Working Paper in Economics No. 709

I Can't Sleep!
Relative Concerns and Sleep Behavior

Alpaslan Akay, Peter Martinsson, Hilda Ralsmark

Department of Economics, October 2017

ISSN 1403-2473 (Print)
ISSN 1403-2465 (Online)

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

I Can't Sleep!
Relative Concerns and Sleep Behavior*

Alpaslan Akay, Peter Martinsson, Hilda Ralsmark

September, 2017

Abstract

We investigate the effect of relative concerns with respect to income on the quantity and quality of sleep using a long panel dataset on the sleep behavior of people in Germany. We find that relative income has a substantial negative effect on number of hours of sleep on weekdays and overall satisfaction with sleep, i.e., sleep quality, whereas absolute income has no particular effect on sleep behavior. The findings are robust to several specification checks, including measures of relative concerns, reference group, income inequality, and local price differences. The paper also investigates the importance of the potential channels including working hours, time-use activities, and physical and mental health to explain how relative concerns relate to sleep behavior. The results reveal that while all of these channels partially contribute to the effect, it appears to be mainly driven by physical and mental health and overall and financial well-being/stress. We also use a subjective well-being valuation approach to calculate the monetary value of sleep lost due to income comparisons. The total cost is as high as about 2.6 billion euro/year (1.8% of the overall monetary value of sleep and 1.3% of total health expenditures) among the working-age population in Germany.

Key Words : Relative Income; Sleeping Satisfaction; Hours of Sleep

JEL Classification : C35, C90, D60

*__Acknowledgements:__ We are grateful for generous financial support from the Swedish Research Council through the project Social Status, Social Preferences, and Public Policy (no. 2016-02371). We also thank the participants in the BEGG (GBG, 2016) and WZB (Social Status and Social Image, Berlin; 2017) conferences, Olivier Bargain, and Olof Johansson-Stenman for valuable comments. Corresponding Author. Akay is affiliated with the University of Gothenburg and IZA. Address: Vasagatan 1, Box: 640, E5, 405 30, Gothenburg, Sweden. Tel: 046(31) 786 4122. Email: alpaslan.akay@economics.gu.se. Martinsson is affiliated with the University of Gothenburg. E-mail: peter.martinsson@economics.gu.se. Ralsmark is affiliated with the University of Gothenburg. Email: hilda.ralkmark@economics.gu.se. All mistakes are our own.

1 Introduction

People derive utility not only from their absolute level of income and consumption, but also from their income and consumption levels relative to those of other people. In other words, people have relative (or positional or status) concerns (e.g., Frank, 1985). This issue has been discussed by many scholars including Veblen (1899/2005) and Duesenberry (1949), but notably also by scholars with different political opinions including Karl Marx, Adam Smith, and John Stuart Mill. There is by now a large and growing empirical literature supporting the notion that relative concerns significantly influence people's utility (Clark et al., 2008; Alpizar et al., 2005).[1] Concerns for relative income and consumption generate negative externalities and there is an also emerging literature in economics including how to use income taxation to reduce these effects (e.g., Aronsson et al., 2016), economic growth (e.g., Easterlin, 1995), labor supply (e.g., Neumark and Postlewaite, 1998), and migration (e.g., Akay et al., 2017). Also, the public health and epidemiological literature argues that lower relative income has a negative effect in particular on the physical and mental health of individuals because it increases the individual's psychosocial stress (e.g., Wilkinson, 1997; Sapolsky, 2004; Miller and Paxson, 2006; Jones and Wildman, 2008; Gravelle and Sutton, 2009). This type of stress is also thought to influence people's sleep behavior negatively (e.g., Linton, 2004; Kim and Dimsdale, 2007; Basta et al., 2007; Vgontzaz et al., 2008). To the best of our knowledge first time in the literature this paper investigates whether the relative concerns influences sleep behavior, i.e., quantity and quality of sleep, and the mechanisms that may explain this relationship.

Sleep is an integral part of daily life and it is recommended that adults sleep 7–9 hours per night (e.g., Hirshkowitz et al., 2015). Even though the exact mechanisms as to why we need to sleep are largely unknown, the importance of sleep, both in terms of duration and quality, on several biological, psychological, and socio-economic outcomes is well documented. For example, poor sleep is an important correlate of both immune system strength (e.g., Hall et al., 1998) and weight gain and obesity (e.g., Vgontzaz et al., 2008; Patel and Hu, 2008), and is also associated with risk-taking behavior, cognitive development, and academic performance (e.g., Moore et al., 2011). Moreover, poor sleep creates large and non-negligible economic costs to the individual and society. For example, in the U.S., the total (direct and indirect) annual cost of insomnia

[1] The literature on relative concerns generally uses either subjective well-being datasets or stated preference methods to identify the direct utility effect of positional concerns (e.g., Clark et al., 2008; Alpizar et al., 2005). This literature suggests that the relative concerns negatively influence the subjective well-being especially in developed countries (Clark et al., 2008). Yet the results are more mixed for transition and poor countries with either insignificant or positive relative income effect (e.g., Akay and Martinsson, 2011). In line with the subjective well-being approach, based on survey experimental methods the stated preference method suggests that people are positional with respect to not only income but also other goods such as a consumption value of a car or vacation days (e.g., Alpizar et al., 2005; Carlsson et al., 2007).

has been estimated to range between 92.5 and 107.5 billion USD (Stoller, 1994).

There is a biological need for a certain number of hours of sleep per night, and this number varies from person to person. Sleep is also largely a choice variable that is influenced by variables affecting the allocation of time.[2] It is therefore not surprising that the determinants of sleep have gained attention in recent years. Today, sleep has been linked to several other important individual variables including marital status, education, working hours and unemployment, and macroeconomic indices (e.g., Biddle and Hammermesh, 1990; Hale, 2005; Szalontai, 2006, Haley and Miller, 2014; Brochu et al., 2012; Antillon et al., 2014; Gruber et al., 2017). One important question is how people's income level is related to their sleep behavior. The recent literature that focuses mainly on people's own income and sleep finds somewhat mixed results. Studies, mainly from psychology, report either a weak positive association between own income and the duration and quality of sleep (e.g., Hale, 2005; Adams, 2006; Lauderdale et al., 2006; Friedman et al., 2007; Grandner et al., 2009). The present paper adds to this literature by analyzing the relationship between income (absolute and relative) and people's sleep behavior. Concerns involving the income level of relevant others might influence sleep through several mechanisms. For example, individuals who try to catch up with others might calibrate their sleeping duration by changing their working hours or time-use (leisure or household production) activities, depending on their opportunity cost of sleep. That is, people might sacrifice their sleep by working more or increase their household production activities to improve their income position. Also, a lower income status might generate psychosocial stress in several domains of life, e.g., personal finances, which may negatively affect a person's physical and mental health and well-being and in turn his or her quantity and quality of sleep.

Our empirical analysis uses a six-year panel dataset collected in Germany (German Socio-Economic Panel – GSOEP)[3], which contains information on people's average number of hours of sleep, on both weekdays and weekends, and sleep satisfaction, which we use as a proxy for sleep quality. Our empirical strategy to identify relative concerns is based on the approach used in most papers on subjective well-being that investigate relative concerns (e.g., Clark and Oswald, 1995; Clark et al., 2008; Senik, 2004; Ferrer-i-Carbonell, 2005; Akay et al., 2011). In this approach, relative concerns are proxied by relative income which is calculated as the average (or median) income of people with whom individuals compare their income, i.e., their reference group (e.g., Senik and Clark, 2010; Akay et al., 2014). Borrowing from this literature,

[2]Research identifies important cyclical patterns in sleep inherited in the biological systems, e.g., the circadian rhythm. Duration of sleep and when people go to bed might be related to these exogenous clocks. The cyclical patterns affect not only biological systems but also socio-psychological behavior and individual outcomes. Yet people can calibrate their duration of sleep depending on the circumstances. Shift-work is a good example of this (see, e.g., Roenneberg et al., 2007).

[3]For further information about the data, see www.diw.de.

in our econometric specifications, we regress sleep duration and quality on absolute and relative income conditional on observed socio-demographic and economic characteristics, which include measures of health status, daily number of working hours, and daily non-paid time-use hours. The panel aspect of the data also allows us to control for the unobserved individual characteristics that are correlated with both relative and absolute income, i.e., individual fixed-effects, which can alleviate the bias due to the omitted variables problem.

The paper presents highly robust results on the relationship between absolute income, relative income, and sleep behavior. The fixed-effect model specifications suggest that the effect of absolute income on sleep, in terms of both quantity and quality, is very small and statistically insignificant in all model specifications. Relative income, however, has a very strong and negative relationship with sleep quantity and quality. We find a large and highly significant negative relationship between relative income and number of hours of sleep on weekdays and overall quality of sleep. Our results suggest that there is no statistically significant association between relative income and number of hours of sleep on weekends. Overall, our results are robust to several checks with respect to estimators, measures of absolute and relative income, alternative definitions of reference groups, local income inequality, and local price differences. Further, one of the novelties of this paper is that we report an extensive investigation of the potential mechanisms that may mediate or confound the negative relationship between relative income and sleep. We analyze three interrelated channels that relate to working hours, time-use patterns, and physical and mental health/stress. We find that each channel partially contributes to our findings in expected directions. In particular, the income comparisons largely affect people with short working hours and high time use in household production. The negative relative income effect is mostly explained by the physical and mental-health/stress levels of the individuals. We calculate the monetary value of sleep lost due to relative concerns using subjective well-being valuation method (van Praag and Baarsma, 2005; Powdthavee and van Den Berg, 2011). We find that the total price/cost is as high as about 2.6 billion euro/year among the working-age population in Germany. The relative value of the cost is about 1.8% of the overall monetary value of sleep and 1.3% of total health expenditures of Germany in year 2013.

The remaining part of the paper is organized as follows: Section 2 presents the dataset, the sample selection criteria, measures of sleep and relative income, and the statistics of key measures. Section 3 presents the econometric specifications, where we discuss important econometric problems that may bias our results. Section 4 presents the baseline results, sensitivity and robustness checks, and observed heterogeneity. Section 5 presents the mechanisms through which relative income might influence sleep quantity and quality. Section 6 presents results from the subjective well-being valuation of sleep lost due to relative concerns. Finally, Section 7 summarizes the main findings and discusses the economic implications.

2 Data

2.1 Sample Selection

Our empirical analysis uses data from the German Socio-Economic Panel (GSOEP), which is a large and nationally representative longitudinal panel dataset that is based on annual household interviews that started in 1984.[4] Around 25,000 individuals in 12,000 households are surveyed in each wave. An advantage of the GSOEP is that it is very rich with regard to socio-demographic and economic characteristics, individual and household characteristics, as well as measures to relate the individuals with the characteristics of the local regions where they reside. It also has low attrition, which is a crucial aspect for our identification strategy (Knies and Spiess, 2007). The main advantage of GSOEP for the purpose of the present study is that the six waves from 2008 to 2013 contain information on sleep behavior. Therefore, our analysis is restricted to these waves. We focus on the native German working-age population aged $20 - 65$ to eliminate age- and migration-related confounders. After deleting the missing values, our final estimation sample consists of 76,046 individual-year observations.

2.2 Measures of Sleeping Behavior

We use two key measures related to sleep behavior. The first is number of hours (i.e., the quantity) of sleep. This information is provided for both workdays, i.e., weekdays, and weekends and is obtained with the question: "*On average on a normal day during the workweek, how many hours do you sleep? How many hours a day on a normal weekend?*" The second measure is sleep satisfaction, and this information is obtained with the question: "*How satisfied are you with your sleep*?", which comes with an 11-point response scale (0 = "*completely dissatisfied*" and 10 = "*completely satisfied*"). We consider this measure a proxy for sleep quality based on the idea that the sleep-satisfaction question measures the (experienced) utility or well-being derived from sleep (see, e.g., Kahneman and Sugden, 2005).[5] Our sleep measures might include measurement error problems which lead to bias in estimators. First, the quality and quantity of people's sleep may vary across the year and thus the measures may not reflect actual averages. Second, the measures might be affected by the temporal circumstances surrounding the interview day (e.g., whether the interview is conducted on a long and light summer day or on a short and dark winter day). To deal with these measurement problems, our model

[4] The panel aspect of GSOEP dataset is created using PanelWhiz software (http://www.panelwhiz.eu/). Please see Haisken-DeNew and Hahn (2010) for further information.

[5] There has been a long discussion in the subjective well-being literature on whether the measure of overall life-satisfaction or domain satisfaction, e.g., sleep or leisure satisfaction, are sufficient measures of people's well-being (e.g., Kahneman and Sugden, 2005; Layard et al., 2008; Krueger and Schkade, 2008). Today there is a consensus that these simple questions can indeed capture levels of well-being (e.g., Krueger and Schkade, 2008).

specifications allow for individual fixed-effects and also several variables to capture temporal circumstances including indicators for the weekday and month in which the sleep information is obtained.

Statistics. Table 1 presents some descriptive statistics on the sleep behavior. The average German sleeps about 6.94 hours per night (std. 1.03) on weekdays and 8 hours (std. 1.29) per night on weekends (Column I). The mean satisfaction with sleep is 6.83 (std. 2.24). We now calculate average number of working hours and time use on weekdays and on weekends. The former consists of the total hours spent on the primary and other jobs and the latter refers to number of hours spent on a set of very heterogeneous set of household activities, i.e., errands, housework, childcare, care and support for persons in need of care, education or further training, repairs etc., and hobbies. The average number of hours spent on work and time use on weekdays is about 6.9 hours each, which is similar to the average number of hours of sleep. The average number of hours spent on work and time use activities on a weekend day is about 1.4 (std. 2.47) and 7.6 (std. 4.1), respectively.

Table 1 also presents descriptive statistics by employment status to give an initial idea of the sleeping patterns among working and non-working individuals, respectively (Columns II–III). These two groups are expected to display different time-use patterns, which might affect their sleep behavior. As expected, employed individuals sleep shorter hours ($p-value =< 0.001$) on weekdays and longer hours on weekends ($p-value =< 0.001$). There is also a large difference in sleep satisfaction between employed and non-employed individuals ($6.89 - 6.23 = 0.65$, $p-value =< 0.001$). That is, non-employed people sleep more hours on weekdays, yet they are less satisfied with their sleep. Also, they sleep fewer hours on the traditional leisure days, i.e., weekends, implying that they might experience sleep disturbances related to their employment status. The mean age in our sample is about 44 and we have slightly more females than males (53% versus 47%). Fifty-six percent of the individuals are married and they have an average of about 12 years of education, which are figures highly in line with the papers in the literature using similar datasets and sample selection (see, e.g., Ferrer-i-Carbonell, 2005).

2.3 Absolute and Relative Income

Measuring Income. One of the key variables in this study is the measure of income. There are several alternatives that can serve our purpose. Our baseline income definition is based on household income. Yet, we are going to estimate models based on other measures of income as well, including individual labor income. Household income is the sum of all incomes from all sources that enter the household after taxes and social security transfers, i.e., post-government income. We use household size in order to calculate the effective income per individual within the household. That is, we divide the household income by the number of family members using

Table 1: Descriptive Statistics

	Employment Status			Log of Absolute Income			Log of Relative Income		
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IV**
	All	Emp.	Not Emp.	Low	Middle	High	Low	Middle	High
Hours of Sleep: Weekdays	6.941	6.891	7.124	6.951	6.931	6.941	7.033	6.887	6.901
	(1.033)	(0.975)	(1.203)	(1.138)	(1.011)	(0.941)	(1.065)	(0.991)	(1.036)
Hours of Sleep: Weekends	7.997	8.034	7.861	7.915	8.022	8.053	8.276	7.938	7.764
	(1.287)	(1.224)	(1.485)	(1.420)	(1.265)	(1.159)	(1.374)	(1.212)	(1.211)
Sleep Satisfaction	6.833	6.891	6.624	6.640	6.853	7.007	6.989	6.791	6.714
	(2.239)	(2.188)	(2.401)	(2.345)	(2.213)	(2.137)	(2.180)	(2.239)	(2.290)
Hours of Work: Weekdays	6.872	6.872		4.065	5.923	6.839	5.312	6.046	5.461
	(3.432)	(3.432)		(4.020)	(3.843)	(3.815)	(4.133)	(3.819)	(4.193)
Hours of Work: Weekends	1.364	1.364		1.078	1.259	1.060	1.230	1.144	1.032
	(2.474)	(2.474)		(2.319)	(2.470)	(2.124)	(2.495)	(2.275)	(2.156)
Hours of Time use: Weekdays	6.918	6.083	9.941	8.351	6.792	5.612	7.535	7.207	5.960
	(4.452)	(3.926)	(4.912)	(4.926)	(4.263)	(3.641)	(4.529)	(4.888)	(3.657)
Hours of Time use: Weekends	7.602	7.530	7.860	7.988	7.584	7.253	8.101	8.181	6.616
	(4.060)	(3.940)	(4.462)	(4.414)	(4.050)	(3.671)	(4.144)	(4.232)	(3.612)
Age	44.277	44.173	44.651	41.653	43.929	47.247	35.079	43.267	55.066
	(12.748)	(11.485)	(16.527)	(13.337)	(12.532)	(11.696)	(13.404)	(8.014)	(6.444)
Female (=1)	0.525	0.498	0.625	0.558	0.514	0.504	0.536	0.574	0.463
	(0.499)	(0.500)	(0.484)	(0.497)	(0.500)	(0.500)	(0.499)	(0.495)	(0.499)
Married (=1)	0.561	0.579	0.497	0.487	0.586	0.611	0.345	0.638	0.710
	(0.496)	(0.494)	(0.500)	(0.500)	(0.493)	(0.488)	(0.475)	(0.481)	(0.454)
Years of education	12.476	12.748	11.491	11.404	12.240	13.784	12.135	12.771	12.524
	(2.858)	(2.873)	(2.572)	(2.306)	(2.602)	(3.083)	(2.831)	(2.827)	(2.882)
#Observations	76046	59590	16456	25351	25347	25348	25799	25838	24409

Notes: Authors' own calculation from GSOEP. Income is measured using the equalized per capita household income. The relative income levels are obtained using the baseline reference groups definition. Standard deviations are in parentheses.

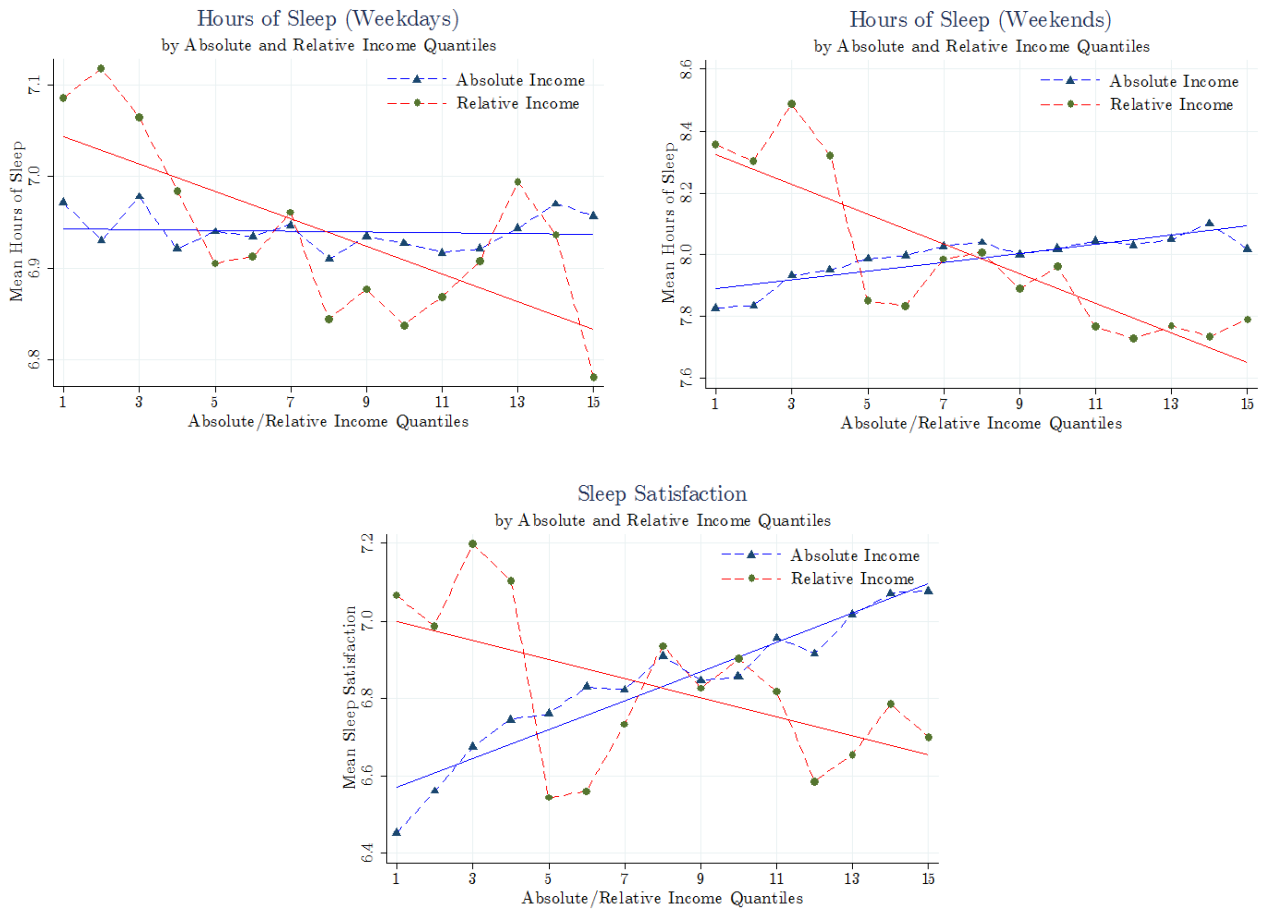
the weights suggested by the OECD equivalence scale.[6] Columns IV–VI of Table 1 present the raw relationship between absolute per capita household income and sleep behavior. To get an initial idea on the relationship between income and sleep behavior, we split the sample into three equal-sized categories of absolute income: low-, middle-, and high-income households. Absolute income is only moderately and positively correlated with longer sleep hours, especially on weekends. The unconditional relationship, however, suggests that high-income individuals are more satisfied with their sleep.

Reference Groups and Measuring Relative Income. To identify the relative income level of an individual, we need to identify the group of people with which individuals compare their income level, i.e., their reference group. The literature uses two approaches to identify reference groups. The first is to directly ask people about the group with which they compare their income (Clark and Senik, 2010; Akay et al., 2014). The second approach is to assume some ad-hoc criteria to define reference groups, which we do in this paper following in particular the subjective well-being literature (e.g., Clark and Oswald, 1996; McBride 2001, Ferrer-i-Carbonell, 2005; Luttmer, 2005). According to our baseline reference group definition, individuals compare their per capita (equalized) household income with the average equalized household income of all people who live in the same region (former West or East Germany), who are in the same age group (younger than 25, $25-34$, $35-44$, $45-65$, and 66 or older), who are similarly educated (fewer than 12 years of education and 12 or more years of education), and who are of the same gender (male or female) in each year from 2008 to 2013. The baseline definition generates 240 reference groups with an average of 482 (std. 250) individuals-year observations per group. Adding more criteria to the definition decreases the number of observations per reference group, which can substantially affect the precision of the estimates for each reference group's average income, i.e., reference income point. We also experiment with the reference group definition by subtracting and adding alternative characteristics, e.g., gender, education, and health status, and comparison orbits, e.g., neighborhoods. Furthermore, we are going to present results obtained from a less ambitious definition of a reference group, which excludes years of education, while we investigate the effects on finer subgroups (see, e.g., Ferrer-i-Carbonell, 2005). We then use federal states (16 regions), NUTS2 (32 regions), and ROR (*Raumordnungsregionen* [ROR], 96 regions)[7] to obtain finer regional units as comparison orbits to check the robustness of the results with respect to reference group definition.

[6] Per capita income is calculated by dividing the household income by the number of members in the household using the standard OECD weights as follows: Per capita income = Household income / (1 + 0.7(#adults) + 0.5(#children)). We have also experimented with the modified scale, which uses weights of 0.5 for each adult and 0.3 for each child in the household.

[7] The ROR-level dataset is a part of INKAR (*Indikatoren und Karten zur Raum- und Stadtentwicklung*). The dataset includes local level economic indicators. Please see www.inkar.de for further information.

Figure 1: Hours of Sleep and Sleep Satisfaction by Absolute and Relative Income



Note: Authors' own calculations from GSOEP. Sleep satisfaction and average hours of sleep on weekdays and weekends are shown by absolute and relative income quantiles. Quantiles are calculated at 15 different points in income distributions. The relative income is calculated using baseline reference group definition. The straight lines are the linear regression lines.

Table 1, Columns VII–IX, presents descriptive statistics of several other characteristics by the different levels of relative income. The statistics suggest important relationships: a higher relative income implies shorter hours of sleep and lower sleep satisfaction for both weekdays and weekends. To further develop our initial understanding of how absolute and relative income levels are associated with sleep behavior, we present the unconditional relationships in Figure 1. The horizontal axes present the 15 quantiles of the absolute and baseline relative income distributions and the vertical axes present the average hours of sleep on weekdays and weekends (top two graphs) and sleep satisfaction (bottom graph). While there is a positive association between absolute income and hours of sleep on weekends, there is no clear association on weekdays. The duration of sleep on weekdays and weekends decreases substantially as relative income increases. The bottom graph shows the relationships for sleep satisfaction. A similar pattern emerges, i.e., the quality of sleep increases for the higher values of absolute income, while people become less and less satisfied with their sleep as their income position decreases.

3 Econometric Specifications

The main objective of the present paper is to investigate the relationship between income (absolute and relative) and sleep measured by hours of sleep and sleep satisfaction, respectively. The average number of sleeping hours is a continuous self-reported variable, whereas sleep satisfaction is reported on an 11-point ordinal scale. In our baseline model specification, we specify a generic linear panel data model for sleep, which is the same for both number of hours of sleep and sleep satisfaction, as follows:

$$S_{it} = \lambda_{abs} \ln(Y_{it}^{abs}) + \lambda_{rel} \ln(Y_{rt}^{rel}) + \mathbf{X}'\beta + \epsilon_{it}, \quad (1)$$

$$\epsilon_{it} = s_k + \tau_t + \alpha_i + \varepsilon_{it}. \quad (2)$$

In equation (1), the dependent variable S_{it} is either hours of sleep or sleep satisfaction, and i indicates the individual and t the year. Y_{it}^{abs} is the absolute level of income measured using per capita household income (see Footnote 5). Y_{irt}^{rel} is relative income and is calculated as $Y_{irt}^{rel} = \frac{1}{N_r - 1} \sum_{m=1}^{N_r - 1} Y_{mt}^{r}$, which is the average income of the people in individual i's reference group r. N_r is the number of people and Y^r is the per capita household income of the people in the reference group. We use the logs for both per capita absolute and relative income to allow some flexibility in the hours of sleep and sleep satisfaction equations. The two key parameters that we estimate are λ_{abs} and λ_{rel}. In particular, we are interested in the sign, size, and significance of the parameter λ_{rel}, which measures how the income of others, i.e., relative income, affects sleep. To identify the relative income effect on sleep behavior, we control for several characteristics of individuals, $\mathbf{X}$, including marital status, years of education, subjective health status, household size and age composition of kids at home, labor force status, wages

and average daily working hours, average daily time use (other than job and training), and the so-called Big-5 personality traits, which are commonly labeled as *extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*, and *openness to experience*, which can correlate with, e.g., lifestyle (e.g., McCrae et al., 1999; Gruber at al., 2017) (see the table in Appendix A for the full set of controls), and β is a corresponding vector of parameters.

The composite error term ϵ_{it} includes several components as shown in equation (2): s_k denotes the regional dummies defined using the 16 federal states (*Länder*) of Germany to capture regional unobserved differences and τ_t denotes the time dummies for all periods of observations which aim to capture overall changes in German society including in economic and political conditions. α_i denotes the unobserved individual effects which are assumed to be correlated with observed characteristics, in particular absolute and relative income. In addition, it is crucial to allow for the unobserved individual effects in order to deal with the omitted variables that may explain sleep behavior, e.g., lifestyles, unobserved health conditions or genetic predisposition. To allow for this correlation, we estimate linear individual fixed-effects models for both sleep duration and sleep satisfaction.[8] To tackle the omitted variables bias further, the baseline model specification controls for the Big-5 personality traits. We also check how sensitive the results are to the model specification. For example, we also present estimates from a quasi-fixed-effects model (henceforth QFE) among our main results below. QFE model is based on an alternative auxiliary function of the unobserved individual effects to capture the correlated effects (à la Mundlak-Chamberlain approach). The auxiliary distribution allows for the within-means of time variant variables such as health status, household size, education, working hours, and time use.

4 Results

We first present estimates from a baseline model where we investigate the relationship between income (absolute and relative) and hours of sleep and sleep satisfaction, respectively. We present several robustness analyses with respect to estimators, measures of absolute and relative income, alternative definitions of reference groups, local income inequality, local price differences, and observed heterogeneity. Then we extensively analyze and discuss the potential channels explaining how relative income relates sleep behavior. Finally, we investigate the price/cost of sleep lost due to relative concerns using the subjective well-being valuation method.

[8]Recent studies suggest that the difference between linear model and ordered probit specifications is very small especially when the number of the ordinal categories is larger (Ferrier-i-Carbonell and Frijters, 2004). Using linear panel data estimators also has several advantages. Most importantly it is very easy to allow for the individual fixed-effects in a linear setting. Nevertheless, we present sensitivity analysis by estimating alternative model specifications.

4.1 Main Results

Baseline Estimates. Table 2 presents the baseline estimation results in the first column. The model controls for the full set of control variables (see Appendix A). To be concise, in the rest of the paper we present only the key variables of interests, i.e., absolute and relative income. In the baseline model specification, absolute income is measured as per capita (equalized) household income and relative income is a person's income relative to the average income of people in the baseline reference group. The baseline model specification allows for the individual fixed-effects (FE) in which the unobserved individual effect is assumed to be correlated with the observed characteristics. The upper part of Column I presents the results for hours of sleep on weekdays. As can be seen, there is no significant relationship between absolute income and hours of sleep; the parameter estimate is 0.020 (s.e. 0.014). The relative income effect is large in magnitude (-0.150, s.e. 0.071), negative, and statistically significant at the 5% level. The second part of Column I gives the results for hours of sleep on weekends. There is a similar pattern as for weekdays, but both parameter estimates are statistically insignificant at conventional levels. The absolute income effect is positive and marginally significant with a size of 0.027 (s.e. 0.017, $p - value = 0.101$). The parameter estimate of the relative income effect on hours of sleep on weekends is less than half the size of that of the corresponding effect on weekdays (-0.068 vs. -0.150). Finally, the last part of Column I presents the baseline results for sleep satisfaction, i.e., sleep quality. The results are similar to those for hours of sleep on weekdays. There is no significant relationship between absolute income and sleep satisfaction, but the relative income effect is large in magnitude, negative, and significant at conventional levels. Thus, the results from the baseline model specifications suggest that there are important relationships between income and sleep behavior. Absolute income does not significantly relate to sleep, while relative income is statistically significant and affects both hours of sleep on weekdays and sleep satisfaction negatively.

Control Variables. We present the full estimation results of our baseline fixed-effects model specifications in Appendix A. The parameter estimates of social-demographic and -economic characteristics are in line with expectations. For example, health status and hours of sleep are positively related, while number of dependent kids aged 0–1 and 2–4 relates negatively with hours of sleep. Years of education is positively and significantly related to sleep on weekdays and as well as sleep satisfaction. Individuals who are currently employed sleep shorter hours and are less satisfied with their sleep, but the parameter estimates are not statistically significant. Compared with other people, individuals who are currently in school/(vocational) training sleep less on weekdays and more on weekends and are less satisfied with their sleep. Two important variables in this study are average daily working hours and time-use hours for non-paid household activities. People who work longer hours sleep less on weekdays and are less

Table 2: Baseline and Initial Sensitivity

	I	II	III	IV	V	VI	VII
	Estimators		Alternative Reference Groups				Income
	FE-Baseline	QFE	RG1	RG2	RG3	RG4	(Median)
Hours of sleep, weekdays							
Absolute Income	0.020	0.037 ***	0.021 *	0.020	0.021	0.019	0.020
	(0.014)	(0.010)	(0.012)	(0.014)	(0.014)	(0.014)	(0.014)
Relative Income	-0.150 **	-0.091 **	-0.252 ***	-0.099 *	-0.098 **	-0.095	-0.118 *
	(0.071)	(0.039)	(0.081)	(0.061)	(0.045)	(0.076)	(0.067)
R-Squared	0.026	0.060	0.027	0.025	0.026	0.021	0.025
#Observations	76046	76046	76046	76046	76046	76046	76046
Hours of sleep, weekends							
Absolute Income	0.027	0.060 ***	0.028 *	0.027	0.027	0.025	0.027
	(0.017)	(0.013)	(0.015)	(0.017)	(0.017)	(0.017)	(0.017)
Relative Income	-0.068	-0.091 *	-0.112	0.014	-0.046	-0.062	-0.040
	(0.089)	(0.047)	(0.098)	(0.074)	(0.057)	(0.092)	(0.084)
R-Squared	0.049	0.115	0.051	0.046	0.045	0.042	0.048
#Observations	75689	75689	75689	75689	75689	75689	75689
Sleep Satisfaction							
Absolute Income	0.008	0.021	0.008	0.008	0.008	0.010	0.008
	(0.025)	(0.020)	(0.023)	(0.025)	(0.025)	(0.025)	(0.025)
Relative Income	-0.233 *	-0.150 **	-0.262 *	-0.130	-0.065	-0.097	-0.290 **
	(0.144)	(0.074)	(0.157)	(0.121)	(0.088)	(0.146)	(0.133)
R-Squared	0.287	0.318	0.287	0.287	0.283	0.277	0.286
#Observations	76031	76031	76031	76031	76031	76031	76031

Notes: Authors' own calculations from GSOEP waves 2008–2013.

The dependent variables are the hours of sleep on weekends and weekdays as well as sleep satisfaction based on the question: "How satisfied are you from your sleep in general?" (values range from 0 to 10).

The models control for full set of control variables with time and state dummies are included (See Appendix A). Standard errors are in parenthesis.

FE is the individual fixed-effects (excludes sex, age and age-squared). QFE is the quasi-fixed-effects includes within-means of household size, age, education, health-status and individual labor income. RG represents reference groups.

*. **. *** indicate significance levels at 10%. 5% and 1%, respectively.

satisfied with their sleep. Yet, they sleep longer on weekends. Time-use is negatively related with sleeping hours only on weekends and a higher time-use also relates negatively with sleep satisfaction. The log of individual labor income and distance to work (measured in km) are not related to hours of sleep and sleep satisfaction. We also find important relationships between personality traits (measured with the Big-5 personality inventory) and sleep behavior.[9] For instance, a higher conscientiousness value, e.g., hardworking and meticulous people, relates to less sleep on both weekdays and weekends. People who are emotionally unstable (neuroticism) also sleep less, but only on weekends. In the remaining part of the paper, we investigate the relationship between income (absolute and relative) and sleep behavior in more detail.

4.2 Is the Effect Stable?

Estimators. We first check the sensitivity of the results using alternative estimators. Our baseline specification is a linear individual fixed-effects model. This model specification is our favorite choice as it eliminates omitted variables that may confound the absolute and relative income effects on hours of sleep and sleep satisfaction. Column II of Table 2 presents the results from an alternative model specification, QFE, which is based on Chamberlain's correlated-effect model. This model specification uses an auxiliary model specification for the unobserved individual effects based on within-means of time-variant variables to capture the correlation between unobserved effects and observed characteristics. The time-variant variables that we use in the specification are health status, education, age, individual labor income, household size, daily working and time-use hours. We also include the Big-5 personality traits into this model specification to add an additional potential proxy for the unobserved individual characteristics to deal extensively with the issue of omitted variables. As can be seen in Column II of Table 2, the results are similar to those for the baseline fixed-effects model in Column I. The QFE model suggests a highly significant absolute income on hours of sleep on weekdays and weekends. The relative income effect is also statistically significant, not only on hours of sleep on weekdays but also on weekends and on sleep satisfaction. We compare the baseline fixed-effect and QFE using the Hausman test. The results strongly favor the fixed-effects specification.[10]

[9] The personality traits are measured in only three waves. We assume that a person's personality is stable in the short term (see Cob-Clark and Schurir, 2012). We assigned the measure in the 2005 wave for the 2008 and 2009 waves. The measure of personality in 2009 is assigned for the 2010, 2011, and 2012 waves. The measure of personality in 2013 is used for the 2013 wave. Thus, we are able to estimate the individual fixed-effects model without losing a large portion of the data. Yet we also have experimented using alternative groupings, and the results are highly comparable.

[10] We also estimate several alternative specifications including a linear model with ordinary least squares, an ordered probit model, the "Blow and Cluster" fixed-effects ordered probit model (Baetschmann et al., 2015) – in the case of sleep satisfaction – and a random-effects model. The results are highly comparable across specifications and available from the authors upon request.

Reference Groups and Income. The definition of the reference group is a key issue when identifying the parameters of the absolute and relative income on sleep behavior. We are going to conduct an extensive sensitivity analysis with respect to reference group definitions differing in comparison orbits and socio-demographic criteria. The reference group in the baseline model is defined as all people in the same region (former West or East Germany), of similar age (younger than 25, $25-34$, $35-44$, $45-65$, and 66 or older), with similar educational level (less than 12 years of education and 12 or more years of education), and of the same gender (male or female) in each year from 2008 to 2013. We now modify the baseline reference group definition by adding and subtracting some other characteristics that have been used when defining reference groups in the subjective well-being literature (e.g., McBride, 2001; Ferrer-i-Carbonell, 2005). In Table 2, Columns III-VI, we present the results when using four alternative reference groups (RG1–RG4). RG1 excludes education from the definition to test how an arbitrary criterion influences the result. This reference group definition allows us to estimate the reference income of each individual with higher precision as the number of reference groups is 120 (20 for each year), each with an average of 877 (std. 845) individuals-year observations. The results are presented in Column III. The definition produces similar yet a larger parameter estimate for relative income. We find statistically significant absolute and relative income effects on hours of sleep on weekdays and a statistically significant relative income effect on sleep satisfaction.

In RG2–RG4, we introduce alternative regional orbits. First, we narrow down the large regional classification used in the baseline (former West and East Germany) to the 16 federal states of Germany and use five age categories. This produces 480 (80 for each year) reference groups. The results are consistent with those for the baseline model, especially in the case of hours of sleep on weekdays. Next, we use the NUTS 2 regional classification, which includes 32 regional units in Germany, together with the five age categories. In this case, the number of reference groups is 960 (160 for each year). The results are highly comparable. The final reference group definition is based on even narrower regional units. Our dataset includes information on the "96 regional policy regions (ROR)" where the individuals reside. Using the spatial information on the local economic characteristics from 2008 to 2013, we match the actual local GDP per capita obtained by the official income registers as the relative income of each individual. The total number of reference groups is 576 (96 for each year). The results (Column VI) are highly consistent yet statistically imprecise. Our experiments suggest that socio-economic characteristics, e.g., age and gender, in the definition of reference groups are crucial to be able to determine a meaningful reference group. The number of robustness checks of reference groups is limited since they normally involve adding more criteria for the reference group, which results in a decreasing number of individuals in each reference group and affects the precision of the reference income estimates. We also tested (not reported here) some additional definitions of reference groups

(such as adding more criteria to the ROR-level information) and, by and large, the results remained the same. In each case, the relative income effect is negative for hours of sleep on weekdays and for sleep satisfaction, with varying levels of statistical significance.

In Table 2 Column VII, we present results aiming to check the sensitivity of results with respect comparison income point. We replace the average income of the reference group with the median income of reference group as it is robust especially when the size of a reference group is small. The results in Column VII and I are highly similar. The relative income effect on hours of sleep on weekdays and on sleep satisfaction is negative and statistically significant. Among the unreported results, we also calculated the median comparison income for reference groups RG1–RG3, and the results turned out to be highly comparable.

Alternative Income Measures. Our baseline income definition is the (post governmental) household income which is equivalized using standard OECD scale. The reason we prefer this income measure is that it better reflects an individual's overall income situation as it accounts for the effective level of income they have access to. We also calculated the modified OECD-equivalent household income (with the weights of 1 assigned to the household head, 0.5 assigned to each additional adult member, and 0.3 assigned to each child). The results are practically the same as those for the baseline model (Table 2, Column I). Therefore, the results are not reported here. To test the sensitivity of the results to the income definition, Column I of Table 3 presents the results when we use household income without equalization. Here, we calculate an individual's relative income using the mean household income in the baseline reference groups. The signs of the parameter estimates of absolute and relative income on hours of sleep and sleep satisfaction are the same as in the baseline case. The relative income effects on sleep satisfaction and on hours of sleep on weekdays are still statistically significant, but the magnitude of the effect is smaller (baseline -0.150 vs. -0.105). Next, we use the absolute and relative "labor income" of each individual. In our analysis, we use all individuals irrespective of employment status. The results based on labor income are given in Column II of Table 3. The results based on individual labor income are highly consistent with those for the baseline case. However, the magnitude of the effects of absolute and relative labor income on sleep behavior are lower. The relative income effect is highly statistically significant for hours of sleep on both weekdays and weekends.

Income Ranks. We also replaced the measure of relative income with the income position of individuals within the income distribution of reference groups. We first sort the household income of the members of the baseline reference group to calculate each individual's income "rank" within his or her reference group. We express the ranks between 0 and 1 by dividing the number of individuals within each reference groups. The rank measure is expected to be

Table 3: Robustness: Incomes, Ranks, Local Inequality, and Price Differences

	I	II	III	IV	V	VI	VII	VIII	IX	X
	Income Definitions		Ranks within Reference Group							
	Total HH Income	Individual Labour Income	Income Rank within (RG)	Rank and Rel. Income	Bottom 25% of Rank	Bottom 25% of Rank and Rel. Income	Inequality within RG (GINI)	Federal State Level Prices (CPI)	Daylight Effect (Month Dummies)	Controlling Sleep-Quality
Hours of sleep, weekdays										
Absolute Income	0.004	0.004	-0.018	-0.014	-0.012	-0.010	0.004	0.017	0.020	0.019
	(0.013)	(0.013)	(0.017)	(0.018)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)
Relative Income	-0.105 *	-0.022 ***		-0.102		-0.108 *	-0.130 **	-0.127 *	-0.148 **	-0.135 **
	(0.056)	(0.006)		(0.067)		(0.065)	(0.065)	(0.073)	(0.071)	(0.069)
Income Rank			0.080 **	0.068 *						
			(0.040)	(0.041)						
Bottom 25%					-0.045 ***	-0.043 ***				
					(0.015)	(0.015)				
Inequality							0.417 **	0.314		
							(0.196)	(0.218)		
Prices								0.577		
								(1.877)		
Hours of sleep, weekends										
Absolute Income	0.015	0.015	0.004	0.008	0.009	0.010	0.020	0.027	0.028 *	0.025
	(0.017)	(0.017)	(0.023)	(0.024)	(0.018)	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)
Relative Income	-0.082	-0.022 ***		-0.100		-0.103	-0.118	-0.059	-0.067	-0.052
	(0.067)	(0.007)		(0.083)		(0.081)	(0.081)	(0.092)	(0.089)	(0.085)
Income Rank			0.058	0.046						
			(0.051)	(0.053)						
Bottom 25%					-0.033 *	-0.031 *				
					(0.018)	(0.018)				
Inequality							0.152	0.160		
							(0.235)	(0.255)		
Prices								2,448		
								(2.227)		

Table 3. Continued

	I	II	III	IV	V	VI	VII	VIII	IX	X
	Income Definitions		Ranks within Reference Group							
	Total HH Income	Individual Labour Income	Income Rank within (RG)	Rank and Rel. Income	Bottom 25% of Rank	Bottom 25% of Rank and Rel. Income	Inequality within RG (GINI)	Federal State Level Prices (CPI)	Daylight Effect (Month Dummies)	Controlling Sleep-Quality
Sleep Satisfaction										
Absolute Income	-0.007	-0.007	-0.026	-0.016	-0.022	-0.019	-0.010	0.000	-0.010	
	(0.024)	(0.024)	(0.033)	(0.034)	(0.026)	(0.027)	(0.025)	(0.025)	(0.025)	
Relative Income	-0.160	-0.021 *		-0.271 **		-0.268 **	-0.278 **	-0.256 *	-0.282 **	
	(0.106)	(0.011)		(0.134)		(0.131)	(0.131)	(0.134)	(0.131)	
Income Rank			0.054	0.021						
			(0.077)	(0.079)						
Bottom 25%					-0.032	-0.027				
					(0.028)	(0.028)				
Inequality							-0.115	0.011		
							(0.376)	(0.385)		
Prices								-1,385		
								(3.369)		

Notes: Authors' own calculations from GSOEP waves 2008–2013.

The dependent variables are hours of sleep on weekends and weekdays, as well as sleep satisfaction based on the question: "How satisfied are you from your sleep in general?" (values range from 0 to 10).

The models control for the full set of control variables including time and state dummies (See Appendix A). Standard errors are in parentheses.

FE is the individual fixed-effects (excludes sex, age, and age-squared). RG represents reference groups.

*. **. *** indicate significance levels at 10%. 5% and 1%, respectively.

positively correlated with the sleep measures. Confirming our expectations, the rank measure of relative concerns produces positive and statistically significant parameter estimates on the hours of sleep on weekdays significant at the 5% level (Column III, Table 3). This result means that a higher income rank in the reference group implies a longer hours of sleep on weekdays. The income rank is positive on the sleep during weekends and on the sleep satisfaction, yet in contrast with the previously reported results, they are not statistically significant.

We now conduct alternative checks by combining relative income and income ranks in the same analysis. First, we allow for the relative income measure (mean income level in the reference group) to be in the same regression with the income rank of the individual. This regression investigates both the level and rank effect of people's income position on sleep behavior. The results suggest that the effect of relative income is still negative and the magnitude of the estimate is similar. Yet it is only marginally significant, while the effect of income rank is positive and statistically significant (Column IV, Table 3). Second, we identify the people who are in the bottom 25% of the income distribution in their reference group to form a dummy variable for the worst off. These people sleep less due to their low-income position (Column V, Table 3). We also add relative income level in the same regression. In this specification, both the parameter estimates of relative income and the indicator for the low-income position are negative and statistically significant at conventional levels (Column VI, Table 3).

Income Inequality within Reference Groups. Next, we investigate the inequality within the reference groups. To be able to tease out this potential confounding effect of income inequality on the relationship between relative income and sleep behavior, we calculate reference group-specific Gini coefficients for each year and add these coefficients as an additional control variable in our baseline fixed-effects model. We find that there is a distinct effect of relative income on quantity of sleep on weekdays. Moreover, allowing for income inequality leads to a larger relative income effect on hours of sleep and on sleep satisfaction (Column VII, Table 3). Basically, the parameter estimates of relative income on sleep behavior are robust with respect to inequality within the reference groups. We also note that, conditional on relative income and other characteristics, there is an additional "income inequality effect" on sleep behavior. The inequality within the reference group is positively related to sleep, which is statistically significant only for sleep on weekdays.[11]

[11] The positive relationship between income inequality and sleep behavior is partially inline with the results reported in the subjective well-being literature. While several studies report a negative relationship between income inequality and utility, i.e., inequality aversion (Alesina et al., 2004), there is a significant number of studies reporting results either insignificant or positive inequality effect on utilities (see Senik, 2005, and Graham and Felton, 2005, for comprehensive reviews). Borrowing from this literature, the interpretation that we favor for the positive effect of the income inequality found in our analysis follows the "tunnel effect" of Hirschman and Rothschild (1973). Conditional on absolute and relative income position, the income inequality

Local Price Differences. One other potential confounding factor on our results is that the relative income effect might be biased if people face large regional price differences. Our identification strategy assumes that the prices that individuals face are the same when they compare their income with that of the reference group. To tease out the confounding effect of local price differences, we control the baseline model for the 16 federal state-level (*Länder*) consumer price index (CPI) observed between 2008 and 2013.[12] Local CPI is calculated using 2010 prices as the reference year. We control our baseline fixed-effects for the time-varying CPI conditional on the full set of variables, income inequality, and federal state-level dummies. The results remain highly stable. The relative income effect is only slightly reduced, yet it is still statistically significant at the 5% level (Column VIII, Table 3).

Further Checks. The reporting of sleep might be affected by when and under what conditions the information is collected. For example, there is seasonal variation in light levels, which might influence people's quantity of sleep (Friborg et al., 2012). The interviews utilized for the present study are conducted throughout the year (except November and December). To capture these variations, we control for the month of interview dummies. The results reported in Table 3, Column IX suggest basically no difference from the baseline model. Among the unreported results, an additional check was conducted by adding the day of the week on which the sleep duration and sleep satisfaction were reported. The baseline results remain unaffected. As a final check, we investigated whether sleep satisfaction, i.e., sleep quality, is one of the important omitted variables affecting sleep duration while correlating with absolute and relative income. To test this, we controlled for sleep satisfaction in the regressions for hours of sleep on weekdays and weekends using ten dummy variables for each ordinal category. The absolute and relative income effects stayed the same (Column X, Table 3).

4.3 Observed Heterogeneity

The baseline results suggest that, on average, there is a robust negative effect of relative income on sleep behavior. The effect of absolute income on sleep behavior is not strong. It is possible that the relationship between absolute and relative income on sleep behavior might differ for different subgroups. We therefore investigate the heterogeneity absolute and relative income effects for some interesting subgroups. To do so, we first define a dummy D, which indicates a binary group, e.g., gender. We then interact D with absolute and relative income to calculate the absolute and relative income effects for $D = 1$ and $D = 0$. Table 4 presents the heterogeneous absolute and relative income effects on hours of sleep on weekdays and weekends and on

serves as a signal for the higher opportunities (see, e.g., Clark, 2003).

[12]The dataset is obtained from the webpage, https://www.destatis.de/DE/Startseite.html. Data are not available for Hamburg and Schleswig-Holstein.

Table 4: Observed Heterogeneity

		Absolute Income			Relative Income		
		Hours of Sleep		Sleep	Hours of Sleep		Sleep
Relative Income Interacted with...		Weekdays	Weekends	Satisfaction	Weekdays	Weekends	Satisfaction
Age	Young (younger than 50)	0.006	0.022	-0.020	-0.197 ***	-0.229 **	-0.159
		(0.015)	(0.021)	(0.029)	(0.076)	(0.095)	(0.148)
	Old (50 and older)	-0.000	0.016	0.013	0.005	-0.025	-0.414 **
		(0.019)	(0.023)	(0.040)	(0.079)	(0.095)	(0.162)
	p-value	0.3239	0.6503	0.7710	0.0019	0.0254	0.0697
Gender	Male	0.026 *	0.053 ***	-0.035	-0.204 ***	-0.260 ***	-0.400 **
		(0.015)	(0.019)	(0.031)	(0.079)	(0.097)	(0.160)
	Female	-0.027	-0.027	0.023	-0.005	0.106	-0.094
		(0.021)	(0.027)	(0.039)	(0.087)	(0.111)	(0.175)
	p-value	0.0652	0.0088	0.3485	0.0457	0.0086	0.1955
Marital Status	Married	0.042 **	0.068 ***	-0.003	-0.195 ***	-0.155 *	-0.442 ***
		(0.019)	(0.022)	(0.042)	(0.073)	(0.090)	(0.150)
	Not Married	-0.013	0.000	-0.014	-0.052	-0.082	-0.089
		(0.015)	(0.021)	(0.028)	(0.077)	(0.098)	(0.153)
	p-value	0.0252	0.0565	0.7463	0.0882	0.7648	0.0831
Dependent Kid at Home	Kids (Aged 0-1)	-0.119 **	-0.115 *	-0.187 *	-0.181	0.028	-0.556 **
		(0.056)	(0.063)	(0.112)	(0.142)	(0.168)	(0.275)
	No Kids (Aged 0-1)	0.008	0.028	-0.002	-0.124 *	-0.124	-0.272 **
		(0.013)	(0.017)	(0.025)	(0.065)	(0.081)	(0.131)
	p-value	0.0650	0.0108	0.1349	0.4300	0.2525	0.1520
Years of Education	High (Education < 11 years)	0.042 ***	0.073 ***	0.065 *	-0.030	0.003	-0.158
		(0.015)	(0.020)	(0.037)	(0.081)	(0.101)	(0.167)
	Low	-0.005	0.042	0.004	-0.177 **	-0.151	-0.229
		(0.020)	(0.028)	(0.033)	(0.083)	(0.104)	(0.164)
	p-value	0.1277	0.6146	0.3843	0.0714	0.2299	0.4683

Notes: Authors' own calculations from GSOEP waves 2008–2013.

The dependent variables are the hours of sleep on weekends and weekdays as well as sleep satisfaction based on the question: "How satisfied are you from your sleep in general?" (values range from 0 to 10).

The models control for full set of control variables including time and state dummies (See Appendix A). The relative income effect is obtained using the baseline reference groups. Standard errors are in parenthesis.

*. **. *** indicate significance levels at 10%. 5% and 1%, respectively.

sleep satisfaction.

The effect of absolute income on sleep behavior does not differ between younger and older people ($D = 1$ if $age < 50$). The effect of relative income on quantity of sleep on weekdays and weekends is larger among younger people, and the effect of relative income on sleep satisfaction is larger among older people. The differences are statistically significant. One potential explanation of the stronger relative income effect on the hours of sleep for younger people is that they might react to their income position by chancing their working and time use hours more than older people. The finding that relative income effect interferes with older people's quality of sleep is also highly in line with the finding of Akay and Martinson (2012) that relative income has a particularly strong effect on the utility of older people. We next investigate gender differences ($D = 1$ if female). The effects of absolute and relative income are more prominent among males for both quantity and quality of sleep (Layard et al., 2008). Turning to the influence of marital status, we find that the absolute and relative income effects on hours of sleep and sleep satisfaction are larger for married individuals. One important factor that might interfere with people's sleep is whether they have dependent kids. Our baseline regression results (Appendix A) suggest that number of kids aged $0-1$ and $2-4$ at home negatively relates to hours of sleep and sleep quality. We now define the binary dummy as years ($D = 1$ if there is at least one dependent kid at home). One interesting result is that people with a dependent kid experience a negative effect of both absolute and relative income, but the differences are significant only for the case of absolute income and hours of sleep on weekdays and weekends. Lastly, we identify individuals with 12 or more years of education ($D = 1$ if 12 or more years of education), which corresponds to university level education. People in this group sleep longer and experience higher sleep satisfaction as their absolute income increases. Individuals with less than 12 years of education display a stronger effect of relative income on sleep behavior, yet the only difference that is statistically significant is in hours of sleep on weekdays.

5 Discussion

Our analysis suggests a robust negative relationship between relative income and sleep satisfaction and hours of sleep on weekdays, respectively. Moreover, there is a positive relationship between absolute income and hours of sleep in most specifications, yet it is never statistically significant. In this section, we turn our attention to possible mechanisms behind these results. We mainly focus on the allocation of time between work, time use, and sleep given the constraints people face. We investigate how the choices made regarding the allocation of time to work and leisure mediate the relationships between relative income and sleep. We then focus on the constraints in terms of physical and mental health/stress people face when allocating their time. That is, we focus on three mutually interrelated mechanisms: 1) working hours, 2)

time use, and 3) physical and mental health/stress. To investigate these channels, we will use interaction models where we also split the data into some smaller groups to investigate alternative hypotheses. To obtain precise reference income estimates, we use the reference group that excludes the education criterion; see RG1 in Table 2, Column III (same region, similar age, and same gender). Since we have established that the absolute income effect on sleep behavior is weak, we focus only on the relative income effect in the remainder of the paper.

5.1 Working Hours

Most individuals allocate a significant share of their time resources to paid work. People who work longer hours are expected to sleep less on weekdays and/or sacrifice leisure time, e.g., spend less time eating out, playing sports, or doing hobbies. They might also sleep more than other people on weekends, for example because they need to catch up on their sleep. Two important issues emerge. First, our baseline regressions and robustness checks suggest that the relative income effect on sleep behavior is not affected by controlling for average daily working hours. Second, the baseline regression results suggest that working hours are negatively (positively) related to hours of sleep on weekdays (weekends) as reported in Appendix A, which is in line with expectations.

We investigate how differences in time allocated to paid work affect the relationship between relative income and sleep behavior by separating people into quartiles of working hours. Then we interact these quartile dummies with relative and absolute income. Figure 2.A reports the parameter estimates and confidence intervals of relative income effects. As expected, quantity of sleep on weekdays is less affected by relative income among hard-working people, i.e., those in the third and fourth quartiles, than among those who work less. We interpret this result as follows: People with longer working hours earn more and catch up with or exceed the income level of their reference group.[13] The differences in relation to the values for the first and second quartiles are large and highly statistically significant. There is no strong influence of working hours on the relationship between relative income and hours of sleep on weekends. The results in terms of the sleep satisfaction of those who work the most hours, i.e., the fourth quartile, suggest a negative but statistically insignificant effect of relative income on sleep quality implying that the relative income disturbs the sleep quality of people who are working lesser hours.

[13] In another model specification, we investigate how relative income is related to working hours using a linear fixed-effects model. In this model specification, the working hours is the dependent variable and the model includes the full set of control variables as well as absolute income, relative income (see Appendix A), and also allows for the unobserved individuals effects. The relative income (based on the baseline reference group specification) enters into regression positive and highly statistically significant implying that a higher relative income is associated with longer working hours. This result is consistent with previous studies (see, e.g., Neumark and Postlewaite, 1998). Full estimation results can be provided upon request.

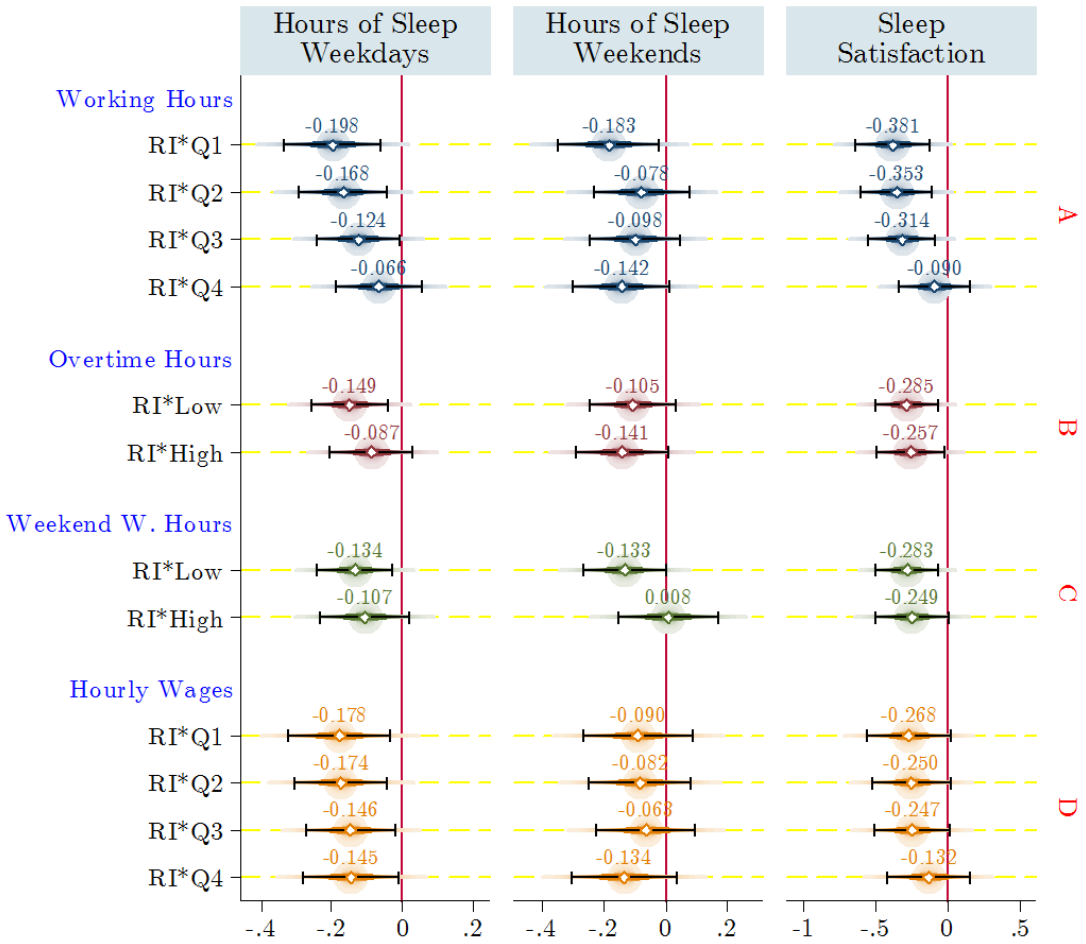
To investigate how working hours mediate sleep behavior, we investigate the group of people with alternative preferences for working hours. We now focus on reported overtime and weekend working hours. We generate a dummy indicating those working more than and equal to 3th quartile of the distribution of overtime hours and present the results from the interaction model in Figure 2.B. Similar to people who work long hours, those who work long overtime hours display a smaller relative income effect on quantity of sleep on weekdays. Yet the difference is not statistically different. Next, we investigate the effect of working hours on weekends (sum of working hours on Saturdays and Sundays). Figure 2.C shows the relative income effects on sleep behavior among those working a lot (more and equal to 3th quartile) and less (less than 3th quartile). The results are strikingly consistent with the previous findings. People who work long hours on weekends do not exhibit a significant negative effect of relative income on their hours of sleep on weekdays or weekends. Yet the people who are working long hours during weekend experience a larger relative income effect with a statistically significant difference.

Opportunity Cost of Sleep. A higher number of working hours, long overtime work, and long working hours during weekend are related to a smaller reduction in sleep duration and sleep satisfaction. However, the relationship between relative income and sleep might not only be mediated by the quantity of working hours but also by productivity, which we measure by hourly wages. When a person's productivity is higher, the opportunity cost of sleeping an extra hour is higher, which might motivate people to sacrifice sleep in order to work more. That is, the negative relative income effect on sleep behavior might be explained by the high opportunity cost of sleep. To test this, we estimate our interaction models using quartiles of hourly wages. To calculate the hourly wages, we divide yearly net individual labor earnings by annual working hours. We exclude individuals with zero working hours and end up with a remaining sample size of $60,073$ individual-year observations, and then generate four quartiles of the hourly-wage distribution to obtain the interactions of relative income with wages on sleep behavior. The results are presented at the bottom of Figure 2.D. As can be seen, the relationship between hourly income and sleep behavior varies hardly at all across the productivity quartiles.

5.1.1 Time Use

The results so far suggest that hard-working people experience less interference with their sleep due to their relative income – irrespective of productivity. That is, the reduction in sleep duration related to relative income among people who work less, implying that they have more time to sleep, should be explained by other activities. We now turn our attention to how time use during leisure mediates the relationship between relative income and sleep behavior. Two important points should be noted: First, the activities carried out during a person's leisure time might be highly heterogeneous, making it impossible to capture the full range of

Figure 2: Working Hours and Productivity



Notes: The models are estimated using the fixed effects specification with the full set of controls (see Appendix A) including personality characteristics, region, and time dummies. The horizontal axes show the magnitude of the parameter estimate on hours of sleep on weekdays and weekends, as well as sleep satisfaction, respectively. On the vertical axis, RI is the relative income defined using the baseline reference group. Figures above the confidence intervals (95%) indicate the magnitude of the parameter estimates. The vertical lines go through zero.

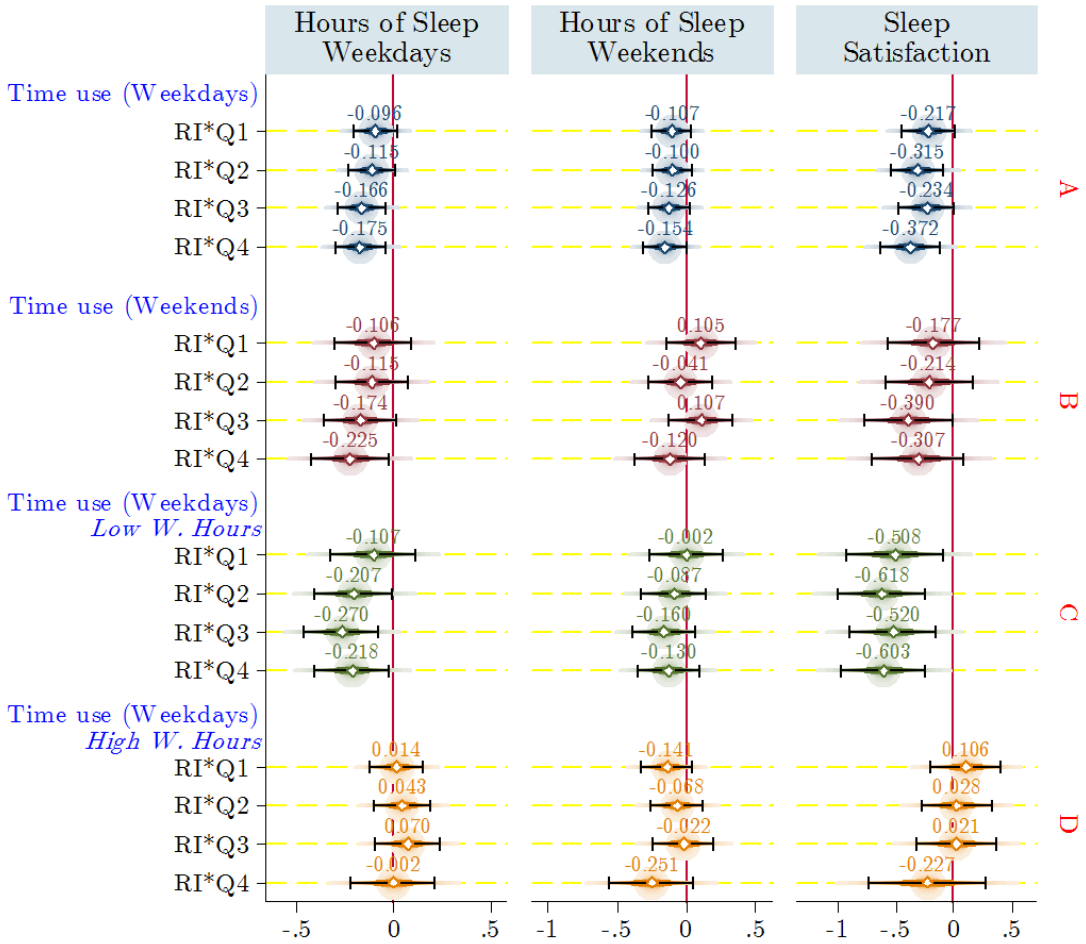
activities. Second, there might be measurement errors in the reporting of the exact number of hours spent on each activity. Yet, our dataset is rich as it contains information on hours spent on a wide range of activities. We focus mainly on the time use activities relating to household production. The information is obtained using the following question: "*What is a typical day like for you? How many hours do you spend on the following activities on a typical weekday, Saturday, and Sunday?*" The activities listed were 1) *job*, *apprenticeship*, *and second job*, 2) *errand*s, 3) *housework*, 4) *childcare*, 5) *care and support of persons in need of special care*, 6) *education or further (vocational) training*, 7) *home-related repairs*, *car repairs*, *and gardening*, *and* 8) *hobbies and leisure activities*.[14]

The hours are reported in separate measures for weekdays, Saturdays, and Sundays. We start by calculating each individual's total time use on a typical weekday and weekend by adding the reported hours spent on each activity. We exclude the activities relating to jobs and apprenticeships as they are already included in our measure of working hours. We sum the hours reported for the activities numbered from 2 to 8. To deal with measurement errors, we eliminated inconsistent answers to generate one solid measure for the degree of time use for each individual. Figure 3.A shows the interaction of relative income with the four quartiles of the time-use distribution on weekdays. The relative income effect on quantity of sleep on weekdays seems to be higher among people who spend more time on time-use activities. Yet the differences are not statistically significant across the time-use quartiles. Number of hours spent on time-use activities on weekdays (Figure 3.A) does not relate to sleep satisfaction and hours of sleep on weekends. We also use our interaction model to investigate relative income effect by time use on a typical weekend. The data contain detailed information for Saturdays and Sundays. We add the number of hours spent on each time-use activity on Saturday and Sunday to obtain an average hours of time-use measure for a weekend day. The results remain largely uncharged and are presented in Figure 3.B. The relative income effect is also partially mediated by hours spent on time-use activities on weekends, especially when it comes to the effect on hours of sleep on weekdays.

We will now conduct the analysis by looking at high vs. low working hours to explore how the interaction between working hours and time use mediate the relationship between relative income and sleep. The strategy is as follows: We split the data by low and high working hours using the median and use interactions with time-use quartiles. Figure 3.C and 3.D shows the

[14]There are several other activities relating to leisure and the time use reported in the data. Yet they are observed only in selected years. These activities are more heterogeneous with measurement error and are complicated to classify into categories. They include going out to eat or drink, playing cards and board games, participating in local politics, attending church or other religious events, watching television, reading fiction and nonfiction, engaging in artistic and musical activities, participating in sports, and going to the movies or concerts.

Figure 3: Time Use by Working Hours



Notes: The models are estimated using the fixed effects specification with the full set of controls (see Appendix A) including personality characteristics, region, and time dummies. The horizontal axes show the magnitude of the parameter estimate on hours of sleep on weekdays and weekends, as well as sleep satisfaction, respectively. On the vertical axis, RI is the relative income defined using the baseline reference group. Figures above the confidence intervals (95%) indicate the magnitude of the parameter estimates. The vertical lines go through zero.

results for high and low working hours interacted with the quartiles of time use on a typical weekday. Striking patterns emerge: First, the effect of relative income on sleep prevails mainly among people who work fewer hours (less than median) and spend many time-use hours on household production. Second, individuals who work long hours are unaffected by relative income, irrespective of the magnitude of their time use.

5.2 Physical and Mental Health

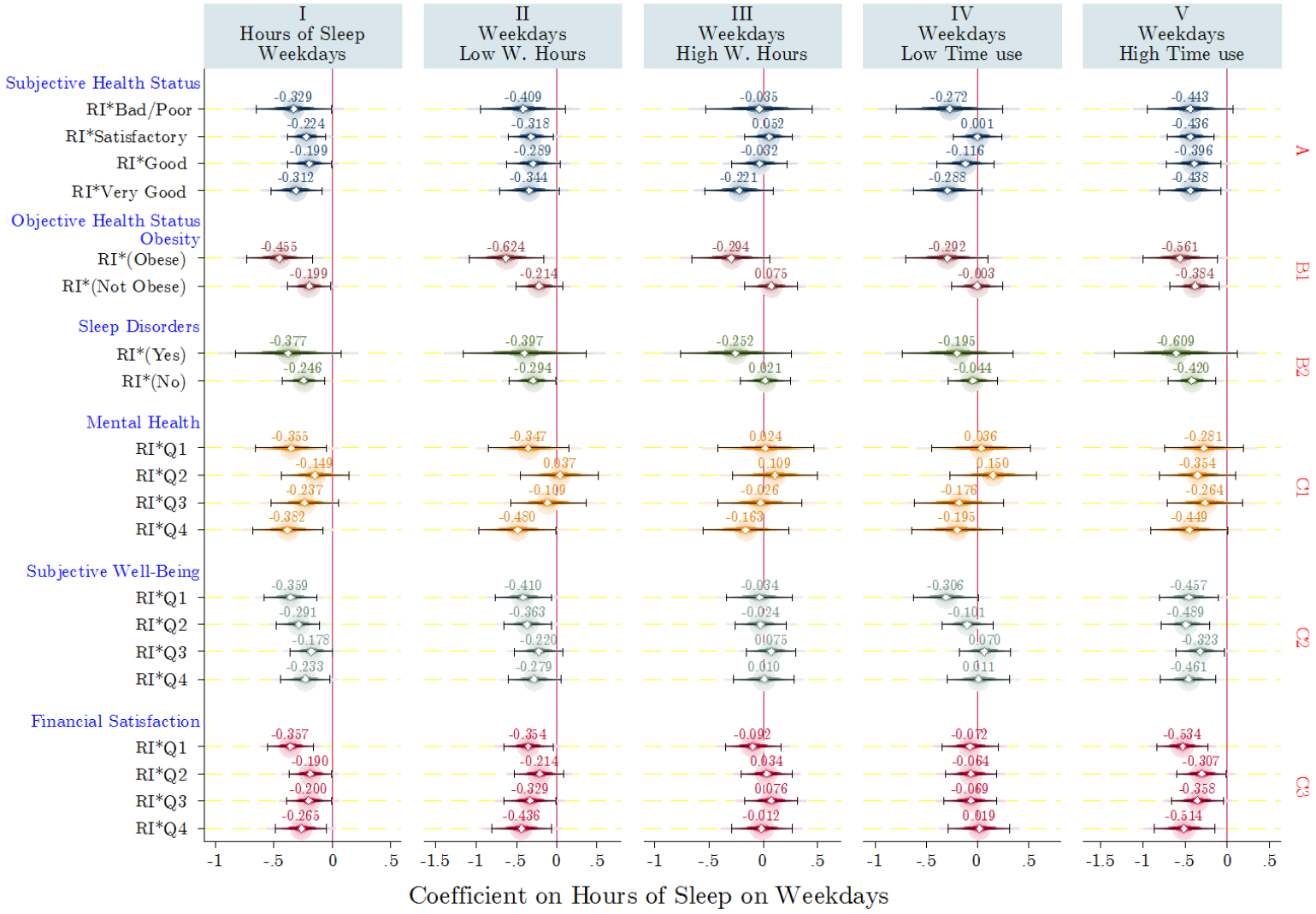
Physical Health. The negative relationship between relative income and sleep behavior is not fully explained by people's time allocation between work and household activities. The effect prevails mainly among people with fewer working hours and high time use for household production. To explore the relative income effect further, we are going to investigate the individual physical and mental health constraints and stress. Our focus is mainly on the physical and mental health/stress among people who work a lot and those who work less and people who spend little and a lot of time on non-work activities. To investigate how health status mediates the relative income effect on sleep behavior, we use subjective and objective measures of health. The first is the subjective health-status measure, which is obtained with the question "*How would you describe your current health?*" on a five-point scale that runs from "*very good*" to "*bad*." We reverse the scale and merge the health categories "*bad*" and "*poor*" into one due to low sample size in these categories (2,072 and 9,093 individual-year observations reported bad and poor health, respectively). The interactions of relative income with the four levels of subjective health status are given in Figure 4.A and 5.A.[15] In the case of hours of sleep on weekdays and on sleep satisfaction, the negative effect of relative income is lower among people who report better health than among those who report bad/poor health (Figure 4.A and 5.A).[16] One important observation is that the relationship is concave implying that hours of sleep and sleep satisfaction of people who report very good health are also significantly affected by their relative income. One potential explanations for the concave relationship is that individuals with excellent physical health might have higher capacity and ambitions about their relative income position, e.g., they work harder and stress more, resulting to a higher relative income effect on their hours of sleep and sleep satisfaction.[17]

[15] The results for the hours of sleep on weekends are given in Appendix B.

[16] It may also be the case that people with excellent and bad/poor health have different reference groups compared with the others. As an additional analysis, we introduce subjective health status into the reference group definition. The results are very similar.

[17] The dataset includes several other measures of health. We also investigated the relationship between relative income and sleep by: 1) health satisfaction, and 2) SF-12 composite physical health-status indicators; 3) number of doctor visits. The results remain largely unchanged. People with better health display a smaller effect of relative income on the duration and quality of sleep. Also, the pattern is concave and differences are only partially statistically significant across the quartiles of the health status distributions, as in the case of subjective health status.

Figure 4: Physical and Mental Health: Hours of Sleep on Weekdays



Notes: The models are estimated using the fixed effects specification with the full set of controls (see Appendix A) including personality characteristics, region, and time dummies. The horizontal axes show the magnitude of the parameter estimate on hours of sleep on weekdays On the vertical axis, RI is the relative income defined using the baseline reference group. Figures above the confidence intervals (95%) indicate the magnitude of the parameter estimates. The vertical lines go through zero.

We use a series of health status proxies that are more objective in nature and relate directly to sleep. The first one is obesity, which is very often used as an objective indicator of health status and is associated with sleep problems (e.g., Haster et al., 2004).[18] To identify obesity, we use body mass index (BMI), which is considered to be a sufficient measure of health status. Our sample contains weight and height information only for $38,666$ individual-year observations. Using $BMI = 30$ to identify the upper limit for healthy people, Figures 4.B (for hours of sleep on weekdays) and 5.B1 (for sleep satisfaction) show that obese people are affected more by their relative income when it comes to number of hours of sleep on weekdays and sleep satisfaction, respectively.[19]

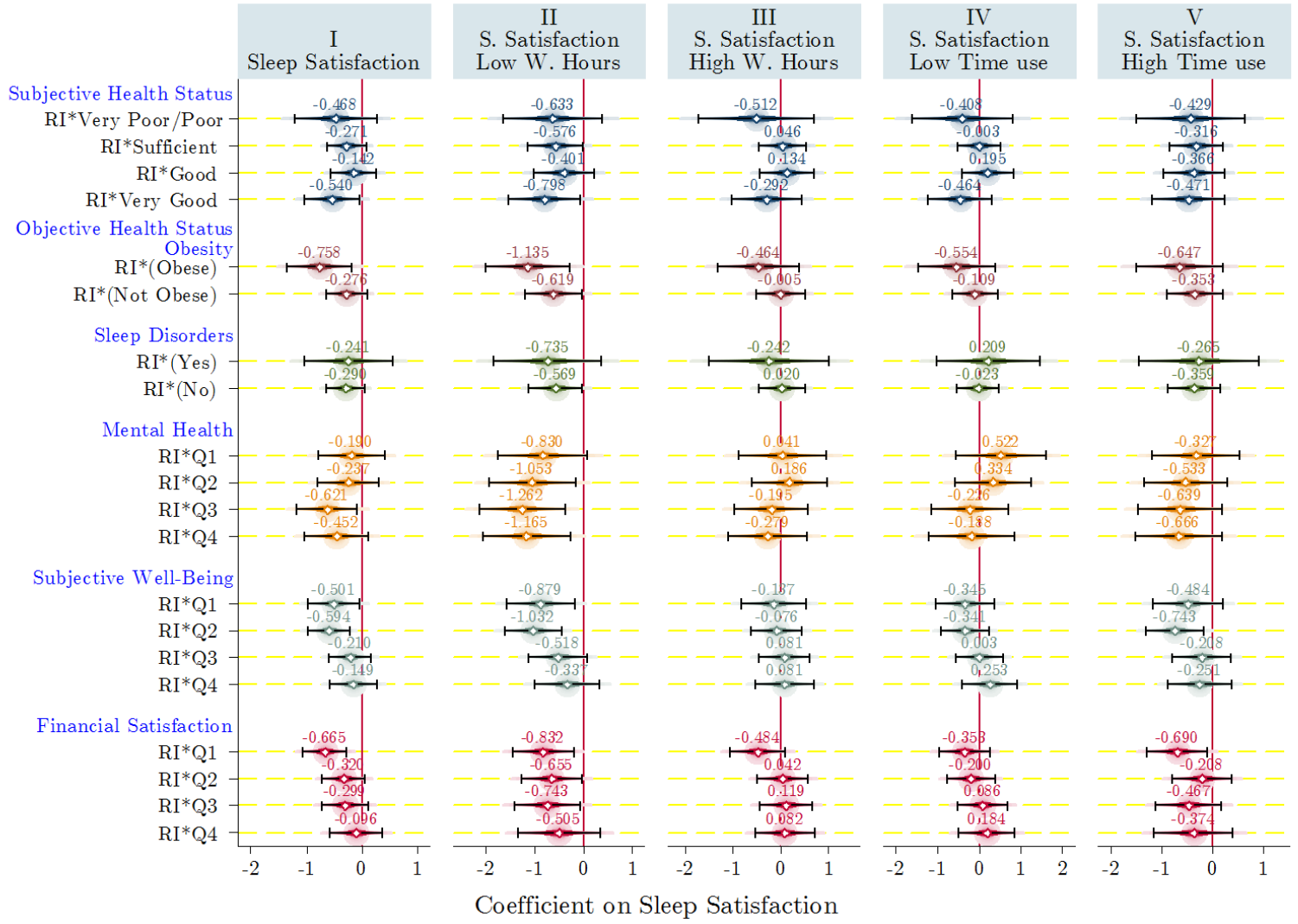
Second, we investigate the effect of having sleep disorders (e.g., Vgontzaz et al., 2008). Presence of sleep disorders might lead to overestimations of the relative income effect on sleep behavior. To tease out the effect of these disorders we use the following question: "*Has a doctor ever diagnosed you with one or more of the following illnesses? Sleep disorders...*," generating a binary response (= 1 if diagnosed). The sleep disorders data is reported for only two waves (2011 and 2013) reducing the sample size to $25,983$ ($2,091$ individual-year observations are identified as having sleep disorders). Nevertheless, conditional on subjective health status, BMI, and the full set of control variables, our fixed-effects interaction model still generates a highly consistent result (Figures 4.B2 and 5.B2). Indeed, people with sleep disorders experience a stronger relative income effect. Yet the differences are not statistically significant.

We now turn our attention to working hours and time-use activities to deeply investigate how physical health mediates the relative income effect on sleep. In Columns II–V of Figures 4 and 5, we present results by low and high working hours and low and high time use split by median working hours (daily average of all hours worked) and (daily average of) time-use activities. Our analysis reveals that the relationship between relative income and sleep is mediated by health mainly in the high work and low time-use groups and partially in the high time-use group. There seems to be no explanatory power of physical health on hours of sleep on weekdays and sleep satisfaction among people with a below-median number of working hours. Yet, we also note that the objective health measures, i.e., obesity and sleep disorders, show a similar pattern compared to the overall sample (Column I of Figure 4 and 5). Overall, physical health only partially explains the relative income effect on sleep behavior, especially among people who work less than median (Figure 4.A and 5.A., Columns II–V).

[18] Among the unreported results, we also find that BMI is negatively and significantly related with both the duration and quality of sleep.

[19] We also look at high blood pressure, which has been linked to several health-related behaviors, such as food intake, drinking, and stress. We find that individuals with high blood pressure are more affected by relative income when it comes to number of hours of sleep on weekdays, but the difference is not statistically significant.

Figure 5: Physical and Mental health: Sleep Satisfaction



Notes: The models are estimated using the fixed effects specification with the full set of controls (see Appendix A) including personality characteristics, region, and time dummies. The horizontal axes show the magnitude of the parameter estimate on sleep satisfaction. On the vertical axis, RI is the relative income defined using the baseline reference group. Figures above the confidence intervals (95%) indicate the magnitude of the parameter estimates. The vertical lines go through zero.

Mental Health and Stress. The effect of relative income may also vary with factors such as mental health, happiness, and stress. To investigate how mental health mediates the relationship between relative income and sleep, we use a mental health measure based on the SF12 questionnaire (Composite Mental Health Scale).[20] The measure is available only for the 2008, 2010, and 2012 waves. Restricting the sample to only these waves reduces the sample size to 38,153 individual-year observations. We identify four quartiles of the mental health distribution and interact these quartiles with each individual's relative income. The results reported in Figure 4.C1 and 5.C1 suggest that the effects of mental health are in line with our findings for physical health, especially with regard to hours of sleep on weekdays (Figure 4.C1). That is, people with better mental health experience less relative income effect on their hours of sleep. We also note that this pattern is observed in all four groups depicted in Figure 4. An important observation is that there is a tendency of a concave relationship between relative income and sleep by the quartiles of mental health scale – as with the physically very healthy individuals. We also note that mental health does not play an important role on the relationship between relative income and sleep satisfaction (Figure 5.C1).

Our second measure is overall life satisfaction, which is a very frequently used proxy for the well-being of individuals.[21] The measure is based on the life-satisfaction question "*How satisfied are you with your life, all things considered?*", and the answers are obtained on an 11-point scale ranging from 0 ("*completely dissatisfied*") to 10 ("*completely satisfied*"). It is highly correlated with mental health (the correlation is 0.4 with our mental health measure based on SF12), stress levels, and more objective measures of health such as blood pressure and cortisol levels (Krueger and Schkade, 2008; Oswald and Wu, 2010). In order to investigate the influence of well-being or stress on the relationship between relative income and sleep, we construct four quartiles of the life-satisfaction distribution and study whether the effect of relative income differs across the quartiles. The results are presented in Figures 4.C2 and 5.C2 and reveal important patterns: higher well-being is correlated with a weaker effect of relative concerns on both on hours of sleep on weekdays and sleep satisfaction. Strikingly, the subjective well-being explains the negative effect of relative income on hours of sleep and sleep satisfaction also among the people who work lower hours (Figure 4.C2 and 5.C2, Column II).

[20] The SF-12 is a short form survey with 12 questions selected from the SF-36 long form health survey. The general scale includes two components for physical and mental functioning. The measures are based on indices that combine the information of each question. The scale ranges from 0 to 100, where the highest score indicates better mental health. The mean mental health in our sample is 49.8 (std. 9.8) with a minimum and maximum of 0.6 and 79.4, respectively.

[21] There is also a developing literature using subjective well-being as a proxy for utility to identify the direct utility effects of relative concerns (Ferrer-i-Carbonell, 2005; Akay et al., 2017). The literature suggests that substantial utility is lost due to income comparisons especially in developed countries. See Clark at al. (2008) for a comprehensive review of the literature.

Our final result is obtained by investigating the influence of financial well-being on the relationship between relative income and sleep. It has been shown that financial difficulties may induce higher stress levels, which in turn may affect a person's sleep negatively (e.g., Lallukka at al., 2012). Our measure of financial satisfaction is obtained with the question "*How satisfied are you at present with the following areas of your life? How satisfied are you with...Personal income*" and the answers are obtained on a scale from 0 ("*completely dissatisfied*"), and 10 ("*completely satisfied*") as in the case of overall life satisfaction. Our regressions control for the actual financial situation of the individual (absolute labor income and household income), which allows us to isolate the well-being/stress dimension of the measure as a mediator of the relationship between relative income and sleep (Figures 4.C3 and 5.C3). The results are highly in line with those for overall well-being. The relationship between relative income and sleep is lower and tends to be statistically insignificant among those who report higher financial satisfaction, i.e., lesser financial stress. The pattern particularly holds for the groups with low working hours and high time use. It appears that higher overall stress levels and greater financial constraints largely explain the relative income effect on hours of sleep on weekdays and sleep satisfaction.

6 Cost of Sleep Lost due to Relative Income

We calculate the monetary value of the sleep lost due to relative income. To do this, we rely on the subjective well-being (life satisfaction or happiness) valuation approach.[22] The approach is based on the idea that subjective well-being is a valid proxy for overall (experienced) utility (e.g., Kahneman and Sugden, 2005). We estimate subjective well-being equations, which is conditioned on the full set of individual socio-demographic characteristics, sleep satisfaction, daily working hours and time use, and also unobserved individual effects. Using the estimated subjective well-being equation, we calculate the marginal rate of substitution between hours of sleep and income. That is, we calculate the amount of income that should be added to the per capita income of individuals corresponding to a minute of less sleep to keep the subjective well-being level constant. To calculate the price or cost of sleep lost due to relative income, we then use the parameter estimates of our baseline fixed-effects model specification (equation (1) for hours of sleep on weekdays and weekends. We then calculate the daily or yearly value of sleep loss due to relative income using the predicted value of sleep per minute.

[22] This approach has recently been applied to value several intangible goods including airport noises (van Praag and Baarsma, 2005), air pollution and climate (Rehdanz and Maddison, 2005; Welch, 2006; Luechinger, 2009), cost of terror in a country (Fray et al., 2007; Frey et al., 2009), and health (Powdthavee and Van Den Berg, 2011), among many others.

To calculate the price we estimate the following well-being equation

$$SWB^{*}_{it} = \varphi \ln(Y_{it}) + \psi_{wd} \ln(Sh^{wd}_{it}) + \psi_{we} \ln(Sh^{we}_{it}) + \psi_{ss} \ln(S^{ss}_{it}) + \mathbf{X}'\beta + \epsilon_{it}, \quad (3)$$

$$\epsilon_{it} = s_k + \tau_t + \alpha_i + \varepsilon_{it}. \quad (4)$$

In equation (3), the latent dependent variable SWB^{*}_{it} is the subjective well-being measured on the 11-point ordinal scale. Y_{it} the level of income measured using per capita household income. Sh^{wd}_{it} is number of hours of sleep on weekdays, wd, Sh^{we}_{it} is number of hours of sleep on weekends, we, and S^{ss}_{it} is sleep satisfaction controlled for using ten dummies for each ordinal category. We use the logs for both per capita income and hours of sleep to allow some flexibility in the well-being equation. The key parameters to be estimated are φ, ψ_{wd}, and ψ_{we}. We control for the same set of individual characteristics, $\mathbf{X}$, as in our baseline model specifications (see Appendix A), including relative income (based on the baseline reference group definition), daily working hours, daily time use (other than job and training), and the Big-5 personality measures, and β is a vector of parameters to be estimated. The composite error term ϵ_{it} it equation (4) is highly similar to the baseline model. s_k is the regional dummies defined using the 16 federal states of Germany to capture regional unobserved differences, and τ_t is the time dummies. α_i is the unobserved individual effects that are assumed to be correlated with sleep behavior. In well-being equations, these characteristics may include personality traits (which we already control for) and genetic predisposition, among others. The models are estimated with linear fixed-effects models (see Footnote 7).

Having estimated the model parameters of the subjective well-being equation in (3) and (4), we can calculate the marginal rate of substitution (MRS) between hours of sleep and per capita income

$$MRS_{wd,y}(Sh^{wd}, Y) = -\frac{\frac{\partial SWB}{\partial Sh^{wd}}}{\frac{\partial SWB}{\partial Y}} = -\frac{\psi_{wd}}{\varphi}\frac{Y}{Sh^{wd}}, \quad (5)$$

$$MRS_{we,y}(Sh^{we}, Y) = -\frac{\frac{\partial SWB}{\partial Sh^{we}}}{\frac{\partial SWB}{\partial Y}} = -\frac{\psi_{we}}{\varphi}\frac{Y}{Sh^{we}}. \quad (6)$$

Equations (5) and (6) can be evaluated at any combination of per capita income and hours of sleep on weekdays and weekends. To calculate the standard errors, we use the delta method. Table 5 summarizes our cost calculations and also reports the figures required for the price/cost calculations.

First, we estimate the well-being equation.[23] To be able to calculate the MRS we need the parameter estimates of hours of sleep and income measures on SWB, and average values of hours of sleep and income. Average hours of sleep on weekdays and weekends for the whole sample is

[23] The estimation results of SWB regressions are highly in line with the literature (please see Dolan et al., 2008). They are available upon request.

6.940 and 7.998, respectively, and average per capita (equalized) yearly income is 21,411 euro (Table 5, Columns I, II, and III). We report the parameter estimates of the log hours of sleep on weekends and weekdays, and per capita income on SWB in Columns IV, V, and VI of Table 5. Sleep measures and per capita income are positive and highly statistically significant on SWB, conditional on the observed and unobserved characteristics including personality and sleep satisfaction. We then plug these values into equations (5) and (6) and use the delta method to calculate the standard errors of price estimates (Column VII and VIII). The *value/price of one minute of sleep* for the whole sample is 0.017 euro (1.02 euro per hour) for both weekdays and weekends, and these figures are highly statistically significant. We investigate the heterogeneity of price among several groups. The price varies across all groups included in the table, with the highest values recorded for people with few working hours and those with few hours spent on time-use.

Cost of Sleep Lost Due to Relative Concerns. To calculate the cost of lost sleep, we use the parameter estimates of our baseline fixed-effects estimates (Table 2). A one percent increase in relative income implies 9.16 minutes (Table 5, Column IX) less sleep on an average weekday ($60 \times 0.150 = 9.16$) and 4.09 minutes (Table 5, Column X) less sleep on an average weekend day ($60 \times 0.068 = 4.09$). Using the price of sleep per minute, we can simply calculate the price of the sleep lost due to relative income for an average weekday or weekend day as $0.017 \times 9.16 = 0.155$ euro/weekday and $0.017 \times 4.09 = 0.071$ euro/weekend day (Columns XI and XII). A similar calculation suggests that the price of sleep lost due to relative concerns is larger in the low working hours (0.222 euro/weekday and 0.095 euro/weekend day) and high time use (0.303 euro/weekday and 0.188 euro/weekend day) groups.

Next, we use the working-age population, i.e., $15-65$ years old individuals, to extrapolate the yearly overall cost of sleep lost due to relative income in Germany. OECD statistics for 2013 suggest that there are about 53,844,000 (65.56% of 82.13 million) working-age individuals in Germany.[24] We assume that there are about 260 weekdays and 105 weekend days in a year. The weighted total yearly cost of sleep lost due to relative income is estimated to equal $2.177 + 0.388 = 2.565$ billion euro (bold figures Column XII and XIII, Table 5). As a final step, to show the relative magnitude of this cost, we calculate the *total yearly price of sleep* in Germany. The results are presented in Column VII and VIII (bold figures). The total yearly price of sleep in the working-age population is $98.98 + 46.35 = 145.33$ billion euro. The relative size of sleep lost due to relative concerns is $2.57/145.33 = \%1.77$ of the total yearly value of sleep in Germany. Finally, we calculate the cost of sleep lost due to income comparisons relative to the total health expenditures of Germany in 2013. The per capita health expenditures amount to 4837.27 USD (constant international dollars with 2011 prices). Using the average exchange

[24] Please see https://data.oecd.org/pop/population.htm#indicator-chart.

Table 5: Cost of Sleep Lost due to Relative Income

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
		Price of Sleep							Cost of Sleep Lost			
	Average Hours of Sleep		Average Income (Euro Per Person)	Fixed-Effects SWB Equation Parameter Estimates			Price of Sleep (Euro Per Minute/Person)		Sleep Lost (Minutes) Basline FE		Price of Sleep Lost (Euro Per Day/Person)	
				Log Hours of Sleep		Log Income						
	Weekday	Weekend		Weekday	Weekend		Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Whole Sample												
	6.940	7.991	21411.0	0.276 ***	0.325 ***	0.096 ***	0.017 ***	0.017 ***	-9.160	-4.089	-0.155 ***	-0.071 ***
Standard Error				(0.062)	(0.057)	(0.023)	(0.006)	(0.005)			(0.006)	(0.005)
Daily Price/Cost (euro)							7.043	8.278				
Population (bill. euro)							**98.977**	**46.354**			**-2.177**	**-0.388**
Low Working Hours (less than median 7.5 hours)												
	7.065	7.869	18681.6	0.298 ***	0.315 ***	0.084 **	0.018 **	0.017 **	-10.632	-4.982	-0.222 ***	-0.095 ***
Standard Error				(0.099)	(0.091)	(0.042)	(0.009)	(0.008)			(0.009)	(0.008)
Daily Price/Cost (euro)							7.574	8.001				
High Working Hours (more than and equal to median 7.5 hours)												
	6.818	8.110	24093.6	0.295 ***	0.305 ***	0.145 ***	0.014 **	0.012 **	-2.164	-1.905	-0.026 ***	-0.020 ***
Standard Error				(0.087)	(0.079)	(0.042)	(0.006)	(0.005)			(0.006)	(0.005)
Daily Price/Cost (euro)							5.602	5.792				
Low Time-Use (less than median 6 hours)												
	6.881	8.077	24219.5	0.336 ***	0.279 ***	0.070 **	0.032	0.023	-1.890	-10.741	-0.053 **	-0.219 ***
Standard Error				(0.101)	(0.090)	(0.029)	(0.021)	(0.015)			(0.021)	(0.015)
Daily Price/Cost (Euro)							13.299	11.057				
High Time Use (less than and equal to median 6 hours)												
	6.992	7.916	18988.6	0.213 **	0.327 ***	0.085 ***	0.013 *	0.017 **	-20.682	-9.632	-0.303 ***	-0.188 ***
Standard Error				(0.091)	(0.083)	(0.032)	(0.007)	(0.008)			(0.007)	(0.008)
Daily Price/Cost (Euro)							5.407	8.298				
Low Health Status (1,2 and 3 over 5 point scale)												
	6.822	7.780	19995.1	0.404 ***	0.374 ***	0.171 ***	0.013 **	0.011 **	-6.865	-0.579	-0.095 ***	-0.006
Standard Error				(0.120)	(0.111)	(0.048)	(0.005)	(0.004)			(0.005)	(0.004)
Daily Price/Cost (euro)							5.388	4.983				
High Health Status (4 and 5 over 5 point scale)												
	7.015	8.123	22300.0	0.156 **	0.187 ***	0.087 ***	0.011 *	0.011 **	-8.894	-4.528	-0.094 ***	-0.049 ***
Standard Error				(0.077)	(0.070)	(0.026)	(0.006)	(0.005)			(0.006)	(0.005)
Daily Price/Cost (euro)							4.560	5.448				

Notes: Authors' own calculations from GSOEP waves 2008–2013 .

Population includes the working-age individuals aged 15–65 (bill. Indicates billion). We calculate per capita effective income using the standard OECD scale.

The models in III, IV, and V use subjective well-being (life satisfaction) as dependent varaible. The models control for full set of control variables (See Appendix A) with time, state dummies and unobserved individual effects (fixed-effects, FE). Standard errors are in parentheses. The standard errors of price/cost estimates are obtained using the delta method.

*. **. *** indicate significance levels at 10%. 5%, and 1%, respectively.

rate in 2013, 1 USD= 0.783 EUR, we calculate the total health expenditures for the working age population as $4837.27 \times 0.783 \times 53,844,000 = 203.94$ billion euro. The cost of sleep lost due to relative concerns is $2.565/203.94 = 1.26\%$ of the total health expenditures of the working-age population of Germany in 2013.[25]

7 Conclusions

This paper investigates how people's absolute and relative income is related to their sleep behavior in terms of hours of sleep on weekdays and weekends and sleep satisfaction. Our dataset includes a six-year panel of information on sleep behavior collected in Germany. The panel data models, which control for a large set of potential determinants of sleep and unobserved individual effects in a fixed-effects specification, suggests that there are important relationships between absolute and relative income and both number of hours of sleep per night and sleep satisfaction. One robust result is that the hours of sleep on weekdays is strongly negatively affected by relative income, measured as a person's income in relation to the average income of his or her reference group, i.e., the group with which he or she potentially compares him- or herself with. Hours of sleep on weekends is only partially explained by relative income. The quality of sleep, measured using sleep satisfaction, is also influenced largely and negatively by relative income. Our results do not suggest any large and statistically significant influence of own income on sleep behavior, conditional on relative income and several other observed and unobserved individual characteristics. The results are highly robust with respect to estimators, alternative measures of relative income, e.g., income ranks, specification of unobserved individual effects, income inequality, and local price differences.

We also investigate the potential mechanisms mediating the relationship between income and sleep. We focus mainly on working hours, time-use behavior, and physical and mental health/stress. Working hours and time use can only partially explain the effect of relative income on sleep. The effect of relative income is particularly strong among people who work less than the median number of hours and people who spend more time on non-work-related activities in the population. Health measures and health related behavior, including physical and mental health/well-being/stress, appear to be important in explaining our results. We find that the negative impact of relative income on sleep is largely explained by well-being/stress and in particular overall subjective well-being and financial well-being. For the first time in the literature, we calculate the monetary value (price/cost) of sleep lost due to relative concerns. The cost is as high as about 2.56 billion euro/year in the working-age population. This figure constitutes

[25] The health expenditures and exchange rate figures are obtained from the World Bank (http://data.worldbank.org).

1.8% of the overall monetary value of sleep and 1.3% of the total health expenditures among the working-age population of Germany in 2013.

The results reported in this paper have important policy implications and show that negative externalities from relative concerns call for policy interventions in addition to income taxation aiming at reducing the external effects. The additional negative effect of relative concerns on sleep duration and quality, which in turn might influence several important outcomes for the individual's well-being especially among people with fewer working hours and more hours spent on household production. Public health policies aiming at restricting hours of work and promoting and subsidizing leisure activities should focus especially on physical- and mental-health/stress outcomes of individuals to reduce the effect of externalities from relative concerns on sleep behavior.

This study has also important limitations that should be addressed in future studies. One is that the non-experimental nature of our data generates several concerns on the causal interpretation of our results. To deal with the omitted variable bias, we have allowed for the individual fixed effects and used proxy variables such as personality traits, which might correlate with omitted variables. Yet we cannot rule out potential reverse causality between hours of sleep, sleep-satisfaction and income. Another related limitation is that our model is not able to allocate the potential simultaneity between choices of sleep, work, and time-use hours given the relative income of individuals. In our model, we assume that working hours and time-use activities are fixed in the short run. Future studies should investigate how the reduction in hours of sleep due to relative income is simultaneously determined by increases in working hours and time use, and also by individual physical and mental health investments to cope with the negative externality of others' income.

References

[1] Adams, J. (2006). Socioeconomic Position and Sleep Quality in UK Adults. *Journal of Epidemiological Community Health*, 60(3): 267–269.

[2] Akay, A., Bargain, O., and Zimmermann, K.F. (2017). Home Sweet Home: Macroeconomic Conditions in Home Countries and the Well-Being of Migrants. *Journal of Human Resources*, 53(3): 351–373.

[3] Akay, A., and Martinsson, P. (2011). Does Relative Income Matter for the Very Poor? Evidence from Rural Ethiopia. *Economic Letters*, 110(3): 213–215.

[4] Akay, A. Andersson, L., Martinsson, P., and Haileselassie M. (2014). Positional Concerns among the Poor: Does Reference Group Matter? Evidence from Survey Experiments. *Journal of African Economies*, 23(5): 673–699.

[5] Alesina, A., Di Tella, R., and MacCulloch, R. (2004). Inequality and Happiness: Are Europeans and Americans different? *Journal of Public Economics*, 88(9–10), 2009–2042.

[6] Antillon, M., Lauderdale, D.S., and John, M. (2014). Sleep Behavior and Unemployment Conditions. *Economics and Human Biology*, 14(1): 22–32.

[7] Aronsson, T. and Johansson-Stenman, O. (2008). When the Joneses' Consumption Hurts: Optimal Public Good Provision and Nonlinear Income Taxation. *Journal of Public Economics*, 92(5–6): 986–997.

[8] Baetschmann, G., K. Staub, and Winkelmann R. (2015). Consistent Estimation of the Fixed-effects Ordered Logit Model. *Journal of the Royal Statistical Society*, 178(3): 685–703.

[9] Basta, M., Chrousos, G.P., Vela-Bueno, A., and Vgontzaz, A.N. (2007). Chronic Insomnia and Stress System. *Sleep Med Clim.*, 2(2): 279–291.

[10] Biddle J.E. and Daniel S.H. (1990). Sleep and the Allocation of Time. *Journal of Political Economy*, 98(5): 922–943.

[11] Brochu, P., Armstrong, C.D, Louis-Philippe, M. (2012). The 'Trendiness' of Sleep: an Empirical Investigation into the Cyclical Nature of Sleep Time. *Empirical Economics*, 43(2): 891–913.

[12] Carlsson, F., O. Johansson-Stenman, and P. Martinsson (2007). Do You Enjoy Having More than Others? Survey Evidence of Positional Goods. *Economica*, 74(296): 586–598.

[13] Clark, A. (2003). Inequality-Aversion and Income Mobility: A Direct Test, DELTA Working Papers.

[14] Clark, A. E., P. Frijters, and M.A. Shields (2008). Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles. *Journal of Economic Literature*, 46(1): 96–144.

[15] Clark, A. E. and A. J. Oswald (1996). Satisfaction and Comparison Income. *Journal of Public Economics*, 61(3): 359–381.

[16] Clark, A.E., and C. Senik, (2010) Who Compares to Whom? The Anatomy of Income Comparisons in Europe. *Economic Journal*, 120(544): 573–594.

[17] Cob-Clark, D. A., & Schurir, S. (2012). The Stability of Big-Five Personality Traits. *Economics Letters*, 115(1): 11–15.

[18] Dolan, P., T. Peasgood, and M. White (2008). Do We Really Know What Makes Us Happy? A Review of the Economic Literature on the Factors Associated with SWB. *Journal of Economic Psychology*, 29(1): 94–122.

[19] Duesenberry, J.S. (1948). "Income - Consumption Relations and Their Implications," in Lloyd Metzler et al., Income, Employment and Public Policy, New York: W.W. Norton & Company, Inc.

[20] Easterlin, R.A. (1995). Will Raising the Incomes of All Increase the Happiness of All? *Journal of Economic Behavior and Organization*, 27(1): 35–47.

[21] Ferrer-i-Carbonell, A. (2005). Income and Well-being: An Empirical Analysis of the Comparison Income Effect. *Journal of Public Economics*, 89(5–6): 997–1019.

[22] Ferrer-i-Carbonell, A. and Frijters, P. (2004). How Important is Methodology for the Estimates of the Determinants of Happiness? *Economic Journa*l, 114(497): 641–659.

[23] Frank, Robert H. (1985). The Demand for Unobservable and Other Nonpositional Goods, *American Economic Review*, 75(1): 101–116.

[24] Frey, B.S., Luechinger, S., and Alois, S. (2007). Calculating Tragedy Assessing the Costs of Terrorism. *Journal of Economic Surveys*, 21(1): 1–24.

[25] Frey, B.S., Luechinger, S., and Stutzer, A. (2009). The life satisfaction approach to valuing public goods: the case of terrorism. *Public Choice*, 138(3–4): 317–345

[26] Friborg, O., Bjorvatn B, Amponsah B, and Pallesen S. (2012). Associations Between Seasonal Variations in Day Length (photoperiod), Sleep Timing, Sleep Quality and Mood: a Comparison Between Ghana (5°) and Norway (69°). *Journal of Sleep Research*, 21(2): 176-84.

[27] Friedman, E.M., Love, G.D., Rosenkranz, M.A (2007). Socioeconomic Status Predicts Objective and Subjective Sleep Quality in Aging Women. *Psychosomatic Medicine*, 69(7): 682–691.

[28] Grandner, M.A., Patel, N.P., Gehrman, P.R., Xie, D., Sha, S.m Weaver, T., and Gooneratne, N. (2009). Who Gets the Best Sleep? Ethnic and Socioeconomic Factors Related to Sleep Complaints. *Sleep Medicine*, 11(5): 470–478.

[29] Gruber, R., Somerville, G., Paquin, S., and Boursier, J. (2017). Determinants of Sleep Behavior in Adolescents: A Pilot Study. *Sleep Health*, 3(3): 157–162.

[30] Graham, C. and Felton, A., (2006). Inequality and Happiness: Insights From Latin America. *Journal of Economic Inequality*, 4(1): 107–122.

[31] Gravelle H and Sutton M. (2009). Income, Relative Income, and Self-Reported Health in Britain 1979-2000. *Health Economics*, 18(2):125–145.

[32] Jones, A.M. and Wildman, J. (2008). Health, Income and Relative Deprivation: Evidence from the BHPS. *Journal of Health Economics*, 27(2): 308–324.

[33] Haisken-DeNew, John P. and Markus H. Hahn (2010). PanelWhiz: Efficient Data Extraction of Complex Panel Data Sets – An Example Using the German SOEP". *Journal of Applied Social Science Studies*, 130(4): 643–654.

[34] Hale, L. (2005). Who Has Time to Sleep? *Journal of Public Health*, 27(2): 205–211.

[35] Haley, M.R. and Miller, L.A. (2015): Correlates of Flexible Working Arrangements, Stress, and Sleep Difficulties in the US Workforce: Does the Flexibility of the Flexibility Matter? *Empirical Economics*, 48(4):1395–1418.

[36] Hall, M., Baum, A., Buysse, D.J., Prigerson, H.G., Kupfer, D.J., Reynolds, C.F. (1988). Sleep as a Mediator of the Stress Immune Relationship. *Psychosomatic Medicine*, 60(1): 48–51.

[37] Hasler, G., Buysse, D.J., Klaghofer, R., Gamma, A., Ajdacic, V., Eich, D., Rössler, W., Angst, J. (2004). The Association Between Short Sleep Duration and Obesity in Young Adults: a 13-Year Prospective Study. *Sleep*, 27(4): 661–666.

[38] Hirshkowitz, M., K.Whiton, S. M. Albert, C. Alessi, O. Bruni, L. DonCarlos, N. Hazen, J. Herman, E. S. Katz, L. Kheirandish-Gozal, D.N. Neubauer, A.E. O'Donnell, M. Ohayon, J. Peever, R. Rawding, R.C. Sachdeva, B. Setters, M.V. Vitiello, J. Catesby Ware and P.J. Adams Hillard (2015)., National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health*, 1(1): 40–43.

[39] Hirschman, A. and Rothschild M. (1973). The changing tolerance for income inequality in the course of economic development. *Quarterly Journal of Economics*, 87 (4):544–566.

[40] Kim, E.J. and J.E. Dimsdale (2007). The Effect of Psychosocial Stress on Sleep: A Review of Polysomnographic Evidence. *Behavioral Sleep Medicine*, 5(4): 256–78.

[41] Krueger, Alan B., and David, S. (2008). The Reliability of Subjective Well-being Measures. *Journal of Public Economics*, 92(8–9): 1833–1845.

[42] Kahneman, D., and Robert, S. (2005). Experienced Utility as a Standard of Policy Evaluation. *Environmental and Resource Economics*, 32(1): 161–181.

[43] Lallukka, T., Ferrie, J.E., Kivimäki, M., Shipley, M.J., Rahkonen, O., and Lehelma, E. (2012). Economic Difficulties and Subsequent Sleep Problems: Evidence from British and Finnish Occupational Cohorts. *Sleep Medicine*, 13(6): 680–685.

[44] Layard G., Mayraz, G., and Nickell, S. (2008). The Marginal Utility of Income. *Journal of Public Economics*, 92(8-9): 1846–1857.

[45] Lauderdale, D.S., Knutson, K.L., and Yan, L.L. (2006). Objectively Measured Sleep Characteristics Among Early-Middle-Aged Adults: the CARDIA Study. *American Journal of Epidemiology*, 164(1): 5–16.

[46] Linton, S.J. (2004). Does Work Stress Predict Insomnia? A Prospective Study. *British Journal of Health Psychology*, 9(2): 127–136.

[47] Luechinger, S. (2009). Valuing Air Quality Using the Life Satisfaction Approach. *Economic Journal*, 119(536): 482–515.

[48] Luttmer, E. (2005). Neighbors as Negatives: Relative Earnings and Well-being. *Quarterly Journal of Economics*, 120(3): 963–1002.

[49] Moore M., Kirchner, H.L., Drotar, D., Johnson, N., Rosen, C., and Redline, S. (2011) Correlates of Adolescent Sleep Time and Variability in Sleep Time: the Role of Individual and Health Related Characteristics. *Sleep Medicine*, 12(3): 239–45.

[50] McBride, M. (2001). Relative-Income Effects on SWB in the Cross-Section. *Journal of Economic Behavior and Organization*, 45(3): 251–278.

[51] McCrae, Robert R., and Paul T. Costa. (1999). "A Five-Factor Theory of Personality." In Lawrence A. Pervin and Oliver P. John, eds., Handbook of Personality: Theory and Research. New York: Guilford.

[52] Miller, D.L., and C. Paxson. (2006). Relative Income, Race, and Mortality. *Journal of Health Economics*, 25(5): 979–1003.

[53] Neumark, D. and Postlewaite, A. (1998). Relative Income Concerns and the Rise in Married Women's Employment. *Journal of Public Economics*, 70(1): 157-183.

[54] Oswald, A.J. and S. Wu (2010). Objective Confirmation of Subjective Measures of Human Well-being: Evidence from the USA. *Science*, 327(5965): 576–579.

[55] Patel, S.R., and Hu, F.B. (2008). Short Sleep Duration and Weight Gain: A Systematic Review. *Obesity*, 16(3):643–653.

[56] Powdthavee, N., and Van Den Berg, B. (2011). Putting Different Price Tags on the Same Health Condition: Re-evaluating the Well-being Valuation Approach. *Journal of Health Economics*, 30(5): 1032–1043.

[57] Roenneberg, T., Kuehnle, T., Juda, M., Kantermann, T., Allebrandt, K., Gordijn, M., & Merrow, M. (2007). Epidemiology of the Human Circadian Clock. *Sleep Medicine Reviews*, 11(4): 429–438.

[58] Senik, C. (2004). When Information Dominates Comparison: A Panel Data Analysis Using Russian Subjective Data. *Journal of Public Economics*, 88(9–10): 2099–2123.

[59] Senik (2005). What Can We Learn from Subjective Data? The Case of Income and Well-being. *Journal of Economic Surveys*, 19(1): 43–63.

[60] Szalontai, G. (2006) The Demand for Sleep: A South African Study. *Economic Modelling*, 23(5): 854–874.

[61] Sapolsky, R.M. (2004). Why Zebras Don't Get Ulcers. An Updated Guide to Stress, Stress-Related Diseases, and Coping (3rd Edition). New York: Freeman.

[62] Spiess, M., and Martin K. (2004). Documentation of Sample Sizes and Panel Attrition in the German Socio-Economic Panel (SOEP) 1984-2003. In: Research Notes No. 28a, DIW.

[63] Stoller, M.K. (1994). Economic Effects of Insomnia. Clinical Therapeutics. *The International Peer-Reviewed Journal of Drug Therapy*, 16(5): 873–97.

[64] Veblen, T., (1899 [2005]). The Theory of Leisure Class. United Stata, Dodo Press.

[65] Van Praag, B., and Baarsma. B. (2005). Using Happiness Surveys to Value Intangibles: the Case of Airport Noise. *Economic Journal*, 115(500): 224–246.

[66] Vgontzaz, A.N., Lin, H-M., Papaliaga, M., Calhoun, S., Vela-Bueno, A., Chrousos, G.P., and Bixler, E.O. (2008). Short Sleep Duration and Abesity: the Role of Emotional Stress and Sleep Disturbances. *International Journal of Obesity*, 32(5): 801–809.

[67] Welsch, H. (2006) Environment and Happiness: Valuation of Air Pollution Using Life Satisfaction Data. *Ecological Economics*, 58(4): 801–813,

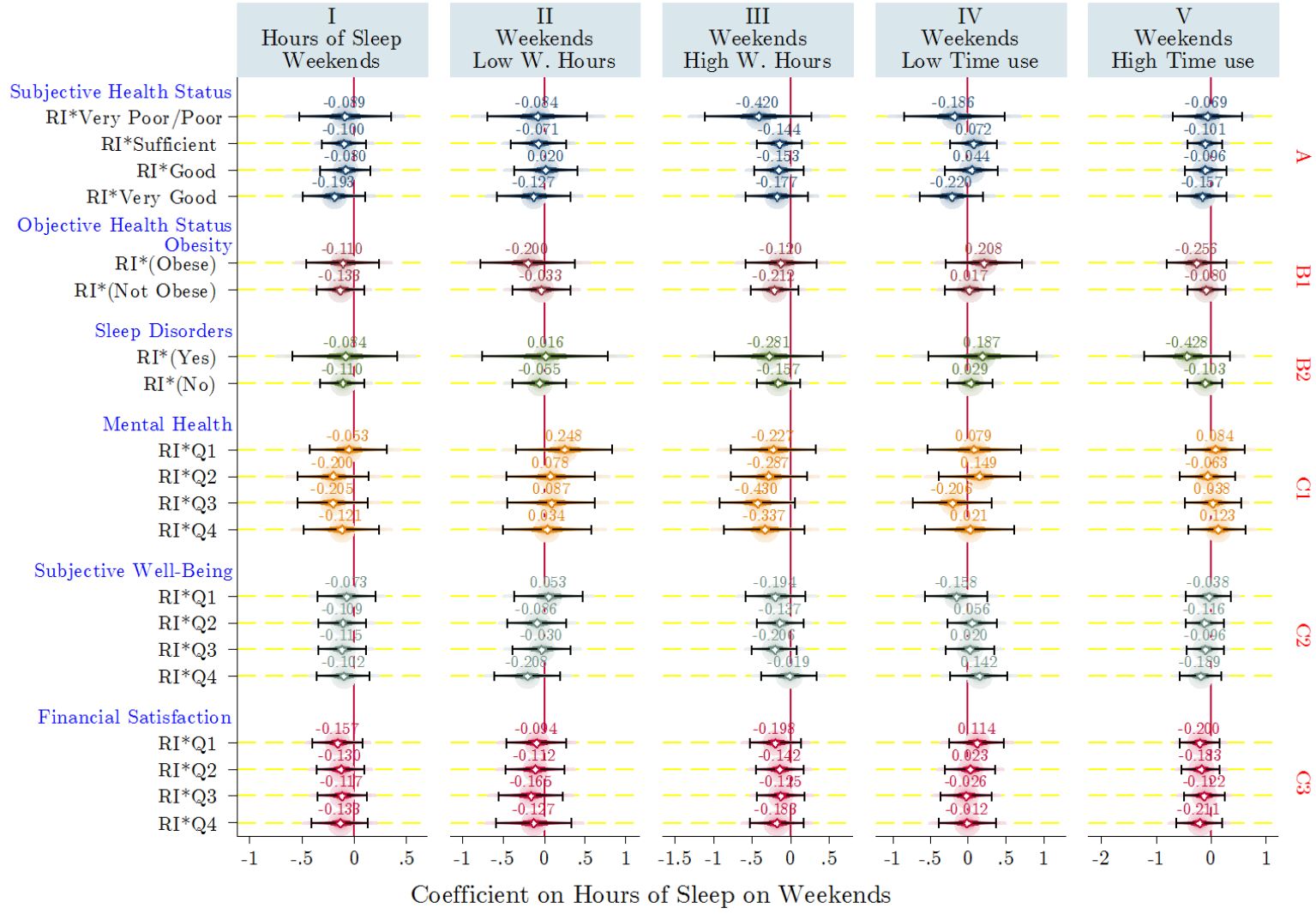
[68] Wilkinson, R.G. (1997). Socioeconomic Determinants of Health: Health Inequalities: Relative or Absolute Material Standards? *British Medical Journal*, 314(7080): 591–595.

A Appendix A. Full Estimation Results: Baseline

	Hours of Sleep		Sleep		Hours of Sleep		Sleep
	Weekdays	Weekend	Satisfaction		Weekdays	Weekend	Satisfaction
Marital S. Separated (1)	-0.182 ***	-0.176 ***	-0.081	Working Hours #	-0.006 ***	0.002 ***	-0.002 ***
	(0.043)	(0.056)	(0.082)		(0.000)	(0.000)	(0.001)
Marital S. Single	-0.011	0.079 *	0.167 **	Time use #	-0.001	-0.009 ***	-0.009 ***
	(0.034)	(0.041)	(0.066)		(0.002)	(0.002)	(0.003)
Marital S. Divorced	-0.074 *	-0.073	0.017	Individual labor income	-0.004	0.003	0.004
	(0.040)	(0.057)	(0.084)		(0.003)	(0.004)	(0.005)
Marital S. Widowed	-0.253 **	-0.208	-0.505 ***	Distance to work (km)	-0.009	0.104	-0.149
	(0.105)	(0.129)	(0.187)		(0.103)	(0.121)	(0.201)
Years of education	0.036 ***	-0.005	0.034 **	Extraversion	0.003	0.002	0.010 *
	(0.008)	(0.010)	(0.015)		(0.003)	(0.004)	(0.006)
West Germany	0.187 **	0.063	-0.057	Aggreableness	0.004	0.001	-0.004
	(0.095)	(0.121)	(0.187)		(0.003)	(0.004)	(0.006)
Health: Poor (2)	0.025	0.079 **	0.802 ***	Conscientiousnes	-0.007 **	-0.011 ***	0.011 *
	(0.025)	(0.031)	(0.059)		(0.003)	(0.004)	(0.007)
Health: Satisfactory	0.071 ***	0.125 ***	1,522 ***	Neuroticim	-0.005 *	-0.008 **	-0.037 ***
	(0.025)	(0.031)	(0.060)		(0.003)	(0.003)	(0.005)
Health: Good	0.106 ***	0.171 ***	2,314 ***	Openness to Experience	-0.002	-0.001	0.001
	(0.025)	(0.031)	(0.062)		(0.003)	(0.003)	(0.005)
Health: Very good	0.114 ***	0.153 ***	2,893 ***				
	(0.027)	(0.033)	(0.066)	Absolute Income	0.021	0.027	0.008
Household size	0.009	0.021	0.056 ***		(0.014)	(0.017)	(0.025)
	(0.010)	(0.013)	(0.018)	Relative Income	-0.153 **	-0.068	-0.235 *
#Kids(0–1) (3)	-0.276 ***	-0.657 ***	-0.778 ***		(0.071)	(0.089)	(0.144)
	(0.031)	(0.038)	(0.059)				
#Kids(2–4)	-0.100 ***	-0.445 ***	-0.278 ***	Constant	8.145 ***	7.703 ***	8.031 ***
	(0.025)	(0.031)	(0.047)		(0.880)	(1.083)	(1.592)
#Kids(5–7)	-0.031	-0.193 ***	-0.060				
	(0.023)	(0.028)	(0.045)	R2-overall	0.023	0.049	0.287
#Kids(8–10)	-0.037 *	-0.044 *	0.004	#Observations	76046	76046	76046
	(0.021)	(0.026)	(0.043)				
#Kids(11–12)	0.001	0.023	0.021	Time dummes	Yes	Yes	Yes
	(0.021)	(0.027)	(0.042)	State dummies	Yes	Yes	Yes
#Kids(13–15)	0.011	0.016	0.001				
	(0.018)	(0.023)	(0.037)				
#Kids(16–18)	-0.022	0.017	-0.015				
	(0.015)	(0.019)	(0.031)				
Employment status	-0.009	-0.009	-0.066				
	(0.023)	(0.030)	(0.042)				
In school/training	-0.078 **	0.181 ***	0.117 *				
	(0.036)	(0.046)	(0.061)				
Self-employed	0.039	-0.026	0.095				
	(0.032)	(0.038)	(0.062)				

Note: *, **, *** indicate significance levels at 10%, 5%, and 1%. The models are estimated using fixed-effects specification. (1) Omitted category is "married". (2) Omitted category is "very poor health". (3) Omitted category is "not having any child". (#) Working hours and time use are the daily hours calculates over the total hours spent on each of them. Age and gender are omitted in fixed-effects specification. State effect denotes the 16 federal states of Germany. Times dummies are included.

B Appendix B. Physical and Mental Health: Hours of Sleep on Weekends



Notes: The models are estimated using the fixed effects specification with the full set of controls (see Appendix A) including personality characteristics, region, and time dummies. The horizontal axes show the magnitude of the parameter estimate on hours of sleep on weekends On the vertical axis, RI is the relative income defined using the baseline reference group. Figures above the confidence intervals (95%) indicate the magnitude of the parameter estimates. The vertical lines go through zero.