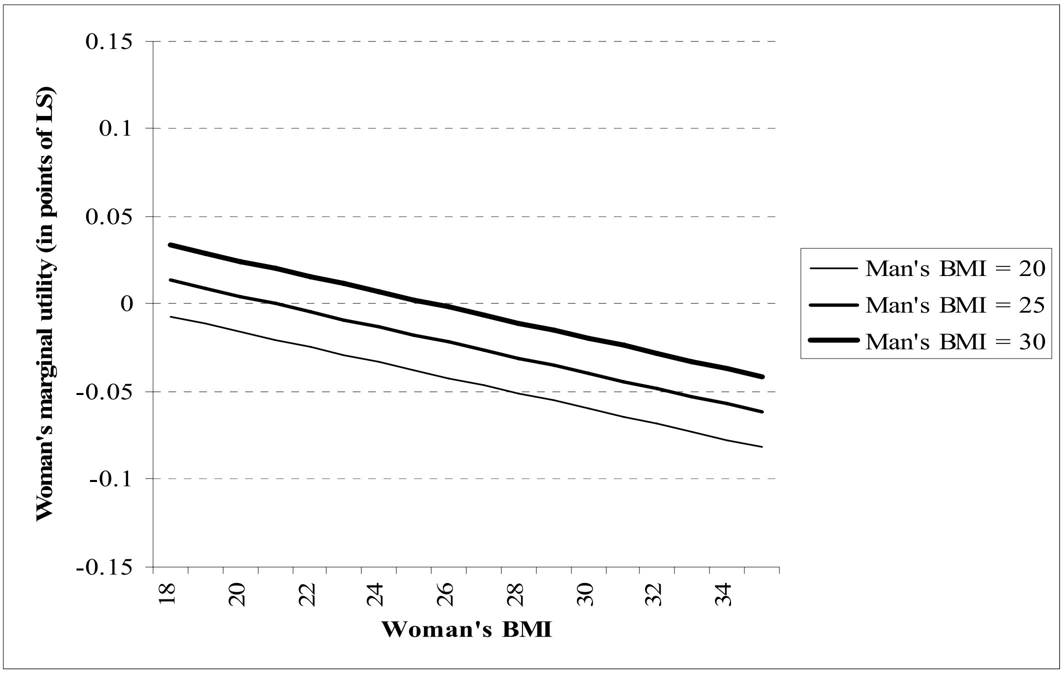


Figure C3. Women's marginal effect of partner's BMI (Table C2's OLS estimates).

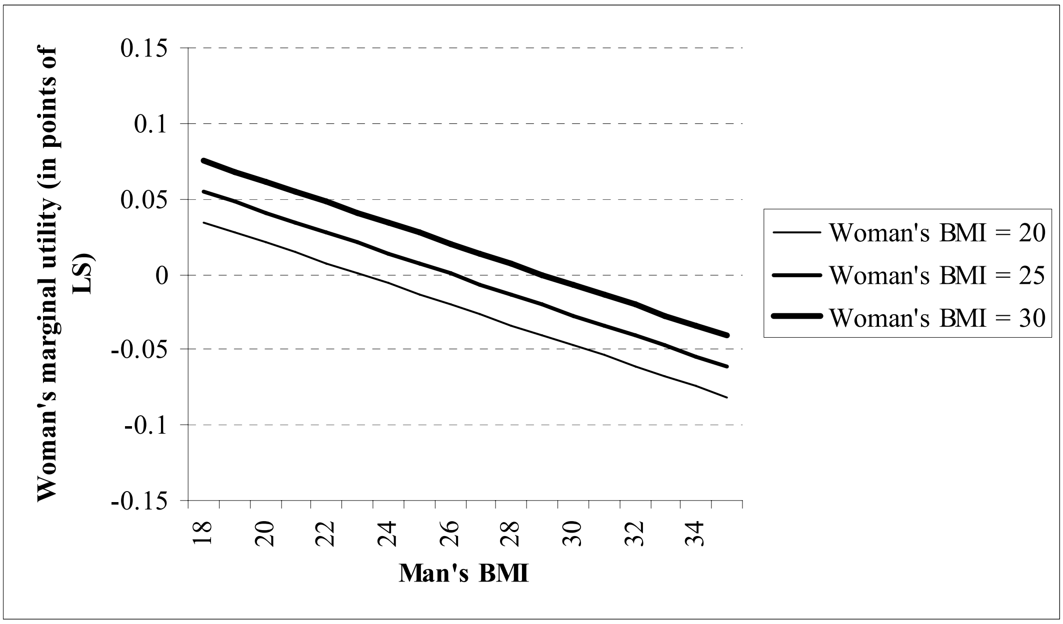


Figure C4. Men's marginal effect of own BMI (Table C2's OLS estimates).

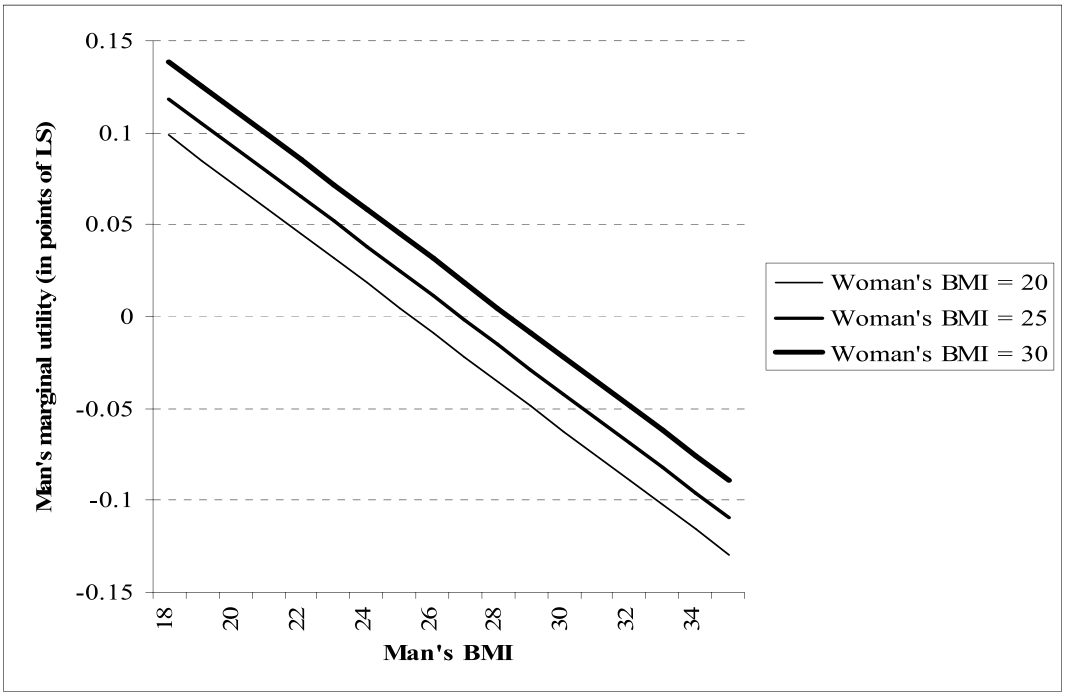


Figure C5. Men's marginal effect of partner's BMI (Table C2's OLS estimates).

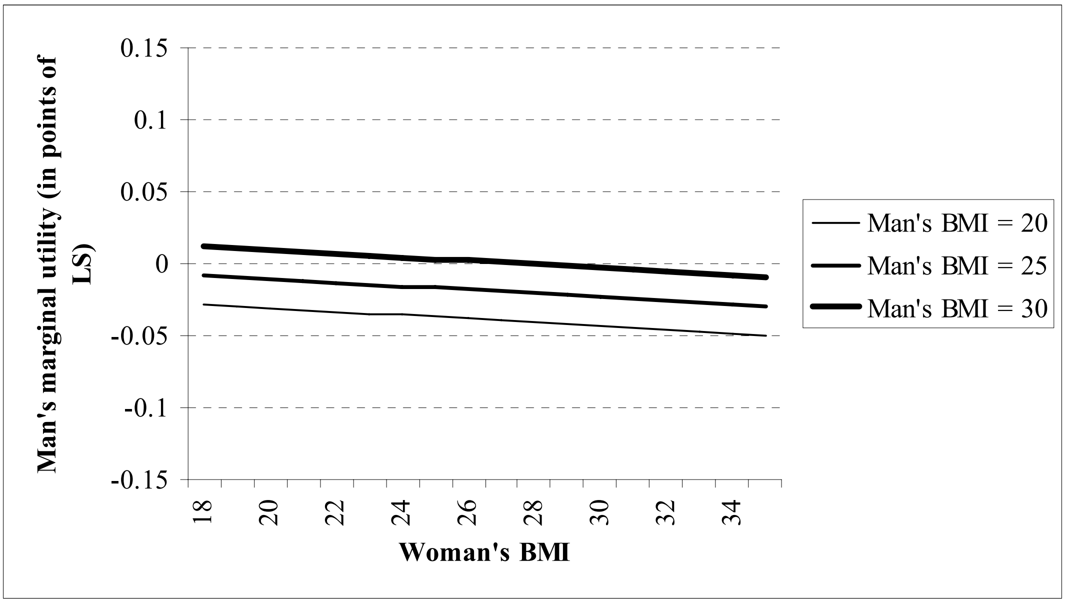


Table C3 – Well-being and partners' BMIs in Sample 2 (N=16683) – further results

Technique	OLS	
	Women	**Men**
Man normal, Woman normal	Ref	Ref
Man overweight, Woman normal	-0.106*** (0.037)	-0.032 (0.036)
Man obese, Woman normal	-0.178*** (0.056)	-0.243*** (0.054)
Man normal, Woman overweight	-0.227*** (0.052)	-0.220*** (0.050)
Man overweight, Woman overweight	-0.098** (0.042)	-0.050 (0.041)
Man obese, Woman overweight	-0.281*** (0.058)	-0.273*** (0.056)
Man normal, Woman obese	-0.509*** (0.081)	-0.347*** (0.079)
Man overweight, Woman obese	-0.253*** (0.057)	-0.083 (0.056)
Man obese, Woman obese	-0.254*** (0.070)	-0.170** (0.068)

Note: Standard errors clustered at the household level in parentheses; * significant at 5%; ** significant at 1%; Normal=(BMI<25) – the term "normal" refers here to the WHO medical norm, Overweight = (BMI>25), Obese=(BMI>30); **Control variables as in Table C1**.

Figure C6. Men's Life Satisfaction

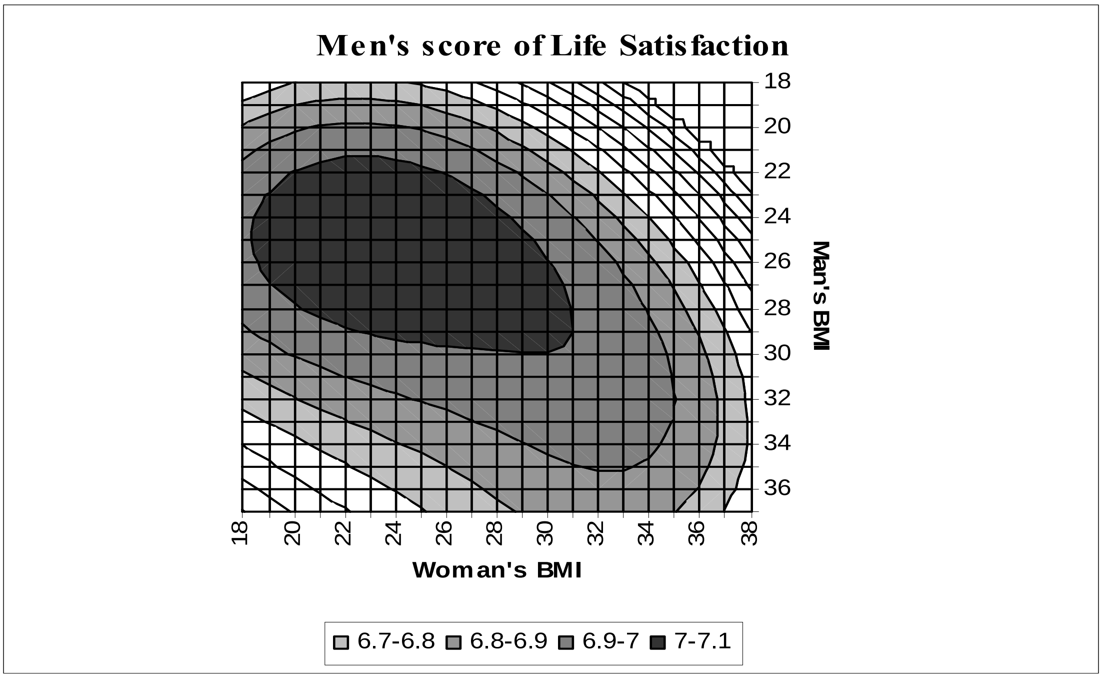


Figure C7. Women's Life Satisfaction

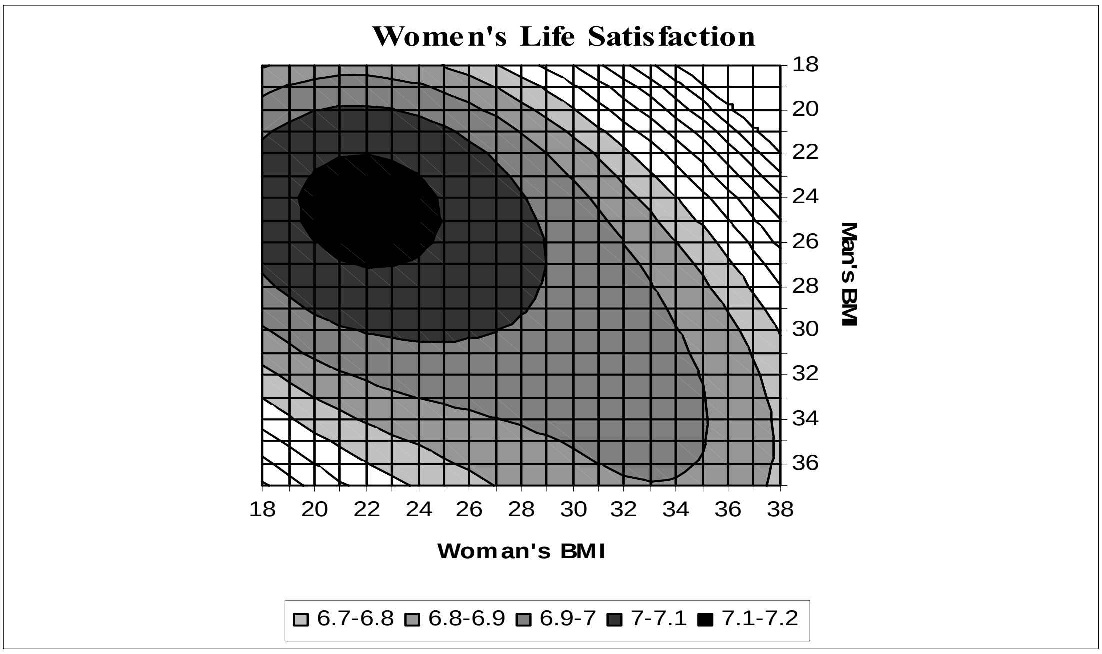


Figure C8. Men's Life Satisfaction – marginal effect of own BMI.

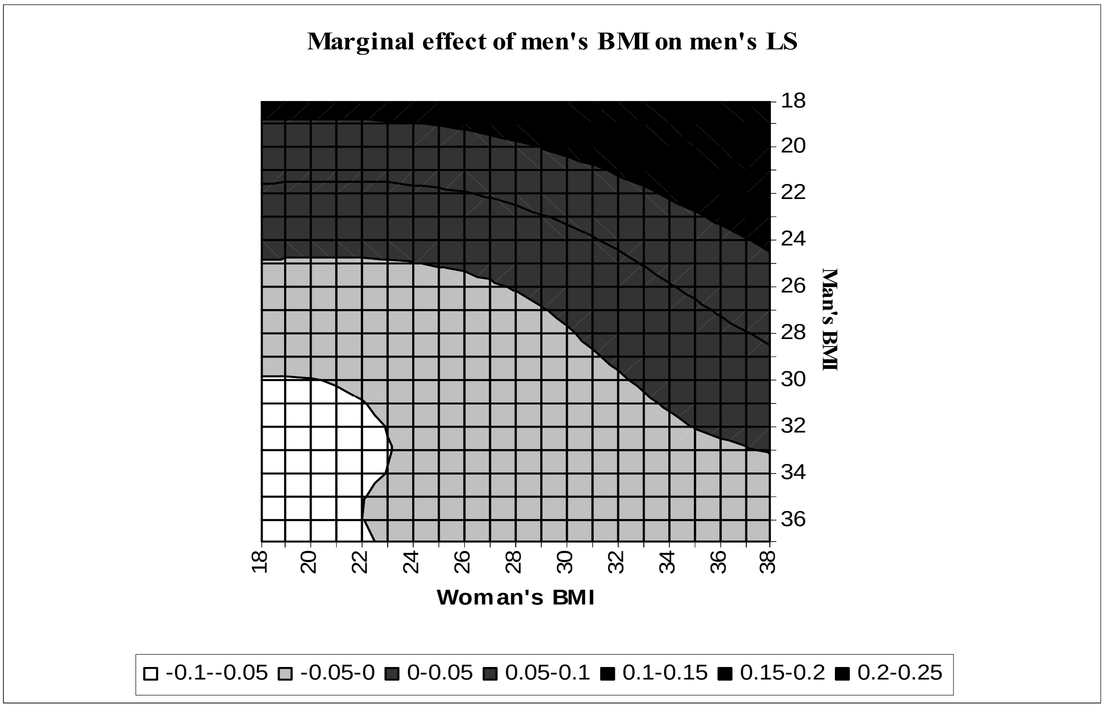
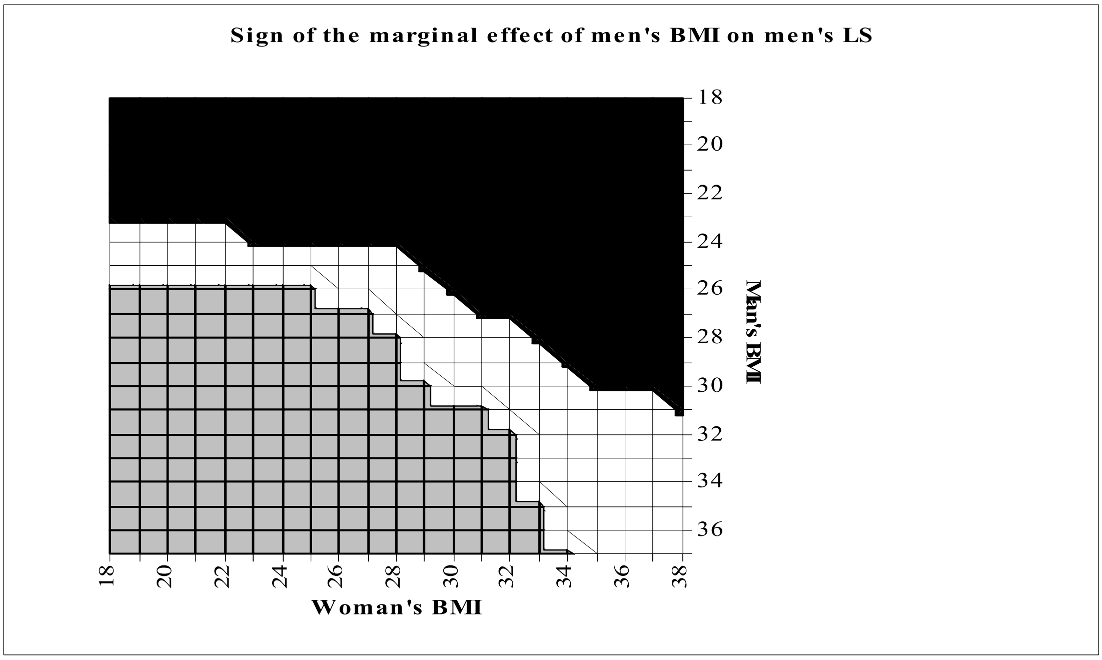


Figure C9. Men's Life Satisfaction – marginal effect of own BMI - sign.



Note: black area: marginal effect significantly positive; white area: marginal effect not significant; grey area: marginal effect significantly negative.

Figure C10. Men's Life Satisfaction – marginal effect of partner's BMI.

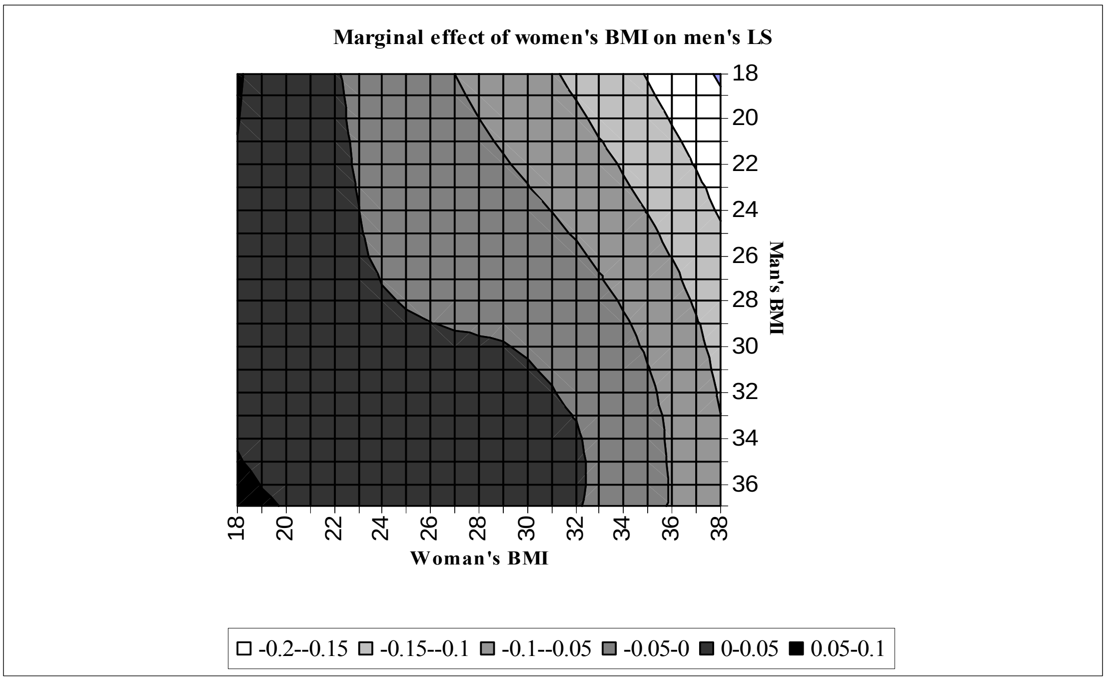
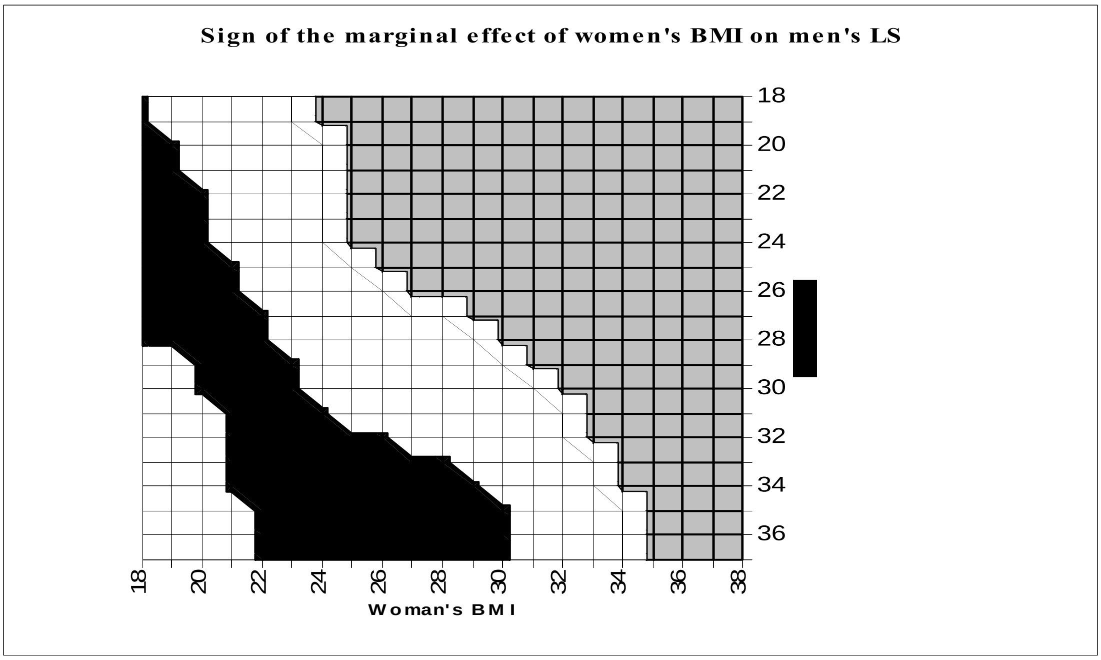


Figure C11. Men's Life Satisfaction – marginal effect of partner's BMI - sign.



Note: black area: marginal effect significantly positive; white area: marginal effect not significant; grey area: marginal effect significantly negative.

Figure C12. Women's Life Satisfaction – marginal effect of own BMI.

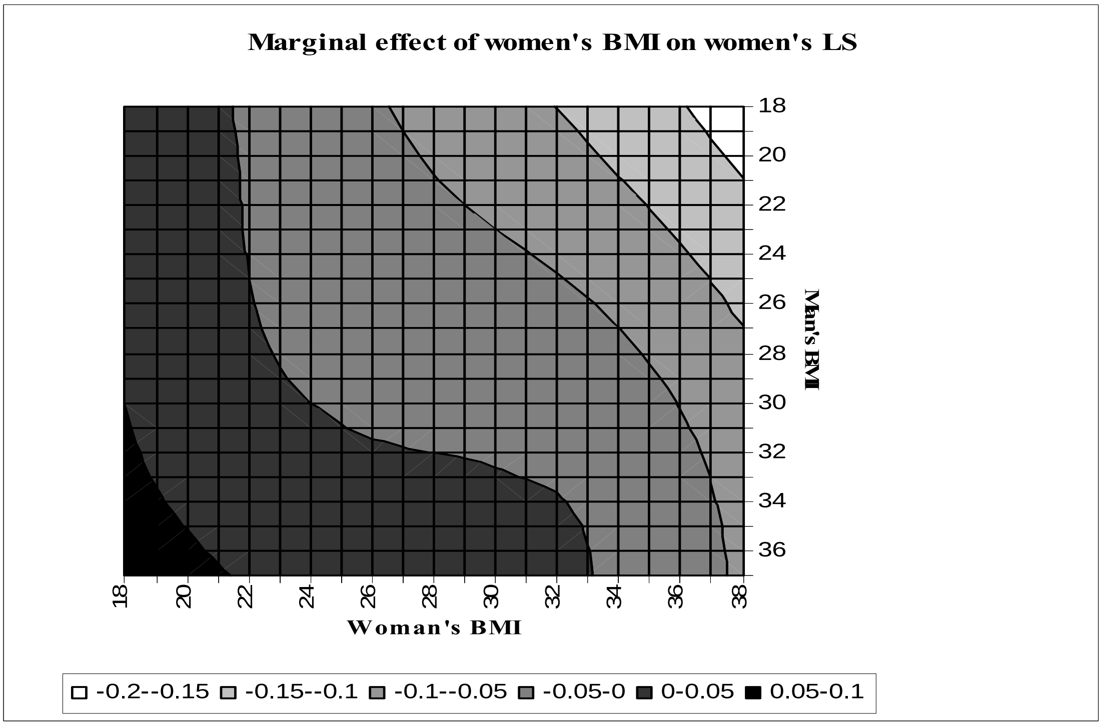
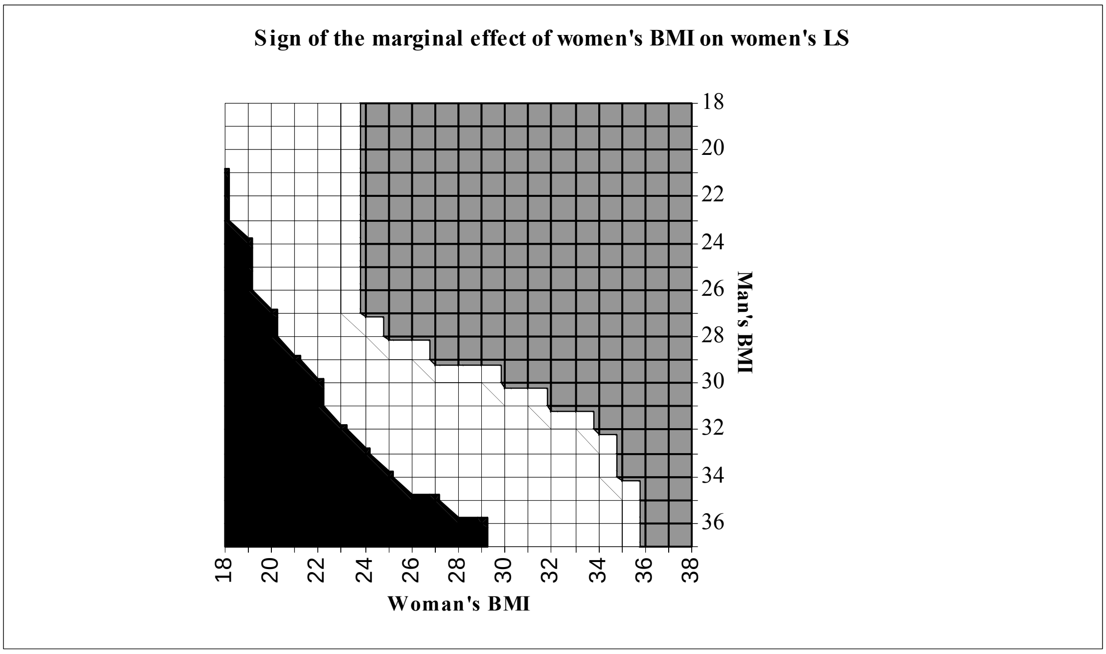


Figure C13. Women's Life Satisfaction – marginal effect of own BMI - sign.



Note: black area: marginal effect significantly positive; white area: marginal effect not significant; grey area: marginal effect significantly negative.

Figure C14. Woman's Life Satisfaction – marginal effect of partner's BMI.

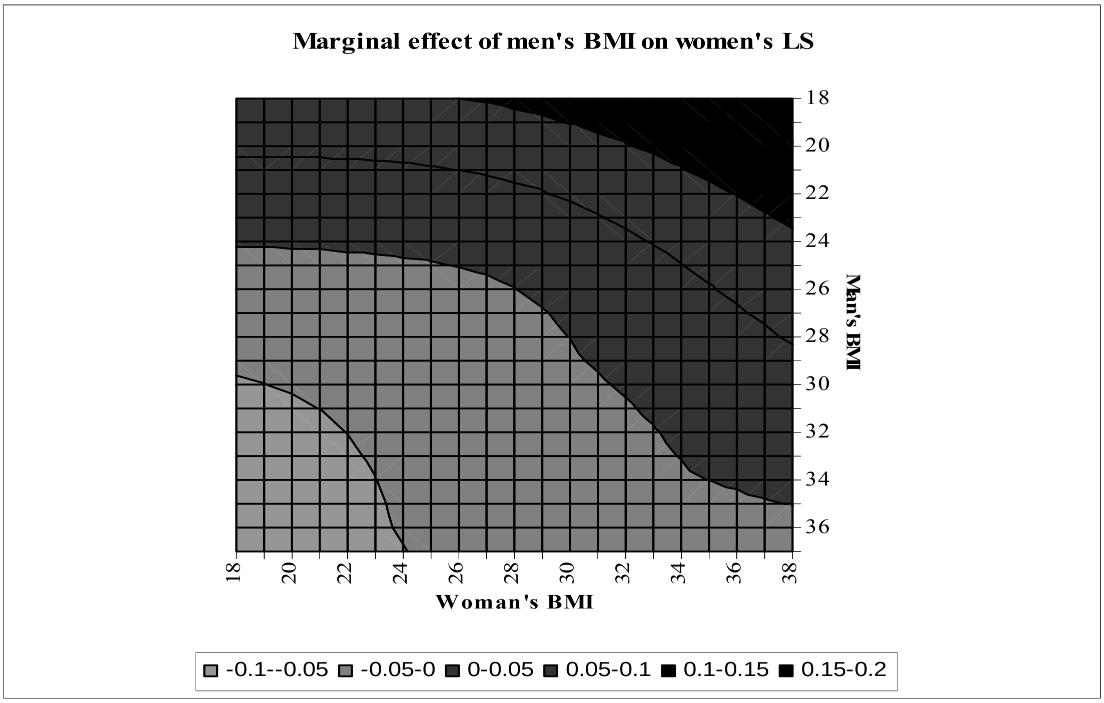
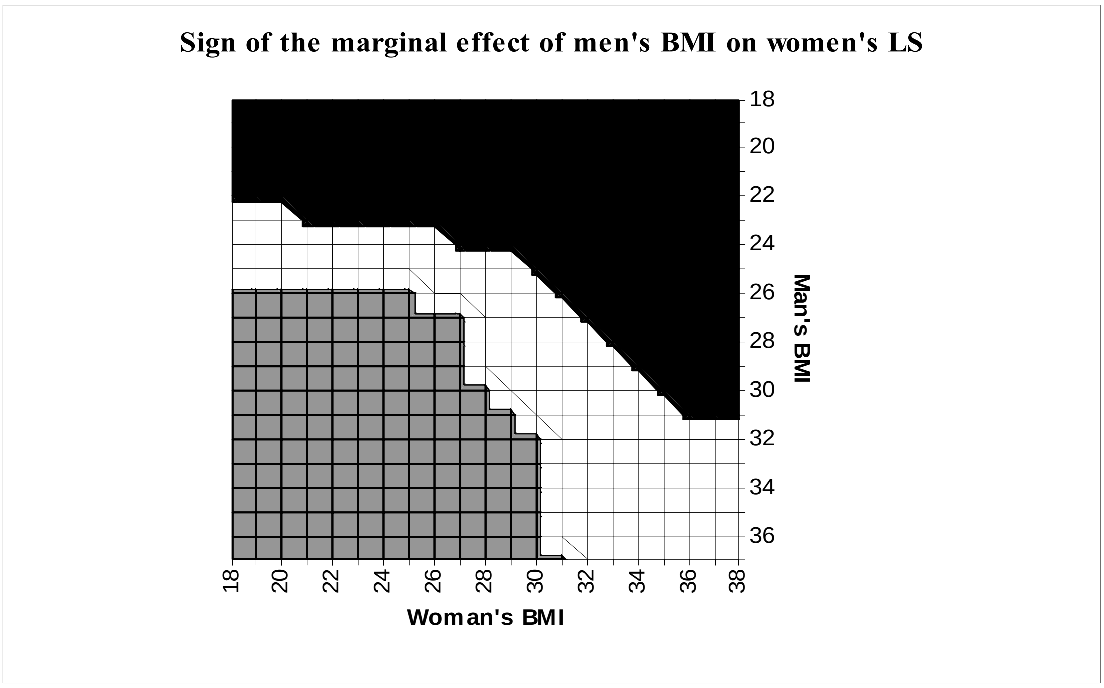


Figure C15. Women's Life Satisfaction – marginal effect of partner's BMI - sign.



Note: black area: marginal effect significantly positive; white are: marginal effect not significant; greay area: marginal effect significantly negative.

Figure C16. Man's Life Satisfaction – interaction effect - sign.

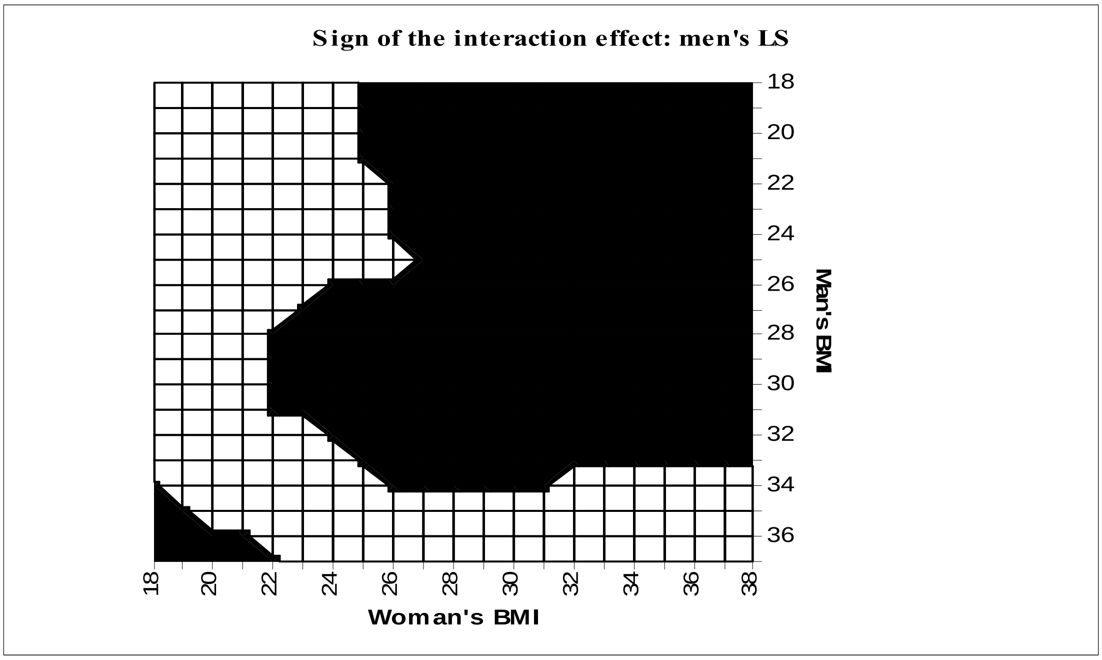
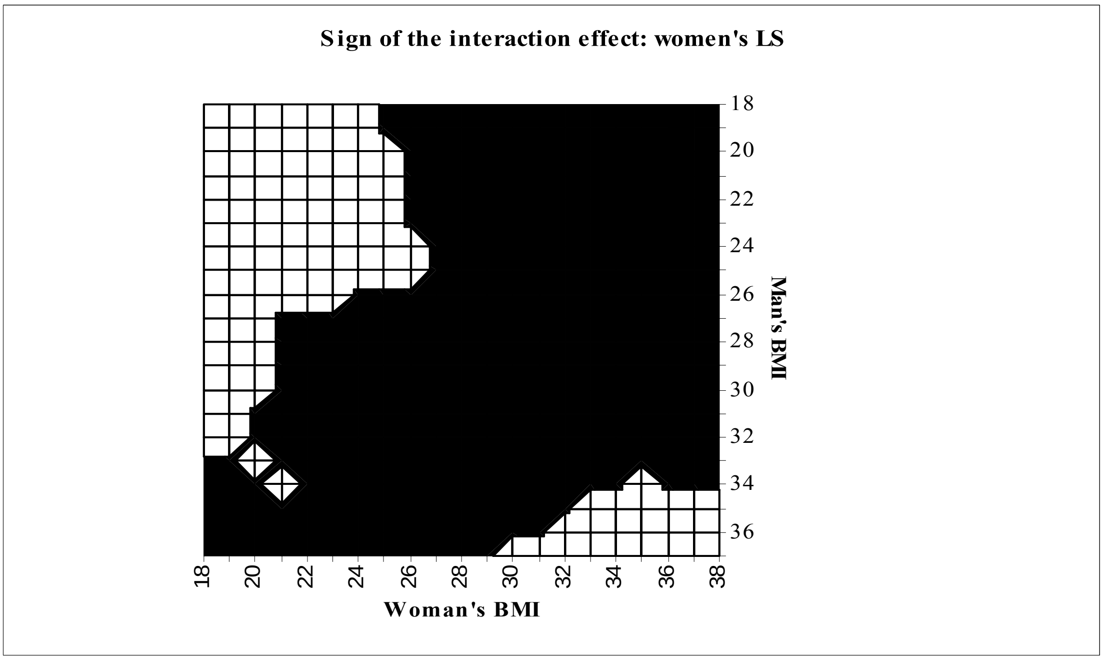


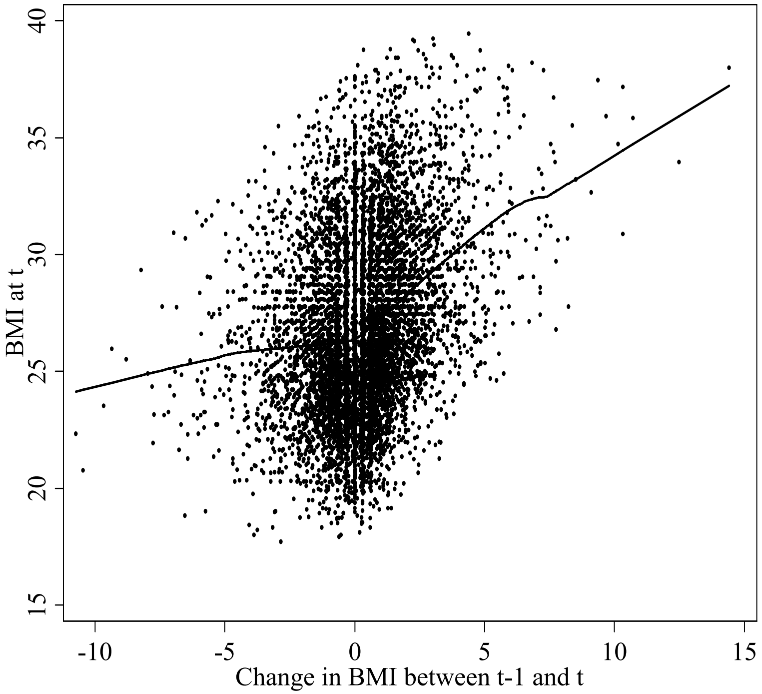
Figure C17. Women's Life Satisfaction – interaction effect - sign.



Note: black area: marginal effect significantly positive; white are: marginal effect not significant; grey area: marginal effect significantly negative.

<u>Appendix D. Instrumental variable results and selection bias.</u>

<u>Figure D1. BMI vs change in BMI – Men (left) and Women (right)</u>



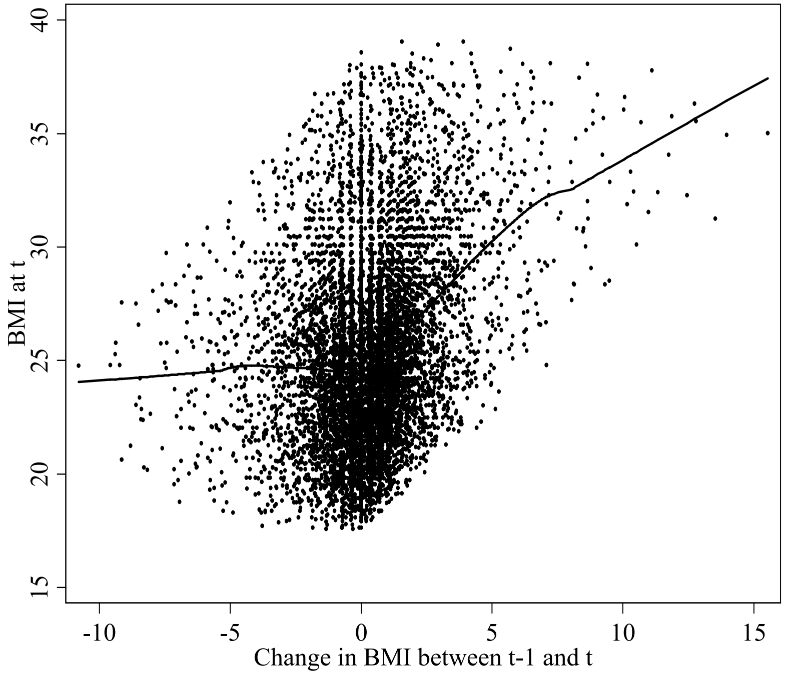


Table D1. Instrumental variable results

	Men			Women		
Model	*1 - OLS*	*2 – Level GMM*	*3 – System GMM*	*1 - OLS*	*2 – Level GMM*	*3 – System GMM*
Own BMI/10	2.740*** (0.858)	8.294*** (2.774)	3.504** (1.757)	-0.133 (0.716)	5.243** (2.090)	3.566** (1.475)
(Own BMI/10) squared	-0.681*** (0.148)	-1.256*** (0.388)	-0.737** (0.289)	-0.186 (0.119)	-0.706** (0.296)	-0.506** (0.233)
Own BMI/10 crossed with Partner's BMI/10	0.373** (0.170)	-0.296 (0.391)	0.273 (0.302)	0.334* (0.174)	-0.556 (0.401)	-0.280 (0.318)
Partner's BMI/10	-0.409 (0.697)	3.095 (2.058)	-1.980 (1.411)	0.402 (0.881)	4.465 (2.830)	0.642 (1.851)
(Partner's BMI/10) squared	-0.135 (0.116)	-0.447 (0.291)	0.203 (0.223)	-0.255* (0.152)	-0.518 (0.394)	0.017 (0.304)
Control variables	As in Table C2					
Cragg-Donald Statistics	_	26.6	_	_	27.0	_
Hansen-Sargan p-value	_	0.771	0.348	_	0.854	0.321
Number of observations	4328	4328	12984	4328	4328	12984
Number of couples	4328					

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table D2-1. Marginal Effect of Own BMI on Men's LS – based on Table D1's estimates.

	OLS				Level-GMM		
	Woman's BMI				*Woman's BMI*		
Man's BMI	20	25	30	*Man's BMI*	20	25	30
20	**0.076**	**0.095**	**0.113**	20	**0.268**	**0.253**	**0.238**
25	0.008	0.027	0.045	25	**0.142**	**0.127**	**0.112**
30	**-0.060**	**-0.041**	**-0.023**	30	0.016	0.002	-0.013

Note: numbers in bold indicate effects significant at the level of 1%; bold and italic at the level of 5%; italic at the level of 10%. For instance, the marginal effect of man's BMI on man's LS when man's BMI is 30 and woman's BMI is 25 is -0.045 points of satisfaction in the OLS regression, significant at the level of 1%, and +0.002 points in the level-GMM regression, not significant.

Table D2-2. Marginal Effect of Partner's BMI on Men's LS– based on Table D1's estimates.

	OLS				Level-GMM		
	Woman's BMI				*Woman's BMI*		
Man's BMI	20	25	30	*Man's BMI*	20	25	30
20	-0.020	**-0.034**	**-0.047**	20	0.072	0.027	-0.018
25	-0.001	***-0.015***	**-0.028**	25	0.057	0.012	*-0.032*
30	0.017	0.004	-0.010	30	0.042	-0.003	**-0.047**

Note: numbers in bold indicate effects significant at the level of 1%; bold and italic at the level of 5%; italic at the level of 10%. For instance, the marginal effect of woman's BMI on man's LS when man's BMI is 25 and woman's BMI is 25 is -0.015 points of satisfaction in the OLS regression, significant at the level of 1%, and +0.012 points in the level-GMM regression, not significant.

Table D2-3. Marginal Effect of Own BMI on Women's LS – based on Table D1's estimates.

	OLS				**Level-GMM**		
	Woman's BMI				*Woman's BMI*		
Man's BMI	20	25	30	*Man's BMI*	20	25	30
20	***0.287***	***0.241***	***0.195***	20	***0.131***	0.060	-0.011
25	***0.131***	*0.086*	0.040	25	***0.103***	0.032	***-0.038***
30	-0.024	-0.070	-0.115	30	0.075	0.005	**-0.066**

Note: numbers in bold indicate effects significant at the level of 1%; bold and italic at the level of 5%; italic at the level of 10%. For instance, the marginal effect of woman's BMI on woman's LS when man's BMI is 25 and woman's BMI is 30 is +0.04 points of satisfaction in the OLS regression, not significant, and -0.038 points in the level-GMM regression, significant at the level of 5%.

Table D2-4. Marginal Effect of Partner's BMI on Women's LS – based on Table D1's estimates.

	OLS				**Level-GMM**		
	Woman's BMI				*Woman's BMI*		
Man's BMI	20	25	30	*Man's BMI*	20	25	30
20	*0.151*	0.063	-0.025	20	0.128	0.100	0.072
25	*0.106*	0.017	-0.071	25	0.076	0.048	0.021
30	0.060	-0.028	*-0.116*	30	0.024	-0.003	-0.031

Note: numbers in bold indicate effects significant at the level of 1%; bold and italic at the level of 5%; italic at the level of 10%. For instance, the marginal effect of man's BMI on woman's LS when man's BMI is 25 and woman's BMI is 20 is +0.106 points of satisfaction in the OLS regression, significant at the level of 10%, and 0.076 points in the level-GMM regression, not significant.

Table D3 – Instrumental variable results – alternative set of instruments – Sample 2

	Men		Women	
Model	*1 - OLS*	*2 – Difference GMM*	*1 - OLS*	*2 – Difference GMM*
Own BMI/10	2.746*** (0.553)	10.900* (5.569)	-0.358 (0.469)	5.364 (3.289)
(Own BMI/10) squared	-0.700*** (0.097)	-1.554* (0.868)	-0.180** (0.080)	-0.858** (0.383)
Own BMI/10 crossed with Partner's BMI/10	0.406*** (0.112)	-0.910 (0.765)	0.418*** (0.116)	-0.090 (0.794)
Partner's BMI/10	-0.989** (0.453)	6.869** (3.178)	0.571 (0.572)	2.633 (5.768)
(Partner's BMI/10) squared	-0.040 (0.077)	-0.884** (0.370)	-0.317*** (0.100)	-0.305 (0.900)
Control variables	As in Table C2			
Hansen-Sargan p-value	_	0.645	_	0.060
Observations	10128	10128	10128	10128

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

[1] In the 2003 fact sheet of the World Health Organization on obesity and overweight. Available on-line at http://www.who.int/hpr/NPH/docs/gs_obesity.pdf.

[2] Christakis and Fowler, (2007, 2008; hereafter CF) find significant effect of others' obesity status on one's own risk of obesity in a collection of social networks made of individuals followed over two decades. Cohen-Cole and Fletcher (2008, 2009) argue that CF's methodology does not distinguish correlation between causality: the estimated effects would reflect selection of obesity-prone individuals into common social networks and/or the impact of common unobservable factors.

[3] Obviously, when preferences are quadratic, continuous and the set of feasible actions is compact, the best-response function does correspond to the linear-in-means model of the SI literature, with endogenous SI effects as long as the cross-partial derivatives of the utility function with respect to partners' choices are non-zero.

[4] There is ethnographic evidence that even obese individuals are able to lose one-third of their weight for some months (see for instance Lhuissier, 2009). Clinical observations of obese individuals suggest however that their ability to lose weight is very limited, even when hypocalorie slimming diet is associated with bariatric surgery (see reference Basdevant). There is however no doubt that individuals can become obese very quickly (as in the film *super size me!*).

[5] Economic constraints refers both to the budget constraint – but individuals are always able to buy less calories, or to eat more cheap energy-dense food to gain weight -, and to labour market constraints: a blue-collar worker in a job that is very demanding in terms of muscle mass might not be able to become thin (see Lakdawalla and Philipson, 2006, on the relationship between jobs and BMI)..

[6] This may explain why the obesity wage penalty is greater in higher- than in lower-income occupations (Carr and Friedman, 2005). However, high-income positions often come with employer-provided health insurance in the US. The obesity wage penalty may simply represent the employer's risk premium (Bhattacharya and Bundorf, 2005).

[7] Veblen (1899, chap. 6) states for instance that: "It is more or less a rule that in communities which are at the stage of economic development at wich women are valued by the upper class for their service, the ideal of female beauty is a robust, large-limbed woman [...] This ideal suffers a change in the succeeding development, when, in the conventional scheme, the office of the high-class wife comes to be a vicarious leisure simply.[...] It has already been noticed that at the stages of economic evolution at which conspicuous leisure as a means of good repute, the ideal requires delicate and diminutive bands and feet and a slender waist". He does however moderate his position by acknowledging that this ideal of beauty may be weakened in the upper leisure class, where individuals have "accumulated so great a mass of wealth as to place (their) wom(e)n above all imputation of vulgarly productive labor". Note also that he does not treat the evolution of ideals of beauty for men, as only women were an object of choice.

[8] Boltanski (1971) notes that working-class men often expressed their disdain for the effeminate bodies of upper-class men.

[9] They suggest that overweight could be debilitating in warm countries, but an asset in cold countries. However, an alternative interpretation is that drinking beer moderately at the pub with one's colleagues may raise a man's pay... as well as his BMI (Van Ours, 2004).

[10] This sequential representation of the household decision process is largely heuristic, as we can imagine that spouses first make labour market choices, and then, conditionally on these (and the income-sharing rule), choose their body shape. Or that all choices are made simultaneously.

[11] Following the economic approach to social interactions (SI), we can reclassify interactions in body shapes within the couple into three categories (Manski, 2000). First, there are preference interactions, whereby individual *j*'s BMI enters directly in the second-stage utility function of individual *i*: social comparisons and the joint production of leisure enter in this category. Second, constraint interactions generated by needs for caring and productivity and bargaining considerations. Third, observational learning produces expectation interactions, as the individual may obtain information on the risk of putting on weight from an obese or overweight partner. Preference, constraint and expectation interactions can all generate contagion effects.

[12] Lundborg *et al*. (2007) uncover empirical evidence of a negative correlation between Body Mass Index (BMI) and the aggregate risk of divorce (proxied by the national rate) among the married middle-aged European individuals in data from SHARE. This correlation is not significant for singles, which is interpreted by the authors as evidence of forward-looking behaviour: the greater the risk of divorce, the more individuals prepare their body for a future come-back on the marriage market. An alternative interpretation is in terms of the value of the threat point if marital gains are shared according to a Nash bargain.

[13] Psychologists often assume a linear reporting device, as in all the structural equation modelling literature: $H(x)=ax+b$. Here, $H'=a$ and $H''=0$. Economists work more often with ordinal reporting devices, such as the ordered probit where $\Pr(LS\geq j)= \Pr(V>b_j)= H_j(V)=1-\Phi(b_j-V)$ with $\{b_j, j=1,\ldots,J\}$ a set of ordered thresholds and $\Phi(.)$ the c.d.f. of the standard normal law . Here, $H_j'=\varphi(b_j-V)>0$ and $H_j''=+(b_j-V)\ \varphi(b_j-V)<0$ for $V>b_j$.

[14] This assumption relies on the observation that individuals in a language community label similarly their internal feelings. See Ferrer-i-Carbonnell and Frijters (2004).

[15] For women, the interaction effect is almost everywhere positive, albeit often not significant (see Figure C17). For men, there is a negative but not significant interaction effect that appears for men who are married with a very thin woman (BMI lower than 20), and are themselves thin.

[16] Such a concern is common when studying the coexistence of obesity and under-nourishment in some developing countries.

[17] For instance, Christakis and Fowler (2007) find that spouse's obesity has a positive causal effect on the probability of becoming obese.

[18] Environmental variables influencing either calorie intakes or expenditures are not good instruments, as they may be correlated with life satisfaction. For instance, local public provision of sport facilities is correlated with the neighbourhood-related overall quality of life, and therefore with life satisfaction. Even food prices may be related to the density of food supply, which is itself a determinant of household allocation of time.

[19] This fact underlines once again the heroic character of our identifying assumption. On the one hand, the instrumentation works, because of this strong positive correlation in overweight and obese between past changes and current levels of BMI. But, ethnographic and clinical accounts of obese lives show that obesity often develops after a shock, such as a divorce, the loss or the birth of a child etc. These events are likely to have a direct impact on LS. On the other hand, the lack of correlation in thin people may explain that the test of over-identifying restrictions pass.