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List of Abbreviations

BMI	Body mass index
SWB	Subjective well-being
SOEP	Socio-Economic Panel
CAPI	Computer-assisted personal interviews
CPI	Consumer Price Index
OLS	Ordinary least squares
IV	Instrument variable
FE	Fixed effects
QALYs	Quality-adjusted life years
DALYs	Disease-adjusted life years
SES	Socioeconomic status
NUTS	Nomenclature of Territorial Units for Statistics
GIC	Growth incidence curves
CDF	Cumulative distribution function
FGT	Foster–Greer–Thorbecke
DIW	German Institute for Economic Research
CPF	Comparative Panel File
HILDA	Household, Income and Labor Dynamics in Australia Survey
KLIPS	Korean Labor and Income Panel Study
RLMS	Russian Longitudinal Monitoring Survey
SHP	Swiss Household Panel
GSOEP	German Socio-Economic Panel
BHPS	British Household Panel Survey
UKHLS	The UK Household Longitudinal Study

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CHAPTER 1
INTRODUCTION

As the global economy and healthcare evolve, subjective well-being is increasingly becoming a topic of interest in the field of health economics. In this dissertation, we try to investigate subjective well-being from two related aspects: obesity and marriage.

Obesity is a global health crisis that has reached alarming proportions in recent years. Defined as an excessive accumulation of body fat, obesity has far-reaching implications for both individual health and society as a whole. Its prevalence has steadily risen, with over 650 million adults worldwide classified as obese, according to data from the World Health Organization (WHO). This epidemic has led to a surge in obesity-related health problems, including diabetes, cardiovascular disease, and certain types of cancer, making it a pressing concern for healthcare systems and policymakers. Estimates of the cost of obesity are an important basis for the development and evaluation of obesity-related policies. Previous studies have estimated the direct and indirect costs of obesity, but in addition to these, the intangible costs of obesity are also noteworthy. The intangible costs of obesity are associated with a loss of well-being. In addition, obesity-related inequality may also combine with peer effects to lead to lower well-being in obese individuals. So, ignoring the intangible costs of obesity may lead to underestimating the benefits of obesity control policies.

Marriage, without a doubt, is a major event in life. People from almost any socio-cultural background consider marriage-related decisions such as whether to get married, when to get married, and with whom to get married. But nowadays, in increasingly countries around the world, marriage rates continue to decline and the age of first marriage continues to be delayed, so we sought to analyze whether these trends are related to marriage-related well-being. The contributions of each chapter are shown below:

Chapter 2 uses SOEP 2002-2018 data and a life satisfaction-based compensation approach to quantify the intangible costs of overweight and obesity. Previous literature documents the direct and indirect economic costs of obesity, yet none has attempted to quantify the intangible costs of obesity. This study focuses on quantifying the intangible costs of one unit body mass index (BMI) increase and being overweight and obese in Germany. Our results underscore how existing research into obesity's economic toll may underestimate its true costs, and they strongly imply that if obesity interventions took the intangible costs of obesity into account, the economic benefits would be considerably larger.

Chapter 3 uses data from the German Socio-Economic Panel (GSOEP), investigates the changes in the BMI distribution and obesity inequality among German adults aged 18+ between 2002–2018 and estimates the relationship between obesity inequality and subjective well-being. The results show that the rise in obesity prevalence is mainly due to an overall rightward shift of the BMI distribution, accompanied by an increase in left skewness. Over the entire 16-year period, obesity inequality increased significantly, especially among females, those with low education levels, and low-income groups. The results also document a significant association between different measures of obesity inequality and subjective well-being, especially among women.

Chapter 4 explores the trends in the subjective well-being (SWB) of never-married people (referenced with the married) and the factors that account for the gaps in SWB between never-married and married people. By employing a harmonized data from surveys conducted in six distinct countries, namely Australia (HILDA), South Korea (KLIPS), Russia (RLMS), Switzerland (SHP), Germany (SOEP), and the United Kingdom (BHPS and UKHLS), our analysis discerns a consistent and statistically significant association between never-married status and lower levels of life satisfaction, a relationship that has exhibited no substantial alteration over time. Particularly noteworthy is the discernible reduction in life satisfaction among never-married individuals in South Korea in comparison to their married counterparts.

The thesis concludes with a short summary in chapter five.

CHAPTER 2

THE INTANGIBLE COSTS OF OVERWEIGHT AND OBESITY IN GERMANY

[1] **Abstract**

Background: Previous literature documents the direct and indirect economic costs of obesity, yet none has attempted to quantify the intangible costs of obesity. This study focuses on quantifying the intangible costs of one unit body mass index (BMI) increase and being overweight and obese in Germany.

Methods: By applying a life satisfaction-based compensation value analysis to 2002–2018 German Socio-Economic Panel Survey data for adults aged 18–65, the intangible costs of overweight and obesity are estimated. We apply individual income as a reference for estimating the value of the loss of subjective well-being due to overweight and obesity.

Results: The intangible costs of overweight and obesity in 2018 amount to 42,450 and 13,853 euros, respectively. A one unit increase in BMI induced a 2553 euros annual well-being loss in the overweight and obese relative to those of normal weight. When extrapolated to the entire country, this figure represents approximately 4.3 billion euros, an intangible cost of obesity similar in magnitude to the direct and indirect costs documented in other studies for Germany. These losses, our analysis reveals, have remained remarkably stable since 2002.

Conclusions: Our results underscore how existing research into obesity's economic toll may underestimate its true costs, and they strongly imply that if obesity interventions took the intangible costs of obesity into account, the economic benefits would be considerably larger.

Keywords: Intangible costs, Obesity, Overweight, Germany

[1] This chapter is based on joint work with Alfonso Sousa-Poza from the University of Hohenheim and Peng Nie from Xi'an Jiaotong University. The candidate's individual contribution focused mainly on methodology, formal analysis and investigation, and writing. This is an accepted manuscript of an article published on Health Economics Review, 13(1), p. 1-10 on 2023, available online with supplementary material: https://doi.org/10.1186/s13561-023-00426-x

2.1 Introduction

As regards weight statistics, Germany currently ranks in the upper middle among OECD countries, with about two-thirds of men and half of women being overweight, a quarter of all Germans being obese [1], and an obesity prevalence double the 2000 rate of 12% [2][3]. As a risk factor for a variety of chronic illnesses - including type 2 diabetes mellitus [4], cardiovascular disease [5][6], and cancer [7] – obesity raises the risk of premature death [8][9] and poses a serious challenge for health systems in Germany and across the globe. Hence, the World Health Organization [10] formulated a goal of no further increase in obesity rates between 2010 and 2025, a goal also adopted as part of the German Federal Government's 2021 Sustainability Development Strategy.

Given these obesity-related health concerns and corresponding health policy measures, it is unsurprising that numerous studies document the obesity-related economic costs to Germany [11][12] [13][14][15][16][17], which one of the most comprehensive calculates at around 63 billion euros annually as of 2012 [16]. Whereas about half this sum (€29.39 billion) refers to directly attributable (medical and non-medical) costs such as diagnosis, treatment, medication, prevention, nursing care, rehabilitation, and accidents, the other half reflects indirect costs associated with productivity loss, including obesity-related absenteeism, unemployment, premature retirement, or premature death. Obesity can also give rise to "intangible" costs not reflected by market-valued transactions but rather directly associated with the pain of losing subjective well-being (SWB) [16] via either obesity- related comorbidities or bullying, stigmatization, and discrimination.

Yet although most research on the cost of obesity acknowledges the existence and importance of intangible costs, we find no study that comprehensively calculates their economic toll. For instance, even though Effertz et al. [16] partially consider intangible costs by using physicians' ICD coding to estimate the probability of obesity- related pain, their analysis, as the authors acknowledge, provides only rough insights into pain frequency during the obese individual's life cycle with no assessment of its monetary value. Nor does it capture any of the loss of well-being caused by discrimination or bullying. This research void is rather surprising given not only the potential economic significance of such intangible costs but also obesity's well-documented negative effects on SWB [18][19][20], often through stigmatization and discrimination [21]. For example, in the US, obese individuals earn about 10% less than their healthy weight counterparts even with productivity controlled for [22] and may even be blatantly dehumanized [23].

The most obvious reason for this dearth is the perceived inability to evaluate associated losses of well-being as market transactions, even though valuing such intangible costs (or well-being losses) has a long tradition in economic studies on pollution [24][25], fear of crime [26], commuting [27], and over-education [28]. In these instances, researchers commonly use a life satisfaction-based compensation value (i.e., shadow price) approach to estimate intangible cost. The researcher assigns a monetary value to the intangible losses by calculating how much income is needed to compensate them. This is equivalent to computing the marginal rate of substitution between income and the negative intangible effect. In this present study, therefore, we apply this approach to 2002–2018 German Socio-Economic Panel (SOEP) data to produce what we believe to be the first estimation of obesity's intangible costs in Germany. Analyzing these costs over such a long period is especially useful because we currently have no a priori knowledge on how the marginal rate of substitution between income and obesity has evolved. If, for instance, the marginal utility of income and the marginal (dis)utility of obesity are not constant across time, then, all else being equal, decreasing stigmatization as obesity levels rise could reduce the latter's disutility and lower its intangible costs.

2.2 The conceptual framework: life satisfaction approach

Our life satisfaction compensation approach [24] calculates the monetary value of three body-weight measures BMI, overweight, and obesity based on the amount of net annual income needed to compensate the life satisfaction lost from a one-unit increase in BMI or overweight/obesity relative to normal weight. After first defining utility as

$$U = U(B, Y) \tag{2.1}$$

where B is individual body-weight status and Y is income, we obtain total differentiation by setting $dU = 0$, which yields

$$dU = MU \cdot dB + MU \cdot dY = 0 \tag{2.2}$$

Sorting gives

$$\frac{dY}{dB} = -\frac{MU_B}{MU_Y} \tag{2.3}$$

Next, using a quasi-linear utility function of the following form,

$$U = \beta B + \delta lnY \tag{2.4}$$

we obtain

$$MU_B = \beta \tag{2.5}$$

$$MU_Y = \frac{\delta}{Y} \tag{2.6}$$

We can then express the income required to compensate an increase in obesity as follows:

$$\frac{dY}{dB} = -\frac{\beta Y}{\delta} \tag{2.7}$$

$$Cost = YI \tag{2.8}$$

where I denotes the negative quotient of β and δ. Eq. 2.7 allows us to calculate the marginal rate of substitution between income (Y) and the bodyweight (B). Hence, we can estimate the monetary value of compensation for an additional unit of BMI while also quantifying the costs of overweight or obesity relative to normal weight when given corresponding β, δ, and income (Y). We will employ different empirical strategies to estimate the coefficients β and δ and measure the estimated cost based on them.

2.3 Data and methods

2.3.1 Survey and sample

We draw our data from the German Socio-Economic Panel (SOEP) version 35 (`https://doi.org/10.5684/soep-core.v35`), a nationally representative longitudinal survey administered annually since 1984 by the German Institute for Economic Research. Interviews are currently conducted via computer-assisted personal interviews (CAPI) to approximately 30,000 of about 15,000 households [29]. Using the latest available wave (2018), we restrict our sample to adults aged 18–65 and exclude respondents who are underweight, without positive income, or have implausible BMI values (BMI > 60) [30][31] for a final 2018 sample of 11,407 respondents.[2] In addition to providing the most recent estimates of obesity's intangible costs, we also examine their evolution by analyzing nine survey waves that include information on individual weight and height (i.e., 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018) for a combined sample of 33,425 individuals and 100,369 observations.

2.3.2 Variables

SWB measure

Our key proxy of SWB is life satisfaction, whose measure we derive from responses to the question "How satisfied are you with your life, all things considered?" ranked on an 11-point Likert scale from 0=completely dissatisfied to 10 = completely satisfied.

Bodyweight measures

We calculate BMI (kg/m^2) based on self-reported height and weight, with normal weight defined as a BMI between 18.5 and 25 kg/m^2. Our bodyweight measures are overweight (BMI 25–30 kg/m^2) and general obesity (BMI ≥ 30 kg/m^2).

[2] The number of respondents before exclusion is 11,984 in 2018.

Income

Because our life satisfaction approach requires an income measure in addition to SWB and bodyweight, we include net annual individual income (in euros) calculated as net monthly income (i.e., after deduction of taxes and social security/unemployment/health insurance) multiplied by 12. When using multiple years, we deflate income to 2018 prices using the Consumer Price Index (CPI) [32].

Individual and household characteristics

Our life satisfaction models include the standard controls [25][26] for individual demographic and socioeconomic characteristics, including age, age squared, gender (1=female, 0=male), education, and marital status. Education is measured by years of schooling ranging from 7 to 18. Marital status is first measured on a 5-point scale of 1 = married, 2 = single, 3 = widowed, 4 = divorced, and 5 = separated, and then re-coded as a binary dummy variable with 1=married and 0 otherwise. Because homeowners tend to have a higher level of life satisfaction than tenants [33][34], the household characteristics include homeownership as well as number of children, with homeownership being a binary variable equal to 1 if the respondent owns his/her dwelling (0 otherwise).

2.3.3 Estimation strategies

In order to estimate the coefficients β and δ in Eq. 2.7, we estimate a regression of the following form:

$$SWB_i = \alpha_1 + \beta_1 BMI_i + \delta_1 ln(income_i) + \gamma_1 X_i + \rho_1 F_i + \varepsilon_i \tag{2.9}$$

where SWB_i, BMI_i, and $ln(income_i)$ denote individual i's life satisfaction, BMI, and translog net income, respectively , X_i is a vector of individual characteristics, and F_i, a vector of household characteristics. Here, the individual characteristics are age, age squared, gender, education, and marital status; and the household characteristics are homeownership and the number of children. β_1 captures the association between each individuals' BMI and SWB, with ϵ_i as the error term.

We use both an ordinary least squares (OLS) and an ordered logit model to estimate this equation. Although the 11-point scaling of the life satisfaction measure may suggest the use of latent variable estimation, the bias from the OLS approach used most commonly in the literature [27][35] is small enough [36]. Note that this regression is only run for overweight and obese individuals as it can be plausibly assumed that increases in BMI among normal individuals would not incur any costs.

Using similar specifications to those in Eq. 2.9, we estimate the model below to analyze the association of SWB with overweight and obesity:

$$SWB_i = \alpha_2 + \beta_2 overweight_i + \beta_3 obese_i + \delta_2 ln(income_i) + \gamma_2 X_i + \rho_2 F_i + u_i \tag{2.10}$$

where $overweight_i$ and $obese_i$ are binary dummies indicating individual i 's weight status, with normal weight as the reference. We also compare the intangible costs of these two groups in an additional regression using only overweight and obese individuals:

$$SWB_i = \alpha_3 + \beta_4 obese_i + \delta_3 ln(income_i) + \gamma_3 X_i + \rho_3 F_i + v_i \tag{2.11}$$

where $obese_i$ denotes whether individual i is obese or not, with overweight as the reference. Lastly, using Eqs. 2.9 and 2.10, we estimate the intangible costs between 2002 and 2018 to assess their dynamics.

We run a number of robustness tests in order to check for the three most common sources of bias: measurement error, omitted variables, and reverse causality. The first may stem from our use of self-reported income, weight, and height measures, which could result in underestimation of actual earnings and BMI [37]. Omitted variable bias could arise if certain unobserved factors affect individual BMI and SWB simultaneously; for example, if personality traits that affect obesity also influence SWB [38]. The final concern, reverse causality, may occur if SWB influences obesity (e.g., through eating habits) as reflected by happier individuals in some societies tending toward higher BMIs [39].

Our primary approach to addressing these potential biases is to adopt an instrument variable

(IV) model capable of handling the endogeneity problem, one whose instrument must fulfill the exclusion restriction. Given the absence of any obvious exogenous IV and having confirmed the error term's heteroskedasticity via a Breusch-Pagan test [40] we adopt Lewbel's (2012) 2SLS approach, which requires heteroskedasticity as a precondition for identification. Both Lewbel [41] and Mishra and Smyth [42] confirm that, given a suitable external IV, this method yields comparable results to those from a conventional external IV while also offering the advantage of combinability with a standard excluded instrument [43][44][45].[3] The approach has thus produced useful insights not only in research on mental health and SWB [47][48] but also in diverse fields of economics [42][49]. We first assume a triangular system in Eqs. 2.12 and 2.13 where SWB_i and BMI_i are endogenous, $X^{'}$ is a vector of exogenous covariates, and ϵ_1 and ϵ_2 are unobserved errors that may correlate with each other. As in a standard IV approach, the exogeneity assumption that $E(\epsilon X) = 0$ and $E(XX^{'})$ is satisfied, and $E(XX^{'})$ is nonsingular. The essential extra conditions of the Lewbel [41] estimator are that $Cov(Z, \epsilon_1\epsilon_2) = 0$ and $Cov(Z, \epsilon_2^2 \neq 0$, where $Z \subseteq X$. Here, the instruments are X and $(Z\bar{Z})\hat{\epsilon_2}$, where $\bar{Z}$ is the mean of Z:

$$SWB_i = a + \beta_5 X_i^{'} + \beta_6 BMI_i + \sigma_1 \tag{2.12}$$

$$BMI_i = b + \beta_7 X_i^{'} + \sigma_2 \tag{2.13}$$

We treat income as exogenous when applying the Lewbel [41] IV approach to BMI to verify the causal relation between bodyweight and life satisfaction. Although income may also be endogenous, the condition of validity for more than one endogenous regressor has not been demonstrated [45].

We further confirm the robustness of our results by first using split analyses by income tercile to check the stability and magnitude of our primary findings in different income groups. In doing so, we ensure as large a sample as possible by estimating Eq. 2.9 with pooled cross-sectional data (2002–2018) and include year dummies (with 2002 as the reference year). We also partially

[3] For this study, we implement the Lewbel [41] IV approach using use the Stata ”ivreg2h” syntax (see Baum & Schaffer [46]).

account for omitted variables bias (caused by time-invariant variables) by using 2016 and 2018 SOEP data to estimate the following fixed effects (FE) model:

$$SWB_{it} = \alpha_6 + \beta_8 BMI_{it} + \delta_6 ln(income_{it}) + \gamma_6 X_{it} + \rho_6 F_{it} + \omega_i + \varepsilon_{it} \tag{2.14}$$

where ω captures unobservable time-invariant individual i effects, X_{it} (F_{it}) is a vector of individual i's time-variant (household) characteristics in period t, and ε_{it} is the error term.

2.4 Results

2.4.1 Descriptive statistics

As Table 1 shows, the average values of life satisfaction and BMI for our sample are 7.527 and 26.505 kg/m^2 in 2018, respectively, with over half of the respondents being overweight or obese (cf. Schienkiewitz et al. [3]). As in Biewen et al. [50], the mean annual income after tax is approximately 22,899 euros. The gender distribution is almost equal (50.2% female), with an average age around 44. A majority (61%) is married with approximately 13 years of education.[4] For respondents with a BMI between 18.5 and 60 kg/m^2 (25 and 60 kg/m^2), however, the BMI values increase from 25.4 (28.6) in 2002 to 26.6 (29.8) in 2018, suggesting an increasing trend in mean BMI among German adults (see Additional file 1: Table A2.2, Panels A and B).

2.4.2 OLS and ordered logit estimates

Our OLS and ordered logit analyses of the intangible costs of BMI, overweight, and obesity (see Table 2) pinpoint three key findings: First, relative to normal weight, overweight and obesity have intangible costs in 2018 of 13,853 and 42,450 euros (OLS) or 17,868 and 45,502 euros (ordered logit), respectively (see columns 1 & 2, Panel A), implying that overweight and obese individuals suffer from larger well-being losses than those of normal weight. At the same time, a one-unit additional increase in BMI among the overweight and obese resulted in 2553 (2562) euros of

[4] The descriptive statistics for the pooled data are given in Additional file 1: Table A1.

Variables	Obs.	Mean	S.D.
Life satisfaction	11,407	7.527	1.535
Body mass index (BMI, kg/m^2)	11,407	26.505	4.974
Obesitya	11,407	0.198	0.399
Overweighta	11,407	0.358	0.480
Normal weighta	11,407	0.444	0.497
Net annual income (euros)	11,407	22898.74	22228.35
Age	11,407	44.087	11.579
Femalea	11,407	0.502	0.500
Marrieda	11,407	0.614	0.487
Years of education	11,407	12.602	2.841
Number of children in the household	11,407	0.913	1.122
Homeownera	11,407	0.483	0.500

a Dummy variables

Notes: BMI means body mass index, which is defined as height (in m) divided by weight (in kg) squared. The measures of obesity, overweight, and normal weight are based on BMI, which is defined as obesity (BMI $\geq$ 30), overweight (25 $\leq$ BMI $<$ 30), and normal weight (18.5 $\leq$ BMI $<$ 25).

Table 2.1: Descriptive statistics: SOEP 2018

well-being loss, while obesity had an annual intangible cost of 23,261 (24,294) euros relative to overweight (see columns 1 & 2, Panel B).

2.4.3 Intangible costs of bodyweight 2002–2018

Although graphing the trends in obesity-attributable intangible costs from 2002 to 2018 suggests a slight increase in obesity (Fig. 2.1c), it reveals no general pattern.[5] Hence, given our estimations' reliance on the marginal effects of obesity and income on life satisfaction, we strive to expand our understanding of the cost dynamics by mapping these key parameters. As Fig. 2.2 shows, the trends for income and the estimated coefficients of BMI, income, and Eq. 2.9 all remain remarkably stable across time. The trends for the estimated coefficients of overweight and obesity are shown in Additional file 1: Figs. A1 and A2, respectively.

[5] Additional file 1: Tables A4 and A5 report the regression results for BMI and overweight/obesity based on Eqs 2.9 and 2.10, respectively.

	OLS	Ordered logit
	(1)	(2)
Panel A: $18.5 \leq \text{BMI} \leq 60$		
Cost of overweight	13,853**	17,868**
95% CI	[1988; 25,717]	[5823; 29,913]
Cost of obesity	42,450***	45,502***
95% CI	[21,281; 63,618]	[24,430; 64,575]
Observations	11,407	11,407
Panel B: $25 \leq \text{BMI} \leq 60$		
Cost of BMI	2553***	2562***
95% CI	[902; 4204]	[989; 4134]
Cost of obesity	23,261***	24,294***
95% CI	[8458; 38,065]	[9388; 39,201]
Observations	6347	6347

Notes: BMI body mass index, defined as height (in m) divided by weight (in kg) squared. Costs are in euros. The overweight, BMI, and obesity costs in Panels A and B are calculated based on Eqs. 2.9, 2.10 and 2.11 respectively. The 95% confidence intervals, given in brackets, are calculated using Fieller's theorem. Significance levels are shown as *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.2: Yearly intangible costs of BMI, overweight, and obesity: SOEP 2018

	Low (1)	Middle (2)	High (3)
Panel A: OLS			
Costs of BMI	1,390***	775***	2,169***
95% CI	[560; 2,221]	[296; 1,253]	[1,405; 2,933]
Observations	15,274	17,609	19,859
Panel B: Ordered logit			
Costs of BMI	1,795***	807***	2,014***
95% CI	[666; 2,924]	[324; 1,291]	[1,331; 2,696]
Observations	15,274	17,609	19,859

Notes: BMI = body mass index, defined as height (in m) divided by weight (inkg) squared. Costs are in euros. The 95% confidence intervals, given in brackets, are calculated using Fieller's theorem. *p <0.1, **p <0.05, ***p <0.01.

Table 2.3: OLS/ordered logit estimates of BMI's intangible costs by income tertile: SOEP 2002-2018

2.4.4 Robustness and heterogeneous analysis

When we compile the different intangible costs of BMI by income terciles based on pooled OLS and ordered logit estimates (see Table 2.3), we find that, compared to the low- and middle-level income groups, the high-level income group experiences the largest BMI-related loss of well-being irrespective of estimation type.[6] This finding implies that the richest may suffer from the largest intangible costs attributable to an additional BMI increment.

Given the potential for BMI endogeneity, in this analysis, we employ both FE and Lewbel IV estimations, both of which corroborate the significant negative association between increased BMI and life satisfaction (see Table 4). Not only does a Breusch-Pagan test verify the appropriateness of the Lewbel IV method by confirming the existence of heteroskedasticity, but the first-stage F statistics, which greatly exceed 10, imply no weak instruments, while the Hanson J test affirms the exogeneity of our IVs. According to the FE estimation, the BMI-related intangible cost is 3229 euros, while that from the Lewbel IV is a lower 2590 euros.

[6]Detailed results are given in Additional file 1: Table A6.

	FE†	Lewbel IV††
	(1)	(2)
BMI	-0.024**	-0.027**
	(0.011)	(0.014)
Costs	3,229**	2,590**
95% CI	[278; 6,180]	[14; 5,165]
Controls	Yes	Yes
Under identification test		<0.001
Weak instrument (F-statistic)		53.061
Hansen J statistic (p-value)		0.894
Observations	13,379	6,315

† Based on 2016 and 2018 data.

†† Based on 2018 data only.

Notes: Dependent variable = life satisfaction. BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. This analysis includes samples with BMI $\geq$ 25. Costs are in euros. The FE model controls for translog income, age, age squared, years of education, number of children, and homeownership, while the Lewbel IV adds in gender and marital status but omits age squared. Standard errors in parentheses; 95% confidence intervals (CI) in brackets. *p <0.1, **p <0.05, ***p <0.01.

Table 2.4: Fixed effects/Lewbel IV estimates of BMI on life satisfaction: SOEP 2016, 2018

2.5 Discussion and conclusions

A large international body of literature documents the economic costs of obesity (e.g. [51]), which, although the estimates vary considerably depending on data and methods, are universally agreed to be substantial. In Germany, for example, the annual economic costs can range between 9.87 billion and 63.04 billion euros [12][16]. Yet all these studies, while acknowledging the existence of obesity's intangible costs, make no attempt to quantify them, focusing only on the direct and indirect expenses. This failure is surprising not only because of the widely documented obesity-SWB link [18][19][20] and obesity stigmatization [52], but because a long tradition of intangible cost estimation in several economics field (e.g., transport, environmental, and public economics) has furnished a viable, but as yet unused, method for measuring obesity's intangible costs.

In this paper, we adopt this life satisfaction approach to estimate the intangible costs of obesity in Germany using rich longitudinal SOEP data. According to our results, not only did the overweight and obese incur 2018 costs of 13,853 and 42,450 euros, respectively, relative to normal-weight individuals, but a one-unit increase in BMI among these groups induced a 2553 euro loss in well- being, which extrapolates to a national cost of approximately 4.3 billion euros.[7] To assess the stability of these intangible costs which, unlike direct and indirect costs, are by definition a reflection of societal views on obesity we also estimate them longitudinally (2002–2018), probing for changing discrimination and stigmatization patterns over time as perceptions of ideal body composition vary [53][54]. In the US, for example, an increasing incidence of obesity has raised American notions of an ideal weight until a growing number of obese individuals see themselves as normal. Our results for Germany, however, show no clear trend. Rather, the intangible costs of obesity remain remarkably stable across time, with neither its effect on SWB nor its effect on income changing noticeably over the past two decades despite a large concurrent increase in obesity rates. This result is interesting as it shows that even over a relatively long time period, the marginal utility of income and the marginal disutility of obesity remain quite constant. In the case of income, this may not be too surprising as real income levels have not changed much. However, in the case of obesity, we have witnessed a large increase in its prevalence, yet no change in the marginal disutility. One plausible assumption would be that as obesity rates rise, a society not only becomes more tolerant of obesity, but also may change its perception about an ideal body image. One possible reason for not observing such an assumed change in the marginal disutility of obesity is that our 16-year analysis may be too short to capture changes in society's perception regarding obesity. In this context it is worth noting that the change of ideal body image in the United States is smaller than the actual change of average weight [54]. Considering the slower rise of obesity in Germany that in the United States, one can assume that perceptions in Germany are changing slowly.

Our study is of course subject to certain limitations; in particular, the relatively large 95% confidence intervals for the estimated income and obesity coefficients in the SWB regressions, which show obesity costs ranging from approximately 21,000 to 64,000 euros. Not only are such

[7]We calculate this extrapolation by first multiplying the average increase in BMI from 2016 to 2018 by 2553 euros and by the number of obese and overweight individuals in 2018 and then dividing the result by 2 to derive an annual value. This extrapolation thus represents the additional costs incurred in one year by the average rise in BMI, which our IV estimates put at 4.4 billion.

large confidence intervals commonplace in life satisfaction-based analyses,[8] however (see, e.g., for over-education [28] and drought [56]), but even the lower- most bounds of these intervals mark the intangible costs as substantial. We also recognize the life satisfaction approach's inherent susceptibility to endogeneity issues as a result of the pertinent explanatory variables (in our case, obesity) being so often endogenous. In our study, however, unlike most others, we not only acknowledge obesity's endogeneity and particularly the resulting risk from reverse causality but perform a robustness check using a heteroskedasticity-based IV estimator. Despite the challenge of controlling simultaneously for several potentially endogenous variables (most notably income, but also obesity and overweight), our IV results with BMI as the sole instrument support our cross-sectional results. As regards the additional concern of measurement errors from the self-reporting of height and weight [57][58], the SOEP is the only available nationally representative data set that provides measures of BMI covering a time-span of nearly two decades. Besides the widespread use of the SOEP obesity data [13][59], there is also some evidence that such self-reports are reasonably accurate [60]. Despite these limitations, our results underscore how significantly existing research into obesity's economic toll may underestimate its true costs, an especially important caveat for the myriad evaluations of obesity- related policy and environmental interventions [61]. Our findings strongly imply that if these interventions took intangible costs into account, the economic benefits would be considerably larger. Yet to date, economic evaluations of obesity interventions measure outcomes only in health-related terms (either quality-adjusted life years (QALYs), disease-adjusted life years (DALYs), or natural health units), thereby ignoring the impact of overweight and obesity on general well-being beyond health-related measures of quality of life [62]. Yet had the cost benefit analysis that found Australia's "reformulation in response to the Health Star Rating system" and "community-based interventions" to combat obesity [63] to be cost ineffective taken into account

[8] Large confidence intervals are a common problem when using Fieller's theorem to calculate the confidence interval for the ratio of two coefficients. Since the two coefficients have different standard errors, Fieller's method constructs a normal distribution by using a linear combination of that ratio and the mean of the two coefficients [55]. The variance of this new normal distribution is larger than the variance of the original two coefficients. The estimated confidence interval for the ratio can be obtained by constructing a variable with a chi-squared distribution with 1 degree of freedom and solving a quadratic inequality. This process may further amplify the confidence interval. Detailed regression results are reported in Additional file 1: Table A3.

intangible costs of at least similar magnitude to the direct and indirect costs, it might have reached the opposite conclusion. Given the global obesity pandemic, accurate assessment of obesity's true cost to society is vital, including consideration of its intangible costs in any intervention-related decision [63][64].

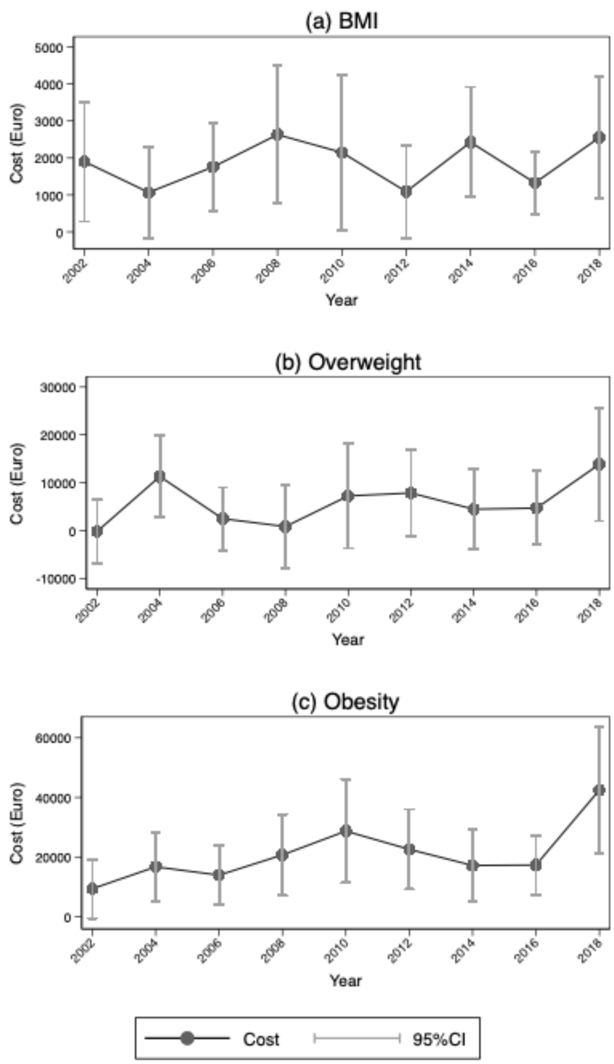

Figure 2.1: Trends in the intangible costs of BMI, overweight, and obesity: SOEP 2002–2018.

Note: a. the trend in intangible costs for BMI; b and c the trends for overweight and obesity, respectively. BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Obesity = BMI $\geq$ 30; overweight = 25 $\leq$ BMI $<$ 30. Confidence intervals are calculated using Fieller's theorem

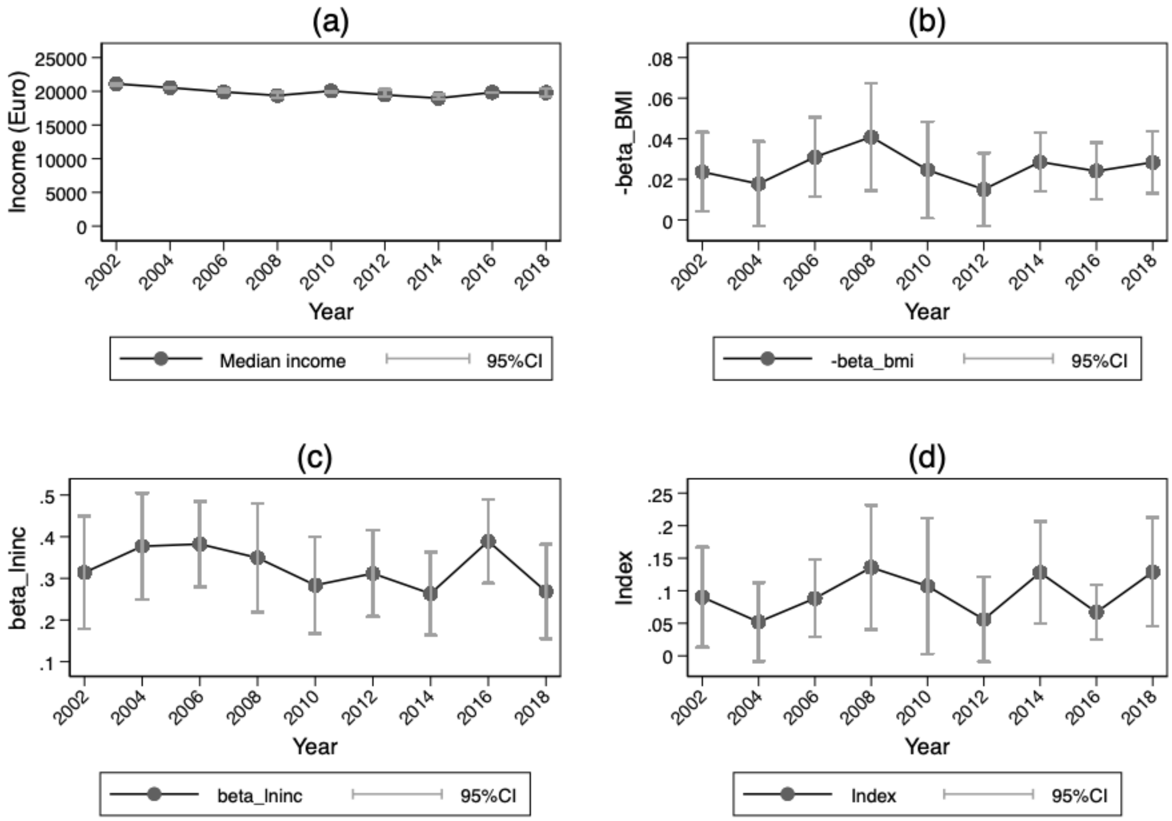

Figure 2.2: Trends in the components of the intangible costs of BMI: SOEP 2002–2018.

Note: a. median annual net income per year in 2018 euros; b and c the coefficients of BMI and income, respectively, based on Eq. 2.9; d. the trend in the index, which denotes the negative division of the coefficient of BMI and income. Confidence intervals are calculated using Fieller's theorem

CHAPTER 3

OBESITY INEQUALITY AND WELL-BEING IN GERMANY

1

Abstract

Using 2002–2018 German Socio-Economic Panel (GSOEP) data for German adults aged 18 + , this study measures changes in the body mass index (BMI) distribution and obesity inequality to estimate the relation between the latter and subjective well-being. In addition to documenting a significant association between the various measures of obesity inequality and subjective well-being, especially among women, we show a significant in- crease in obesity inequality, particularly among females and those with low education and/or low income. This rising inequality points to the need to combat obesity through initiatives targeted at specific sociodemographic groups.

Keywords: Obesity inequality, subjective well-being, obesity, overweight, Germany

[1]This chapter is based on joint work with Alfonso Sousa-Poza from the University of Hohenheim and Peng Nie from Xi'an Jiaotong University. The candidate s individual contribution focused mainly on methodology, software, formal analysis, investigation, and writing. This is an accepted manuscript of an article published on Economics & Human Biology on 2023, available online: `https://doi.org/10.1016/j.ehb.2023.101236`. The authors thank the editor Susan Averett, two anonymous referees and Hamid Oskorouchi for valuable comments and discussions which greatly improved the paper.

3.1 Introduction

Between 1975 and 2016, obesity prevalence almost tripled, resulting in approximately 2 billion overweight (39% male, 40% female) and over half a billion obese (11% male, 15% female) adults worldwide (World Health Organization, 2020). In Germany, the obesity prevalence doubled from 1987 to 2016 [65] to over a quarter of German adults, with both men and women having a mean body mass index (BMI) in 2015 of over 26 [65]. Yet despite wide documentation of obesity's prevalence and serious health risks – including type 2 diabetes mellitus, dyslipidemia, cardiovascular disease, certain cancers [66], and raising the risk of severe pneumonia mortality after infection with Covid-19 [67] – the measures used are too raw to capture the shifts in BMI distribution that drive changes in obesity prevalence and mean BMI. Knowledge of such shifts, however, is crucial to the development and assessment of interventions that successfully combat obesity. For example, an increased obesity rate and mean BMI when the entire population gains weight represents a rightward shift in BMI distribution that requires population-wide policies such as taxes on unhealthy nutrients (e.g., a "fat tax") or labeling rules. The same increase in obesity rate and mean BMI when only part of the population (right end of the distribution) gains weight faster than others represents a left skewing of the distribution that calls for interventions targeted at specific groups (e.g., information campaigns). Should a combined right shifting and left-skewing of the distribution occur, it would indicate a need for hybrid policies aimed at both the entire population and certain subgroups [68].

One particularly useful method for uncovering underlying changes in the BMI distribution is to quantify changes in obesity inequality, a tool recently employed in a small number of investigations for select countries [69][68][70][71][72]. Whereas one such study reports a 13.7% increase in the Gini coefficient of general obesity in China between 1991 and 2011 [68], another documents a 23.3% increase in the US between 1971 and 2014, with obesity inequality being particularly pronounced among women and blacks [70]. This (left) skewing of the BMI distribution may have important welfare implications [68][70], particularly if, as obesity inequality suggests, overweight and obese individuals are gaining weight more rapidly than the remaining population, making them more prone to stigmatization and discrimination [73][21]. That is, even though societal perceptions of ideal body weight may adjust to the prevalence of overweight and obesity in the population [53], a pronounced skewing of the distribution, rather than shifting perceptions, could widen the gap between the obese and those with ideal body weight. For instance, obese individuals might encounter fewer obese peers, resulting in the well-documented phenomenon of peer comparisons negatively influencing individual well-being [74].

This study paints a long-term picture of obesity inequality in Germany by first analyzing changes in the BMI distribution of German adults over two decades (2002–2018) and then using a series of measures to assess the level of obesity inequality and its trends in subgroups over time. Then, because many prior studies express concern over the implications of obesity inequality for subjective well-being (SWB) without actually testing them empirically, it employs empirical strategies to estimate the relation between these two factors. To the best of our knowledge, the study is the first to investigate obesity inequality in Germany and possibly even the first for continental Europe.[2]

3.2 Obesity transition

The obesity transition captures the change in societal obesity from a relatively low to a high level of obesity (and possibly back to a lower level). In principle, this transition can occur either through a rightward shift of the BMI distribution, through a left skewing of the distribution, or through a combination of the two. Depending on the underlying mechanism, obesity inequality is affected differently throughout the transition, which Jaacks et al.[78] divide into the following four stages:

- Stage 1: a rise in obesity prevalence to above 5% but not higher than 20%, with higher obesity rates among women, adults, and individuals with a higher socioeconomic status

[2] It should be noted that there is a large field of research that analyzes the degree of income inequality in the distribution of obesity (see, for example, [75]. In essence, it shows that, when income inequality exists, obesity is more concentrated in lower levels of income [76]. In Sweden, the income-related obesity inequality declined because obesity increased uniformly throughout income levels [77]. Contrary to this literature, our study focuses on obesity inequality.

(SES);

- Stage 2: the prevalence of obesity ranges from 20% to 40%, with a large increase in the prevalence among adults, a narrowing of the gap between sexes, and a narrowing of SES differences;

- Stage 3: the between-sex gaps in obesity prevalence close, while the importance of SES reverses so that lower SES groups have the higher obesity rates;

- Stage 4: obesity prevalence declines, primarily due to lower obesity rates among high SES children.

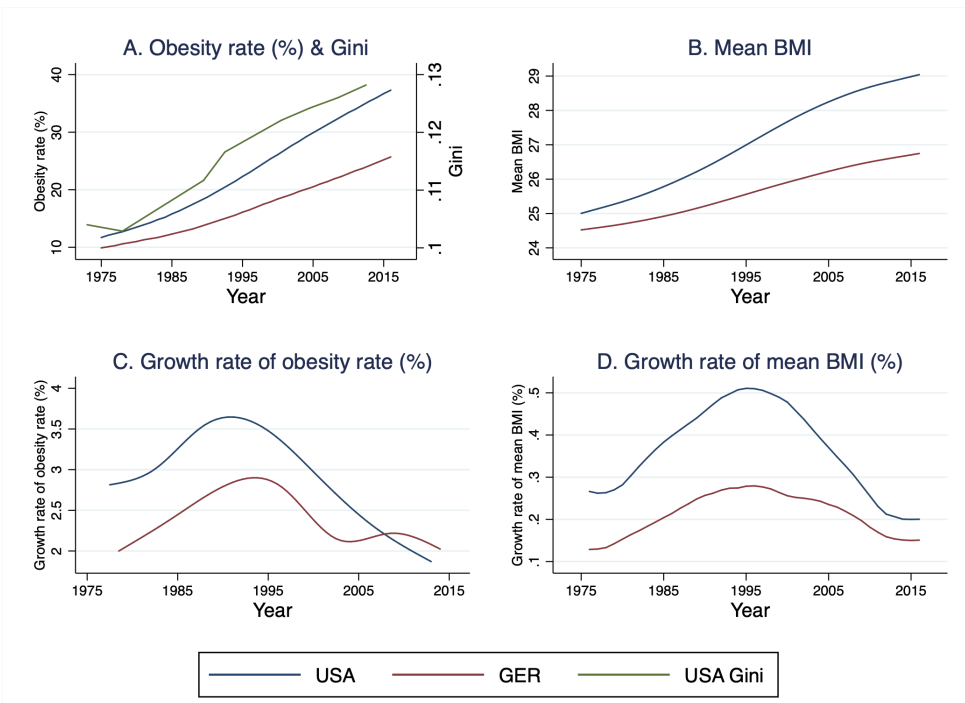

Figure 3.1: Obesity rate, mean BMI, and their growth rates and obesity inequality over time in the US and Germany

Note: The data are from Ritchie and Roser (2017)[65] and Pak et al. (2016)[70].

As Fig. 3.1 shows, over the past four decades, obesity rates have increased substantially in both Germany (9.9–25.7%) and the US (11.7–37.3%), with accompanying increases in average BMI (24.5–26.7 kg/m2 and 25.0–29.0 kg/m2, respectively), although both growth rates peaked in the mid-1990s. According to the Jaacks et al.[78] framework, the obesity transition is still ongoing with stage 4 not yet reached. That is, the higher prevalence of obesity among lower SES groups in both Germany and the US (Wang and Beydoun, 2007; Kuntz and Lampert, 2010) indicates that both countries are currently in stage 3 [78]. From this perspective, obesity inequality should rise in stages 1 and 2, and potentially 3, making it difficult to predict the evolution of obesity inequality until obesity rates level out at the end of stage 3, although some authors predict that nearly 50% of the US population will be obese by 2030 [79]. If a large portion of the population is bunched into a relatively narrow BMI range (of about 30–40), obesity inequality could fall; however, such a decrease would be strongly dependent on how BMI levels develop in the rest of the population. For example, if overweight levels decrease substantially in the coming decade (for which there appears to be some evidence, see Fig. A1 in the Appendix), obesity inequality will actually increase.

By the final stage 4, predicting obesity inequality's movement is speculative, with Jaacks et al.[78] suggesting that obesity could this case, obesity inequality could change because of either a leftward shift of the BMI distribution, an increasing right skewing of the distribution, or a combination of the two. Because the prevalence of child obesity has leveled off in Germany and the US but not yet shown a downward trend [65], it will be several years (if not decades) before children with lower obesity rates become a major component of the adult population and thereby affect obesity inequality. We cannot, however, exclude the possibility of weight loss among adults. According to Pak et al.[70], between 2007 and 2014 in the US, the growth rate of BMI at the left end of the BMI distribution was negative, implying that the relatively slim population lost weight. If this trend continues and is accompanied by weight gain at the right end of the distribution, then it will lead to more polarization and an increase in obesity inequality. In fact, as the Fig. 3.1 (panel A) shows, obesity inequality in the US has increased continuously since the start of the obesity epidemic and the minimal evidence of its decline makes its reduction in coming decades seem unlikely.

3.3 Data and Methods

3.3.1 Data and study population

We draw our data from the German Socio-Economic Panel (GSOEP) version 35 (`https//doi.org/10.5684/soep-core.v35`), a nationally representative longitudinal survey administered annually since 1984 by the German Institute for Economic Research, which conducts computer-assisted personal interviews (CAPI) with approximately 30,000 individuals from about 15,000 households [29]. This present study uses biennial GSOEP data from the 2002–2018 waves that record individual self-reported weight and height; namely, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018. We limit our sample to individuals over the age of 18, for a total sample size of 199,175 observations from 56,315 individuals. To enable comparison of inequality trends across periods, we split the nine waves into two periods: 2002–2010 (early period) and 2010–2018 (late period). Our analysis will also in part use an unbalanced panel structure of the GSOEP in order to estimate fixed effects estimators (discussed below). The average panel duration is 3.6 periods.

3.3.2 Variables

Obesity measurement

We define body mass index (BMI) as weight in kilograms divided by height in meters squared. As is common practice, we define obesity as a BMI greater than or equal to 30 [80].[3] Our measures of weight and height are self-reported. Such measures may lead to an underestimation of BMI [57][58]. There is, however, also evidence that self-reported BMI and measured BMI are correlated and concordant [60]. There is also some discussion on the appropriateness of BMI itself as a proxy for body fat because it does not account for age, gender, bone structure, and muscle mass [81]. Nevertheless, the National Institutes of Health says it is a good indicator of health risks and is widely used by doctors and the general public (National Institute of Health, 2022).

[3] As in Pak et al.[70], we drop implausible values of BMI (i.e., greater than 60).

SWB measurement

To assess the potential implications of obesity inequality for well-being, we proxy SWB with life satisfaction based on the question, "How satisfied are you with your life, all things considered?", with responses measured on an 11-point Likert scale from 0 = completely dissatisfied to 10 = completely satisfied.

Demographic, socioeconomic and regional characteristics

To capture subpopulation heterogeneity in obesity inequality, we include the demographic and socioeconomic characteristics of gender (1 = female, 0 = male), age group (18–39 years, 40–59 years, and 60 + years), educational level (recoded as: 0 = low: years of education $\leq$ 10, 1 = medium: 10 $<$ years of education $\leq$ 14 and 2 = high: years of education $>$ 14), and household income level (recoded into terciles: 0 = low, 1 = medium and 2 = high). We also control for region of residency (1 = West Germany; 0 = East Germany).

3.3.3 Stochastic dominance test

The stochastic dominance test, widely applied in income distribution and income inequality analyses [82](Davidson and Duclos, 2000) as well as obesity studies (see, e.g., [68][70][71]), compares two BMI distributions independent of the obesity threshold selected [70] to determine which is superior. See the Appendix A0 for the derivation of stochastic dominance test.

3.3.4 Growth incidence curve

We employ anonymous growth incidence curves (GIC) to measure the change in BMI at each quantile over time. If we first set X_t (BMI) as a continuous random variable with probability density function (PDF) $f_t(x)$ and cumulative distribution function (CDF) $F_t(x)$ at time t, then the inverse of the CDF, the quantile function, is

$$Q_t(p) = F_t^{-1}(x) \tag{3.1}$$

where p denotes quantile. We can then derive the growth rate in BMI of the p-quantile for each p by comparing two time points tn and t_{n1} to yield a BMI growth rate of

$$g_{t_n}(p) = \frac{Q_{t_n}(p)}{Q_{t_{n-1}}(p)} - 1 \simeq log(Q_{t_n}(p)) - log(Q_{t_{n-1}}(p)) \tag{3.2}$$

where p varies from 0 to 1, and g_{t_n} identifies the GIC [83].

3.3.5 Obesity inequality measures (Gini and Foster–Greer–Thorbecke index)

Because the stochastic dominance test can rank different distributions but not identify cardinal distributional differences, we follow much of the income or consumption inequality research [84][85] by using inequality to capture distributional dispersion. Specifically, following [68] and [70], we quantify obesity inequality using the most popular measure in inequality analyses, the Gini coefficient, which quantifies statistical dispersion. The Gini coefficient measures dispersion in a given distribution on a range from 0 (complete equality) to 1 (complete inequality), which is twice the area between the Lorenz curve and the 45-degree line [86]:

$$Gini_t = \frac{2}{m_t N_t^2} \sum_{i=1}^{N_t} BMI_{it} r_{it} - \frac{N_t + 1}{N_t} \tag{3.3}$$

where N_t is the sample size at time t, m is the average BMI, BMI_it is the individual i's BMI value at time t, and r_it denotes the ranking of i^{th} BMI at time t in ascending order.

In order to account for differences above and below the obesity threshold, we also employ Foster–Greer–Thorbecke (FGT) indexes to measure the severity of obesity. Specifically, the FGT index is defined as follows [87]:

$$P_\alpha = \frac{1}{N} \sum_{i=1}^{q} [\mathbb{1}(y_i \geq z)(\frac{y_i - z}{z})^\alpha] \tag{3.4}$$

where N is the total number of samples, q is the number of obese samples, y_i is the BMI for obese people, and z is the obesity threshold (i.e., 30). $\mathbb{1}(\cdot)$ is an indicator functor, which is 1 when individual BMI is larger than the obesity threshold. Three FGT indices are commonly used based on values of α, specifically, α equals to 0, 1, and 2. In this study, we employ FGT(0) and FGT(2) on different decompositions, which will be introduced later. In the context of obesity, FGT(0) (headcount index) is simply the obese rate of the population. The interpretation of FGT(2) (obesity severity index) is somewhat less intuitive, but captures inequality among obese people, which gives more weight to higher levels of obesity. The larger the index, the more severe the obesity is among the obese.

3.3.6 Growth-redistribution decomposition

We adopt Kakwani[88] decomposition to partition the total change in the FGT index into a mean growth and a redistribution component. To do so, we first denote the FGT index at time $t(P_t)$ as

$$P_t = f(T|m_t; c_t) \tag{3.5}$$

where T is the obesity threshold (30 for general obesity), m is the average BMI at time t, and c is the Lorenz curve indicating the CDF of the BMI probability distribution. The change in the FGT index between the two periods is then decomposable as

$$\begin{aligned} P_t - P_{t-1} = &\frac{1}{2}\{[f(T|m_t; c_{t-1}) - f(T|m_{t-1}; c_{t-1})] + [f(T|m_t; c_t) - f(T|m_{t-1}; c_t)]\} \\ &+ \frac{1}{2}\{[f(T|m_{t-1}; c_t) - f(T|m_{t-1}; c_{t-1})] + [f(T|m_t; c_t) - f(T|m_t; c_{t-1})]\} \end{aligned} \tag{3.6}$$

The first term in Eq. 3.66 is the growth effect, which denotes the change in obesity prevalence due to a horizontal shift in the BMI distribution while the relative position (determined by the Lorenz curve) is held constant. The second term is the redistribution component, which denotes the change in relative position when the average BMI remains constant. We calculate the growth-redistribution decomposition of the most well-known FGT index (i.e., FGT(0)), which corresponds to the obesity prevalence.

3.3.7 Decomposition by population subgroup

In addition to the dynamic decomposition of obesity inequality, we are also interested in decompositions by subgroup, which involves partitioning the data into demographically defined groups and then calculating the contribution of each group. Due to possible overlaps of BMI observations in subgroups, the Gini coefficient is unsuitable [89],[4] and we thus apply the FGT index. Dividing the population into m subgroups with populations n_i (i = 1, ..., m), the FGT index can be written as a population-weighted mean of each subgroup's FGT index as follows:

$$P_\alpha = \sum_{i=1}^{m} \frac{P_{\alpha i} n_i}{N} \tag{3.7}$$

where P_α is the obesity index of the total population, and $P_{\alpha i}$ measures obesity in subgroup i. Then, the contribution of subgroup i to the total obesity level can be calculated as follows:

$$C_{\alpha i} = \frac{\left(\frac{P_{\alpha i} n_i}{N}\right)}{P_\alpha} = \frac{P_{\alpha i} n_i}{P_\alpha N} \tag{3.8}$$

We decompose the FGT(2) index by age, gender, education, income, and region to uncover potential heterogeneities in the population subgroups.

3.3.8 Impact of obesity inequality on SWB

Based on our initial conjecture that dissatisfaction related to obesity may stem from peer comparison, after first defining peer as an individual of the same gender and similar age, we employ three measures to represent the degree of inequality: the Gini coefficient, which measures the obesity inequality of a subgroup; relative BMI, the ratio between an individual BMI and the median BMI; and distance to the median BMI, the absolute value of the individual BMI minus the median BMI. In generating the latter, like Blanchflower et al.[90] and Card et al.[91], we use the median level of BMI as a reference. We then calculate all inequality measures for subgroups of individuals within

[4] If overlaps of BMI by subgroup exist, then an exact decomposition of Gini is not possible.

the same gender and age category (18–39 years, 40–59 years, or 60 + years), and estimate the effect of obesity inequality on life satisfaction based on the following two-way fixed effects (TWFE) model[5]:

$$Y_{it} = \beta_0 + \beta_1 I_{ijt} + \theta X_{it} + p_i + \tau_t + \varepsilon_{it} \tag{3.9}$$

where Y_{it} is the life satisfaction of individual i at time t, and I_{ijt} is the obesity inequality measure (i.e., Gini coefficient, relative BMI) of individual i in group j at time t, where group j is determined by state, survey year, gender, and age group. X_{it} represents the time-variant socioeconomic characteristics and body weight of individual i at time t; p_i and τ_t are the fixed effects of individual i and time t, respectively; and ϵ_{it} is the idiosyncratic error term.

Because the effects of being below and above the median could differ [91], when using the distance to the median as the inequality measure, our model includes an interaction term to capture these differences:

$$Y_{it} = \beta_0 + \beta_1 I_{ijt} + \beta_2 T_{ijt} + \beta_3 I_{ijt} \cdot T_{ijt} + \theta X_{it} + p_i + \tau_t + \varepsilon_{it} \tag{3.10}$$

where I_{ijt} is the distance to the median BMI of individual i in group j at time t, with group j determined by state, survey year, gender, and age group. T_{ijt} is a dummy equal to 1 if individual i's BMI is larger than the median BMI in group j at time t.

3.4 Results

According to our graphic analysis of the BMI distribution across the entire 16 years, the kernel density plot of BMI shifts to the right, while the CDF curves also show a rightward shift, especially between 2002 and 2010 (see Fig. 3.2).[6] The kernel density curve also becomes flatter, implying that the BMI distribution is more spread out.

[5]Because our dependent variable (life satisfaction) is ordinal, we also employ fixed effects ordered logit models (see [92]) as robustness checks (see Appendix Table A3.1).

[6]We also provide the density curves and CDF curves of 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018 in Appendix (see Figs. A2 and A3).

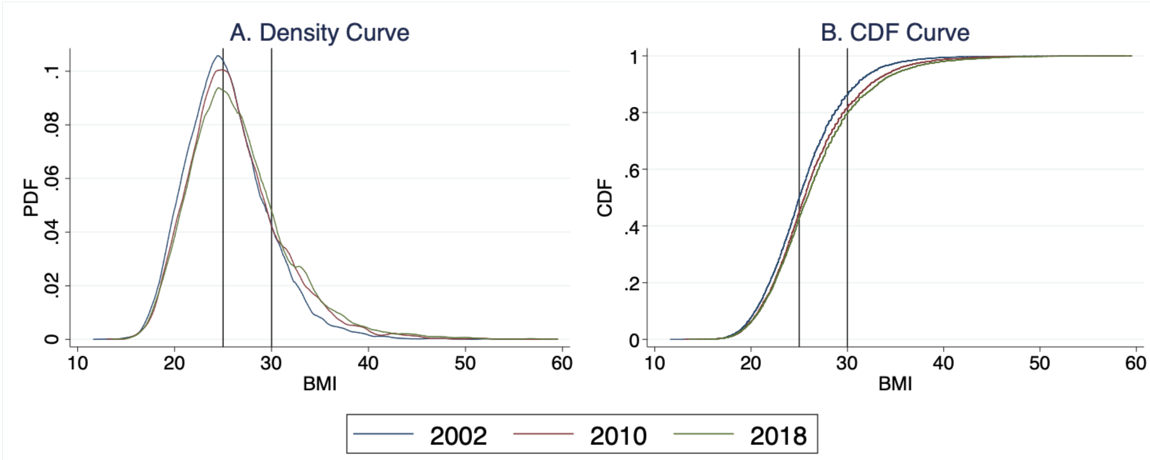

Figure 3.2: BMI distribution over time, 2002–2018 Sources: GSOEP 2002, 2010 and 2018.

Percentiles	BMI in 2002	BMI in 2010
25%	22.23	22.78
50%	24.80	25.39
75%	27.76	28.58
90%	30.86	32.00

Table 3.1: Percentiles and corresponding BMI: GSOEP 2002 and 2010

For ease of interpretation, we also depict changes in CDF curves over the three time periods in Fig. 3.3, which shows a clear rightward shift in the BMI distribution, with negative differences in the CDF that reflect a weight gain. The largest of these negative values is discernible at a BMI of approximately 26, indicating a significant decrease in the proportion of individuals of normal weight. When comparing the two time periods (see Figs. 3.3A and 3.3B), the area under the horizontal line becomes smaller in the more recent time period, implying that BMI differences between periods appear to be growing smaller.

An additional comparison of differences between the two CDFs using the stochastic dominance test reveals clear second-order dominance between 2002 and 2018 – as well as between 2002 and 2010 after an intersection of 15.543 (i.e., less than the first percentile) – while the distribution of BMI in 2018 is third-order stochastic dominant over 2010.[7] These findings are consistent with the

[7]Second-order dominance implies third-order dominance since the requirements are less strict the higher the order of stochastic dominance [82]. Group A is second-order dominant over group B, meaning that the BMIs of group B have a higher level of obesity risk, even if the two groups have the same BMI expectation. In this case, third-order dominance means that BMIs in 2018 are more likely to have an extremely high BMI than in 2010.

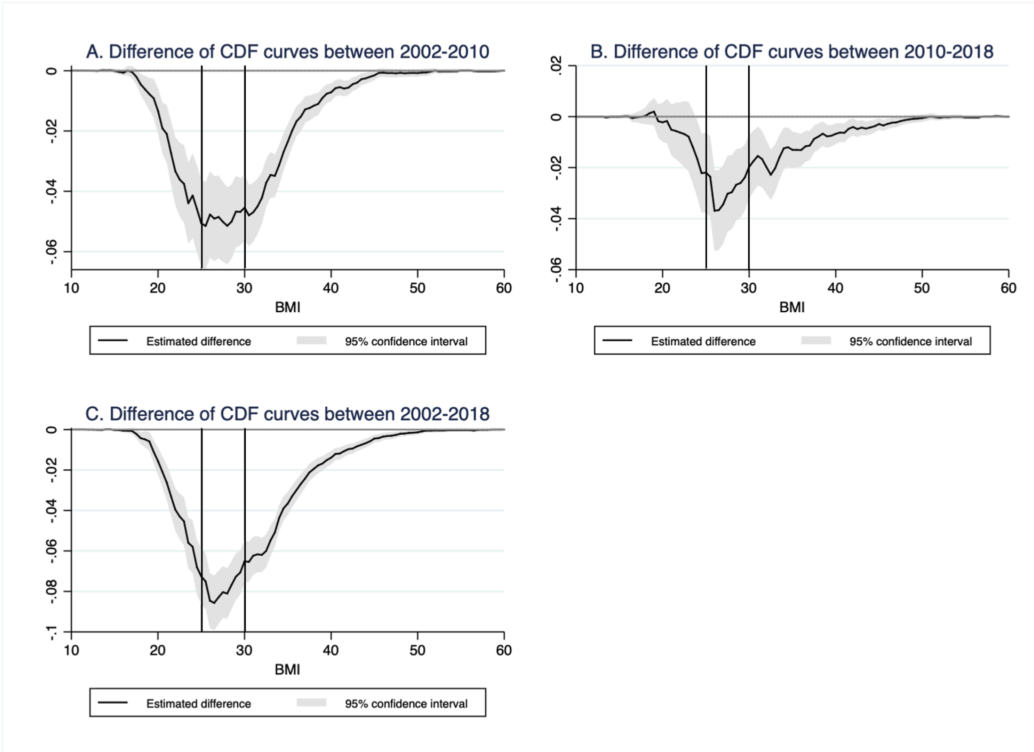

Figure 3.3: Differences in the BMI CDF curve: 2002–2010, 2010–2018, and 2012–2018.

small percentage of positive values on the left side of both graphs in Fig. 3.3, whose negative values reflect the significant differences in CDFs for 2002–2010, 2010–2018, and 2002–2018.(Table 3.1).

According to the anonymous GIC analysis, the average growth rate in BMI (depicted by the horizontal line) declined from 2.96% to 1.3% between the periods 2002–2010 and 2010–2018, respectively (see Fig. 3.4). A further comparison of these periods also indicates a significant change in growth rates across the entire distribution: with particularly high growth rates between 2002 and 2010 at the right end of the distribution (BMI $>$ 28 kg/m2), but relatively constant and below average growth rates in other parts. For the period 2010–2018, growth rates remained well above average at the right end of the distribution but decreased substantially in other parts, with growth rates at the left end in fact being negative. Overall, therefore, the growth rate is gradually slowing down, with an interesting similarity between the positively sloped GIC curves for Germany over the entire 2010–2018 period and those7for the US in the 1976–1991 period, albeit with lower growth rates.[8]

[8]We also employ the non-anonymous growth incidence curve (NAGIC) to measure the change in BMI against the

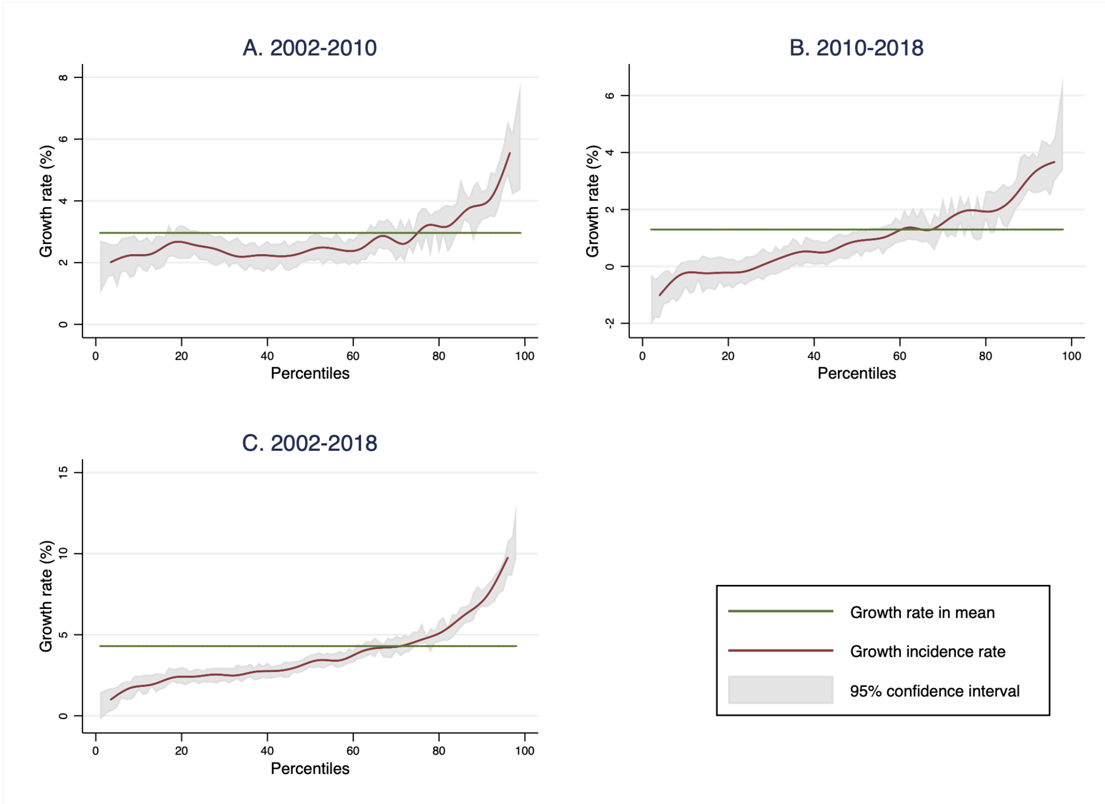

Figure 3.4: BMI anonymous growth incidence curves.

As regards the rise in obesity, our Kakwani [88] decomposition of obesity rates into growth and redistribution components (see Table 3.2) shows a 4.5% increase between 2002 and 2010, 85% of it attributable to the growth component and about 15% to distributional skewing. Between 2010 and 2018, however, although obesity rates rose by only about 2.6%, approximately 35% of that increase was attributable to distributional skewing. Thus, the increase in obesity rates in both periods were more a result of a general rise in BMI across the entire population (i.e., a flat GIC curve over much of the distribution), whereas the more substantial increase in the later period is ascribable to above average increases at the right end of the distribution. Taken over the entire 16-year period, approximately 21% of the 7% point increase in obesity rates is attributable to distributional skewing – that is, increased obesity inequality – compared to only 11% of the 8% point increase over 20 years (1991–2011) in China's obesity rate [68]. In the US, in contrast,

various quantiles of the initial distribution [93]. However, small sample sizes, poor coverage at the top of the distribution, and measurement errors might contribute to over- estimation of relative mobility, resulting in more negative slopes in NAGIC [94]. These results are available upon request.

Survey year	Difference	Growth component (G)	Redistribution component (R)	G/(G+R)(%)	R/(G+R) (%)
2002-2010	0.0448	0.0382 (0.0021)	0.0066 (0.0023)	85.29	14.71
2010-2018	0.0255	0.0165 (0.0019)	0.009 (0.0025)	64.60	35.4
2002-2018	0.0704	0.0553 (0.0021)	0.0151 (0.0021)	78.59	21.41

Note: Standard errors are in parentheses.

Table 3.2: Decomposition of increase in general obesity prevalence into mean growth and redistribution components

Survey year	Gini coefficient	FGT(2)	% change between t and t-1	
			Gini	FGT(2)
2002	0.0922	0.0032		
2010	0.099	0.006	7.3190***	87.5000***
2018	0.1038	0.0083	4.8681***	38.3333***
2002-2018			12.5434***	159.3750***

Notes: FGT refers to Foster–Greer–Thorbecke. *** indicates 1% significance in the t-test for differences between the inequality indexes for two different sampling periods.Standard errors are in parentheses.

Table 3.3: Intertemporal trends in obesity inequality

over the 15-year period between 1976–1991, about 27% of the approximate 6% point increase in obesity rate is attributable to this indicator [70].

Whereas Figs. 3.3 and 3.4 graph the changes in obesity inequality trends, our two inequality indexes quantify the inequality status and degree of change (see Table 3.3). That is, the augmenting Gini coefficient, from 0.092 in 2002 to 0.099 in 2010 to 0.104 in 2018, reflects a 12.5% increase in inequality over 16 years, while the corresponding FGT(2) shows significantly greater increases over the same period, about 1.6 times for FGT(2). Although the ratios of changes of FGT(2) are large, the variations themselves are small. It is also important to note that changes in FGT(2) reflect changes in inequality above the key thresholds, whereas changes in Gini reflect inequality across all parts of the distribution and it is sensitive on the changes on the middle. This makes a comparison of the two measures difficult.

Next, to throw additional light on the drivers of obesity inequality, we decompose this latter by

		2002		2010		2018	
		FGT(2)	Contribution rate to the total (%)	FGT(2)	Contribution rate to the total (%)	FGT(2)	Contribution rate to the total (%)
Gender	Female	0.0033	52.4577	0.0068	56.3625	0.0093	57.6871
	Male	0.0031	47.5423	0.0053	43.6375	0.0072	42.3129
Age	Young	0.0022	23.2466	0.0034	15.3719	0.0072	24.9024
	Middle-age	0.0043	45.1442	0.0081	49.7533	0.0105	42.6622
	Old	0.0032	31.6091	0.0060	34.8748	0.0072	32.4355
Education	Low	0.0043	21.7122	0.0098	22.0483	0.0100	17.2055
	Medium	0.0035	71.1931	0.0064	67.4164	0.0094	65.9960
	High	0.0013	7.0947	0.0028	10.5353	0.0051	16.7985
Income	Low	0.0042	50.4602	0.0070	48.1551	0.0111	50.6498
	Medium	0.0028	32.0124	0.0061	32.1819	0.0074	28.5561
	High	0.0024	17.5010	0.0044	19.6630	0.0058	20.7769
Region	West	0.0032	78.0388	0.0063	81.9662	0.0082	79.1842
	East	0.0033	21.9612	0.0052	18.0338	0.0089	20.8158

Notes: Age groups = 18-39, 40-59, 60 and above; gender = female, male; education = low ([7, 10] years), medium ((10, 14] years), or high ((14, 18] years); income (based on three different tertiles) = low, medium, high; region = west, east.

Table 3.4: Subgroup decomposition of obesity inequality in FGT(2)

subgroups (see Table 3.4). Here we use the obesity severity index FGT(2) by gender, age, education, household in- come, and region (east and west). Although both women and men experienced an increase in obesity inequality between 2002 and 2018, female inequality is always higher and its contribution rate to the total inequality increases over time. In terms of age, obesity inequality rises for all three groups but is substantially higher among those middle-aged. An even clearer distinction emerges based on education: higher education levels are associated with lower levels of obesity inequality. Obesity inequality is highest in those with the lowest household income. Although inequality does not differ significantly between East and West Germany, the dominance of contributions from the West is mainly due to the population share, similar to the medium education group.[9]

When we use a fixed effects estimator to assess the effects of obesity inequality on SWB (see Table 5), both the Gini coefficients and the relative BMI are statistically significant and negatively related to life satisfaction for females but insignificant for males. Moreover, women with a BMI greater than the median are more likely to report lower life satisfaction; for men, distance to the median is negative (0.046, $p < 0.001$) regardless of whether the BMI is above or below

[9]Furthermore, we draw GICs for these various demographic and socioeconomic characteristics (see Appendix Figs. A4-A7). The rise in obesity inequality is strongly driven by distributional left skewing.

the threshold (i.e., the interaction term is insignificant). To determine the reason for this unexpected result for the male sub-sample, we run additional regressions by age group (young: 18–39; middle-aged: 40–59; and older: 60 +), which reveal a certain degree of heterogeneity among men. That is, whereas obesity inequality and life satisfaction are negatively related for the young males (18–39 years),[10] being overweight is less likely to affect older males. Lastly, because the NUTS1 regional level used in the main model (see Table 5) could be too large to capture an individual's relevant social environment, we replicate the analysis at different geographic levels (i.e., NUTS2 and NUTS3).[11] Despite the smaller samples in each region, these replications validate the main results in terms of direction and numerical magnitude (see Appendix Tables A3 and A4).[12]

[10]See Appendix Table A3.2 for the regression results.

[11]NUTS is an abbreviation for the Nomenclature of Territorial Units for Statistics.

[12]The reduced sample size is due to our deletion of groups with fewer than 15 observations. The differences in significance between NUTS1 and NUTS2/3 may be because the sample size in the latter is too small and the random variation may be too large. Even though we dropped the groups with fewer than 15 observations, groups with fewer observations are still more susceptible to extreme values.

	(1) Total	(2) Female	(3) Male	(4) Total	(5) Female	(6) Male	(7) Total	(8) Female	(9) Male
Gini	-2.555***	-3.951***	-1.431						
	(0.696)	(0.935)	(1.112)						
Relative BMI				-0.471***	-0.590***	-0.022			
				(0.150)	(0.192)	(0.252)			
Distance to median BMI							-0.009	0.010	-0.046***
							(0.008)	(0.010)	(0.012)
Distance to median BMI × T†							-0.025*	-0.048***	0.029
							(0.013)	(0.018)	(0.021)
T†							-0.039***	-0.026	-0.056***
							(0.014)	(0.020)	(0.020)
BMI	0.092***	0.075***	0.118***	0.112***	0.102***	0.120***	0.077***	0.083***	0.057***
	(0.009)	(0.012)	(0.014)	(0.011)	(0.015)	(0.017)	(0.013)	(0.017)	(0.021)
BMI squared	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.002***	-0.001***	-0.001**	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	0.006*	0.019***	-0.008	-0.002	0.005	-0.009*	-0.001	0.005	-0.007
	(0.003)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Age squared	-0.000***	-0.000***	-0.000	-0.000**	-0.000***	0.000	-0.000**	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed†	0.034***	0.012	0.063***	0.033***	0.011	0.062***	0.033***	0.011	0.062***
	(0.012)	(0.017)	(0.019)	(0.012)	(0.017)	(0.019)	(0.012)	(0.017)	(0.019)
Years of education	-0.030***	-0.013	-0.049***	-0.027***	-0.008	-0.050***	-0.027***	-0.007	-0.052***
	(0.008)	(0.011)	(0.012)	(0.008)	(0.011)	(0.012)	(0.008)	(0.011)	(0.012)
Married†	0.146***	0.109***	0.195***	0.148***	0.113***	0.195***	0.149***	0.114***	0.196***
	(0.017)	(0.023)	(0.024)	(0.017)	(0.023)	(0.024)	(0.017)	(0.023)	(0.024)
Ln(household income)	0.149***	0.134***	0.170***	0.147***	0.131***	0.170***	0.148***	0.131***	0.172***
	(0.010)	(0.014)	(0.015)	(0.010)	(0.014)	(0.015)	(0.010)	(0.014)	(0.015)
Constant	4.605***	4.693***	4.377***	4.627***	4.741***	4.316***	4.642***	4.375***	5.243***
	(0.198)	(0.266)	(0.298)	(0.200)	(0.271)	(0.299)	(0.242)	(0.315)	(0.391)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	187991	98779	89212	187991	98779	89212	187991	98779	89212

Notes: Dependent variable = life satisfaction; relative BMI = BMI / (median BMI), with the relative BMI and Gini coefficient generated by gender and age in each state and year. Distance to median = —BMI - median BMI—, with T = 1 if BMI is larger than the median BMI. Standard errors are in parentheses. *p ¡ 0.1, **p ¡ 0.05, ***p ¡ 0.01. The coefficients of distance to the median BMI and the interaction term are jointly significant in columns 7, 8, and 9.
† Dummy variable.

Table 3.5: The effect of obesity inequality on subjective well-being: GSOEP 2002-2018

3.5 Discussion

Developing and testing appropriate interventions to combat obesity require a clear understanding of the obesity transition, an insight derivable only through analysis of shifts in the entire BMI distribution. Yet, despite a wealth of global research on obesity prevalence and mean BMI, this study is the first to analyze such changes in the weight distribution across the entire population of German adults. In capturing the (changing) shape of the BMI distribution, as with income, inequality is a crucial measure for determining whether obesity reduction interventions should be targeted or population wide and how obesity affects subjective well-being via peer effects and societal norms.

Overall, the rise in obesity prevalence in Germany is due primarily to a rightward shift in the BMI distribution, accompanied by an increase in left skewness that accounts for 15% of this rise between 2002 and 2010 and 35% between 2010 and 2018. Our results thus suggest that BMI distributional skewing is of growing importance in explaining the rise in obesity. Such skewing also leads to an increase in obesity inequality, whose Gini coefficient increases by 12.5% between 2002 and 2018. The magnitude of this increase becomes clearer if we compare it with the 5.7% increase (i.e., from 0.299 to 0.316) in the Gini coefficient for the change in income inequality in Germany during the same period [95]. This comparison is particularly illustrative given that the BMI distribution (unlike the income distribution) has an upper bound and cannot increase indefinitely. We also document a substantial increase of 1.6 times in FGT(2), indicating a significant increase in obesity severity. This increase in inequality differs notably among socioeconomic groups, being always higher in females and those with low education and/or low income. Nevertheless, the bulk of the rise in obesity rates, no matter what period we choose, arises owing to an increase in overall BMI. The change in the distribution never accounts for more than about one-third of the overall rise.

As Fig. 3.5 shows, obesity inequality in Germany has accompanied an increase in the obesity rate, which, as in the US, represents stage 3 of the obesity transition [78]. This denotation implies

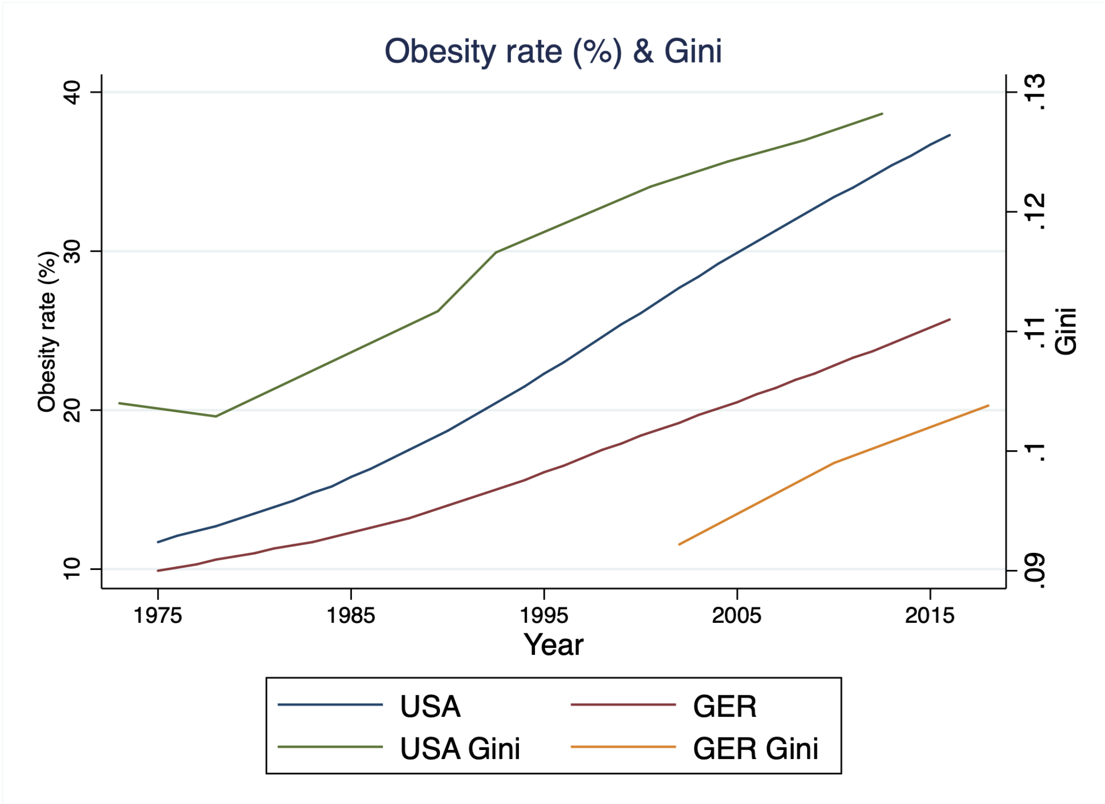

Figure 3.5: Obesity rate, mean BMI, and Gini coefficient of obesity inequality across time in the US and Germany

Note: Based on data from [65]Ritchie and Roser (2017) and [70]Pak et al. (2016), together with author calculations of GSOEP data.

that obesity rates are still rising, driven mainly by individuals with low SES,[13] and the nation will not begin the stage 4 decline until its obesity growth rate becomes negative. As is clear from the figure, however, obesity growth rates remained quite large (approximately 2%) in 2016 in both Germany and the US, decreasing only about 1% and 1.7% point (s), respectively, since peaking in the late 1980 s and mid-1990s. Assuredly, then, they will remain positive for the next 1–2 decades. Average BMI is also increasing despite declining growth rates in past decades and a noticeable leveling off of average BMI at approximately 0.15% in Germany (0.2% in the US). At the same time, the negative BMI growth rates in the first 30% of the distribution identified in our GIC analysis for 2010–2018 suggest that it is relatively thin individuals who are losing weight. A

[13]We also calculate concentration indices for obesity [77][76], which are negative and significant statistically, supporting that the low SES group has a higher body weight. The results of the indices are available upon request.

reduced average BMI may thus not necessarily imply reduced obesity rates, especially given the high BMI growth rates at the upper end of the distribution (i.e., among obese individuals), which are worsening obesity inequality. These observations have implications for interventions aimed at counteracting obesity. For example, given negative BMI growth rates at the left end and positive rates at the right end of the BMI distribution, introducing a population wide "fat tax" may be less efficient than targeted measures like facilitating access to shopping areas – and thus healthy foods – in disadvantaged areas (i.e., combating "food deserts"). Nutritional education, both at school and as ad hoc courses for adults, may also be an effective targeted initiative, especially given the empirical evidence that such programs can reduce obesity rates [96][97]. Nevertheless, the reality that rising obesity is not solely the result of distributional skewing implies that hybrid interventions are also needed.

Another important reason for addressing obesity inequality is the effect of inequality on well-being, which our results show to be negatively associated with various measures of obesity inequality. In particular, we note that both individuals living in social contexts with higher inequality and those with higher relative weight (using the median BMI of peers as a reference) tend to have lower subjective well-being, with the latter association most probably driven by higher risks of discrimination and stigmatization, especially among women. That is, although obesity rates do not vary much between genders, women are more likely to suffer from weight-based teasing [59], and among older women, obesity is often associated with social isolation [98]. The cultural environment thus drives women to care more about their (absolute and relative) weight and be more prone to low self-esteem or depression because of overweight. Men, in contrast, are more likely to be comfortable with their weight [99].

Limitations. Although the GSOEP survey is one of the few data sets that enables analysis of the changing BMI distribution across a reasonably long-time horizon, using such long running panel data sets has certain inevitable drawbacks. One particularly relevant shortcoming is the potential bias from self-reported BMI given individual tendencies to underreport weight and overreport height, which could yield a lower BMI [57][58]. Given that this tendency applies particularly to obese individuals [57][58], our estimated obesity inequality may be downwardly biased. Yet even with this potential bias, the GSOEP is widely used in obesity-related research [13][59]. A second weakness is the trade-off between precise social context definitions and statistical noise in estimating the effects of obesity inequality on life satisfaction. That is, although we would like to define "peers" at the lowest possible geographic level to better approximate individuals' real social contexts, the GSOEP data, despite its amplitude, does not permit reliable measurement of obesity inequality in small geographic regions (e.g., at the NUTS2 or NUTS3 level). Lastly, because our analysis of obesity inequality and subjective well-being is based on observational data, we cannot fully rule out unobserved confounders in so far as they are not captured by our fixed-effects estimators. The implication is that the effects are not necessarily causal due to these possible problems of endogeneity.

3.6 Conclusions

By examining long-term changes in the BMI distribution and obesity inequality among German adults between 2002 and 2018, we show that the rise in obesity prevalence over this 16-year period is due to a combination of an overall rightward shift and increasing distributional left skewness. By comparing the evolution of obesity inequality in Germany to that of the US, we demonstrate that obesity growth in the former is still in a relatively significant upward phase, meaning that obesity inequality will most likely continue to increase in future. This rising inequality points to the need to combat obesity through initiatives targeted at specific sociodemographic groups (in particular, women and individuals with lower education and/or income levels), especially given the negative relation between obesity inequality and subjective well-being.

CHAPTER 4

TRENDS IN THE SUBJECTIVE WELL-BEING OF NEVER-MARRIED PEOPLE IN SIX COUNTRIES

[1]

Abstract

Declining marriage rate and increasing average age of first marriage make the ratio of never-married people increased in recent decades. In this paper, we explore the trends in the subjective well-being (SWB) of never-married people (referenced with married) and the factors that account for the gaps in SWB between never-married and married people. Employing a harmonized data based on the Comparative Panel File (CPF) from surveys in six countries: Australia (HILDA), South Korea (KLIPS), Russia (RLMS), Switzerland (SHP), Germany (SOEP), and the United Kingdom (BHPS and UKHLS), we find that individuals who have never been married are significantly and consistently associated with lower levels of life satisfaction, and this association remains unchanged over time. Of particular significance is the notable decline in life satisfaction among unmarried individuals in South Korea when contrasted with their married counterparts.

Keywords: Subjective well-being, Marriage, Trend

[1]This chapter is single authored work, and has not yet been submitted to a journal. The underlying analysis is based on the harmonized data from Household, Income and Labor Dynamics in Australia Survey, HILDA), South Korea (Korean Labor and Income Panel Study, KLIPS), Russia (Russian Longitudinal Monitoring Survey, RLMS), Switzerland (Swiss Household Panel, SHP), Germany (German Socio-Economic Panel, SOEP), and Great Britain (British Household Panel Survey, BHPS and Understanding Society – The UK Household Longitudinal Study, UKHLS).

4.1 Introduction

Over recent decades, the marriage rate has seen a decline, while the average age at marriage has risen in the majority of developed nations as well as in select developing societies [100]. In an expanding set of countries, the mean age of marriage for both genders now surpasses 30 years. Notably, between 2000 and 2018, the proportion of Americans who remained unmarried increased from 21% to 35% [101]. A report from the Pew Research Center posits that, given the marital trends through 2012, up to a quarter of contemporary young Americans may opt never to marry [102]. Historical data reveals that Western European nations have long held traditions of later marital ages [103], a trend that has further intensified in more recent times [100]. However, this trend isn't confined solely to the Western hemisphere. In Japan, a developed nation with deep Confucian roots, there is an escalating trend towards postponed first marriages, with some individuals remaining single throughout their lives (Statistical Handbook of Japan 2022, 2022). This pattern is also emerging in South Korea [104] and China [105], despite these shifts presenting contrasts to traditional cultural values that emphasize marriage and familial ties. The increasing proportion of individuals who never marry necessitates greater scholarly attention. Furthermore, alterations in marital patterns may have subsequent implications for associated subjective well-being.

Prior research indicates that marital status significantly influences subjective well-being. Multiple studies have consistently established that individuals who are married report greater life satisfaction and happiness compared to their unmarried counterparts [106][107][108]. Those who are divorced tend to report the lowest levels of subjective well-being, while the well-being of widowed and never-married individuals lies between that of married and divorced groups. One area of contention is the potential reverse causality in the association between marriage and life satisfaction. It raises the question: do inherently happier individuals opt for marriage, or does the institution of marriage inherently enhance happiness? Longitudinal studies provide some insight, suggesting that while marriage may marginally elevate life satisfaction in the initial stages, this effect tends to diminish over time. Interestingly, in some instances, individuals might even experience lower life satisfaction post-marriage than they did prior [109][110][111]. Various disciplines, including psychology, sociology, and economics, have proposed hypotheses regarding the underlying mechanisms of marriage's role in shaping subjective well-being [112][113][114]. However, in contemporary society, marriage appears to be transitioning from a fundamental necessity to a discretionary option.

The decline in the perceived necessity of marriage can be attributed to three primary factors: evolving social norms, economic challenges, and shifts in legal policies. A prominent catalyst for this shift in perception relates to the altered roles of men and women in modern society. Historically, marriage was perceived as a mechanism for women to attain financial security, with the onus on men to be the breadwinners. However, with increased access to education and employment for women and the gradual blurring of rigid gender roles, the traditional paradigm of marriage has diminished in significance. The growing endorsement of individualism, where the single lifestyle and the quest for personal fulfillment are esteemed, further reinforces this shift [115]. Economic constraints of the modern age further complicate the decision to marry. Escalating living expenses, including housing costs, have made financial stability elusive for many young adults [116][117][118], rendering the prospect of marriage and family establishment less enticing. Additionally, the broadening acceptance of non-conventional relationship models further challenges traditional views. Cohabitation, which was previously stigmatized, is now widely recognized as a legitimate alternative to marriage. As societies grow increasingly secular and diverse, the religious and cultural weight previously accorded to marriage diminishes for many. Legally, there is a convergence of rights for both married and unmarried couples in numerous jurisdictions [119][120]. Protections like inheritance rights, healthcare benefits, and mutual decision-making rights in medical scenarios, traditionally reserved for married couples, are now extended to unmarried couples and their offspring. This progressive legal framework, in essence, minimizes socio-cultural obstacles for unmarried individuals and potentially augments their subjective well-being.

A large number of exiting studies have examined the trend of subjective well-being (SWB) through diverse analytical perspectives. Notably, Bjørnskov et al. (2008) [121] introduces the role of Gross Domestic Product (GDP) growth and government consumption in shaping well-being trends across 15 European countries from 1973 to 2002. Contrary to income alone, faster GDP growth and government consumption are associated with positive trends in life satisfaction, aligning with aspirations theory and reference group comparisons. Challenging the predominant GDP-centric paradigm governing prognostications of SWB, Bartolini and Bilancini (2010)[122] introduce a novel dimension through the prism of sociability or relational goods. They argue that social relationships significantly predict well-being, as evidenced by cross-sectional and longitudinal data from the US and Germany. Expanding this discourse, Sarracino (2010)[123] delves into the nexus between social capital and well-being, marshaling evidence drawn from the comprehensive World Values Survey spanning the years 1980 to 2000 across 11 Western European nations. The results suggest a decline in confidence in societal institutions, particularly in the United Kingdom, emphasizing the nuanced relationship between social capital and well-being. In a more recent investigation, Jebb et al. (2020)[124] mention that marriage has very small associations with subjective well-being. Conversely, the state of employment exhibits more pronounced effects, with the zenith of its influence observed around the age of 50. In their study, individuals in a marital union consistently exhibit higher levels of life satisfaction when compared to their unmarried counterparts. Within their rubric, the term ”unmarried” encompasses individuals who were either divorced, widowed, or single.

In light of the expanding number of adults who have never been married, we would like to investigate if this subgroup of individuals has recently exhibited elevated levels of subjective well-being in comparison to their married counterparts. Additionally, we aim to provide an overarching perspective on the long-term dynamics of subjective well-being throughout this transitional period and endeavor to elucidate any factors that may contribute to these changes, should they be discernible. This study draws upon a harmonized dataset compiled from surveys conducted in six countries, namely Australia (Household, Income and Labor Dynamics in Australia Survey, HILDA), South Korea (Korean Labor and Income Panel Study, KLIPS), Russia (Russian Longitudinal Monitoring Survey, RLMS), Switzerland (Swiss Household Panel, SHP), Germany (German

Socio-Economic Panel, SOEP), and Great Britain (British Household Panel Survey, BHPS and Understanding Society – The UK Household Longitudinal Study, UKHLS). It is noteworthy that, to our knowledge, no prior research has undertaken an investigation into the cross-temporal trends in life satisfaction toward marital status, especially within the context of longitudinal and cross-country datasets. This study is thus poised to contribute a pioneering examination of the trends in subjective well-being disparities between never-married and married individuals, capitalizing on extensive time frames and cross-national data sources. Remarkably, the primary focus of our study leans more towards the never-married cohort, representing a departure from the customary emphasis on married individuals that characterizes much of the existing literature.

4.2 Data and Methods

4.2.1 Data and study population

We draw our data from long-running household panel surveys conducted in six countries, which are as follows: Australia (Household, Income and Labor Dynamics in Australia Survey, HILDA), South Korea (Korean Labor and Income Panel Study, KLIPS), Russia (Russian Longitudinal Monitoring Survey, RLMS), Switzerland (Swiss Household Panel, SHP), Germany (German Socio-Economic Panel, SOEP), and Great Britain (British Household Panel Survey, BHPS and Understanding Society – The UK Household Longitudinal Study, UKHLS). Employing the Comparative Panel File (CPF, for details, refer to Turek et al., 2021), we harmonized these surveys to explore the evolving trends in subjective well-being among individuals who have never married across the six aforementioned countries. As per the precedent set by Jebb et al. (2020b)[124], we imposed an upper age limit of 80 years on our sample. Taking into account the lower age threshold, our primary analysis centers on individuals aged 35 and older; however, we also present our findings when including individuals as young as 30 years old in the sample. This lower age boundary is established because the examination of marital effects on individuals at an early age is devoid of meaningful implications. Notably, the majority of the population remains unmarried at the age of 20, after which the marriage rate experiences a swift upswing. By approximately age 35, the

	Australia	Korea	Russia	Switzerland	Germany	UK
SWB	7.809	5.569	4.737457	7.994	7.071	6.856
	(1.504)	(1.364)	(2.608)	(1.394)	(1.810)	(2.414)
Nvmarr	0.150	0.049	0.044	0.123	0.085	0.144
	(0.357)	(0.217)	(0.204)	(0.329)	(0.278)	(0.351)
Age	50.973	50.480	50.824	52.002	50.464	51.465
	(9.950)	(10.103)	(10.136)	(9.797)	(9.960)	(10.126)
Number of kids	0.821	0.677	0.457	0.685	0.764	0.602
	(1.162)	(0.935)	(0.791)	(1.033)	(1.101)	(0.974)
Observations	148,444	175,271	162,438	84,173	425,432	322,749

Notes: Standard deviations are in parentheses.

Table 4.1: Descriptive statistics

percentage of the population who have never married reaches a relatively stable equilibrium.

Given the intricate and potentially conflicting impacts of the one-time shock stemming from the Covid-19 pandemic on subjective well-being, particularly with respect to marital status and parental status, as demonstrated in studies such as Giménez-Nadal et al. (2023)[125] and Möhring et al. (2021)[126], we have restricted our dataset to include data up to and including the year 2019. Descriptive statistics for the dataset can be found in Table 4.1.

4.2.2 Variables

SWB measurement. To assess the potential implications of never-married for well-being, we proxy SWB with life satisfaction in a 11-point Likert scale from 0 = completely dissatisfied to 10 = completely satisfied. Different scales are used in these seven surveys, we harmonized them into the most common 11-point scale by following CPF [127]. We also tested the validation of estimates based on the harmonized scale.

Marital status measurement. We mainly use a dummy variable never-married (i.e., 1 = never married; 0 = married) to indicate individuals who has not been formally married until the interview time. We also define never-married based on the primary partnership status, i.e., 1 = never married and 0 = married or living with partner, for robustness checks.

Demographic and socioeconomic characteristics. To capture subpopulation heterogeneity in SWB, we include the demographic and socioeconomic characteristics of gender (1 = female, 0

= male), age, age squared, educational level (recoded as: 0 = primary, 1 = secondary lower, 2 = secondary upper, 3 = tertiary lower (bachelor), 4 = tertiary upper (master/doctoral)), employment status (recoded as: 0 = employed, 1 = unemployed (active), 2 = retired, disabled, 3 = not active/home, 4 = in education), income, and with children. Because most people who are not married do not have children, and because the differences in the effect of having children on subjective well-being may be much larger than the effect of having one more child if they do have children. Thus the 0-1 variable that distinguishes whether or not one has children may be more appropriate than the number of children. We mainly use equivalent disposable income based on net adjusted household income after taxes and transfers. As the individual income is only available in limited countries, we use individual income for robustness checks when it is available.

4.2.3 Impact of being never-married on SWB

To assess the gap in subjective well-being associated with the marital status of never having been married, we employ the following equation:

$$SWB_{it} = \beta_0 + \beta_1 nvmarr_{it} + X_{it}\gamma + \eta_y + \varepsilon_{it} \tag{4.1}$$

where SWB_{it} represents the life satisfaction of individual i, $nvmarr_{it}$ is a binary dummy variable that takes the value of 1 when individual i is unmarried and 0 otherwise, X_{it} denotes a vector encompassing individual-specific characteristics, η_y represents a vector of year-specific dummy variables, and ε_{it} is the error term associated with the model. Given the discrete nature of the dependent variable, which is measured on an 11-point scale, we opt for the ordered probit model as the appropriate statistical framework for estimation. To enhance the reliability of our estimates, we compute robust standard errors while clustering observations by both individual and year to account for potential heteroscedasticity and serial correlation in the data.

4.2.4 Estimating the trends of SWB among the never-married

In accordance with prior research conducted by Blanchflower and Oswald (2004) and Herbst and Ifcher [128], this study seeks to ascertain trends in subjective well-being (SWB) among individuals categorized as never-married and married. To facilitate this analysis, we employ the following econometric model:

$$SWB_{it} = \beta_0 + \beta_1 nvmarr_{it} + \beta_2(nvamrr_{it} \cdot trend_t) + \beta_3(marr_{it} \cdot trend_t) + X_{it}\gamma + \varepsilon_{it} \quad (4.2)$$

where SWB_{it}, $nvmarr_{it}$, and X_{it} retain their previously established definitions, while $marr_{it}$ serves as a binary variable equaling 1 for individuals who have ever been married and 0 otherwise. The parameter $trend_t$ represents the survey year t subtracted from the initial year of the survey, subsequently divided by 100. The division by 100 is performed to magnify the coefficient's magnitude, allowing it to signify the net change in SWB anticipated over the span of a century, a methodology in line with the approach adopted by Stevenson and Wolfers (2009) and Stevenson and Wolfers (2012). We again employ an ordered probit estimation technique to estimate Equation 4.2 and calculate robust standard errors while clustering observations by year. Notably, year fixed effects are excluded from the analysis since the primary objective is to estimate temporal trends.

Our primary focus lies on the estimation of β_2 and β_3. These coefficients capture the temporal dynamics of SWB within the never-married and married cohorts, respectively. A positive (negative) estimate of β_2 or β_3 suggests an upward (downward) trajectory in SWB over time within the respective group. An informative parameter is $\Delta\beta = \beta_2 - \beta_3$, which encapsulates the disparity in temporal trends between the two groups. A positive (negative) $\Delta\beta$ value signifies that SWB among the never-married has risen (declined) over time relative to the ever-married cohort.

4.2.5 Oaxaca-Blinder decomposition

In addition to the differences of SWB among the never-married and married, there is also interest in the factors account for the differences between two groups. A classical method to decompose the difference between subgroups is Oaxaca-Blinder (OB) decomposition approach [129][130]. Using this approach, the differences are classified as the differences in characteristics (composition effect) and differences in coefficients related those characteristics (structure effect). The standard OB decomposition also makes the contribution of each covariate to the structure effect sensitive to the choice of the base group. although there are some extensions of OB decomposition, the validation of standard OB decomposition employing on panel data was confirmed by Kröger and Hartmann [131]. In this study, the OB decomposition is first used to check how the composition and coefficients effects changed across time, and then we focus on the income. The details of the method are shown in Appendix A1 .

4.3 Results

4.3.1 the SWB gap of never-married and ever-married people

Based on our graphical analysis delineating the trajectories of average gap of life satisfaction, a conspicuous augmentation emerges between the cohorts of unmarried and married individuals within the context of Germany, whereas in the United Kingdom, the upward trend is with more fluctuations. Conversely, within other national contexts, this particular trend exhibits a relatively more consistent demeanor. This phenomenon can potentially be attributed to a synchronous modulation in the subjective well-being of both cohorts within the same nation, as shown in Appendix Figure A4.1. It is plausible that heightened life satisfaction may be experienced by both the unmarried and married segments of the population during periods characterized by favorable economic and sociocultural circumstances, and vice versa.

The estimation of Equation 1 was performed utilizing Ordinary Least Squares (OLS) and Ordered Probit models. The coefficient β_1 corresponding to individuals who have never been married is identified to hold a negative value and exhibits statistical significance, as indicated in Table 4.2. This observation concurs with prior literature emphasizing higher life satisfaction among married individuals [124]. The effects of dummies unveil that, across all nations, the predicted probability of reporting "satisfied" for individuals who have never been married is consistently lower than that

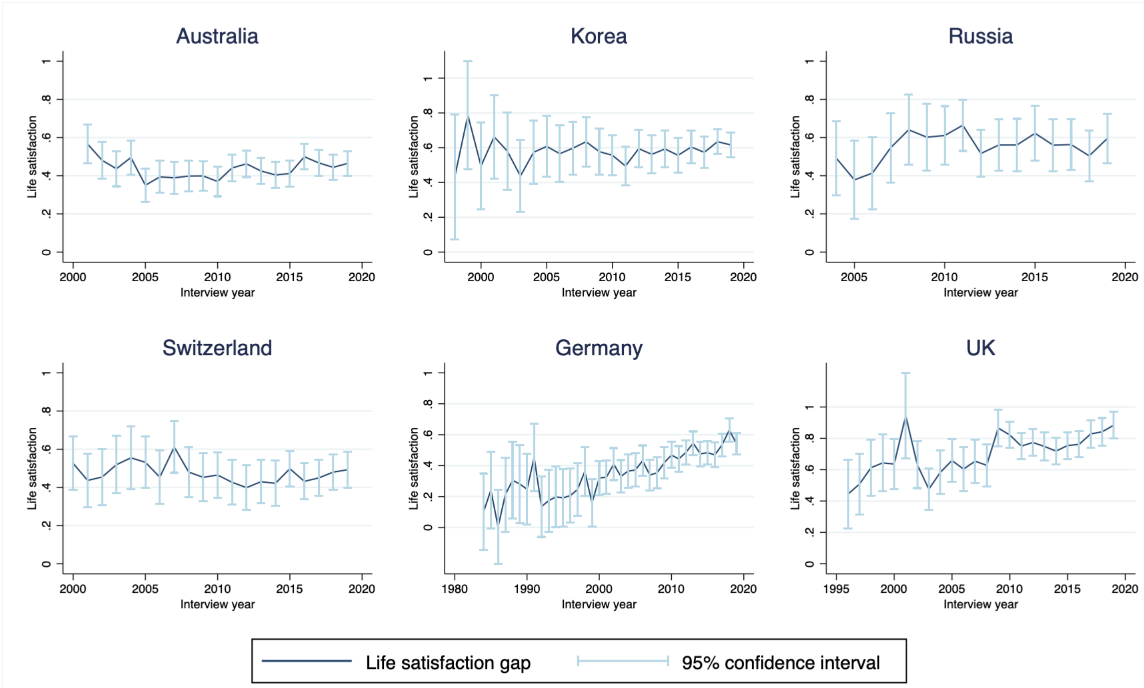

Figure 4.1: Gap of average life satisfaction between married and never-married people

Note: the gap between married and never-married people is obtained by subtracting the mean life satisfaction of never-married from the mean life satisfaction of married group.

for their married counterparts. Particularly noteworthy is the context of South Korea, where the predicted probability disparity between the unmarried and married individuals amounts to 0.639 ($SE = 0.018$). This aligns with the notion found in the literature that marriage (associated with happiness) is a requisite for a contented life within distinct cultural frameworks [104]. Correspondingly, concerning the category of "dissatisfied," those who have never been married report a higher probability of being "dissatisfied" compared to their married counterparts.

4.3.2 The trends of the effects of being never-married on SWB

Table 4.3 presents an analysis of the temporal variation in Subjective Well-Being (SWB) among individuals who have never married, juxtaposed with their married counterparts, as reflected by the difference in linear SWB time trends ($\beta_2 - \beta_3$). The findings reveal a statistically significant negative disparity in SWB between these two groups within the contexts of Korea, Russia, and Germany. This suggests that the SWB of individuals who have never married exhibited a decreasing

		(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Life satisfaction	OLS	-0.403***	-0.470***	-0.678***	-0.510***	-0.428***	-0.624***
		(0.010)	(0.015)	(0.020)	(0.016)	(0.010)	(0.013)
Life satisfaction	Ordered probit	-0.283***	-0.455***	-0.309***	-0.395***	-0.249***	-0.272***
		(0.007)	(0.014)	(0.009)	(0.012)	(0.006)	(0.005)
Satisfied	Probit	-0.355***	-0.639***	-0.325***	-0.498***	-0.281***	-0.329***
		(0.013)	(0.018)	(0.011)	(0.023)	(0.008)	(0.007)
Dissatisfied	Probit	0.347***	0.173***	0.304***	0.415***	0.276***	0.300***
		(0.018)	(0.023)	(0.011)	(0.035)	(0.010)	(0.008)
Controls		✓	✓	✓	✓	✓	✓
Observations		144890	169556	97685	78552	380704	306450

Notes: Standard errors (clustered by person year) are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5.

Table 4.2: Estimates of the SWB gap of never married

trend relative to that of their married counterparts in these particular societies. Conversely, in other nations, the observed differences fail to attain statistical significance, and their magnitudes are comparatively smaller. Consequently, it can be inferred that the SWB of never-married individuals in these countries may not exhibit statistically significant changes when compared to their married counterparts. Moreover, when we take into consideration the dummy variables denoting satisfaction and dissatisfaction, the analysis demonstrates that, among never-married individuals, the predicted probability of reporting ”satisfied” witnessed a decline, while the likelihood of reporting ”dissatisfied” increased notably in Korea and Russia, in contrast to their married counterparts.

Additionally, we conducted regression analyses, in accordance with Equation 1, on an annual basis for each country (excluding year dummies) to ascertain the trend associated with the coefficient on never-married individuals (β_1). As presented in Appendix Figure A4.2-A4.7, the impact of being never-married on life satisfaction is consistently observed to be negative and on a declining trajectory in all examined countries, with the exception of Switzerland. When considering the interaction between never-married status and time dummies, a discernible downward trend in the interaction coefficient is only evident in Germany, as depicted in Figure A4.8.

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-0.334***	2.757***	2.470***	0.095	0.531***	-0.667***
	(0.114)	(0.217)	(0.176)	(0.179)	(0.068)	(0.088)
Married	-0.498***	4.183***	3.194***	-0.193**	0.761***	-0.540***
	(0.058)	(0.052)	(0.087)	(0.076)	(0.021)	(0.037)
Difference	0.164	-1.426***	-0.724***	0.288	-0.430***	-0.127
	(0.127)	(0.221)	(0.195)	(0.192)	(0.071)	(0.093)
Panel B: Satisfied						
Never-married	0.441**	1.826***	2.475***	1.143***	1.000***	-0.757***
	(0.185)	(0.283)	(0.216)	(0.296)	(0.084)	(0.113)
Married	0.612***	3.530***	3.283***	1.316***	1.129***	-0.707***
	(0.122)	(0.055)	(0.106)	(0.166)	(0.027)	(0.049)
Difference	-0.171	-1.704***	-0.807***	-0.173	-0.129	-0.049
	(0.219)	(0.287)	(0.240)	(0.333)	(0.088)	(0.122)
Panel C: Dissatisfied						
Never-married	0.018	-4.526***	-3.350***	-0.772*	-0.592***	1.862***
	(0.246)	(0.325)	(0.220)	(0.418)	(0.101)	(0.127)
Married	-0.541***	-6.790***	-4.178***	-0.273	-0.747***	2.023***
	(0.176)	(0.095)	(0.115)	(0.263)	(0.035)	(0.058)
Difference	0.559*	2.264***	0.828***	-0.499	0.155	-0.161
	(0.299)	(0.336)	(0.247)	(0.486)	(0.107)	(0.138)
Controls	✓	✓	✓	✓	✓	✓
Observations	144890	169556	97685	78552	380704	306450

Notes: Standard errors (clustered by person and year) are in parentheses. * $p<0.10$, * $p<0.05$, *** $p<0.01$. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5.

Table 4.3: Estimates of SWB time trends for never-married, married, and the difference

4.3.3 Oaxaca-Blinder decomposition

The Figure 4.2 illustrates the decomposition of life satisfaction gaps in Australia, South Korea, Russia, Switzerland, Germany, and the United Kingdom from 2004 to 2019. Overall, the coefficients (structural factors) primarily account for the differences, while endowments are relatively low in each country. Specifically, in Russia, Switzerland, and Germany, the 95% confidence intervals for endowments in most regions are below zero, in the United Kingdom, they are above zero, and in Australia and South Korea, they hover around zero. Endowments represent the explainable portion contributed by observable characteristics. Endowments close to zero indicate that the observable characteristic differences between married and unmarried individuals are relatively small.

Interestingly, endowments for all countries are close to zero. This implies that the endowment gap between the two groups is small, and the difference in life satisfaction is primarily due to differences in coefficients. In Australia, the endowment effect nearly coincides with the x-axis, while the coefficients almost overlap with the differences. This suggests that the differences in subjective well-being between the two groups in Australia are mostly attributed to unobservable factors rather than easily measurable individual characteristics such as gender, age, income, education, and parenthood status. In the United Kingdom, although the three trajectories are not entirely identical, they exhibit similar increasing trends. In Germany, while the life satisfaction gap between unmarried and married individuals increased during that period, endowments remained stable, and the coefficient portion increased with the growing differences. This indicates that during that time, factors not captured by personal and social characteristics had a greater impact on the subjective well-being differences between unmarried and married individuals in Germany. In the case of South Korea, the endowment trajectory shows a significant confidence interval, which may be due to heteroscedasticity between the two compared groups.

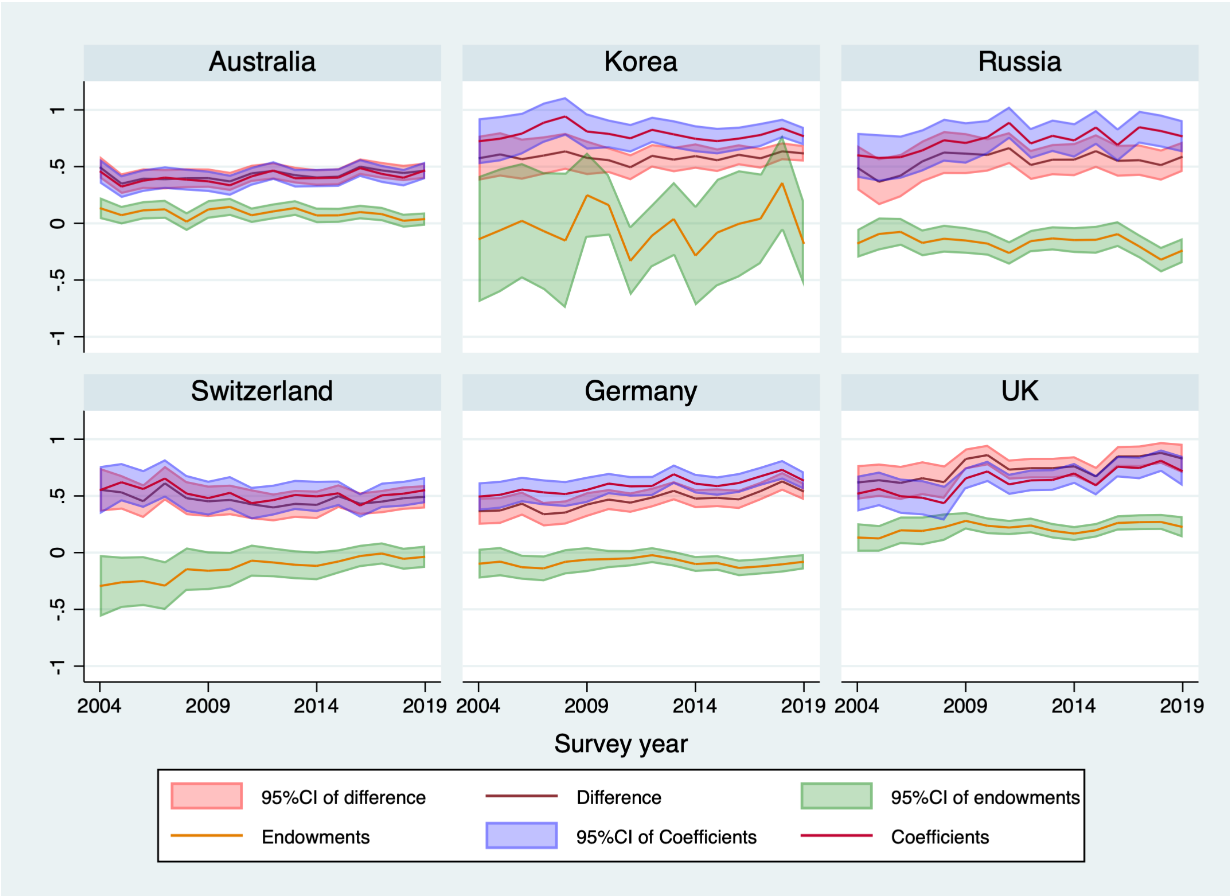

Figure 4.2: Trends of oaxaca-Blinder decomposition between married and never-married people

Data source: Australia: Household, Income and Labor Dynamics in Australia Survey. South Korea: Korean Labor and Income Panel Study. Russia: Russian Longitudinal Monitoring Survey. Switzerland: Swiss Household Panel. Germany: German Socio-Economic Panel. The United Kingdom: British Household Panel Survey and Understanding Society – The UK Household Longitudinal Study.

4.4 Robustness checks

To assess the robustness of our primary analysis results, we conducted replications of Tables 4.2 and 4.3 through several modifications. Firstly, we redefined the category of ”married” to encompass individuals engaged in unmarried cohabitation. Secondly, we adjusted the age interval within our sample, specifically, by altering the lower age boundaries to 30 and 50 years, respectively, and explored combinations of these two adjustments. This approach was motivated by several considerations. Firstly, prior research has indicated that unmarried cohabitation may exert a comparable influence on subjective well-being as formally registered marriages [132], a hypothesis we sought to corroborate through our robustness checks. Moreover, we encountered a trade-off in our selection of sample age: our aim was to concentrate on the group of individuals who remain unmarried while the majority of their peers have already entered into marital unions, ensuring that this unmarried status is likely to persist, rather than examining those on the cusp of imminent marriage. Consequently, in our primary analysis, we established 35 years as the lower age threshold for sample inclusion. However, recognizing that the average age of first marriage varies across countries, some are younger than 30 years old, especially for women, so we also replicated our analysis for samples spanning the age range from 30 to 80 years. It is worth noting that while it is technically only possible to definitively ascertain an individual's ”never married” status at the culmination of their life, previous investigations and statistics have often ignored first marriages over the age of 50 due to their low probability of occurrence [133][134].

When examining the estimates pertaining to the SWB disparity between individuals who have never married and those who are married, a consistent pattern emerges: never-married individuals consistently report lower levels of life satisfaction. Furthermore, they exhibit a smaller likelihood of expressing life satisfaction and an increased likelihood of reporting life dissatisfaction across diverse contexts, encompassing different countries, age groups, and the inclusion of cohabiting couples, as shown in Appendix Table A4.1-A4.5. However, it is important to note that the temporal trends in these patterns exhibit greater variability (see details in Appendix Table A4.6-A4.10).

The most stable results are observed in South Korea, where over time, the subjective well-being of unmarried individuals, relative to their married counterparts, decreased. The likelihood of reporting dissatisfaction with life increases, while the likelihood of reporting satisfaction with life decreases. Although the numerical values vary, the statistical significance remains consistent ($p < 0.05$). When the age range of the sample is narrowed down to 50-80 years old, the level of significance slightly decreases (i.e., from a p-value less than 0.01 to less than 0.05).

In the case of Germany and Russia, the results are highly influenced by the selection of the age range in the sample. For Germany, when we include samples aged 30-34 years, the differences in subjective well-being between unmarried and married individuals over time are not statistically significant. However, when the sample age range is restricted to 50-80 years old, the unmarried group reports a significantly increased likelihood of dissatisfaction with life compared to their married counterparts, while also reporting a significantly decreased likelihood of satisfaction with life. Conversely, the situation in Russia is the opposite: the younger the sample's average age, the more statistically significant the declining trend in subjective well-being of unmarried individuals relative to married ones. However, if the focus is on individuals aged 50 and above, regardless of whether the married group includes cohabiting unmarried individuals, the differences are not statistically significant.

Australia presents another intriguing picture. Age does not seem to be a critical factor, but rather how "married" is defined. If the focus is on formally registered marital status, when the sample age is limited to 35-80 years, which is our primary analysis, unmarried individuals report an increasing likelihood of dissatisfaction with life ($p < 0.1$). However, if we include samples aged 30-34 years, unmarried individuals show an increasing trend in subjective well-being relative to married individuals over time. Interestingly, the likelihood of dissatisfaction with life also rises in comparison to married individuals ($p < 0.1$). Nevertheless, if we exclude cohabiting unmarried individuals from the "never married" group, then regardless of age grouping, over time, the unmarried group reports a decrease in subjective well-being relative to married individuals, with a higher likelihood of reporting dissatisfaction with life and a lower likelihood of reporting satisfaction with life, and these differences are statistically significant.

Regarding Switzerland and the United Kingdom, overall, over time, the differences in subjective well-being between the two groups are not very significant. When considering cohabitation among unmarried individuals, in Switzerland, the probability of life satisfaction decreases for the group that has never been married and does not cohabit when the lower age limit of the sample is set at 30 or 35 years. For the United Kingdom, the probability of reporting dissatisfaction with life for unmarried individuals relative to married ones decreased ($\beta_2 - \beta_3$ is negative), although it is statistically significant only when considering the elderly population.

4.5 Discussion

Many studies have analyzed the relationship between subjective well-being and marital status. A substantial body of research indicates that married individuals are generally happier. However, with the increasing proportion of the never-married population, this paper shifts the focus to the never-married group. Over the past few decades, advancements in science, technology, and cultural trends have seemingly made alternative lifestyles outside of marriage more accessible and acceptable, transforming marriage from a mandatory life milestone to an elective choice. Many countries have revised laws and regulations to grant greater rights and opportunities to the unmarried population. Consequently, this study investigates whether the subjective well-being of the never-married has improved relative to that of ever-married individuals. Our findings reveal that the subjective well-being of the never-married is lower than that of the married, and the well-being gap between the two groups has not decreased over the past few decades.

Our findings indicate that married individuals have higher life satisfaction and are more likely to report being ”satisfied” with their lives. On the other hand, the never-married group is more likely to report being ”dissatisfied” with life. Marriage and cohabitation can provide companionship and emotional support, which can be vital for psychological well-being. In many societies, marriage is considered a societal norm or a milestone of adulthood. Not achieving this milestone might make individuals feel ”left out” or ”different”, potentially influencing life satisfaction ratings. In South Korea, marriage symbolizes social success and is closely related to women's economic well-being and men's subjective well-being [104]. Unmarried people are more likely to be dissatisfied with life, which could due to the lack of benefints from a union or more external pressures from the socitiel culture. On the other hand, not everyone chooses to remain unmarried due to negative circumstances. Some may prioritize career, personal growth, or other life experiences over marriage. While some may report dissatisfaction, it might not solely be because of their marital status.

Typically, during periods of rapid socioeconomic development, the majority of societal groups tend to benefit, resulting in higher levels of subjective well-being, like in Korea, Russia, and Germany. Conversely, in the United Kingdom, both never-married and married have a decreasing subjective well-being. This study focus on the changes of the gap between two groups over time. The most noteworthy observation pertains to the declining life satisfaction among unmarried individuals in South Korea compared to their married counterparts. This trend may be attributed to various factors. Influenced significantly by Confucianism, South Korean society traditionally places a strong emphasis on family values and filial piety. Unmarried individuals may find themselves disconnected from these values, potentially leading to internal dissatisfaction and external societal pressures. These adverse effects on happiness tend to exacerbate over time and with the increasing age of unmarried individuals. Furthermore, owing to the influence of traditional culture, marriage often involves the groom's family providing a house. Thus, marriage can serve as a solution to housing issues for women. For men, getting married at an earlier age may reduce the financial pressure associated with purchasing a house, especially considering the ongoing rise in apartment prices in South Korea last decades (South Korea House Price Index, 2023). Consequently, if one remains unmarried, the financial stressors may contribute to the relative dissatisfaction with life among unmarried individuals.

The level of societal tolerance towards late marriage or remaining unmarried in German society may be higher than that in South Korea. Consequently, unmarried individuals are less likely to experience significantly increased pressures as they age when compared to their counterparts in South Korea, particularly during their relatively younger years. In economic terms, over half of Germans opt for renting housing(Germany Has the Highest Proportion of Rental Tenants in the EU, 2022), and the concept of marriage is not strongly linked to property ownership or home purchase. As a result, the influence of this aspect on the well-being of unmarried individuals tends to be relatively minor. However, for middle-aged and elderly individuals, who is older than 50 years old in this study, the negative impact of lacking a partner on subjective well-being may become increasingly pronounced as their health gradually deteriorates and they experience the effects of aging. The situation in Russia appears to be precisely the opposite of that in Germany. Whether or not to marry does not exhibit statistically significant effects on the happiness trends of individuals aged 50 and above. Unsatisfactory marital conditions may play a crucial role in this regard.

Although this study utilizes representative longitudinal panel data from six countries to analyze the relationship between marital status and trends in subjective well-being, the lack of information on individuals' attitudes towards marriage poses limitations. We cannot ascertain certain potentially important factors: whether individuals who have never married hold negative or indifferent attitudes towards marriage or if they desire to marry but have been unable to do so due to various reasons. In Japan, roughly two-thirds of remained unmarried people can be classified as 'drifting' into singlehood, about 30% as 'failing to realize marriage desires', and no more than 5% as 'rejecting marriage' [135]. Similarly, for the sample of married individuals, we cannot determine to what extent their marriage status is a result of societal and cultural pressures or a reflection of their aspiration for married life. So, if future research can be based on more detailed information, it will help us to think about this issue better.

CHAPTER 5
DISCUSSION

This dissertation examined two determinants that influence subjective well-being (SWB). It quantified the intangible costs associated with overweight and obesity and delved into the correlation between obesity inequality and subjective well-being. Additionally, the study investigated temporal trends in the SWB of individuals who have never been married. The findings from this research provided valuable insights for policymakers aiming to devise interventions to enhance the welfare of pertinent sub-populations.

In chapter two, it has been shown that the intangible costs of overweight and obese individuals incur 2018 costs of 13,853 and 42,450 euros, respectively, relative to normal-weight individuals, but a one-unit increase in BMI among these groups induced a 2553 euro loss in well-being, which extrapolates to a national cost of approximately 4.3 billion euros. In addition, although obesity prevalence has increased in recent decades, the intangible cost of obesity has been relatively stable. Compared to the United States, a possible explanation is that the increasing obesity rate slowly changed the ideal body shape in German society. Due to the fact that the measurement of SWB can only capture limited variation, the confidence interval is relatively large. But even if you look at the lower bound of the confidence interval, the intangible cost of obesity is also unavoidable. So, if the intangible costs of obesity can be considered when we evaluate a strategy to combat obesity, maybe the potential benefits are bigger than health-related measures of quality of life.

To effectively devise interventions aimed at combating obesity, it is imperative to comprehend the intricacies of the obesity transition. This necessitates an examination of changes in the entire Body Mass Index (BMI) distribution. Similar to income disparities, evaluating the shifts in the BMI distribution is instrumental in understanding inequality, which subsequently determines whether interventions should be universally applicable or specifically targeted. Furthermore, it influences the assessment of how obesity impacts subjective well-being through peer interactions and societal standards. Chapter 3 illustrates that the escalation in obesity prevalence in Germany is predominantly attributed to a pronounced shift to the right in the BMI distribution, coupled with heightened left skewness. Consequently, the skewing of the BMI distribution plays an increasingly significant role in elucidating the surge in obesity. This skewness is also concomitant with a rise in obesity inequality, which displays marked differences among socioeconomic strata, invariably being more pronounced among females and individuals with diminished educational and financial resources. However, the predominant increase in obesity prevalence, regardless of the time frame considered, emerges from an augmentation in the aggregate BMI. The shift in distribution contributes to no more than approximately one-third of the comprehensive ascent.

Germany witnesses an upward trajectory in obesity inequality, obesity rate, and mean BMI, predominantly propelled by individuals of lower socioeconomic status (SES). This aligns with stage 3 of the obesity transition, mirroring the scenario in the United States. Stage 4, marked by a decline in obesity rates, will not commence until there's a downturn in the obesity growth rate. These observations underscore the necessity for interventions to address the varied BMI distribution within the populace. Strategic initiatives, such as ensuring accessibility to nutritious food in underserved regions and promoting dietary education, could prove beneficial. Given that the proliferation of obesity isn't exclusively attributable to distributional bias, a combination of interventions is requisite.

It's also pivotal to address obesity inequality due to its detrimental effects on well-being. Our findings reveal a negative correlation between numerous metrics of obesity inequality and well-being. Specifically, individuals situated in socio-environments with elevated inequality, and those whose weight significantly deviates from the median BMI of their peers, generally exhibit diminished subjective well-being. This trend is presumably intensified by increased susceptibility to discrimination and stigmatization, especially among females. While obesity prevalence exhibits minimal gender discrepancies, women are more susceptible to weight-based derision (as per [59]). Among senior women, obesity frequently correlates with social alienation (as indicated by Hajek and Koenig [98]). Cultural norms exert pressure on women to be acutely conscious of their weight, both in absolute and relative terms, making them more vulnerable to low self-esteem or depression due to being overweight. Conversely, men tend to exhibit greater acceptance of their weight, as outlined by Millstein et al.[99].

In Chapter 4, the discussion on the marital status of ”never married” revealed some intriguing insights regarding subjective well-being (SWB). It is consistent with prior research that individuals who are married report higher levels of SWB. However, what is unexpected is the persistent and significant gap in SWB between those who are married and those who have never been married. This is particularly striking given the observable societal shift towards greater acceptance of unmarried individuals, as evidenced by the declining marriage rates and the upward trend in the age of first marriage. One might posit that, in certain cultures, marriage potentially elevates one's economic standing or brings about heightened satisfaction due to its emblematic association with success. If we operate under the presumption that there is an increased societal acceptance of remaining unmarried, it suggests that contemporary marriages might be less about attaining a societal status and more about genuine personal choices, possibly amplifying the positive impacts of marriage. Conversely, those who opt to remain unmarried might harbor elevated aspirations, both personally and professionally. If these aspirations are unmet, it could result in diminished life satisfaction. These hypotheses warrant further exploration with a more comprehensive dataset.

While the GSOEP survey stands as one of the select datasets that facilitates the examination of BMI distribution shifts over an extended temporal span, there are inherent limitations associated with utilizing longitudinal panel data of such duration. A salient limitation is the potential for bias arising from self-reported BMI, as individuals may have propensities to underestimate their weight and overstate their height, potentially resulting in a lower BMI representation [57][58]. Regarding marital status-related information, the public data utilized in this dissertation lacks quantifiable metrics on marital quality and duration, which somewhat constrains our further analysis.

In summation, when examining social phenomena or assessing policy implications, it is imperative to consider their influence on subjective well-being. The intangible costs and benefits related to well-being can be significant. Furthermore, it is crucial to utilize survey data to its full potential, while concurrently acknowledging its constraints, and striving for objectivity in the interpretation of findings derived from it.

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Appendices

Variables	Obs.	Mean	S.D.
Life satisfaction (0-10)	100,369	7.261	1.595
Body mass index (kg/m2)	100,369	25.961	4.514
Obesity[a]	100,369	0.162	0.369
Overweight[a]	100,369	0.363	0.481
Normal weight[a]	100,369	0.475	0.499
Net annual income	100,369	23177.280	20533.620
Age	100,369	43.171	11.356
Female[a]	100,369	0.485	0.500
Married[a]	100,369	0.621	0.485
Years of education	100,369	12.689	2.752
Number of children in household	100,369	0.741	1.013
Homeowner[a]	100,369	0.526	0.499

a. Dummy variables

Notes: BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Obesity = BMI $\geq$ 30; overweight = 25 $\leq$ BMI$<$3; normal weight = 18.5 $\leq$ BMI$<$25.

Net annual income is in euros.

Table A2.1: Descriptive statistics for adults aged 18-65: SOEP 2002-2018

Survey years	Weighted obs.	Mean	SD	Min.	Max.
Panel A: 18.5 $\leq$ BMI $\leq$ 60					
2002	30,225,965	25.402	4.021	18.508	56.495
2004	30,354,902	25.557	4.127	18.508	57.099
2006	30,500,125	25.744	4.326	18.508	59.515
2008	32,661,480	25.983	4.452	18.513	59.028
2010	28,832,815	26.220	4.639	18.508	56.811
2012	27,528,187	26.217	4.645	18.508	58.280
2014	33,369,471	26.250	4.756	18.508	58.228
2016	33,595,886	26.435	4.813	18.508	58.770
2018	27,174,173	26.627	5.021	18.508	58.770
Panel B: 25 $\leq$ BMI $\leq$ 60					
2002	14,459,108	28.624	3.278	25	56.495
2004	15,071,400	28.714	3.407	25	57.099
2006	15,644,538	28.902	3.641	25	59.515
2008	17,321,454	29.097	3.775	25	59.028
2010	15,732,495	29.337	3.965	25	56.811
2012	15,099,007	29.322	3.962	25	58.280
2014	18,066,621	29.464	4.112	25	58.228
2016	18,771,482	29.568	4.127	25	58.770
2018	15,338,314	29.788	4.424	25	58.770

Note: BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. These results have sampling weights applied.

Table A2.2: Descriptive statistics of BMI: SOEP 2002-2018

	BMI ≥ 18.5		BMI ≥ 25			
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Ordered logit	OLS	OLS	Ordered logit	Ordered logit
Overweight[a]	-0.127**	-0.206***				
	(0.054)	(0.066)				
Obesity[a]	-0.378***	-0.510***		-0.257***		-0.320***
	(0.067)	(0.080)		(0.067)		(0.081)
BMI (kg/m^2)			-0.028***		-0.034***	
			(0.008)		(0.009)	
Ln(income)	0.207***	0.259***	0.268***	0.269***	0.313***	0.314***
	(0.041)	(0.047)	(0.058)	(0.058)	(0.066)	(0.066)
Age	-0.040**	-0.062***	-0.041*	-0.043*	-0.056**	-0.059**
	(0.016)	(0.020)	(0.023)	(0.023)	(0.028)	(0.028)
Age squared	0.000*	0.001**	0.000	0.000	0.001*	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female[a]	0.156***	0.207***	0.121	0.113	0.138	0.129
	(0.054)	(0.063)	(0.076)	(0.075)	(0.089)	(0.088)
Years of education	0.013	0.012	-0.008	-0.007	-0.009	-0.008
	(0.009)	(0.011)	(0.013)	(0.013)	(0.015)	(0.015)
Married[a]	0.480***	0.562***	0.564***	0.563***	0.676***	0.672***
	(0.055)	(0.067)	(0.073)	(0.073)	(0.089)	(0.089)
Number of children	0.047*	0.083**	0.033	0.039	0.072	0.080*
	(0.026)	(0.034)	(0.034)	(0.034)	(0.047)	(0.047)
Homeowner[a]	0.118**	0.133**	0.060	0.053	0.037	0.025
	(0.050)	(0.059)	(0.066)	(0.066)	(0.079)	(0.079)
Constant	5.992***		6.324***	5.587***		
	(0.414)		(0.590)	(0.564)		
Observations	11407	11407	6347	6347	6347	6347

a. Dummy variables

Notes: Dependent variable = life satisfaction. BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Obesity = BMI ≥ 30; overweight = 25 ≤ BMI<30; normal weight = 18.5 ≤ BMI<25. Standard errors are in parentheses. *p <0.1, **p <0.05, ***p <0.01.

Table A2.3: OLS/ordered logit estimates of bodyweight on life satisfaction: SOEP 2018

	(1) SWB	(2) SWB	(3) SWB	(4) SWB	(5) SWB	(6) SWB	(7) SWB	(8) SWB	(9) SWB
BMI (kg/m2)	-0.024**	-0.018*	-0.031***	-0.041***	-0.025**	-0.015*	-0.029***	-0.024***	-0.028***
	(0.010)	(0.011)	(0.010)	(0.014)	(0.012)	(0.009)	(0.007)	(0.007)	(0.008)
Ln(income)	0.314***	0.377***	0.382***	0.349***	0.284***	0.312***	0.263***	0.389***	0.268***
	(0.069)	(0.065)	(0.052)	(0.067)	(0.059)	(0.053)	(0.051)	(0.051)	(0.058)
Age	-0.129***	-0.198***	-0.169***	-0.135***	-0.161***	-0.119***	-0.099***	-0.074***	-0.041*
	(0.026)	(0.027)	(0.025)	(0.029)	(0.027)	(0.022)	(0.020)	(0.022)	(0.023)
Age squared	0.001***	0.002***	0.002***	0.001***	0.002***	0.001***	0.001***	0.001**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female[a]	0.248***	0.213**	0.195**	0.063	0.248***	0.167**	0.128**	0.303***	0.121
	(0.083)	(0.093)	(0.084)	(0.094)	(0.087)	(0.076)	(0.065)	(0.069)	(0.076)
Years of education	0.016	0.020	0.032**	-0.001	0.020	0.013	-0.000	-0.018	-0.008
	(0.014)	(0.014)	(0.013)	(0.015)	(0.014)	(0.013)	(0.011)	(0.012)	(0.013)
Married[a]	0.413***	0.438***	0.430***	0.448***	0.484***	0.341***	0.319***	0.383***	0.564***
	(0.084)	(0.091)	(0.086)	(0.087)	(0.092)	(0.078)	(0.067)	(0.071)	(0.073)
Number of children	-0.084**	-0.047	0.053	0.022	0.129***	0.046	0.069**	0.054*	0.033
	(0.036)	(0.041)	(0.042)	(0.049)	(0.050)	(0.049)	(0.029)	(0.032)	(0.034)
Homeowner[a]	0.252***	0.220***	0.232***	0.102	0.127*	0.220***	0.169***	0.161**	0.060
	(0.066)	(0.072)	(0.069)	(0.077)	(0.075)	(0.068)	(0.059)	(0.064)	(0.066)
Constant	6.834***	7.044***	6.980***	7.482***	7.997***	6.916***	7.560***	6.163***	6.324***
	(0.845)	(0.751)	(0.675)	(0.833)	(0.756)	(0.673)	(0.556)	(0.584)	(0.590)
Observations	5727	5305	5432	5137	4837	5143	7782	7032	6347

a. Dummy variables

Notes: Dependent variable = life satisfaction. BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Columns (1) through (9) use data from SOEP 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016 and 2018, respectively. Standard errors are in parentheses. *p <0.1, **p <0.05, ***p <0.01.

Table A2.4: OLS estimates of BMI on life satisfaction: SOEP 2002-2018

	(1) SWB	(2) SWB	(3) SWB	(4) SWB	(5) SWB	(6) SWB	(7) SWB	(8) SWB	(9) SWB
Overweight[a]	0.002	-0.153***	-0.041	-0.011	-0.080	-0.091*	-0.049	-0.061	-0.127**
	(0.049)	(0.057)	(0.055)	(0.062)	(0.063)	(0.054)	(0.047)	(0.051)	(0.054)
Obesity[a]	-0.136*	-0.228***	-0.222***	-0.275***	-0.313***	-0.254***	-0.181***	-0.222***	-0.378***
	(0.074)	(0.078)	(0.078)	(0.086)	(0.084)	(0.070)	(0.061)	(0.062)	(0.067)
Ln(income)	0.316***	0.302***	0.335***	0.284***	0.249***	0.241***	0.222***	0.270***	0.207***
	(0.041)	(0.044)	(0.038)	(0.046)	(0.044)	(0.036)	(0.035)	(0.036)	(0.041)
Age	-0.137***	-0.153***	-0.143***	-0.119***	-0.123***	-0.101***	-0.088***	-0.075***	-0.040**
	(0.015)	(0.018)	(0.016)	(0.019)	(0.019)	(0.015)	(0.014)	(0.015)	(0.016)
Age squared	0.001***	0.002***	0.002***	0.001***	0.001***	0.001***	0.001***	0.001***	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female[a]	0.271***	0.186***	0.171***	0.155**	0.233***	0.147***	0.113**	0.223***	0.156***
	(0.052)	(0.062)	(0.057)	(0.063)	(0.064)	(0.051)	(0.048)	(0.048)	(0.054)
Years of education	0.039***	0.032***	0.036***	0.027***	0.040***	0.027***	0.020**	0.007	0.013
	(0.009)	(0.011)	(0.009)	(0.010)	(0.011)	(0.009)	(0.008)	(0.009)	(0.009)
Married[a]	0.342***	0.367***	0.338***	0.348***	0.398***	0.312***	0.307***	0.328***	0.480***
	(0.057)	(0.065)	(0.063)	(0.065)	(0.067)	(0.056)	(0.049)	(0.053)	(0.055)
Number of children	-0.012	-0.025	0.066**	0.039	0.065*	0.054	0.068***	0.089***	0.047*
	(0.026)	(0.029)	(0.032)	(0.035)	(0.037)	(0.034)	(0.022)	(0.023)	(0.026)
Homeowner[a]	0.296***	0.259***	0.273***	0.169***	0.114**	0.228***	0.160***	0.193***	0.118**
	(0.045)	(0.051)	(0.050)	(0.055)	(0.058)	(0.048)	(0.043)	(0.046)	(0.050)
Constant	6.019***	6.426***	5.982***	6.271***	6.689***	6.771***	6.698***	6.438***	5.992***
	(0.414)	(0.424)	(0.395)	(0.454)	(0.479)	(0.380)	(0.344)	(0.369)	(0.414)
Observations	11985	10793	10657	9725	9044	9391	14523	12844	11407

a. Dummy variables

Notes: Dependent variable = life satisfaction. BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Obesity= BMI $\geq$ 30; overweight = 25 $\leq$ BMI$<$30; normal weight = 18.5 $\leq$ BMI$<$25. Columns (1) through (9) use data from SOEP 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018, respectively. Standard errors are in parentheses. *p $<$0.1, **p $<$0.05, ***p $<$0.01.

Table A2.5: OLS estimates of overweight and obesity on life satisfaction: SOEP 2002-2018

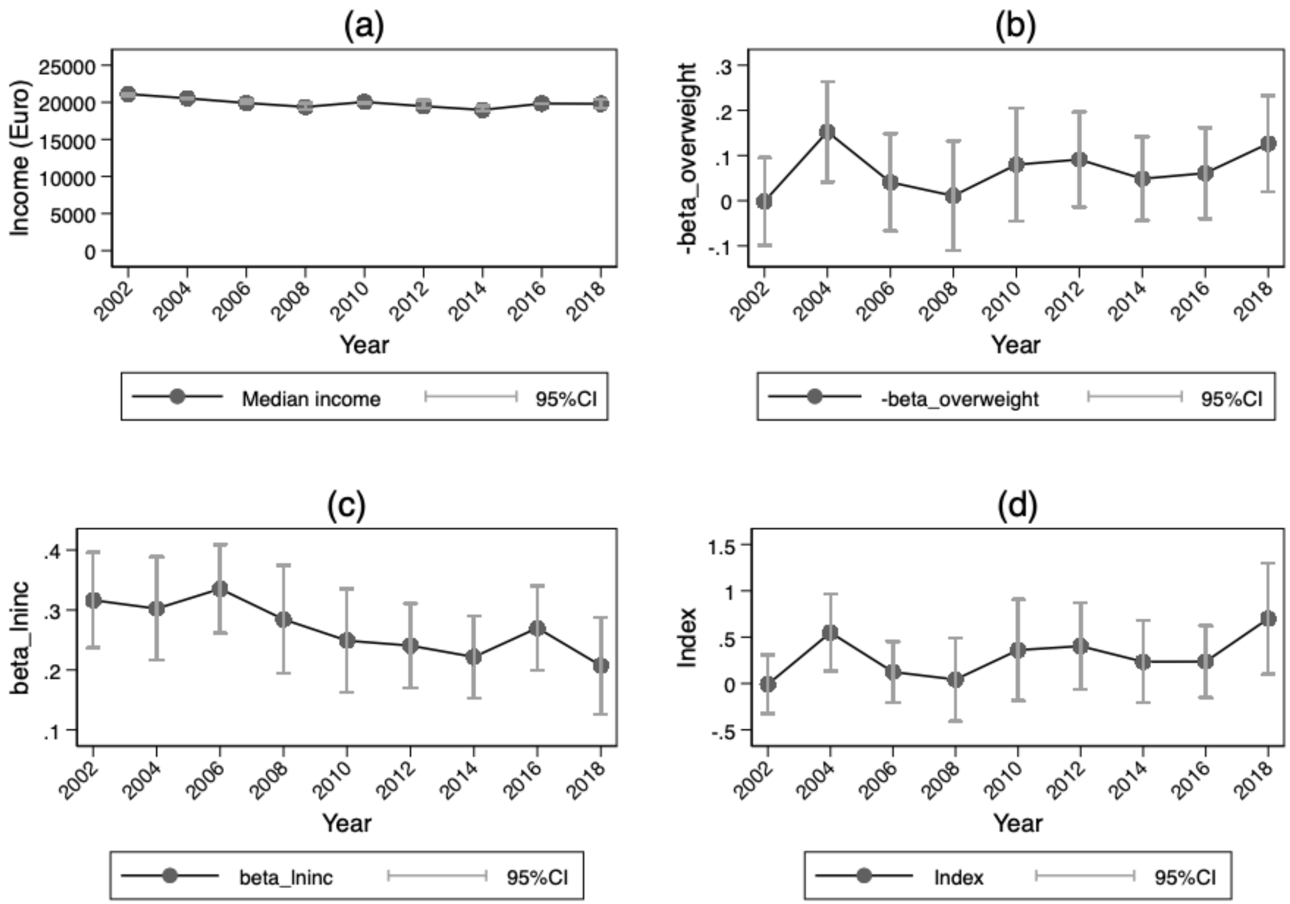

Figure A2.1: Trends in the components of the intangible cost of overweight

(a) median annual net income in 2018 in euros. (b) and (c) the coefficients of overweight and income, respectively, based on equation 9. (d) the trend in the index, which denotes the negative division of the coefficient of overweight and income. The confidence interval is calculated using Fieller's theorem (see Appendix Table A2.5 for regression results).

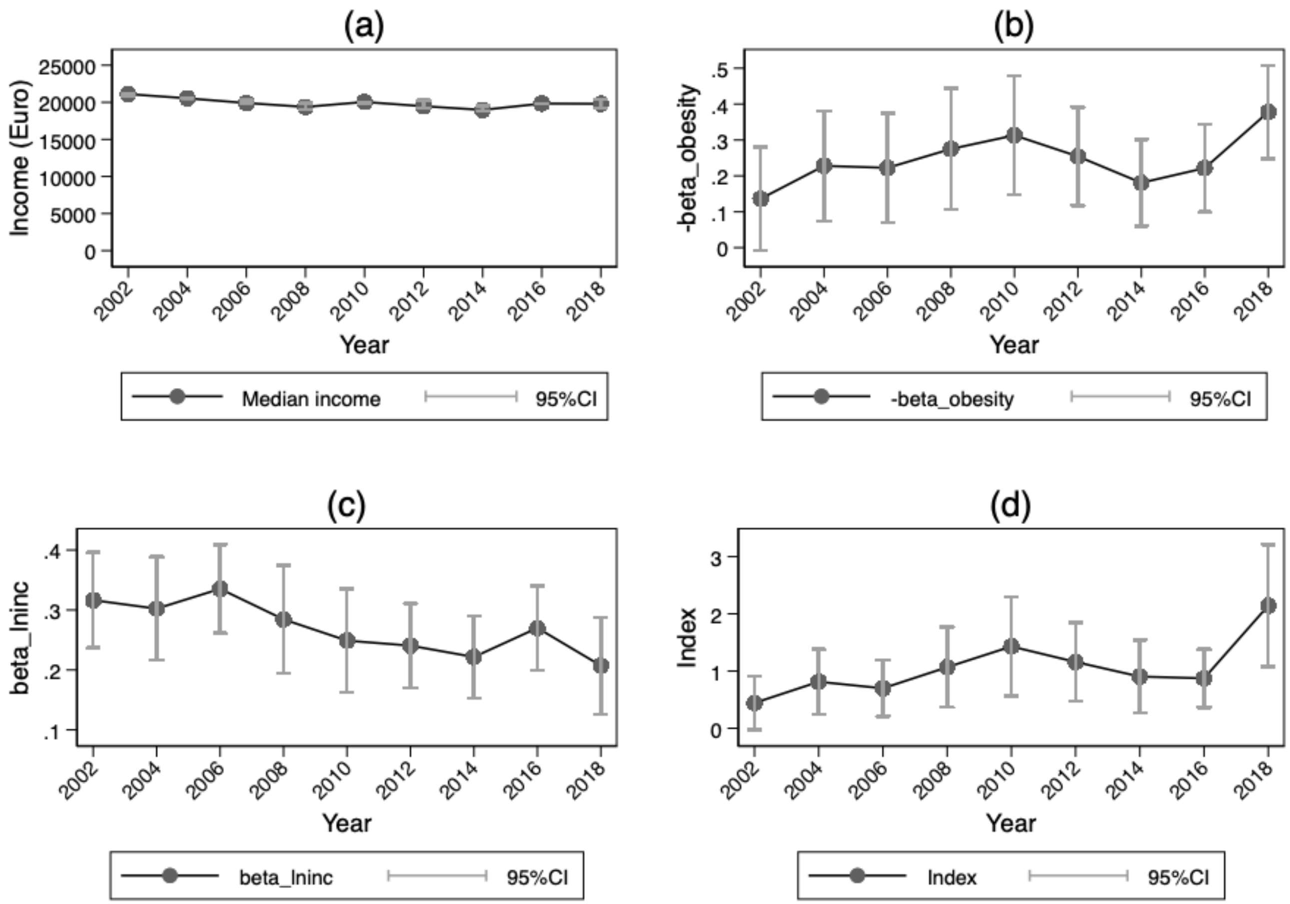

Figure A2.2: Trends in the components of the intangible cost of obesity

(a) median annual net income in 2018 in euros. (b) and (c) the coefficients of obesity and income, respectively, based on equation 9. (d) the trend in the index, which denotes the negative division of the coefficient of obesity and income. The confidence interval is calculated using Fieller's theorem (see Appendix Table A2.5 for regression results).

	OLS			Ordered logit		
	(1)	(2)	(3)	(5)	(6)	(7)
	Low	Middle	High	Low	Middle	High
BMI (kg/m2)	-0.025***	-0.021***	-0.033***	-0.026***	-0.023***	-0.042***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)
Ln(income)	0.186***	0.617***	0.556***	0.161***	0.663***	0.758***
	(0.041)	(0.129)	(0.050)	(0.041)	(0.137)	(0.070)
Age	-0.137***	-0.124***	-0.123***	-0.138***	-0.132***	-0.160***
	(0.014)	(0.014)	(0.017)	(0.015)	(0.016)	(0.022)
Age squared	0.001***	0.001***	0.001***	0.001***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female[a]	0.278***	0.188***	0.080*	0.288***	0.238***	0.124**
	(0.054)	(0.043)	(0.048)	(0.054)	(0.047)	(0.061)
Years of education	-0.023**	-0.001	0.002	-0.022**	-0.002	-0.001
	(0.011)	(0.009)	(0.006)	(0.011)	(0.010)	(0.008)
Married[a]	0.594***	0.351***	0.282***	0.574***	0.373***	0.361***
	(0.058)	(0.044)	(0.042)	(0.057)	(0.048)	(0.053)
Number of children	0.024	0.019	-0.010	0.023	0.029	0.010
	(0.029)	(0.024)	(0.019)	(0.029)	(0.028)	(0.025)
Homeowner[a]	0.213***	0.144***	0.118***	0.232***	0.144***	0.127***
	(0.045)	(0.039)	(0.036)	(0.047)	(0.044)	(0.046)
Constant	8.557***	4.013***	5.107***			
	(0.455)	(1.268)	(0.625)			
Observations	15274	17609	19859	15274	17609	19859

a. Dummy variables

Notes: BMI = body mass index, defined as height (in m) divided by weight (in kg) squared. Columns (1)-(3) report the OLS estimates for the low-, middle-, and high-income quartiles, respectively; columns (4)-(6) report the same estimates from the ordered logit model. *p <0.1, **p <0.05, ***p <0.01.

Table A2.6: OLS/ordered logit estimates of BMI on life satisfaction by different income levels: SOEP 2002-2018

A3.1 Stochastic dominance test

Given two bodyweight distributions Y_{t_n} and $Y_{t_{n-1}}$ with cumulative distribution functions (CDFs) $F_{t_n}(x)$ and $F_{t_{n-1}}(x)$, where t_n and t_{n-1} represent two time points n and n-1, respectively, if $F_(t_n)(x)$ lies nowhere above and at least somewhere below $F_{t_{n-1}}(x)$ then distribution Y_{t_n} displays first-order stochastic dominance over distribution $Y_{t_{n-1}}$. Hence in distribution Y_{t_n}, for all levels of BMI, there are no more individuals with BMI less than a given BMI level in distribution $Y_{t_{n-1}}$:

$$F_{t_n}(x) \leq F_{t_{n-1}}(x) \text{for all x} \tag{A3.1}$$

which can also be written

$$D^1_{t_n}(x) \leq D^1_{t_{n-1}}(x) \text{for all x} \tag{A3.2}$$

where

$$D^1_t(x) = \int_0^x dF_t(y) = F_t(x) \tag{A3.3}$$

Similarly, distribution Y_{t_n} stochastically dominates distribution $Y_{t_{n-1}}$ at order s:

$$D^s_{t_n}(x) \leq D^s_{t_{n-1}}(x) \tag{A3.4}$$

where

$$D^s_t(x) = \int_0^x D^{s-1}_t(y)dy, s \geq 2 \tag{A3.5}$$

When the dominance is strict, equation A3.4 can be written as

$$D^s_{t_n}(x) < D^s_{t_{n-1}}(x) \tag{A3.6}$$

In stochastic dominance theory, the higher the order, the less stringent the condition.

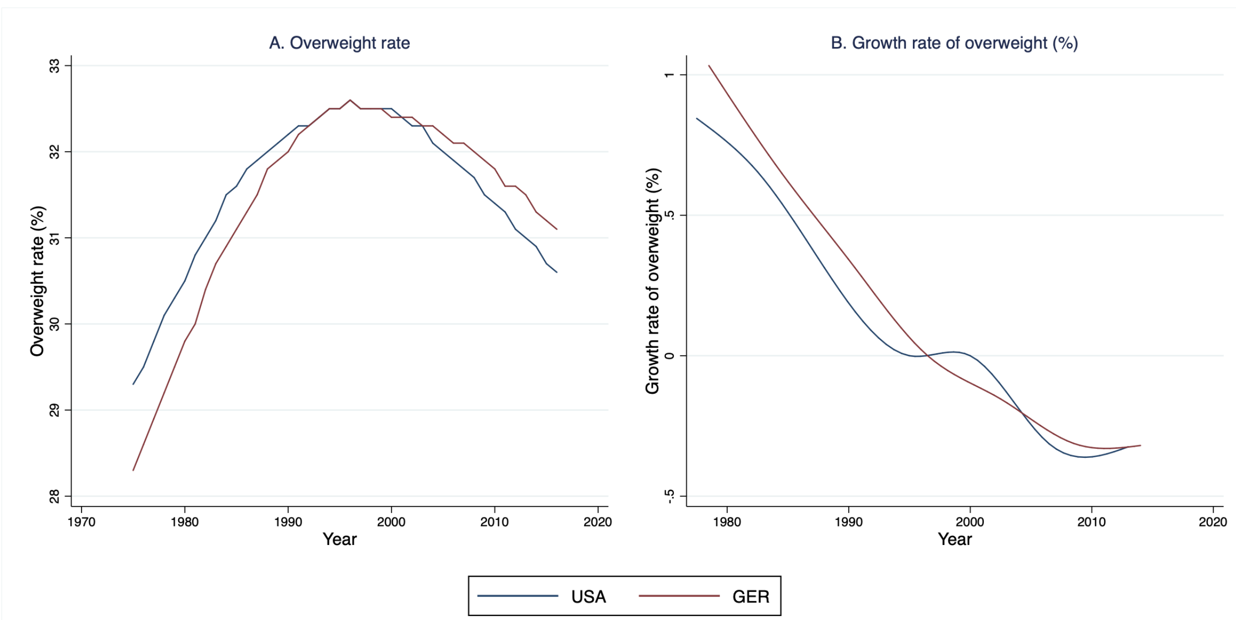

Figure A3.1: Trends of overweight rate and growth rate in Germany and the United States

Note: Data are from Ritchie & Roser (2017).

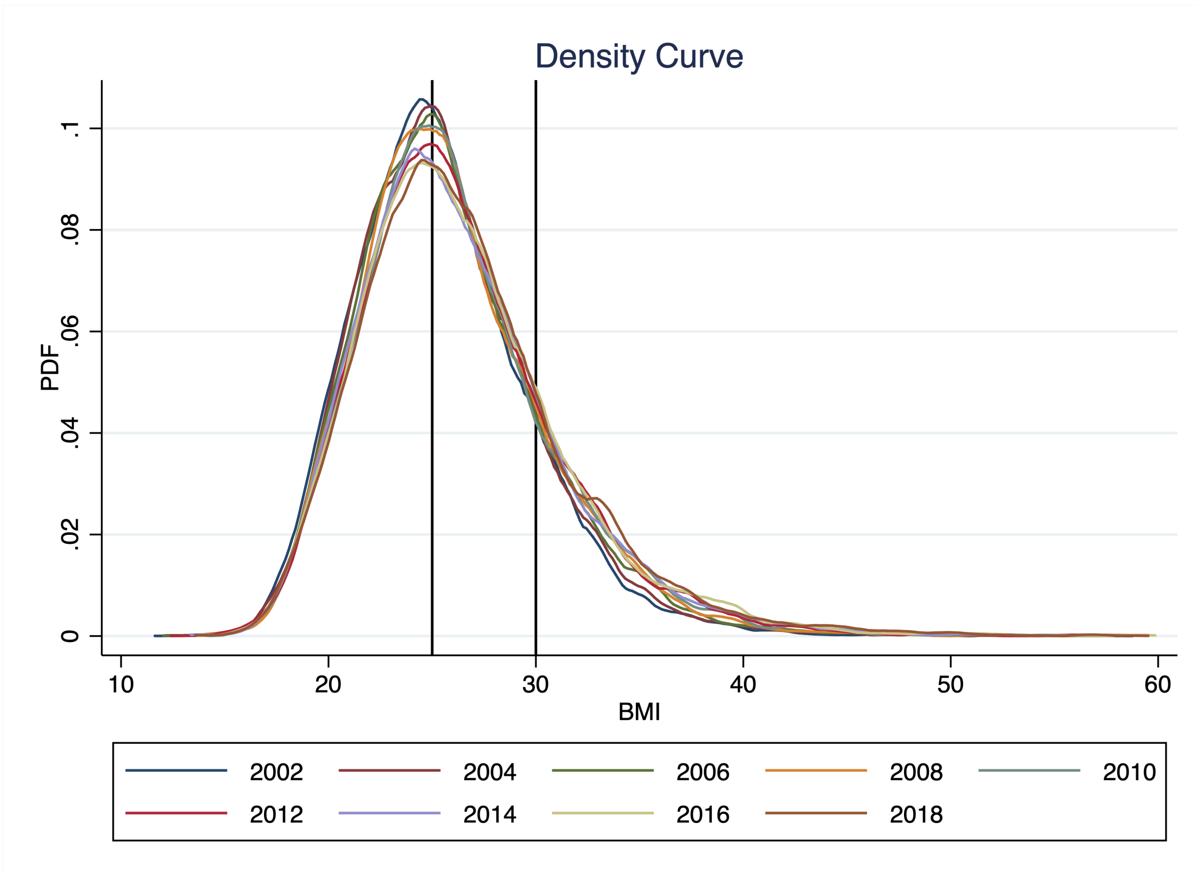

Figure A3.2: Density curves over time, 2002-2018

Sources: GSOEP 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018

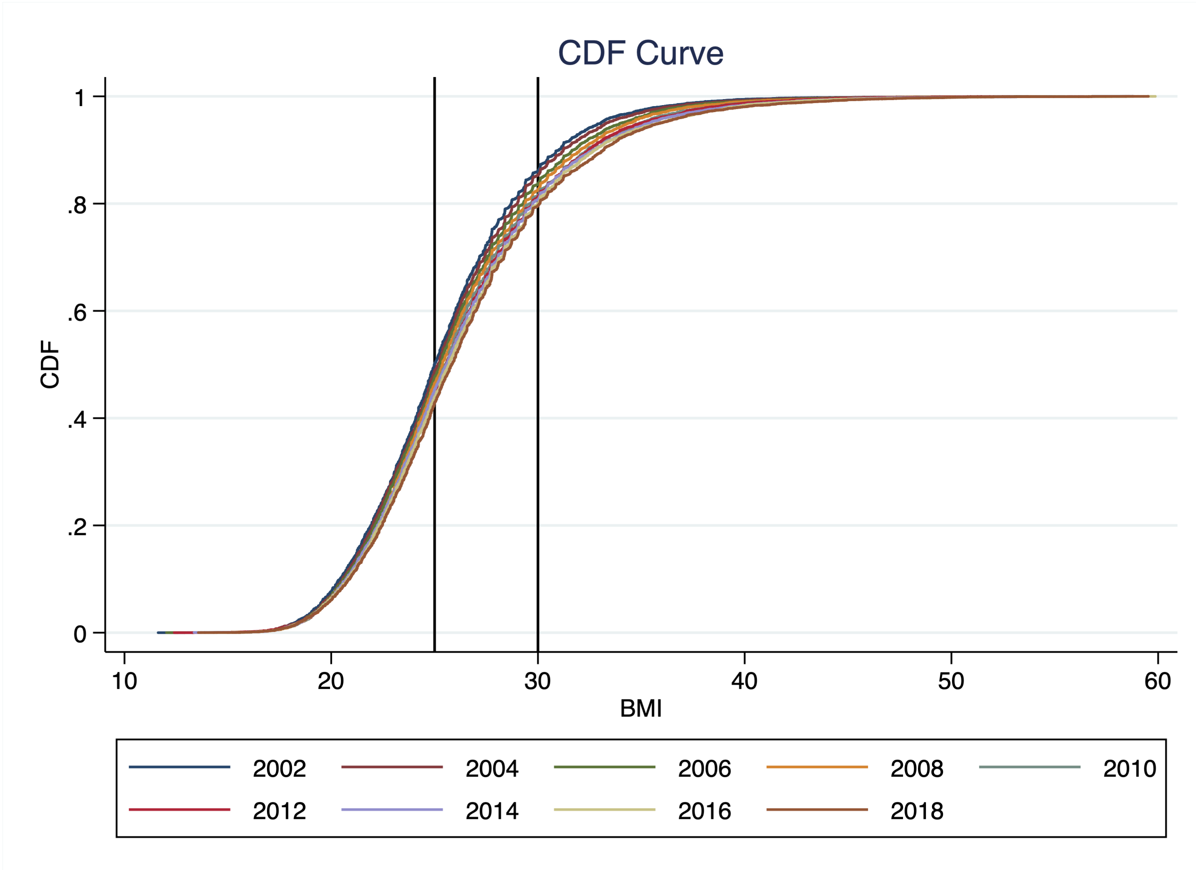

Figure A3.3: CDF curves over time, 2002-2018

Sources: GSOEP 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018

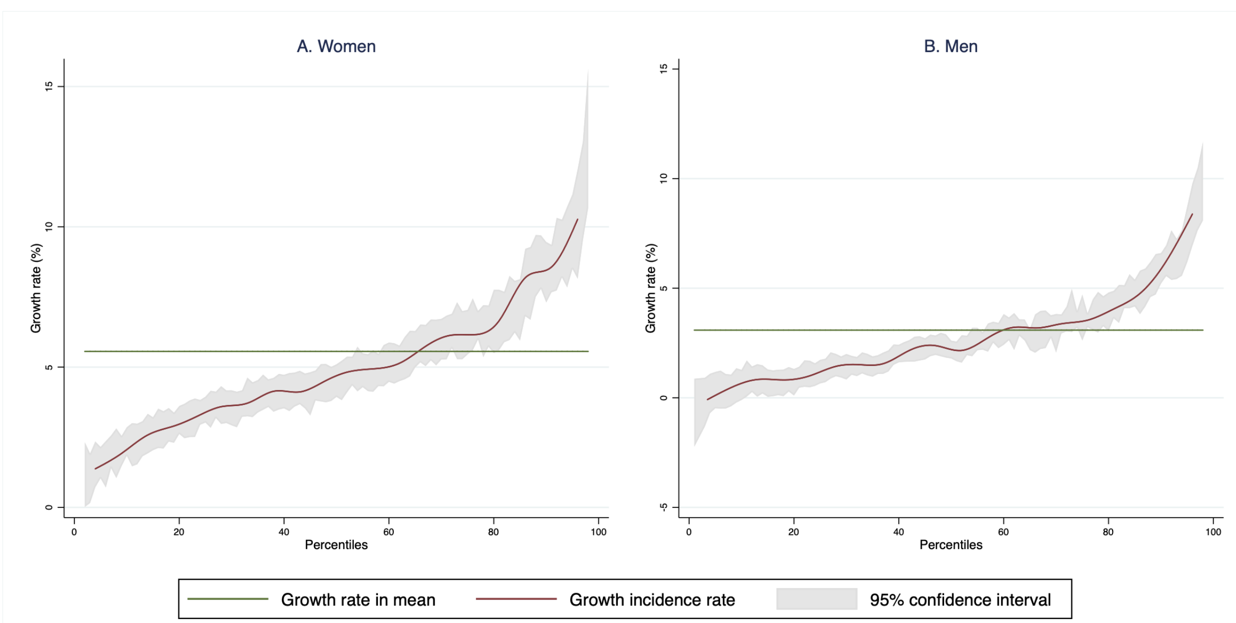

Figure A3.4: BMI anonymous growth incidence curves by gender

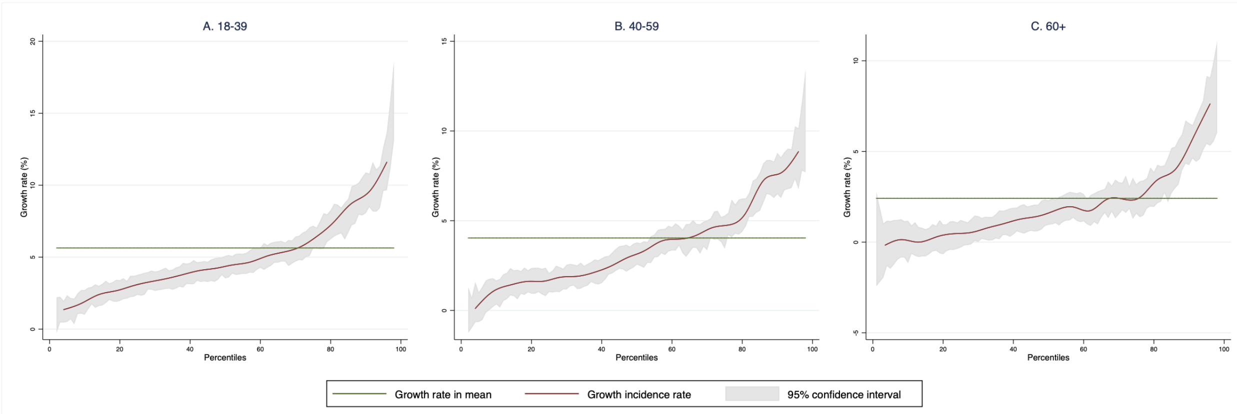

Figure A3.5: BMI anonymous growth incidence curves by age category

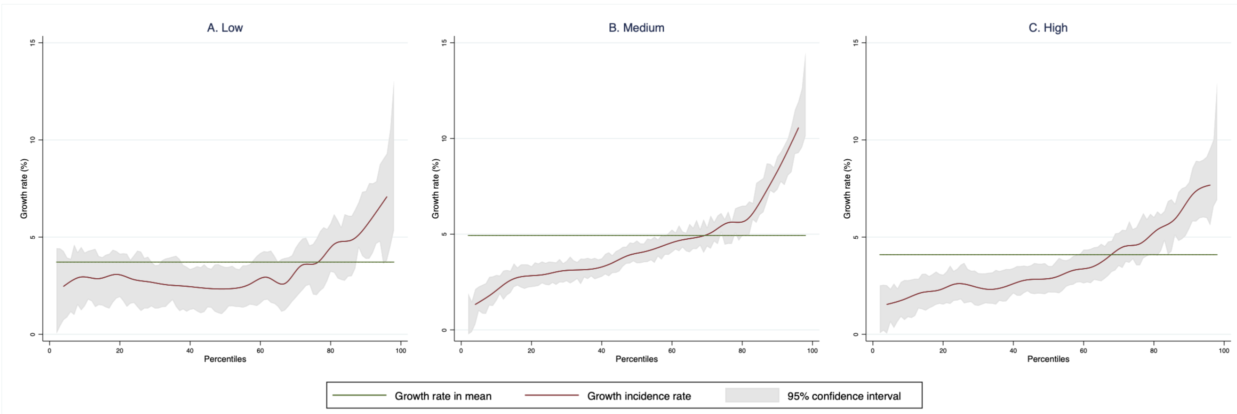

Figure A3.6: BMI anonymous growth incidence curves by education level

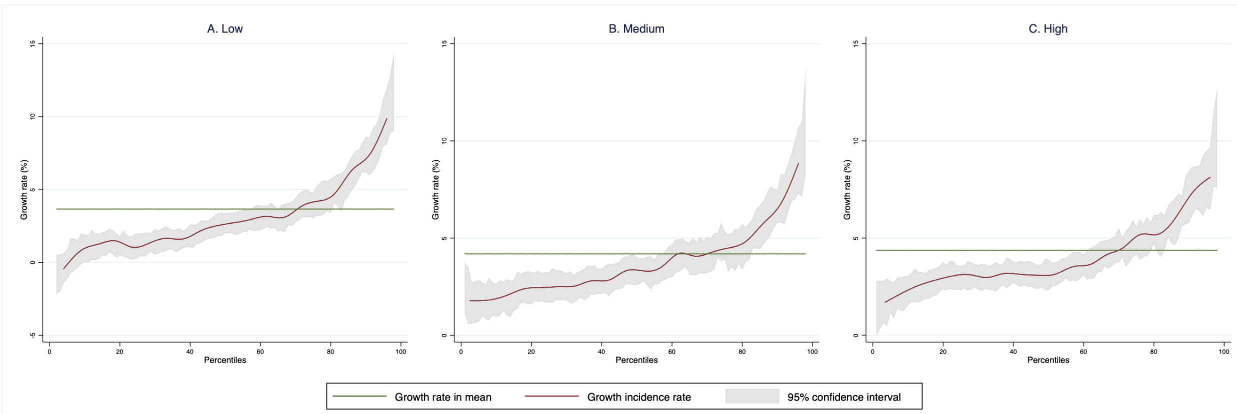

Figure A3.7: BMI anonymous growth incidence curves by income level

	(1) Total	(2) Female	(3) Male	(4) Total	(5) Female	(6) Male	(7) Total	(8) Female	(9) Male
Gini	-3.593***	-4.550***	-3.531*						
	(1.268)	(1.642)	(2.058)						
Relative BMI				-0.556**	-0.789**	0.329			
				(0.272)	(0.337)	(0.472)			
Distance to median BMI							-0.030**	0.003	-0.096***
							(0.013)	(0.017)	(0.022)
Distance to median BMI × T†							-0.022	-0.064**	0.078*
							(0.024)	(0.031)	(0.040)
T†							-0.043*	-0.022	-0.072**
							(0.025)	(0.034)	(0.036)
BMI	0.128***	0.104***	0.164***	0.152***	0.139***	0.152***	0.054***	0.066***	0.017
	(0.017)	(0.021)	(0.027)	(0.020)	(0.026)	(0.032)	(0.013)	(0.016)	(0.021)
BMI squared	-0.002***	-0.001***	-0.002***	-0.002***	-0.001***	-0.002***			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
Age	0.018***	0.035***	-0.002	0.007	0.017*	-0.002	0.010	0.019*	0.002
	(0.007)	(0.009)	(0.010)	(0.007)	(0.010)	(0.011)	(0.007)	(0.010)	(0.011)
Age squared	-0.000**	-0.000***	0.000	-0.000	-0.000**	0.000	-0.000*	-0.000**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed†	0.069***	0.028	0.121***	0.067***	0.027	0.118***	0.066***	0.026	0.118***
	(0.023)	(0.029)	(0.036)	(0.023)	(0.029)	(0.036)	(0.023)	(0.029)	(0.036)
Years of education	-0.045***	-0.011	-0.085***	-0.042***	-0.005	-0.089***	-0.042***	-0.003	-0.093***
	(0.016)	(0.021)	(0.024)	(0.016)	(0.021)	(0.024)	(0.016)	(0.021)	(0.024)
Married†	0.226***	0.165***	0.319***	0.229***	0.169***	0.317***	0.233***	0.173***	0.320***
	(0.032)	(0.043)	(0.048)	(0.032)	(0.043)	(0.049)	(0.032)	(0.043)	(0.049)
Ln(household income)	0.250***	0.221***	0.292***	0.248***	0.217***	0.293***	0.249***	0.217***	0.295***
	(0.020)	(0.026)	(0.032)	(0.020)	(0.026)	(0.032)	(0.020)	(0.026)	(0.032)
Observations	433946	236011	197935	433946	236011	197935	433946	236011	197935

Notes: Dependent variable = life satisfaction. We employ fixed effects ordered logit estimators. Relative BMI = BMI / (median BMI), with relative BMI and Gini coefficient generated by gender and age category in each state and year. Distance to median = |BMI - median BMI|. T = 1 if BMI is larger than the median BMI. Standard errors are in parentheses. *p <0.1, **p <0.05, ***p <0.01
† Dummy variable.

Table A3.1: Fixed effects estimates of the effect of obesity inequality on life satisfaction: GSOEP 2002-2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Young	Middle-aged	Older	Young	Middle-aged	Older	Young	Middle-aged	Older
Gini	-2.412	1.822	3.675						
	(2.106)	(2.207)	(2.378)						
Relative BMI				-1.829**	1.482*	1.332			
				(0.841)	(0.856)	(0.838)			
Distance to median BMI							0.069*	-0.099***	-0.062*
							(0.038)	(0.035)	(0.034)
Distance to median BMI × T†							-0.157**	0.129*	0.072
							(0.072)	(0.067)	(0.066)
T†							-0.020	-0.056*	-0.098***
							(0.040)	(0.034)	(0.035)
BMI	0.081***	0.086***	0.199***	0.156***	0.031	0.149***	0.148***	-0.038	0.132***
	(0.025)	(0.026)	(0.025)	(0.042)	(0.041)	(0.040)	(0.048)	(0.047)	(0.047)
BMI squared	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.002***	-0.001*	0.000	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Age	-0.140***	-0.084***	0.223***	-0.144***	-0.079***	0.227***	-0.145***	-0.081***	0.223***
	(0.024)	(0.029)	(0.028)	(0.024)	(0.029)	(0.028)	(0.024)	(0.029)	(0.028)
Age squared	0.002***	0.001***	-0.002***	0.002***	0.001***	-0.002***	0.002***	0.001***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed†	0.212***	0.338***	-0.042	0.210***	0.337***	-0.042	0.210***	0.333***	-0.043
	(0.034)	(0.044)	(0.032)	(0.034)	(0.044)	(0.032)	(0.034)	(0.044)	(0.032)
Years of education	-0.025*	-0.088	0.002	-0.025*	-0.087	0.001	-0.026*	-0.091	-0.002
	(0.013)	(0.065)	(0.104)	(0.013)	(0.065)	(0.104)	(0.013)	(0.065)	(0.104)
Married†	0.254***	0.142***	0.210***	0.254***	0.142***	0.210***	0.256***	0.143***	0.207***
	(0.042)	(0.044)	(0.058)	(0.042)	(0.044)	(0.058)	(0.042)	(0.044)	(0.058)
Ln(household income)	0.122***	0.222***	0.194***	0.121***	0.223***	0.194***	0.122***	0.224***	0.195***
	(0.023)	(0.030)	(0.034)	(0.023)	(0.030)	(0.034)	(0.023)	(0.030)	(0.034)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.397***	6.075***	-6.128***	7.323***	6.002***	-6.077***	5.562***	8.585***	-4.574**
	(0.554)	(1.158)	(1.696)	(0.540)	(1.157)	(1.694)	(1.038)	(1.437)	(1.912)
Observations	26242	35513	27457	26242	35513	27457	26242	35513	27457

Notes: Dependent variable = life satisfaction. Columns are classified by age groups: young (18-39), middle-aged (40-59), and older (60+).
RelativeBMI= BMI / (median BMI), with relative BMI and Gini coefficient generated by gender and age category in each state and year.
Distance to median = |BMI - median BMI|. T = 1 if BMI is larger than the median BMI. Standard errors are in parentheses.
*p <0.1, **p <0.05, ***p <0.01.
† Dummy variable.

Table A3.2: Fixed effects estimates of the effect of obesity inequality on life satisfaction among men: GSOEP 2002-2018

	(1) Total	(2) Female	(3) Male	(4) Total	(5) Female	(6) Male	(7) Total	(8) Female	(9) Male
Gini	-1.902***	-2.620***	-1.278						
	(0.502)	(0.667)	(0.794)						
Relative BMI				-0.175	-0.129	-0.077			
				(0.129)	(0.165)	(0.218)			
Distance to median BMI							-0.017***	-0.007	-0.039***
							(0.007)	(0.009)	(0.010)
Distance to median BMI × T†							-0.003	-0.010	0.020
							(0.011)	(0.015)	(0.018)
T†							-0.032**	-0.008	-0.059***
							(0.014)	(0.020)	(0.019)
BMI	0.091***	0.075***	0.117***	0.100***	0.082***	0.121***	0.069***	0.063***	0.068***
	(0.009)	(0.012)	(0.014)	(0.011)	(0.014)	(0.016)	(0.012)	(0.016)	(0.020)
BMI squared	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.002***	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	0.006	0.017***	-0.008	0.001	0.010**	-0.009*	0.002	0.010**	-0.008
	(0.003)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Age squared	-0.000***	-0.000***	-0.000	-0.000***	-0.000***	0.000	-0.000***	-0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed†	0.034**	0.011	0.062***	0.032***	0.010	0.062***	0.032**	0.009	0.062***
	(0.012)	(0.017)	(0.019)	(0.012)	(0.017)	(0.019)	(0.012)	(0.017)	(0.019)
Years of education	-0.030***	-0.013	-0.049***	-0.029***	-0.011	-0.050***	-0.029***	-0.010	-0.051***
	(0.008)	(0.011)	(0.012)	(0.008)	(0.011)	(0.012)	(0.008)	(0.011)	(0.012)
Married†	0.145**	0.109***	0.194***	0.147***	0.111***	0.194***	0.148***	0.112***	0.196***
	(0.017)	(0.023)	(0.024)	(0.017)	(0.023)	(0.024)	(0.017)	(0.023)	(0.024)
Ln(household income)	0.149**	0.134***	0.172***	0.148***	0.132***	0.170***	0.148***	0.132***	0.171***
	(0.010)	(0.014)	(0.015)	(0.010)	(0.014)	(0.015)	(0.010)	(0.014)	(0.015)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.585***	4.649***	4.379***	4.55***	4.59***	4.333***	4.806***	4.692***	5.067***
	(0.197)	(0.265)	(0.297)	(0.199)	(0.270)	(0.298)	(0.233)	(0.305)	(0.373)
Observations	187,832	98,714	89,118	187,832	98,714	89,118	187,832	98,714	89,118

Notes: Dependent variable = life satisfaction. Relative BMI = BMI / (median BMI), with relative BMI and Gini coefficient generated by gender and age category in each NUTS2 area and year. Distance to median = |BMI - median BMI|. T = 1 if BMI is larger than the median BMI. Standard errors are in parentheses. *p <0.1, **p <0.05, ***p <0.01.

† Dummy variable.

Table A3.3: Fixed effects estimates of the effect of obesity inequality on life satisfaction at a NUTS2 level: GSOEP 2002-2018

	(1) Total	(2) Female	(3) Male	(4) Total	(5) Female	(6) Male	(7) Total	(8) Female	(9) Male
Gini	-0.894**	-0.808	-1.413**						
	(0.428)	(0.547)	(0.704)						
Relative BMI				-0.457***	-0.455***	-0.370			
				(0.138)	(0.173)	(0.236)			
Distance to median BMI							-0.003	0.001	-0.013
							(0.007)	(0.010)	(0.012)
Distance to median BMI × T†							-0.033***	-0.036**	-0.021
							(0.012)	(0.015)	(0.020)
T†							-0.016	-0.002	-0.036
							(0.020)	(0.027)	(0.028)
BMI	0.095***	0.071***	0.137***	0.114***	0.090***	0.154***	0.081***	0.060***	0.115***
	(0.014)	(0.018)	(0.022)	(0.015)	(0.019)	(0.024)	(0.017)	(0.022)	(0.028)
BMI squared	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.002***	-0.001***	-0.000	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.008	-0.001	-0.019**	-0.015***	-0.009	-0.023***	-0.014***	-0.008	-0.023***
	(0.005)	(0.007)	(0.008)	(0.005)	(0.007)	(0.008)	(0.005)	(0.007)	(0.008)
Age squared	-0.000	-0.000	0.000	0.000	-0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed†	0.063***	0.046*	0.084***	0.063***	0.046*	0.084***	0.063***	0.046*	0.085***
	(0.019)	(0.025)	(0.030)	(0.019)	(0.025)	(0.030)	(0.019)	(0.025)	(0.030)
Years of education	-0.019	0.001	-0.044**	-0.016	0.005	-0.042**	-0.016	0.005	-0.043**
	(0.012)	(0.017)	(0.018)	(0.012)	(0.017)	(0.018)	(0.012)	(0.017)	(0.018)
Married†	0.146***	0.104***	0.211***	0.148***	0.106***	0.212***	0.149***	0.107***	0.213***
	(0.026)	(0.035)	(0.038)	(0.026)	(0.035)	(0.038)	(0.026)	(0.035)	(0.038)
Ln(household income)	0.164***	0.157***	0.177***	0.163***	0.156***	0.176***	0.163***	0.156***	0.176***
	(0.016)	(0.022)	(0.024)	(0.016)	(0.022)	(0.024)	(0.016)	(0.022)	(0.024)
Time fixed effects	✓	✓	✓	✓	Yes	✓	✓	✓	✓
Constant	4.594***	4.643***	4.353***	4.695***	4.786***	4.350***	4.669***	4.698***	4.536***
	(0.299)	(0.394)	(0.466)	(0.302)	(0.400)	(0.467)	(0.330)	(0.426)	(0.537)
Observations	87,911	48,302	39,609	87,911	48,302	39,609	87,911	48,302	39,609

Notes: Dependent variable = life satisfaction. Relative BMI = BMI / (median BMI), with relative BMI and Gini coefficient generated by gender and age category in each NUTS3 area and year. Distance to median = |BMI - median BMI|. T = 1 if BMI is larger than the median BMI. Standard errors in parentheses. *p <0.1, **p <0.05, ***p <0.01.
† Dummy variable.

Table A3.4: Fixed effects estimates of the effect of obesity inequality on life satisfaction in NUTS3 level: GSOEP 2002-2018

A4.1 Oaxaca-Blinder decomposition approach

We start with a basic linear regression model for an outcome Y and two groups A and B:

$$Y_t^l = X_t^l \beta_t^l + \epsilon_t^l, E(\epsilon^l) = 0, cov(X, \epsilon) = 0, l \in [A, B] \tag{A4.1}$$

X represents the matrix of covariates, including the unity vector, while β contains the $k-1$ coefficients and the constant, t denotes the time, and ϵ is the error term. The Oaxaca-Blinder decomposition applies to data with one time point and divides the mean outcome difference between the two groups into a part that is explained by differences in the groups into a part that is explained by differences in the groups' characteristics and an unexplained part. Given the outcome difference:

$$\Delta Y_t = E(Y_t^A) - E(Y_t^B) = E(X_t^A)\beta_t^A - E(X_t^B)\beta_t^B \tag{A4.2}$$

and given that $E(X_t^l \beta_t^l + \epsilon_t^l) = E(X_t^l \beta_t^l)$, the outcome difference can be decomposed into

$$\Delta Y_t = E_t + C_t + I_t \tag{A4.3}$$

$$E_t = E(X_t^A) - E(X_t^B)\beta_t^B \tag{A4.4}$$

$$C_t = E(X_t^B)(\beta_t^A - \beta_t^B) \tag{A4.5}$$

$$I_t = E(X_t^A) - E(X_t^B)(\beta_t^A - \beta_t^B) \tag{A4.6}$$

E_t is defined as the part of the difference that is due to differences in the groups' characteristics at time t (endowments effect). C_t is the part of the difference that is due to differences in the coefficients at time t. I_t, finally, is the part of the difference at time t that is due to the interaction of the groups' different characteristics and coefficients.

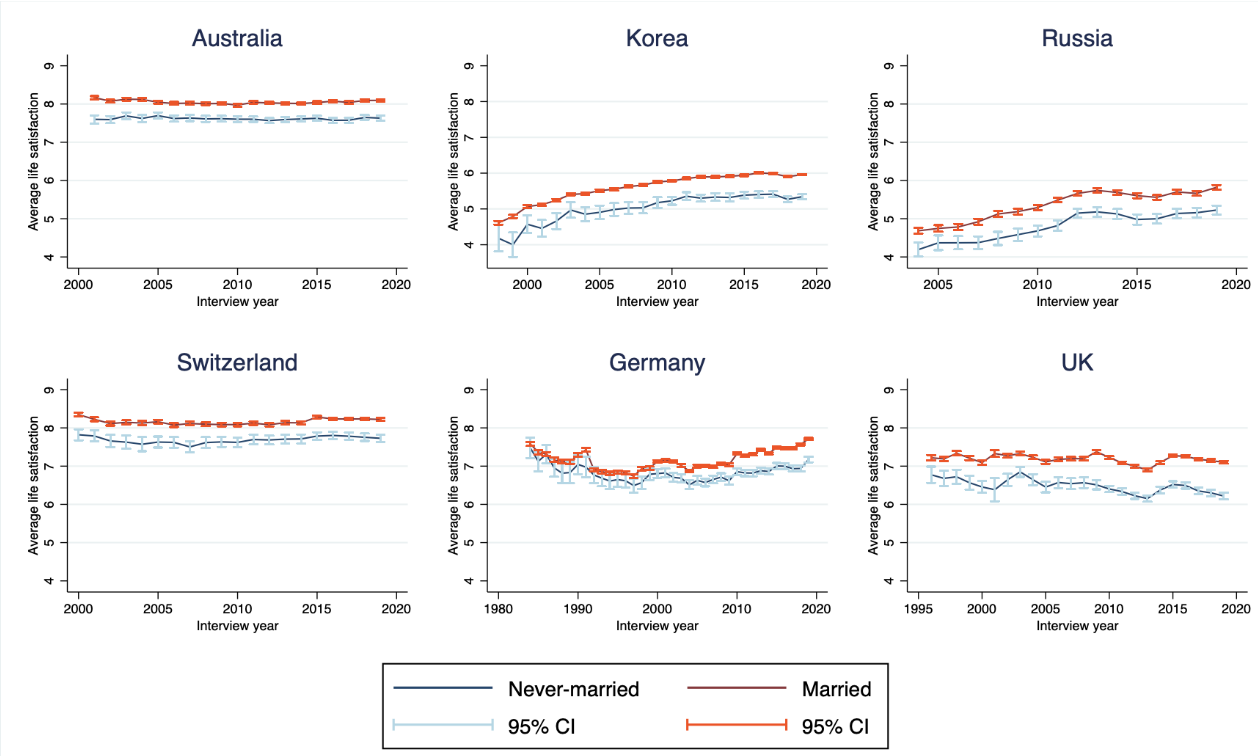

Figure A4.1: Life satisfaction trends of never-married and married people in six countries

Data source: Australia: Household, Income and Labor Dynamics in Australia Survey. South Korea: Korean Labor and Income Panel Study. Russia: Russian Longitudinal Monitoring Survey. Switzerland: Swiss Household Panel. Germany: German Socio-Economic Panel. The United Kingdom: British Household Panel Survey and Understanding Society – The UK Household Longitudinal Study.

		(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Life satisfaction	OLS	-0.609***	-0.470***	-0.909***	-0.558***	-0.428***	-0.738***
		(0.015)	(0.015)	(0.034)	(0.019)	(0.010)	(0.015)
Life satisfaction	Ordered probit	-0.421***	-0.455***	-0.409***	-0.419***	-0.249***	-0.316***
		(0.010)	(0.014)	(0.015)	(0.014)	(0.006)	(0.007)
Satisfied	Probit	-0.456***	-0.639***	-0.405***	-0.525***	-0.281***	-0.373***
		(0.016)	(0.018)	(0.018)	(0.024)	(0.008)	(0.008)
Dissatisfied	Probit	0.430***	0.173***	0.418***	0.471***	0.276***	0.336***
		(0.021)	(0.023)	(0.018)	(0.035)	(0.010)	(0.009)
Controls		✓	✓	✓	✓	✓	✓
Observations		144890	169556	97685	82510	380704	306576

Notes: The definition of married includes cohabitation. Standard errors (clustered by person year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5.

Table A4.1: Estimates of the SWB gap of never married

		(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Life satisfaction	OLS	-0.418***	-0.510***	-0.708***	-0.510***	-0.435***	-0.634***
		(0.009)	(0.013)	(0.018)	(0.015)	(0.009)	(0.011)
Life satisfaction	Ordered probit	-0.298***	-0.496***	-0.324***	-0.398***	-0.259***	-0.281***
		(0.007)	(0.011)	(0.008)	(0.011)	(0.005)	(0.005)
Satisfied	Probit	-0.368***	-0.662***	-0.344***	-0.495***	-0.279***	-0.337***
		(0.012)	(0.014)	(0.010)	(0.022)	(0.007)	(0.006)
Dissatisfied	Probit	0.364***	0.183***	0.332***	0.425***	0.274***	0.306***
		(0.016)	(0.019)	(0.010)	(0.033)	(0.009)	(0.007)
Controls		✓	✓	✓	✓	✓	✓
Observations		168606	196269	117391	86111	436451	345333

Notes: Standard errors (clustered by person year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 30 to 80 years old.

Table A4.2: Estimates of the SWB gap of never married

		(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Life satisfaction	OLS	-0.625***	-0.510***	-0.947***	-0.561***	-0.435***	-0.769***
		(0.013)	(0.013)	(0.029)	(0.018)	(0.009)	(0.014)
Life satisfaction	Ordered probit	-0.438***	-0.496***	-0.430***	-0.423***	-0.259***	-0.335***
		(0.009)	(0.011)	(0.013)	(0.013)	(0.005)	(0.006)
Satisfied	Probit	-0.481***	-0.662***	-0.427***	-0.527***	-0.279***	-0.392***
		(0.014)	(0.014)	(0.016)	(0.022)	(0.007)	(0.007)
Dissatisfied	Probit	0.457***	0.183***	0.443***	0.478***	0.274***	0.350***
		(0.019)	(0.019)	(0.016)	(0.032)	(0.009)	(0.008)
Controls		✓	✓	✓	✓	✓	✓
Observations		168606	196269	117391	90179	436451	345475

Notes: The definition of married includes cohabitation. Standard errors (clustered by person year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 30 to 80 years old.

Table A4.3: Estimates of the SWB gap of never married

		(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Life satisfaction	OLS	-0.361***	-0.458***	-0.572***	-0.542***	-0.368***	-0.570***
		(0.015)	(0.034)	(0.030)	(0.024)	(0.018)	(0.019)
Life satisfaction	Ordered probit	-0.246***	-0.412***	-0.255***	-0.401***	-0.203***	-0.245***
		(0.011)	(0.029)	(0.013)	(0.017)	(0.010)	(0.008)
Satisfied	Probit	-0.337***	-0.556***	-0.253***	-0.534***	-0.260***	-0.311***
		(0.019)	(0.042)	(0.016)	(0.029)	(0.013)	(0.010)
Dissatisfied	Probit	0.363***	0.263***	0.258***	0.474***	0.242***	0.258***
		(0.026)	(0.045)	(0.016)	(0.044)	(0.016)	(0.012)
Controls		✓	✓	✓	✓	✓	✓
Observations		78630	87011	51299	46456	202859	174993

Notes: Standard errors (clustered by person year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 50 to 80 years old.

Table A4.4: Estimates of the SWB gap of never married

		(1)	(2)	(3)	(4)	(5)	(6)
		Australia	Korea	Russia	Switzerland	Germany	UK
Life satisfaction	OLS	-0.545***	-0.458***	-0.741***	-0.549***	-0.368***	-0.609***
		(0.023)	(0.034)	(0.053)	(0.028)	(0.018)	(0.021)
Life satisfaction	Ordered probit	-0.364***	-0.412***	-0.329***	-0.397***	-0.203***	-0.259***
		(0.015)	(0.029)	(0.023)	(0.019)	(0.010)	(0.009)
Satisfied	Probit	-0.433***	-0.556***	-0.333***	-0.533***	-0.260***	-0.321***
		(0.023)	(0.042)	(0.029)	(0.030)	(0.013)	(0.011)
Dissatisfied	Probit	0.431***	0.263***	0.339***	0.498***	0.242***	0.272***
		(0.031)	(0.045)	(0.028)	(0.044)	(0.016)	(0.013)
Controls		✓	✓	✓	✓	✓	✓
Observations		78630	87011	51299	49103	202859	175063

Notes: The definition of married includes cohabitation. Standard errors (clustered by person year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 50 to 80 years old.

Table A4.5: Estimates of the SWB gap of never married

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-0.992***	2.757***	2.572***	-0.426*	0.531***	-0.793***
	(0.172)	(0.217)	(0.318)	(0.221)	(0.068)	(0.106)
Married	-0.506***	4.183***	3.004***	-0.242***	0.761***	-0.592***
	(0.055)	(0.052)	(0.081)	(0.072)	(0.021)	(0.036)
Difference	-0.486***	-1.426***	-0.431	-0.184	-0.230***	-0.201*
	(0.180)	(0.221)	(0.327)	(0.230)	(0.071)	(0.111)
Panel B: Satisfied						
Never-married	-0.181	1.826***	2.521***	0.629*	1.000***	-0.787***
	(0.246)	(0.283)	(0.395)	(0.335)	(0.084)	(0.133)
Married	0.552***	3.530***	3.075***	1.275***	1.129***	-0.783***
	(0.111)	(0.055)	(0.098)	(0.154)	(0.027)	(0.048)
Difference	-0.732***	-1.704***	-0.554	-0.646*	-0.129	-0.004
	(0.269)	(0.287)	(0.406)	(0.364)	(0.088)	(0.140)
Panel C: Dissatisfied						
Never-married	0.554*	-4.526***	-2.868***	-0.383	-0.592***	1.967***
	(0.322)	(0.325)	(0.384)	(0.463)	(0.101)	(0.147)
Married	-0.414***	-6.790***	-4.017***	-0.429*	-0.747***	2.063***
	(0.159)	(0.095)	(0.106)	(0.244)	(0.035)	(0.057)
Difference	0.969***	2.264***	1.150***	0.045	0.155	-0.095
	(0.357)	(0.336)	(0.398)	(0.515)	(0.107)	(0.156)
Controls	✓	✓	✓	✓	✓	✓
Observations	144890	169556	97685	82510	380704	306576

Notes: The definition of married includes cohabitation. Standard errors (clustered by person and year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction > 5, dissatisfied: life satisfaction <5.

Table A4.6: Estimates of SWB time trends for never-married, married, and the difference

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-0.034	3.480***	2.422***	0.141	0.788***	-0.513***
	(0.097)	(0.147)	(0.152)	(0.151)	(0.054)	(0.073)
Married	-0.428***	4.262***	3.194***	-0.081	0.853***	-0.489***
	(0.055)	(0.049)	(0.080)	(0.073)	(0.019)	(0.035)
Difference	0.395***	-0.782***	-0.773***	0.222	-0.065	-0.023
	(0.111)	(0.153)	(0.171)	(0.166)	(0.057)	(0.079)
Panel B: Satisfied						
Never-married	0.671***	2.814***	2.479***	1.083***	1.241***	-0.727***
	(0.160)	(0.183)	(0.187)	(0.261)	(0.070)	(0.096)
Married	0.643***	3.672***	3.284***	1.455***	1.219***	-0.710***
	(0.116)	(0.052)	(0.097)	(0.160)	(0.026)	(0.047)
Difference	0.027	-0.858***	-0.806***	-0.372	0.022	-0.017
	(0.196)	(0.189)	(0.210)	(0.302)	(0.074)	(0.105)
Panel C: Dissatisfied						
Never-married	-0.047	-5.393***	-3.283***	-0.707*	-0.865***	1.957***
	(0.215)	(0.242)	(0.192)	(0.369)	(0.084)	(0.109)
Married	-0.538***	-6.887***	-4.121***	-0.290	-0.819***	2.019***
	(0.168)	(0.092)	(0.107)	(0.256)	(0.033)	(0.056)
Difference	0.491*	1.493***	0.838***	-0.416	-0.046	-0.062
	(0.270)	(0.256)	(0.219)	(0.442)	(0.090)	(0.120)
Controls	✓	✓	✓	✓	✓	✓
Observations	168606	196269	117391	86111	436451	345333

Notes: Standard errors (clustered by person and year) are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 30 to 80 years old.

Table A4.7: Estimates of SWB time trends for never-married, married, and the difference

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-0.729***	3.480***	2.297***	-0.354*	0.788***	-0.670***
	(0.145)	(0.147)	(0.264)	(0.193)	(0.054)	(0.092)
Married	-0.399***	4.262***	3.042***	-0.123*	0.853***	-0.532***
	(0.051)	(0.049)	(0.074)	(0.069)	(0.019)	(0.034)
Difference	-0.330**	-0.782***	-0.745***	-0.231	-0.065	-0.138
	(0.153)	(0.153)	(0.273)	(0.203)	(0.057)	(0.096)
Panel B: Satisfied						
Never-married	0.036	2.814***	2.171***	0.616**	1.241***	-0.752***
	(0.211)	(0.183)	(0.324)	(0.300)	(0.070)	(0.116)
Married	0.627***	3.672***	3.127***	1.406***	1.219***	-0.781***
	(0.104)	(0.052)	(0.090)	(0.148)	(0.026)	(0.046)
Difference	-0.591**	-0.858***	-0.956***	-0.790**	0.022	0.029
	(0.235)	(0.189)	(0.336)	(0.330)	(0.074)	(0.123)
Panel C: Dissatisfied						
Never-married	0.531*	-5.393***	-2.654***	-0.385	-0.865***	2.001***
	(0.279)	(0.242)	(0.319)	(0.412)	(0.084)	(0.130)
Married	-0.436***	-6.887***	-4.004***	-0.433*	-0.819***	2.068***
	(0.150)	(0.092)	(0.098)	(0.235)	(0.033)	(0.054)
Difference	0.967***	1.493***	1.350***	0.048	-0.046	-0.066
	(0.315)	(0.256)	(0.334)	(0.468)	(0.090)	(0.139)
Controls	✓	✓	✓	✓	✓	✓
Observations	168606	196269	117391	90179	436451	345475

Notes: The definition of married includes cohabitation. Standard errors (clustered by person and year) are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5.The age of samples ranges from 30 to 80 years old.

Table A4.8: Estimates of SWB time trends for never-married, married, and the difference

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-1.249***	2.331***	2.838***	-0.714**	-0.249**	-0.897***
	(0.186)	(0.608)	(0.271)	(0.298)	(0.112)	(0.144)
Married	-0.949***	3.572***	3.061***	-0.697***	0.349***	-1.063***
	(0.079)	(0.072)	(0.121)	(0.102)	(0.029)	(0.048)
Difference	-0.299	-1.241**	-0.223	-0.017	-0.598***	0.166
	(0.201)	(0.611)	(0.294)	(0.312)	(0.116)	(0.151)
Panel B: Satisfied						
Never-married	-0.232	-0.421	2.643***	1.216***	0.210	-0.788***
	(0.308)	(0.786)	(0.333)	(0.436)	(0.136)	(0.180)
Married	0.192	2.683***	2.975***	1.071***	0.789***	-1.051***
	(0.163)	(0.077)	(0.145)	(0.217)	(0.038)	(0.065)
Difference	-0.425	-3.104***	-0.332	0.145	-0.579***	0.263
	(0.345)	(0.789)	(0.362)	(0.478)	(0.141)	(0.190)
Panel C: Dissatisfied						
Never-married	0.321	-4.342***	-3.662***	-1.191*	0.279	1.780***
	(0.399)	(0.813)	(0.337)	(0.619)	(0.171)	(0.205)
Married	-0.224	-6.228***	-4.143***	-0.090	-0.395***	2.277***
	(0.233)	(0.124)	(0.155)	(0.350)	(0.048)	(0.077)
Difference	0.544	1.886**	0.481	-1.100	0.674***	-0.497**
	(0.456)	(0.822)	(0.369)	(0.696)	(0.177)	(0.217)
Controls	✓	✓	✓	✓	✓	✓
Observations	78630	87011	51299	46456	202859	174993

Notes: Standard errors (clustered by person and year) are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5. The age of samples ranges from 50 to 80 years old.

Table A4.9: Estimates of SWB time trends for never-married, married, and the difference

	(1) Australia	(2) Korea	(3) Russia	(4) Switzerland	(5) Germany	(6) UK
Panel A: Life satisfaction						
Never-married	-2.019***	2.331***	3.259***	-0.678**	-0.249**	-0.982***
	(0.284)	(0.608)	(0.496)	(0.338)	(0.112)	(0.156)
Married	-0.987***	3.572***	2.941***	-0.778***	0.349***	-1.087***
	(0.075)	(0.072)	(0.114)	(0.098)	(0.029)	(0.048)
Difference	-1.032***	-1.241**	0.317	0.100	-0.598***	0.105
	(0.293)	(0.611)	(0.508)	(0.349)	(0.116)	(0.162)
Panel B: Satisfied						
Never-married	-1.142***	-0.421	3.215***	1.003**	0.210	-0.890***
	(0.408)	(0.786)	(0.632)	(0.475)	(0.136)	(0.192)
Married	0.154	2.683***	2.842***	0.976***	0.789***	-1.083***
	(0.153)	(0.077)	(0.137)	(0.205)	(0.038)	(0.065)
Difference	-1.296***	-3.104***	0.373	0.027	-0.579***	0.193
	(0.433)	(0.789)	(0.645)	(0.509)	(0.141)	(0.202)
Panel C: Dissatisfied						
Never-married	1.629***	-4.342***	-3.354***	-0.977	0.279	1.912***
	(0.523)	(0.813)	(0.613)	(0.656)	(0.171)	(0.218)
Married	-0.232	-6.228***	-4.032***	-0.310	-0.395***	2.287***
	(0.217)	(0.124)	(0.145)	(0.326)	(0.048)	(0.076)
Difference	1.861***	1.886**	0.679	-0.667	0.674***	-0.376
	(0.562)	(0.822)	(0.628)	(0.720)	(0.177)	(0.230)
Controls	✓	✓	✓	✓	✓	✓
Observations	78630	87011	51299	49103	202859	175063

Notes: The definition of married includes cohabitation. Standard errors (clustered by person and year) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Satisfied: life satisfaction >5, dissatisfied: life satisfaction <5.The age of samples ranges from 50 to 80 years old.

Table A4.10: Estimates of SWB time trends for never-married, married, and the difference

Summary

English version:

As the global economy and healthcare evolve, subjective well-being is increasingly becoming a topic of interest in the field of health economics. In this dissertation, we try to investigate subjective well-being from two related aspects: obesity and marriage.

Obesity is a global health crisis that has reached alarming proportions in recent years. Defined as an excessive accumulation of body fat, obesity has far-reaching implications for both individid- ual health and society as a whole. Its prevalence has steadily risen, with over 650 million adults worldwide classified as obese, according to data from the World Health Organization (WHO). This epidemic has led to a surge in obesity-related health problems, including diabetes, cardio- vascular disease, and certain types of cancer, making it a pressing concern for healthcare systems and policymakers. Estimates of the cost of obesity are an important basis for the development and evaluation of obesity-related policies. Previous studies have estimated the direct and indirect costs of obesity, but in addition to these, the intangible costs of obesity are also noteworthy. The intangible costs of obesity are associated with a loss of well-being. In addition, obesity-related inequality may also combine with peer effects to lead to lower well-being in obese individuals. So, ignoring the intangible costs of obesity may lead to underestimating the benefits of obesity control policies.

Marriage, without a doubt, is a major event in life. People from almost any socio-cultural background consider marriage-related decisions such as whether to get married, when to get married, and with whom to get married. But nowadays, in increasingly countries around the world, marriage rates continue to decline and the age of first marriage continues to be delayed, so we sought to analyze whether these trends are related to marriage-related well-being. The contributions of each chapter are shown below:

Chapter 2 uses SOEP 2002-2018 data and a life satisfaction-based compensation approach to quantify the intangible costs of overweight and obesity. Previous literature documents the direct and indirect economic costs of obesity, yet none has attempted to quantify the intangible costs of obesity. This study focuses on quantifying the intangible costs of one unit body mass index (BMI) increase and being overweight and obese in Germany. Our results underscore how existing research into obesity's economic toll may underestimate its true costs, and they strongly imply that if obesity interventions took the intangible costs of obesity into account, the economic benefits would be considerably larger.

Chapter 3 uses data from the German Socio-Economic Panel (GSOEP), investigates the changes in the BMI distribution and obesity inequality among German adults aged 18+ between 2002–

2018 and estimates the relationship between obesity inequality and subjective well-being. The results show that the rise in obesity prevalence is mainly due to an overall rightward shift of the BMI distribution, accompanied by an increase in left skewness. Over the entire 16-year period, obe- sity inequality increased significantly, especially among females, those with low education levels, and low-income groups. The results also document a significant association between different measures of obesity inequality and subjective well-being, especially among women.

Chapter 4 explores the trends in the subjective well-being (SWB) of never-married people (referenced with the married) and the factors that account for the gaps in SWB between never-married and married people. By employing a harmonized data from surveys conducted in six distinct countries, namely Australia (HILDA), South Korea (KLIPS), Russia (RLMS), Switzerland (SHP), Germany (SOEP), and the United Kingdom (BHPS and UKHLS), our analysis discerns a consistent and statistically significant association between never-married status and lower levels of life satisfaction, a relationship that has exhibited no substantial alteration over time. Particularly noteworthy is the discernible reduction in life satisfaction among never-married individuals in South Korea in comparison to their married counterparts.

The thesis concludes with a short summary in chapter five.

German version:

Im Zuge der Entwicklung der globalen Wirtschaft und des Gesundheitswesens wird das subjektive Wohlbefinden zunehmend zu einem interessanten Thema im Bereich der Gesundheitsökonomie. In dieser Dissertation versuche ich, das subjektive Wohlbefinden aus zwei verwandten Perspektiven zu untersuchen: Fettleibigkeit und Ehe.

Fettleibigkeit stellt eine weltweite Gesundheitskrise dar, die in den letzten Jahren alarmierende Ausmaße erreicht hat. Als übermäßige Ansammlung von Körperfett definiert, hat die Fettleibigkeit weitreichende Auswirkungen sowohl auf die individuelle Gesundheit als auch auf die Gesellschaft als Ganzes. Ihre Verbreitung hat kontinuierlich zugenommen, und nach Daten der Weltgesundheitsorganisation (WHO) gelten weltweit über 650 Millionen Erwachsene als fettleibig. Diese Epidemie hat zu einem Anstieg der fettleibigkeitsbedingten Gesundheitsprobleme geführt, darunter Diabetes, Herz-Kreislauf-Erkrankungen und bestimmte Krebsarten, was sie zu einer drängenden Angelegenheit für Gesundheitssysteme und politische Entscheidungsträger macht. Schätzungen der Kosten der Fettleibigkeit bilden eine wichtige Grundlage für die Entwicklung und Evaluierung von politischen Maßnahmen zur Fettleibigkeitsbekämpfung. Frühere Studien haben die direkten und indirekten Kosten der Fettleibigkeit geschätzt, aber zusätzlich dazu sind auch die immateriellen Kosten der Fettleibigkeit beachtenswert. Die immateriellen Kosten der Fettleibigkeit sind mit einem Verlust des Wohlbefindens verbunden. Darüber hinaus können fettleibigkeitsbedingte Ungleichheiten zusammen mit Peer-Effekten zu einem geringeren Wohlbefinden bei fettleibigen Personen führen. Daher kann die Vernachlässigung der immateriellen Kosten der Fettleibigkeit dazu führen, dass die Vorteile von Maßnahmen zur Fettleibigkeitskontrolle unterschätzt werden.

Die Ehe ist zweifellos ein bedeutendes Ereignis im Leben eines Menschen. Menschen aus nahezu jedem soziokulturellen Hintergrund treffen Entscheidungen im Zusammenhang mit der Ehe, wie etwa die Frage, ob sie heiraten sollen, wann sie heiraten sollen und mit wem sie heiraten sollen. Doch heutzutage sinken in immer mehr Ländern weltweit die Heiratsraten, und das Alter bei der ersten Heirat wird immer weiter hinausgeschoben. Daher haben wir untersucht, ob diese Trends im Zusammenhang mit dem durch die Ehe bedingten Wohlbefinden stehen. Die Beiträge jedes Kapitels werden nachfolgend aufgezeigt:

Kapitel 2 verwendet Daten aus dem Sozio-oekonomischen Panel (SOEP) der Jahre 2002 bis 2018 und einen auf Lebenszufriedenheit basierenden Kompensationsansatz, um die immateriellen Kosten von Übergewicht und Fettleibigkeit zu quantifizieren. Die bisherige Literatur dokumentiert die direkten und indirekten wirtschaftlichen Kosten der Fettleibigkeit, jedoch hat bisher niemand versucht, die immateriellen Kosten der Fettleibigkeit zu quantifizieren. Diese Studie konzentriert sich darauf, die immateriellen Kosten eines Anstiegs des Body-Mass-Index (BMI) um eine Einheit sowie die Kosten des Übergewichts und der Fettleibigkeit in Deutschland zu quantifizieren. Unsere Ergebnisse verdeutlichen, wie bestehende Forschung zur wirtschaftlichen Belastung durch Fettleibigkeit die tatsächlichen Kosten unterschätzen könnte, und sie legen nahe, dass, wenn

Maßnahmen zur Bekämpfung von Fettleibigkeit die immateriellen Kosten berücksichtigen würden, die wirtschaftlichen Vorteile erheblich größer wären.

Kapitel 3 verwendet Daten aus dem Deutschen Sozio-oekonomischen Panel (GSOEP), untersucht die Veränderungen in der Verteilung des BMI und der Fettleibigkeitsungleichheit bei deutschen Erwachsenen ab 18 Jahren zwischen 2002 und 2018 und schätzt die Beziehung zwischen der Fettleibigkeitsungleichheit und dem subjektiven Wohlbefinden. Die Ergebnisse zeigen, dass der Anstieg der Fettleibigkeitsprävalenz hauptsächlich auf eine insgesamt nach rechts verschobene BMI-Verteilung zurückzuführen ist, begleitet von einer Zunahme der Linksschiefe. Über den gesamten Zeitraum von 16 Jahren hinweg stieg die Fettleibigkeitsungleichheit signifikant an, insbesondere bei Frauen, Personen mit geringer Bildung und niedrigen Einkommensgruppen. Die Ergebnisse dokumentieren auch eine signifikante Verbindung zwischen verschiedenen Maßnahmen der Fettleibigkeitsungleichheit und dem subjektiven Wohlbefinden, insbesondere bei Frauen.

Kapitel 4 untersucht die Trends im subjektiven Wohlbefinden (SWB) von nie verheirateten Personen (verglichen mit Verheirateten) und die Faktoren, die die Unterschiede im SWB zwischen nie verheirateten und verheirateten Personen erklären. Durch die Verwendung harmonisierter Daten aus Umfragen in sechs verschiedenen Ländern, nämlich Australien (HILDA), Südkorea (KLIPS), Russland (RLMS), der Schweiz (SHP), Deutschland (SOEP) und dem Vereinigten Königreich (BHPS und UKHLS), zeigt unsere Analyse eine konsistente und statistisch signifikante Assoziation zwischen dem Status "nie verheiratet" und niedrigeren Lebenszufriedenheitsniveaus auf, eine Beziehung, die sich im Laufe der Zeit nicht wesentlich verändert hat. Besonders bemerkenswert ist die deutliche Reduzierung der Lebenszufriedenheit bei nie verheirateten Personen in Südkorea im Vergleich zu ihren verheirateten Pendants.

Die Dissertation schließt mit einer kurzen Zusammenfassung in Kapitel fünf.