Happy House: Spousal weight and individual well-being

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SPOUSAL WEIGHT AND INDIVIDUAL WELL-BEING

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Abstract

We use life satisfaction and Body Mass Index (BMI) information from three waves of the GSOEP to test for social interactions in BMI between spouses. Semi-parametric regressions show that partner's BMI is, beyond a certain level, negatively correlated with own satisfaction. Own BMI is positively correlated with satisfaction in thin men, and negatively correlated with satisfaction after some threshold. Critically, this latter threshold increases with partner's BMI when the individual is overweight. The negative well-being impact of own BMI is thus lower when the individual's partner is heavier. This is consistent with social contagion effects in weight. However, this cross-partial effect is insignificant in instrumental variable regressions, suggesting that the uninstrumented relationship reflects selection on the marriage market or omitted variables, rather than contagion.

Keywords: Obesity, subjective well-being, BMI, social interactions.

JEL Codes: C14, I12, I3.

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1   Introduction

One of the most remarkable social changes in developed countries over the past 30 years has been the sharp increase in the prevalence of obesity and overweight. This has been so rapid that the World Health Organisation declared in 2003 that "obesity has reached *epidemic* proportions".[2] Although the rise in weight can be analysed through any number of different lenses, it is the use of the word "epidemic" here which has attracted a certain amount of attention. Epidemics are typically diseases that are transmissible through identifiable pathogenic agents; here the term is applied to health changes that are, *a priori*, under the individual's own control.

Obesity can however have an epidemic dimension if others' body weight somehow affects the individual's (optimal) decisions regarding their own body weight. Along these lines, a vigorous recent debate has developed regarding the existence of such contagion effects in social networks (Christakis and Fowler, 2007, and Fowler and Christakis, 2008, *vs*. Cohen-Cole and Fletcher, 2008a and 2008b).[3] This literature typically looks for contagion effects in data on what are arguably individual choice variables, such as BMI or obesity, and individual outcomes are modelled as a function of those in the individual's peer group.

The key question in this contagion literature is whether the identified correlations between individual and peer-group outcomes in the data are causal. As is by now well-known, finding that individuals who are located in the same area (or network, or peer group) have similar

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[2] 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.

[3] Christakis and Fowler 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 argue that Christakis and Fowler'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.

outcomes along some dimension is not sufficient to show that they influence each other (Manski, 1993, 2000).

A first point is that individuals who live in the same area may well be subject to the same prices, environment or other constraints. In the context of the current paper, those living close to each other will be very similar in terms of food prices and food supply. This is the standard issue of a hidden common factor or contextual effect: correlation in outcomes here does not reflect causality.

Second, individuals choose where they live and with whom they interact. For "birds of a feather" reasons, those we observe in close proximity to each other may well have similar (observed or unobserved) tastes. As above, their outcomes will then likely look the same, and again this does not prove causality.

The last possibility is that there are indeed contagion or peer effects, in the sense that the behaviour of my peer group affects my own marginal utility and therefore my decisions. Regarding body weight, we may well imagine that a heavier peer group reduces my own incentives to lose weight.

Empirically, it is not easy to distinguish between these three possibilities using only data on observable outcomes, which explains why the case of contagion effects in obesity is far from being closed. We here propose a complementary approach to the existing literature, by appealing to individual well-being scores, and relating them to both own and peer-group weight.

The reason for doing so is that, as noted above, social contagion requires that others' outcomes change the marginal utility (or cost) of my own actions (Clark and Oswald, 1998). In the current paper's context, if my own disutility of being overweight falls with the weight of my peer group then snowball effects will result. Having access to well-being data allows us to test this implication directly. We here use life satisfaction as the well-being measure, and the Body Mass Index (BMI: weight in Kilograms divided by height in Metres squared) to account for weight. Absent good information on who is in the individual's peer group (and how much they weigh), we consider a very local peer group: the individual's partner. We thus estimate life-satisfaction equations as a function of own and partner's BMI in three waves of German Socio Economic Panel data (2002, 2004 and 2006). We introduce both main effects of own and

3

partner's BMI, and, crucially, an interaction between the two. This latter is what identifies the effect of partner's weight on the marginal utility (or disutility) of own weight.

We find that partner's weight reduces the disutility of own weight when the individual is overweight, consistent with social contagion. We can calculate ideal BMI levels, at which life satisfaction is maximised. When both partners are thin, ideal BMI is close to 21-22 for women, and 24-25 for men.

However, BMI levels are likely to be endogenous, as they represent choice outcomes, and therefore unobserved preferences, and omitted variables that are common to both partners. We thus implement an instrumental-variable strategy, which changes the results: the interaction effects between BMIs become insignificant overall, and significantly negative in longer-lasting marriages.

The contrast between the instrumented and uninstrumented results is key. Observationally (i.e. in the uninstrumented results), own-weight matters less for well-being when one's partner is overweight too. However, within a couple, if we exogenously make one member heavier, the marginal disutility of own weight is unaffected. The instrumented results are thus inconsistent with social contagion; the fact that couples with similar weights seem to be happier thus likely reflects positive assortative matching on weight in the marriage market (similar weight individuals are more likely to marry each other) or some omitted variable.

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 partner BMI on well-being. Section 3 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.

4

2 Social Interactions, Utility and BMI

Our aim in this paper is to evaluate the relationship between BMI and utility within couples.[4] The critical questions are thus how partner's BMI affects the individual's own utility, and whether this effect depends on the individual's own BMI. The remainder of this section appeals to the existing literature in Economics and Sociology to discuss the basis of such interaction effects with respect to body weight.

2.1 Social interactions and the utility function

Clark and Oswald (1998) explore in detail the consequences of social interactions, both from a normative (they may generate multiple equilibria, with no guarantee of Pareto optimality) and a positive point of view (they can explain both following and deviant behaviours). While research in the domain of social interactions has mostly focussed on the identification of reaction functions,[5] we here borrow empirical tools from the economics of well-being to identify directly one of the primitives of social interactions: the effect of others' body shape on the marginal utility of my own weight, where "others" here refers to the individual's partner.

We thus distinguish below between the direct welfare effects of own and partner's BMI on the individual's utility, and, critically for the social interaction aspect of our work, the cross-partial derivative. As noted above, if this latter is non-zero having a heavier spouse may affect the marginal utility of my own weight, and therefore the incentives to gain or lose weight.[6]

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[4] The analysis here, and the term "married", refers to men and women who report being together in a couple, regardless of the actual legal arrangement describing their relationship.

[5] 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 social interactions literature, with endogenous social interaction effects as long as the cross-partial derivatives of the utility function with respect to partners' choices are non-zero.

[6] Blanchflower *et al.* (2009) used GSOEP data to analyse the impact of own BMI, relative to the average BMI by age, on life satisfaction. Our work differs from theirs in three key ways. 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 use a non-specific measure of well-being, life satisfaction, rather than a directly weight-related one (feeling overweight). Last, we take endogeneity concerns seriously.

5

2.2 The utility of own BMI

Individuals have some degree of control over their body shape, even though this latter is limited by physiological mechanisms, at least in the short run (Cabanac, 2001). There is evidence from the social-psychology literature that individuals have an ideal body shape, which maximizes their satisfaction with body size. This latter can be thought of as a sum of satisfactions over a number of domains, amongst which probably figure health, beauty and the utility of eating (Etilé, 2007). Ideal body shape, and so BMI, is therefore likely related to health concerns, aesthetic preferences, and the taste for food.[7]

The health aspect of BMI typically concerns both under- and over-weight. According to the World Health Organisation, individuals are underweight when BMI is under 18.5, overweight when it is over 25, and obese for figures of 30 or more. Epidemiological work has shown that mortality and morbidity risks increase significantly for BMI over a threshold of 27-28 for most adults (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 will lower utility. Health is likely linked to productivity, and therefore labour-market outcomes. Both Averett and Korenman (1996) and Cawley (2004) find that medically-obese white women earn lower wages in the USA. BMI may therefore affect utility through health-related labour-market outcomes.

Aesthetic preferences are especially influenced by social norms of beauty, which differ across time and social classes.[8] Using individual French data on actual and ideal BMIs, Etilé (2007) finds that, for given levels of education, income and household structure, average ideal BMI does

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[7] 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). However, for most adults, the correlation between BMI and body fat remains fairly strong (Prentice and Jebb, 2001).

[8] The turn of the Twentieth century was marked by a change in ideals of beauty, especially for women. 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 (Fischler, 1990). This diffusion process 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, and Boltanski (1971) notes that working-class men often expressed their disdain for the effeminate bodies of upper-class men.

6

not differ between employees, professionals and executives, while blue-collar workers have higher ideal BMIs. Ideal BMI will not thus necessarily correspond to any health threshold (*i.e.* neither the 27-28 BMI health threshold, nor the official WHO overweight threshold of 25). This diversity in ideal BMI may spill over to the labour-market outcomes evoked above: using ECHP data, Brunello and D'Hombres (2007) show that the wage-BMI relationship is significantly negative in Southern European countries, but zero in Northern Europe.

Finally, BMI is 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.

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: 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 left 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 that likely differs from the medical threshold of 27-28, and asymmetric, being flatter to the left of this peak. This peak represents ideal BMI, which maximises individual utility.

2.3 Partner's BMI and utility

Partner's BMI may well have a direct effect on utility, independently of the individual's own BMI. It can also affect the marginal utility of own BMI, so as to produce contagion effects; these will be discussed in Section 2.4 below.

Partner's health and labour-market outcomes depend on their BMI, as discussed above. Part of the individual's preference for partner's health is undoubtedly altruistic. A more self-interested argument is that individuals prefer to have a healthy partner to look after them in case they

7

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).

Individuals have aesthetic preferences over themselves (wanting to look good), but also their partners. 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 may be explained by social norms. Partner's BMI therefore affects individual utility for both health and aesthetic reasons.

2.4   BMI interactions

We now consider interactions between own and partner's BMI in utility, which we refer to as cross-partial effects. There are four different channels of influence.

First, there is ***household production***, and we can specifically imagine the joint production of leisure, where a significant gap in BMIs may prevent the couple from undertaking certain activities together (e.g. eating or strenuous physical activity).

Second, individuals may compare their body weights to each other, as in the literature on relative utility (see Clark, 2008, and Clark *et al*., 2008). While being overweight likely reduces utility, ***social comparisons*** imply that this negative impact is watered down if the partner is overweight too. With a household-based reference group, an overweight individual should suffer less psychologically if their spouse is overweight as well.

Social comparisons and household production arguments both imply that the cross-partial effect is positive when both partners' BMIs are both under or both 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. In this case, an overweight partner's BMI may have a negative effect on the marginal utility of own BMI. Further, individuals with overweight and ill partners may be responsible for part of their health care and provide a greater part of household production. Both of these will be easier if they are not overweight themselves. Both ***health care needs*** and ***information*** about health risks

8

may switch the complementarity of BMIs in the production of utility into substitutability when both partners are overweight.

Last, there is a ***productivity and household bargaining*** argument. The BMI-income relationship will have an effect on both the amount of household output, as discussed in Section 2.3 above, but also potentially on its division. An overweight spouse may earn less, reducing household resources. However, if bargaining power in the household depends on relative weight (via individuals' chances in the remarriage market), then those whose spouse puts on weight will see their bargaining power rise.[9] The overall cross-partial effect here is uncertain, as the individual gains a larger share of a smaller cake, and any data is consistent with the presence of this phenomenon.

These four aspects of spousal interactions imply that partners' BMIs may be complements or substitutes in the production of utility, depending on the values of own and partner's BMIs. Only complementarity (a positive cross-partial effect) is consistent with contagion effects. Section 3 below presents the data that we will use to evaluate the sign of the cross-partial effect in life-satisfaction regressions.

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 our key 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

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[9] 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 married middle-aged European individuals in SHARE data. This correlation is insignificant 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.

9

year only. 73.4% of the 52699 individual-year observations represent individuals who are living in a couple ("married"). The main estimation sample, Sample 2, is made up of the couples of men and women in Sample 1, producing information on 6555 couples, of whom 66.0% are observed over all three years. There are fewer married couples in Sample 2 than in Sample 1, due to transitions into and out of marriage between 2002 and 2006 (see Table A1).

Table A2 in Appendix A shows the descriptive statistics for the married and unmarried in both samples. There are 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 in apprenticeship or unemployed than are married men. These statistics reflect the matching equilibrium in 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. The married in Sample 2 are mostly similar to those in Sample 1. We now present our key variables: life satisfaction and BMI.

The dependent variable in the empirical analysis is Life Satisfaction. 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 (Ferrer-i-Carbonell and Frijters, 2004; van Praag and Ferrer-i-Carbonell, 2004).

The main explanatory variable in our analysis is BMI. Table A2 shows that the single have lower BMIs than do the married, with this BMI gap being smaller for women than for men. This gender difference may partly reflect age, 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.

Figure 1 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

10

satisfaction is almost always decreasing in own BMI, while men's satisfaction is hump-shaped, increasing up to a BMI of about 25 (the threshold for overweight), and then decreasing. Men with low BMIs are more satisfied than men with BMIs of over 32, but less satisfied than overweight men. One reading of Figure 1 is that ideal BMI is relatively low for women, but close to the overweight level for men. This gender asymmetry may reflect gender differences in aesthetic norms or tastes for food, since medical norms are not gendered.

4   Satisfaction and Couple BMI

This section estimates life satisfaction equations using both least squares and semi-parametric methods. The empirical model is:

$$LS_{it} = f(W_{it}, W_{jt}) + \alpha X_{it} + \varepsilon_{it} \tag{1}$$

where W_{it} and W_{jt} are the two partners' BMIs at time t, X_{it} is a set of control variables, and ε_{it} is an error term.

4.1   *Parametric regressions*

We first estimate equation (1) parametrically by gender, specifying the function f(.) as a series of dummy variables. We construct three dummies showing whether the individual is not overweight (BMI<25), overweight but not obese (25≤BMI<30) or obese (BMI≥30). The dummies for the two partners are then interacted, producing nine possible combinations of spousal weights.

The other control variables in the regressions include age, real equivalent after-tax and transfers income (in 2004 Euros), the number of individuals in the household, labour market status (full-time employee, which is the reference category, part-time employee, apprentice, retiree, unemployed, housewife/husband, and other), education (in years), and wave and region

11

(Länder). These linear equations for men and women are estimated simultaneously by 3SLS techniques.[10]

The omitted BMI category in these regressions is "Man not overweight: Woman not overweight". The estimated coefficients in Table 1 show that life satisfaction is lower for all other spousal weight categories. For ease of presentation, the pattern of estimated coefficients in Table 1 is also depicted graphically in Figure 2.

The top-left panel of Figure 2 shows that women's life satisfaction falls with their partner's BMI, as long as they are not overweight themselves. However, when they are overweight, they are better-off when their partner is overweight too (top-middle panel), and when they are obese, they are better off when their partner is overweight or obese (top-right panel: the life-satisfaction difference is 0.25 points in the latter case). For women, the best life-satisfaction situation is always to have the same weight status as their partner.

The story for men is somewhat different. As for women, non-overweight men are most satisfied, *ceteris paribus*, when their partner is not overweight either. However, and contrary to women, overweight men are also the most satisfied when their partners are not overweight. The situation changes for obese men, who are the most satisfied with an obese partner.

The "matching" between partners' weights thus seems perfect for women, but less so for men who are most satisfied with partners in the lowest-weight category, as long as they are not obese themselves. The overall conclusion from these parametric regressions is that there would seem to be significant positive cross-partial effects in BMI for women, but rather less so for men.

The regressions in Table 1 include all of the standard control variables described above. We have not shown their estimated coefficients for space reasons (and because there are now any number of published pieces of work which appeal to GSOEP life satisfaction regressions). As is often found, life satisfaction is higher for the richer and the better-educated, lower for the unemployed, and there is a U-shape relationship with age, minimising in the late forties.

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[10] The ordered probit model is very popular in the well-being literature. In our sample, 3SLS, OLS and ordered probit with or without individual random effects yield very similar results.

The results so far have relied on an *ad hoc* specification of the f(.) function in equation **(1)**. Following the arguments in Section 2.4, the sign of the cross-partial effect likely depends on own and partner's BMIs. To trace out the points at which this effect changes sign, and to check that our empirical results do not depend on the choice of functional form, we now turn to semi-parametric estimation.

4.2   Semi-parametric regressions

We here estimate equation **(1)** without explicitly specifying the shape of the relationship between partner BMI and own life satisfaction. To this end, we use a penalized-spline approach, which is implemented using linear mixed models and bivariate basis functions of partner BMI (Ruppert *et al.*, 2003). Some technical details of the estimation procedure are provided in Appendix B.

The regression results are depicted by a series of figures which represent contour maps of life satisfaction levels, marginal effects and cross-partial effects, in the space of own and partner BMIs. In all of the figures, the man's BMI appears on the Y-axis and the woman's BMI on the X-axis.

The left and right panels of Figure 3 show the conditional mean life satisfaction scores for men and women respectively. These are conditional in the sense that all of the standard control variables described in Section 4.1 above are also included in the regressions (which controls attract coefficients that are qualitatively extremely similar to those in the parametric analysis).

The figures are to be read as contour maps. The highest life satisfaction scores are reached at the peak of the hills. In the left-hand panel, this peak satisfaction corresponds to an own BMI of between 22 and 23 for women, and a partner BMI of between 24 and 25. Remarkably, the coordinates of peak satisfaction for men in the right-hand side panel are almost exactly the same. Hence, there seems to be little gender difference in the BMI values at which both partners' satisfactions are maximised.

The iso-satisfaction lines around the peak are approximately symmetric around the 45-degree line. Any deviation from this line corresponds to lower life satisfaction. Satisfaction also falls as we move away from the peak along the 45-degree line, be it to the South-West or the North-East.

13

Hence, both jointly high levels of BMI and jointly low levels of BMI are associated with lower well-being, as is the BMI gap between partners.

Figure 4 presents the results of significance tests for the marginal effects of women's BMI on their own and their partner's life satisfaction. The black area here denotes BMI pairs for which the marginal effect of women's BMI is significantly positive at the 5% level, the grey area BMI pairs for which it is significantly negative, and white areas insignificant effects. These figures thus provide information about the significance of the slopes of the hills depicted in Figure 3.

Figure 4 refers to the marginal satisfaction effects of female BMI. As women put on weight we move horizontally from left to right in this figure. For example, in the left-hand panel, consider a very slender woman (i.e. at the far left of the figure) whose partner has a BMI of 25. As this woman gains weight, her satisfaction increases significantly, but only up until her BMI hits around 19.5. After that point, increasing BMI has no significant effect on her satisfaction, and indeed starts to reduce it significantly once she hits a BMI of 23.5. With a male BMI level of 25, the woman's ideal BMI from her point of view is thus somewhere between 19.5 and 23.5.

Now imagine the same women, but this time with a partner whose BMI is 30 (so that we start from a point in the North-West of the figure). As she gains weight her satisfaction increases significantly up to an own BMI level of 21.5, and now does not turn down again significantly until an own BMI level of 26.5. With a much heavier male partner, the woman's ideal BMI from her point of view is now in the interval between 21.5 and 26.5.

The right-hand panel of Figure 4 shows the effect of female BMI on her partner's satisfaction. This figure is read completely analogously to the left-hand panel for female satisfaction described above. From a BMI of 25 male point of view, the woman's ideal BMI is in the 20.5-24.5 range, while from a BMI of 30 male point of view, the woman's ideal BMI is in the 23.5-30.5 range.

For completeness' sake, Figure 5 shows the analogous figures for the marginal effect of male BMI on both own and partner's life satisfaction. As men put on weight we move vertically from bottom to top in this figure. The results here are comparable to those in Figure 4 and probably do not call for any particular further comment.

14

Figures 4 and 5 thus underline three main points about weight and well-being in couples. The first is that the cross-partial effect is positive, which is consistent with household production complementarity and social comparison noted in Section 2.4 above. The marginal effect of own BMI on own and partner's life satisfaction is more positive at higher values of partner's BMI. This is illustrated in Figure 6 which shows that the cross-partial effect is always positive, although it is not significant for low-BMI couples and very-high BMI couples.

The second main point that comes out of these figures is that, perhaps unsurprisingly, males' ideal BMI from both their own and their partner's point of view is greater than females' ideal BMI (again, both from their own and their partner's point of view).

Last, there is a sex difference in terms of views of women's ideal BMI: the ideal woman from the male point of view has a higher BMI than the ideal woman from the female point of view. One interpretation of this finding is that women may be more sensitive to would-be body shape norms (regarding women's weight) than are men.[11]

This section has thus presented evidence of significant cross-partial effects in partners' weights, for both men and women. One remaining question is what exactly drives these significant findings. The key distinction here is between the exogeneity and endogeneity of weight. To identify social interactions, we require that an exogenous movement in one partner's weight affect the marginal utility of one's own weight (and thus one's own behaviour). Alternatively, if weight is considered to be endogenous, then our results in this Section could instead represent a hidden common factor which drives both partners' weights and their satisfaction, or selection into couples, whereby individuals of roughly the same weight are more likely to be in a couple together. The following section attempts to distinguish between these alternatives by appealing to instrumental variable techniques.

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[11] The same result is found using French data in Etilé (2007).

15

5 Instrumental Variable Results

To instrument weight, we return to a parametric specification. This is justified by the fact that the cross-partial effect is positive for all of the BMI values in the Figures above. We consider a linear specification of equation **(1)** where own and partner's weight enter quadratically plus an interaction term between the two weights. We instrument these five weight terms via their first differences.[12] As we only have three waves of data, this boils down to modelling life satisfaction in the third wave of our data (2006), and instrumenting the weight variables by their evolution between waves 1 and 2, and 2 and 3 (i.e. 2002-2004, and 2004-2006). This provides five over-identifying restrictions (one for each instrumented variable); a Hansen-Sargan statistic is used to test their validity. We also report the Cragg-Donald statistic 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, and a value greater than 10 indicates that the instruments are fairly strong (Stock and Yogo, 2005).

Figure A1 in Appendix A shows that the correlation between BMI at 2006 and the change in BMI between 2004 and 2006[13] is positive and significant for the overweight only. As such, our instrumented estimates give more weight to individuals with higher levels of BMI, and the results should be thought of as more representative for the overweight.[14]

Table 2 presents both the instrumental variable results and, for comparison purposes, those of OLS regressions of the same specification. The results are presented separately for men and women. For each sex, three different samples are used: everyone, and then distinguishing between shorter and longer marriages (as defined by the median duration of marriage of 22 years in our data). The statistics at the foot of the table show that the over-identifying restrictions are accepted, and that the instruments are of good quality.

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[12] Weight is a dynamic process. As such we can appeal to the standard instrumentation techniques in linear dynamic models (Blundell and Bond, 1998).

[13] This is the most important of the two instruments, even though both are significant in the first-state regressions.

[14] As emphasised by Angrist and Imbens (1995), IV estimates of heterogeneous treatment effects identify average causal response in the population, and over-represent individuals whose behaviour is more affected by the instrument.

16

Own BMI exhibits a hump-shaped relationship with satisfaction in the instrumented results. This is to be compared to the negative correlation identified in Figure 1 for women. The instrumented and uninstrumented results likely differ due to the presence of an omitted variable which is correlated with BMI and satisfaction in opposite directions (from environment, personality, upbringing, or something else). Between women, those with lower BMI are thus more satisfied, but within subject the BMI-satisfaction relationship is not necessarily negative. Something similar can be seen for men. The weight-satisfaction relationship is hump-shaped in all specifications for them, but the peak shifts notably to the right in the instrumented results, again consistent with an omitted variable. It should again be borne in mind here that the instrumental approach tends to pick up local effects, and is more representative of the overweight in our data (see Figure A1).

Of most interest in this table is the fifth line, which shows the estimated coefficient on the interaction between own and partner weight in a life satisfaction regression. This interaction, which is positive in the OLS regressions for both sexes in the full sample, becomes negative, but insignificant, after instrumentation. The change from positive to negative can be read as signifying a selection effect, whereby individuals are happy to be in a couple with someone of the same weight. If such weight complementarity exists, then we will see positive assortative matching on the marriage market: individuals who are closer to some ideal BMI will tend to marry each other (as in Becker, 1973).[15] This positive assortative matching effect is what we pick up in the uninstrumented results.

Alternatively, the uninstrumented results may have been driven by a hidden common factor. It may be the case for instance that richer areas both provide healthier food options and better sporting facilities, affecting weight, and are also in general more pleasant places to live. Once

[15] 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. An 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.

17

within these common areas, changing spousal weight does not affect the disutility of my own weight.

Within a given couple, the instrumental results show that an increase in one member's weight no longer reduces the incentives of the other member to lose weight. As such, our results are not consistent with a contagion effect of weight within couples.

Columns 3 to 6 of each panel of Table 2 show the results when we split our sample up into shorter and longer marriage durations. It is striking that all of the difference between the OLS and the IV results comes from individuals who are in longer marriages. Any bias in the cross-partial effect then seems to concern primarily those in longer marriages.

The instrumented cross-partial effect for those in longer marriages is negative, and significantly so for women. As noted in Section 2.4 above, this is consistent with a healthcare effect, which may indeed be particularly salient in longer marriages where couples are likely older on average. It is also consistent with the fact that the instrument reflects more the experience of the overweight.

6 Conclusion

This paper has used three waves of German panel data to analyse the relationship between well-being and BMI in couples. While the analysis of well-being is of interest in its own right to describe the distribution of welfare, our particular aim here was to ask whether there exist social contagion effects in weight. To do so, we appeal to a very narrow peer group, the individual's partner. We then estimated life satisfaction equations to show that the negative effect of own weight was attenuated by partner's weight. Taken at face value, this is consistent with social contagion in weight: as others get heavier, my incentive to lose weight is reduced. This could reflect, amongst other things, social comparison of body shape or complementarity in household production.

However, we probably should not take these results at face value. While we are sure that the identified correlation is correct, it does not show causality and therefore does not prove contagion. To investigate, we instrument both own and partner's weight. The main result here is

18

that the attenuation (or positive cross-partial) effect found above completely disappears in instrumental variable analysis. We argue that this is consistent with matching by body weight (or by something correlated with body weight) on the marriage market, or an omitted variable. Individuals are happy to be in a couple with someone who has the same body shape as them, but within a marriage the fact that their partner puts on a few pounds does not affect their own preferred body shape. In longer-lasting marriages, we even identify a negative cross-partial effect: the heavier I am, the less satisfied I am that my partner gain weight. This may well show that one of the positive returns of being in a couple is mutual health insurance.

We conclude that social contagion in weight is unlikely to pertain in overweight couples. Health policy may not be able to count on a snowball effect in weight, at least within the household. As perhaps in other health domains, intervention needs to target individuals directly.

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20

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21

Tables and Figures

Figure 1. Life Satisfaction vs. own BMI, for men and women – univariate nonparametric regressions by gender - Sample 2
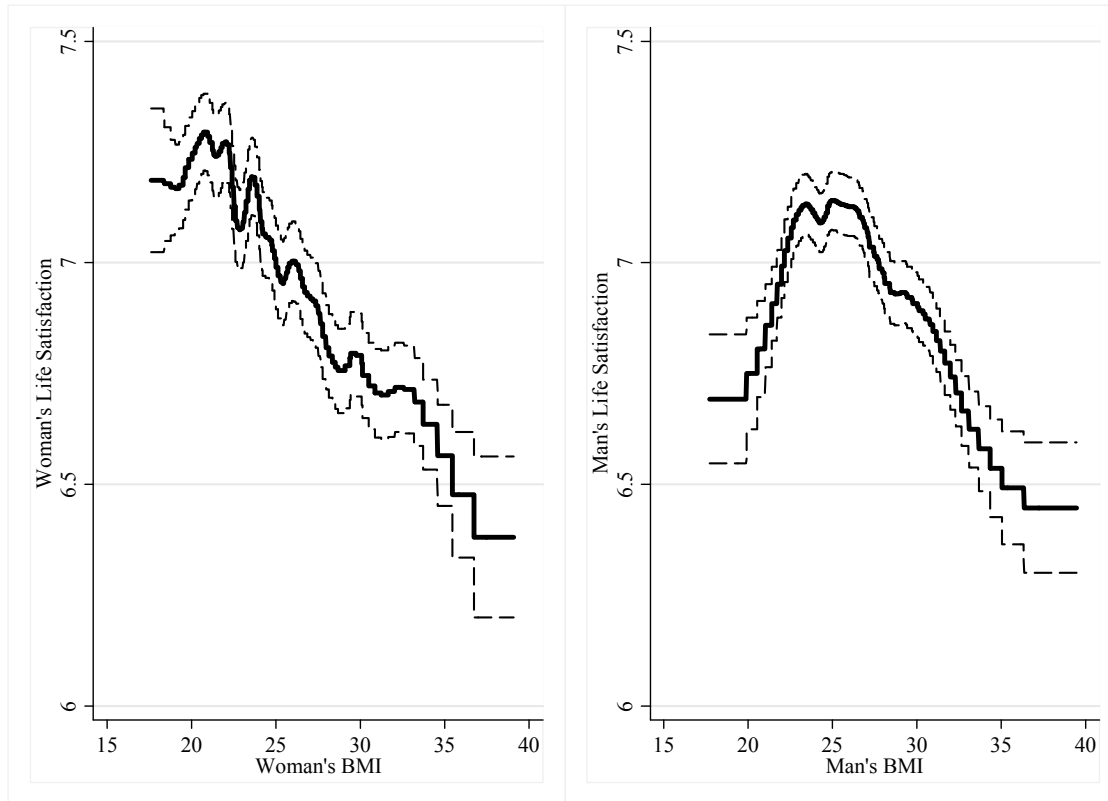
Table 1. Satisfaction and partners' BMIs – Parametric specification – Sample 2.

Gender	Women	Men
Technique	**3SLS**	**3SLS**
Man non-overweight, Woman non-overweight	Reference	Reference
Man overweight, Woman non-overweight	-0.106***	-0.032
	(0.037)	(0.036)
Man obese, Woman non-overweight	-0.178***	-0.243***
	(0.056)	(0.054)
Man non-overweight, Woman overweight	-0.227***	-0.220***
	(0.052)	(0.050)
Man overweight, Woman overweight	-0.098**	-0.050
	(0.042)	(0.041)
Man obese, Woman overweight	-0.281***	-0.273***
	(0.058)	(0.056)
Man non-overweight, Woman obese	-0.509***	-0.347***
	(0.081)	(0.079)
Man overweight, Woman obese	-0.253***	-0.083
	(0.057)	(0.056)
Man obese, Woman obese	-0.254***	-0.170**
	(0.070)	(0.068)

Control variables: partner's height, the interaction between own and partner's height, age, age squared, log(income), individual's years of education, number of household individuals, legal arrangement, dummies for labour market status (part-time worker, apprenticeship, retired, unemployed, full-time worker, house-wife/husband, and other), waves and Länder dummies.

Coefficient of correlation	0.512***
	Breusch-Pagan test of independence: p-value=0

Note: Standard errors clustered at the household level in parentheses; ** significant at 5%; *** significant at 1%; Normal = 1 if BMI<25 and 0 otherwise – the term "non-overweight" refers here to the WHO medical norm; Overweight = 1 if BMI ≥ 25 and BMI>30, and 0 otherwise; Obese = 1 if BMI ≥ 30 and 0 otherwise.

Figure 2. The effect of the own and the partner's BMI on Life Satisfaction – based on Table 1

Women's Life Satisfaction

Men's Life Satisfaction
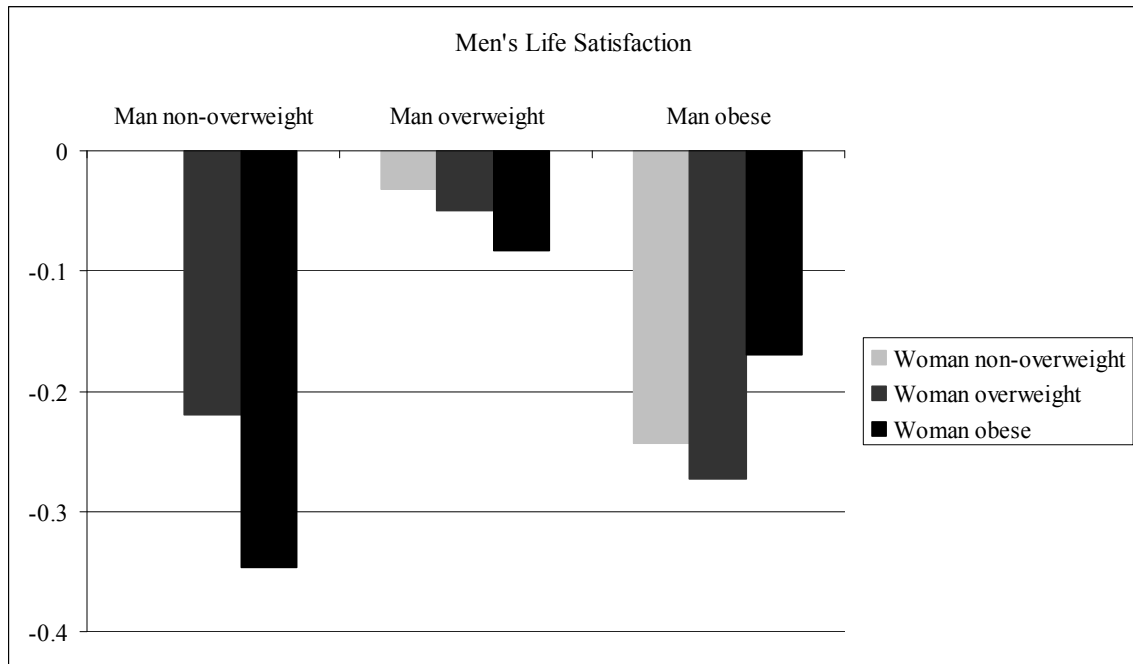
Note: These figures illustrate Table 1's results. They show for each sex, and for various assortments of BMI statuses, the average loss of Life Satisfaction in comparison with the Life Satisfaction of individuals in couples where both are non-overweight.

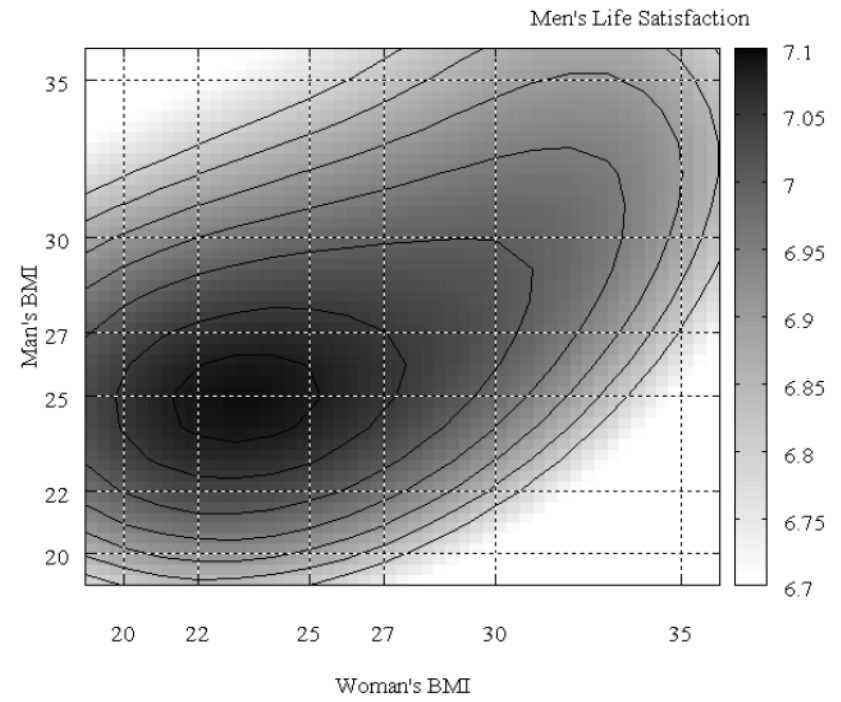*Figure 3. Hills of Life Satisfaction – semi-parametric regressions – Sample 2*
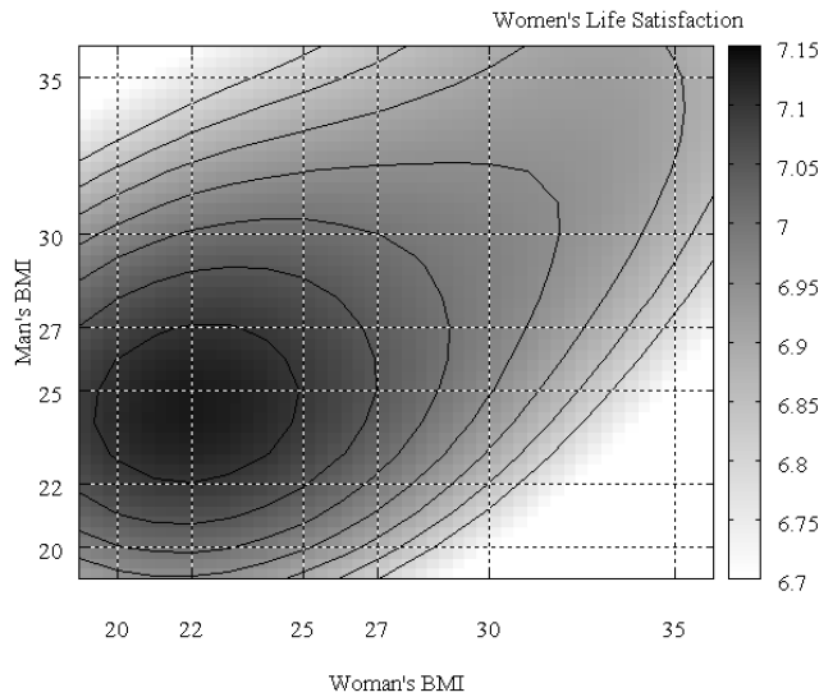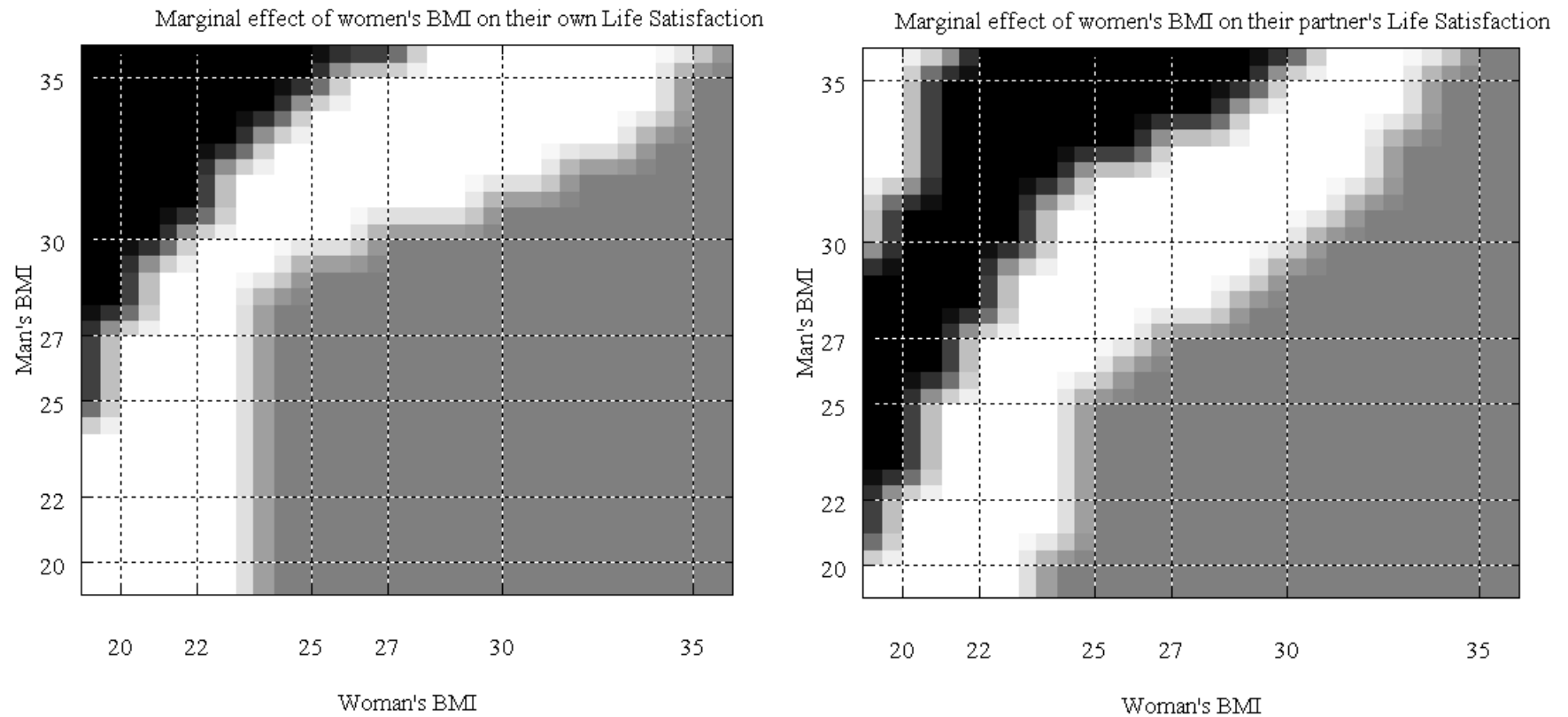
Figure 4. Slopes of the Hills - The marginal effect of women's BMI on their own and their partner's Life Satisfaction – significance at the 5% level

Marginal effect of women's BMI on their own Life Satisfaction

Marginal effect of women's BMI on their partner's Life Satisfaction

Note: Black areas correspond to a positive marginal effect; white areas to an insignificant effect; and grey areas to a negative marginal effect.
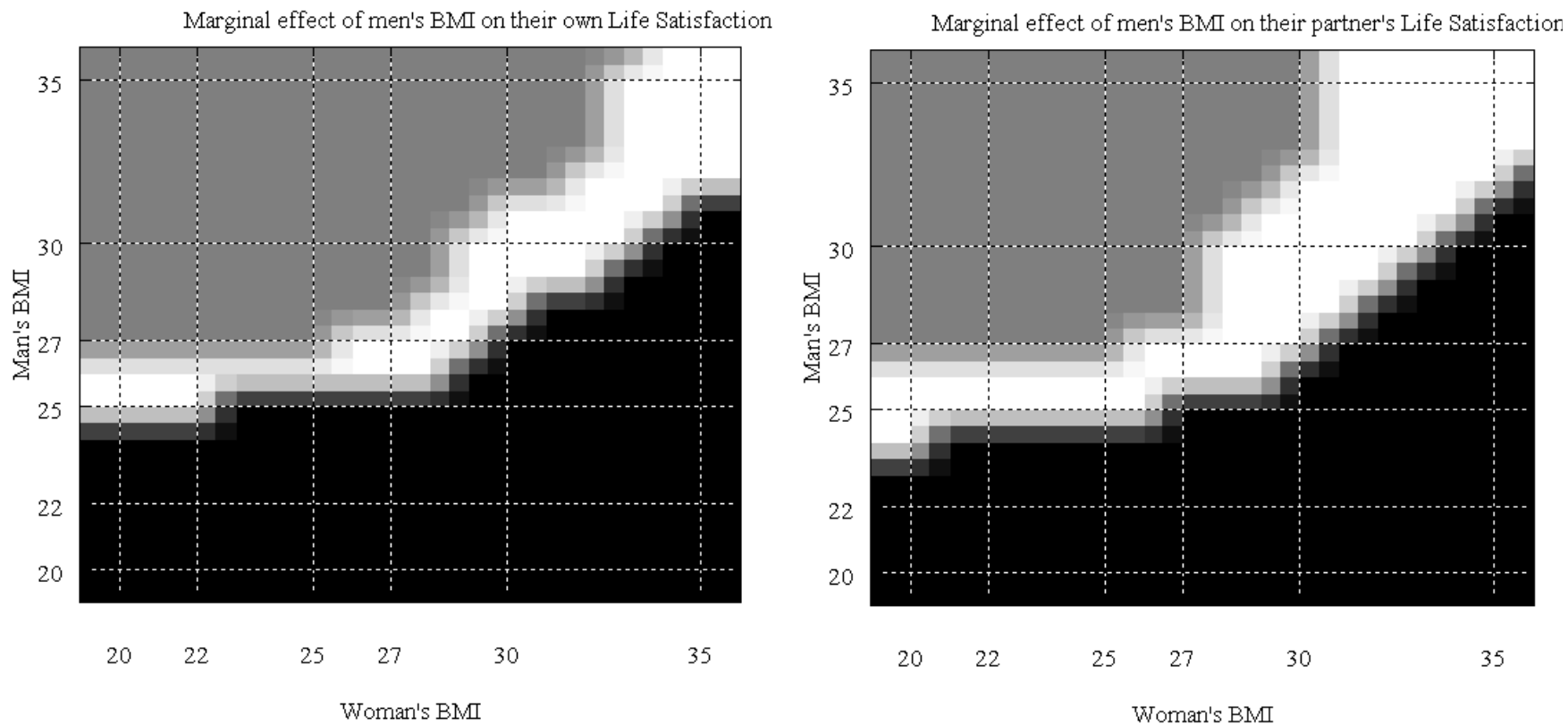
Figure 5. Slopes of the Hills - the marginal effect of men's BMI on their own and their partner's Life Satisfaction – significance at the 5% level
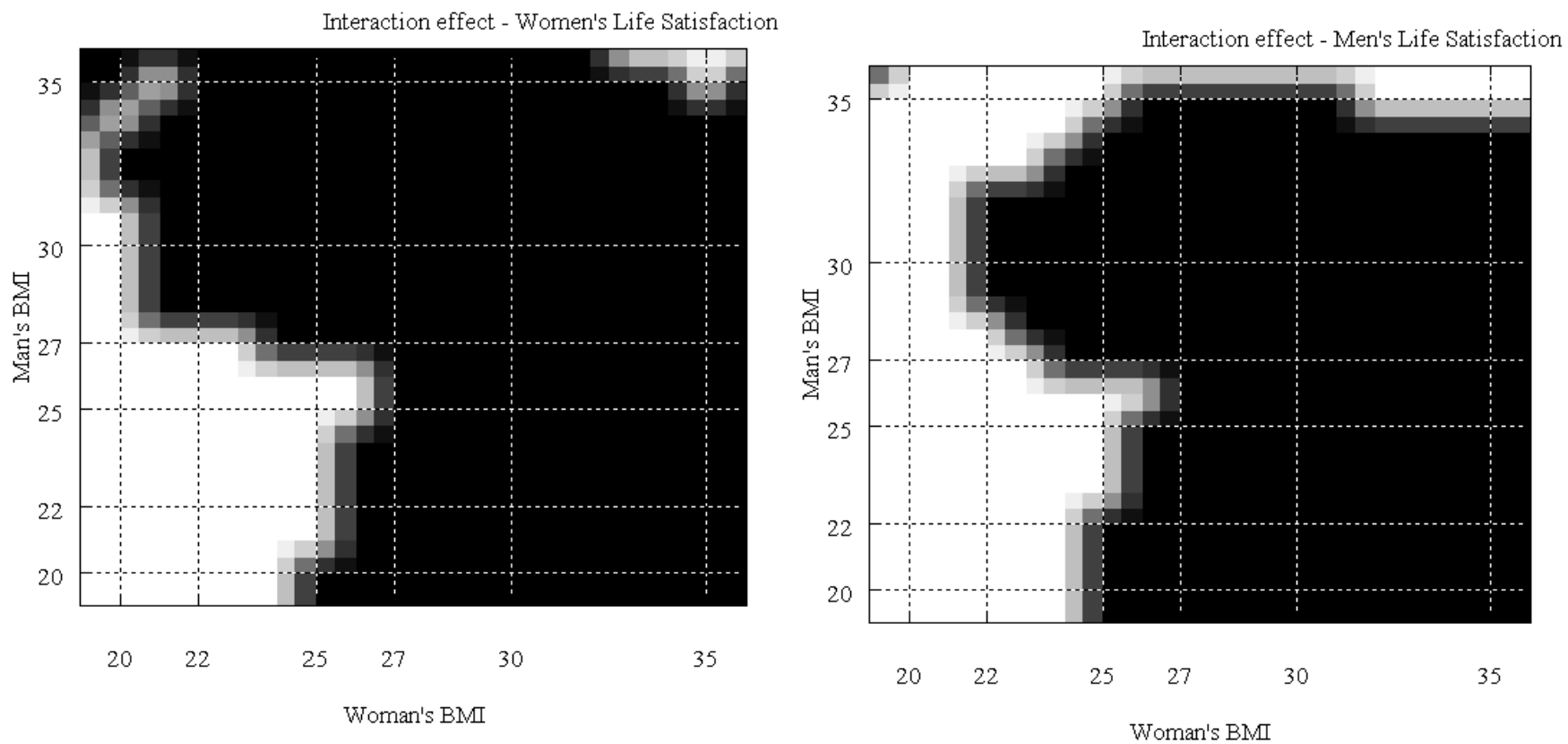

Note: Black areas correspond to a positive marginal effect; white areas to an insignificant effect; and grey areas to a negative marginal effect.

27

Figure 6. Interaction effects between own and partner's BMIs – significance at the 5% level

Note: Black areas correspond to a positive cross-partial effect, and white areas to an insignificant effect.

28

Table 2. Instrumental variable regression results – Individuals in sample 2 observed in 2002, 2004 and 2006

Gender	Women						Men					
Sample Selection	All		Short marriage		Long marriage		All		Short marriage		Long marriage	
Technique	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Own BMI/10	-0.133	5.243**	-0.014	1.446	-0.186	8.218***	2.740***	8.294***	1.946*	8.345*	3.467***	7.618**
	(0.716)	(2.090)	(0.966)	(2.798)	(1.083)	(3.016)	(0.858)	(2.774)	(1.134)	(4.302)	(1.290)	(3.395)
(Own BMI/10) squared	-0.186	-0.706**	-0.109	-0.330	-0.246	-1.037**	-0.681***	-1.256***	-0.435**	-1.422**	-0.896***	-1.061**
	(0.119)	(0.296)	(0.159)	(0.383)	(0.180)	(0.444)	(0.148)	(0.388)	(0.193)	(0.600)	(0.223)	(0.489)
Partner's BMI/10	0.402	4.465	-1.011	2.558	1.838	4.398	-0.409	3.095	-1.214	-0.736	0.780	6.928**
	(0.881)	(2.830)	(1.194)	(4.462)	(1.303)	(3.421)	(0.697)	(2.058)	(0.917)	(2.698)	(1.072)	(2.997)
(Partner's BMI/10) squared	-0.255*	-0.518	0.110	-0.470	-0.595***	-0.319	-0.135	-0.447	0.146	0.076	-0.456**	-1.051**
	(0.152)	(0.394)	(0.203)	(0.620)	(0.225)	(0.492)	(0.116)	(0.291)	(0.150)	(0.368)	(0.178)	(0.441)
Own BMI/10 crossed with Partner's BMI/10	0.334*	-0.556	0.098	0.008	0.503*	-0.888*	0.373**	-0.296	0.119	0.046	0.571**	-0.448
	(0.174)	(0.401)	(0.240)	(0.597)	(0.260)	(0.523)	(0.170)	(0.391)	(0.228)	(0.574)	(0.257)	(0.514)
Cragg-Donald Statistic		27.02		10.24		16.06		26.62		10.27		13.49
Hansen-Sargan test: p-value		0.85		0.91		0.83		0.77		0.86		0.65
Number of observations		4328		2127		2201		4328		2127		2201

<u>Note:</u> Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Control variables as in Table 1. IV = Instrumental Variables; OLS = Ordinary Least Squares. A Cragg-Donald statistic over 10 indicates that the instruments are not weak (Stock and Yogo, 2005). If the p-value of the Hansen-Sargan test of the over-identifying restrictions is greater than 0.1, then the exclusion restrictions can not be rejected.

Appendix A: Additional Statistics

Table A1. Characteristics of the samples

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

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

Gender		Women			Men	
Sample	1	1	2	1	1	2
Marital status	Single	Married	Married	Single	Single	Married
N	7753	19380	16683	6259	19307	16683
Life satisfaction	6.62	7.00	7.02 (1.73)	6.68 (1.88)	6.98	6.99 (1.69)
	(1.90)	(1.74)			(1.70)	
BMI	24.6	25.1	25.1	24.9	26.7	26.8
(Body Mass Index)	(4.4)	(4.2)	(4.1)	(3.6)	(3.5)	(3.5)
Height (in cm)	165.3	165.3	165.1	178.7	177.4	177.2
	(6.8)	(6.3)	(6.2)	(7.4)	(7.1)	(7.1)
Age	49.2	48.9	50.1	38.4	51.8	52.8
	(22.1)	(14.0)	(13.7)	(17.7)	(14.2)	(13.8)
Income: real	16397.2	22384.4	23 368.4	21227.7	22831.4	23 368.4
equivalenced after tax	(11149.6)	(23325.7)	(24630.9)	(27977.2)	(23439.3)	(24630.9)
and transfer, in 2004						
Euros						
Years of schooling minus	4.6	5.0	5.0	5.0	5.5	5.6
seven	(2.5)	(2.6)	(2.6)	(2.5)	(2.9)	(2.9)
Type of marital arrangement						
Legally married	0.0%	0.0%	94.5%	0.0%	0.0%	94.5%
Cohabiting couples	0.0%	12.5%	5.5%	0.0%	11.8%	5.5%
Other control variables						
Full-time worker	27.4%	25.1%	22.9%	47.3%	61.9%	61.1%
Part-time worker	13.5%	29.1%	29.8%	6.6%	3.6%	3.5%
Apprenticeship	5.6%	0.4%	0.2%	11.7%	0.3%	0.2%
Retired	34.2%	18.3%	19.6%	13.4%	24.9%	26.4%
Unemployed	6.1%	5.4%	5.1%	9.5%	5.9%	5.5%
Housewife/husband	10.8%	24.7%	25.9%	1.8%	1.8%	1.8%
Other job status	9.8%	2.6%	2.4%	11.2%	3.3%	3.2%
Number of individuals in	2 (1.4)	3.0 (1.1)	3.0 (1.1)	2.2 (1.5)	3.0 (1.1)	3.0 (1.1)
the household						
Year = 2002	31.7%	33.6%	34.0%	32.3%	33.7%	34.0%
Year = 2004	34.9%	35.3%	35.0%	35.5%	35.2%	35.0%
Year = 2006	33.4%	31.1%	31.0%	32.2%	31.2%	31.0%

Figure A1. BMI in 2006 vs. change in BMI between 2004 and 2006 –nonparametric regressions – Women (left) and Men (right)
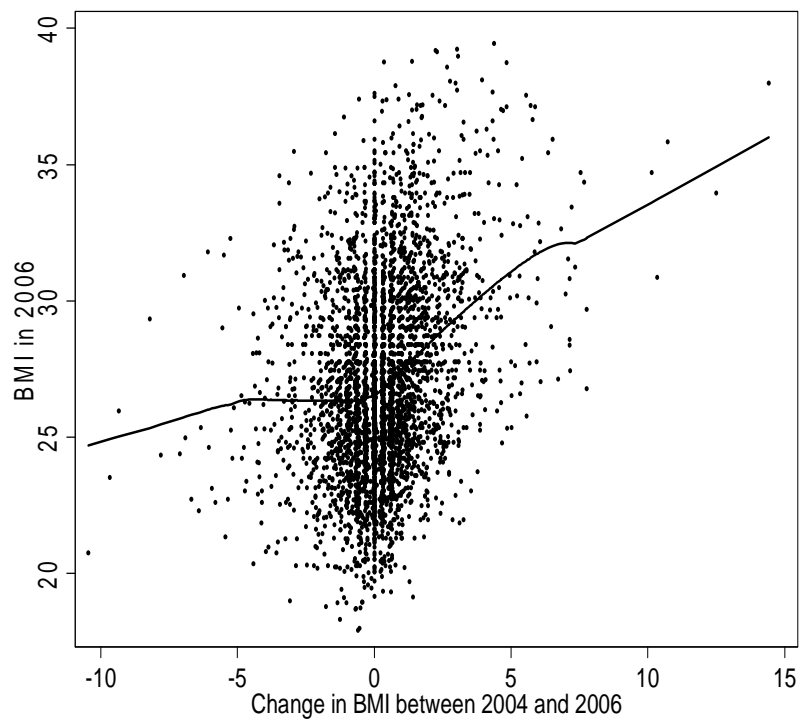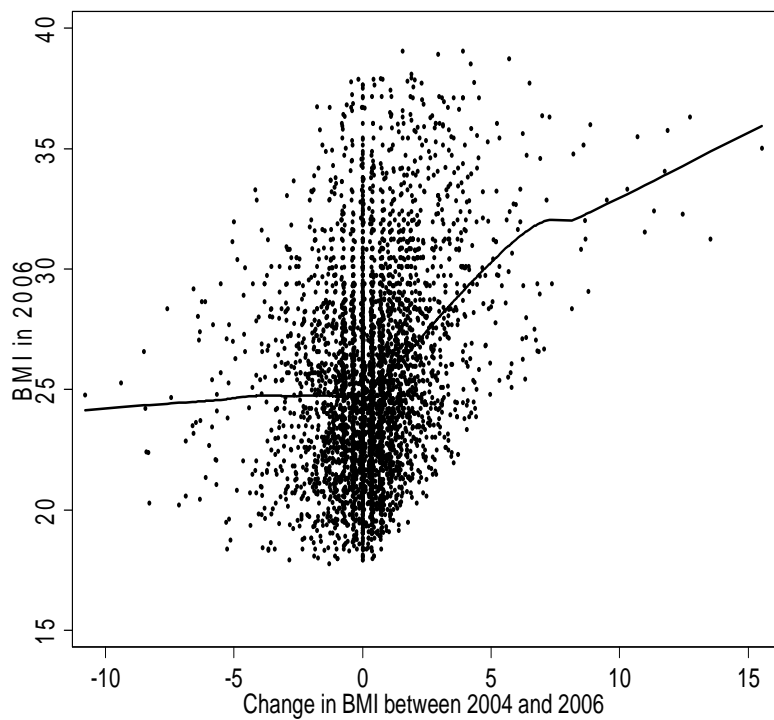
Appendix B: Semi-parametric Regressions

Consider model **(1)**:

$$LS_{it} = f(W_{it}, W_{jt}) + \alpha X_{it} + \varepsilon_{it} \tag{1}$$

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

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

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 the kth element being:

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

In **(B2)**, $\kappa' = (\kappa_{ok}, \kappa_{pk})$ represents a knot in the BMI^2 space, and $\|.\|$ is the Euclidean distance. Hence, the estimator approximates the shape of the relationship between the BMIs and life satisfaction 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 using a two-stage procedure. First, we construct a rectangular lattice over BMI^2 containing all of the $\{W_{it}, W_{jt}\}$ 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 that we finally obtain are the knots we use in the estimates. As there are fewer observations in the corners of the $\{W_{it}, W_{jt}\}$ space, there are also fewer knots in these regions, which limits the loss of information (the variance is lower compared to the case in which there are more knots in sparse regions), but also the quality of the approximation.

The model is then estimated following the algorithm proposed in Chapter 13.5 of Ruppert *et al.*. Standard errors and the values of the derivatives are computed using the formulae in Chapters 6.4. and 6.8.