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Unfair Wage Perceptions and Sleep: Evidence from German Survey Data

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Abstract

The author uses large-scale German survey data for the years 2009, 2011 and 2013 in order to analyze the nexus between the individual perception of being unfairly paid and measures for quantity and quality of sleep, namely, hours of sleep during workweek and during weekend, happiness with sleep, and sleep disorders diagnosed by a doctor. Main findings of the regression analysis are that workers, who perceive their own wage as unfair, sleep significantly less during the workweek (1.2 to 2.5 percent), are significantly less satisfied with their sleep (1 to 5 percent) and are significantly more likely to have sleep disorders (7 to 36 percent). Moreover, workers with more weekly working hours sleep significantly less during the workweek (0.1 to 0.2 percent per hour) and are significantly less satisfied with their sleep (0.1 percent per hour). The size of the hourly wage is however not significantly correlated with any of the sleep outcomes and the household income seems also of minor importance, even though the estimated coefficients have the expected signs implied by substitution and income effects. The overall results suggest that unfair wage perceptions, which are related to stress, negatively affect workers' sleep and, consequently, their health.

JEL Classification: I12, J22, J31

1. Introduction

In this paper, I analyze the nexus between the individual perception of being unfairly paid and measures for the quantity and quality of sleep. The quantity and quality of sleep has tremendous effects on our physical and mental health.[1] Sleep restrictions, sleep deprivations, and sleep disturbances can, for example, increase cardiovascular risks, lead to daytime cognitive dysfunctions and lower learning abilities, and even to obesity and diabetes. In addition to the direct

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1 For a review on physiological and neurobehavioral consequences of sleep see Banks and Dinges (2007). Boonstra et al. (2007) and Walker (2008) review the effects of sleep deprivation on neural functioning and the cognitive consequences. Knutson et al. (2007), Spiegel et al. (2009), and Cappuccio et al. (2010) review studies on the effects of quantity and quality of sleep on obesity and diabetes.

individual and public health costs, consequences for others can also occur. For example, Monaco et al. (2005) report evidence that fewer hours of sleep increase the probability that a truck driver has dozed or fallen asleep at the wheel, which increases the risk of severe traffic accidents. Landrigan et al. (2004) analyze the effect of a change in the work schedule of doctors in a hospital from long work shifts of more than 24 hours to a new schedule with shorter work shifts and less weekly working hours. Doctors made significantly fewer serious medical, medication and diagnostic errors under the new schedule, which allowed more regular sleep. Moreover, Lombardi et al. (2012) find that workers with less sleep are more likely to experience work accidents.

Even though the allocation of time has received remarkable attention in economics since the 1960s (e.g., Becker, 1965) and the division between working and leisure hours is standard in labor supply models, the time spent sleeping has received surprisingly little attention. The explicit economic analysis of sleep in the economic literature probably started with the two miscellaneous papers in the Journal of Political Economy by Bergstrom (1976) and Hoffman (1977), who discussed the result of a short paper by El-Hodiri (1973). El-Hodiri (1973) applied a simple utility function and budget constraint, from which he derived the result that the share of sleep in total time is always one third, i.e., 8 hours per day. Bergstrom (1976) added non-labor income and Hoffman (1977) added an interdependent utility function for partners as well as the value of non-market production to the demand for sleep model. When applying comparative statics, the revised models imply that sleep time decreases with working hours and wages (opportunity costs, substitution effect) and increases with income (income effect). A more serious economic and econometric analysis was then conducted by Biddle / Hamermesh (1990). They added other wake leisure activities, which are also necessary in order to consume market goods, to the demand for sleep model. The theoretical results imply substitution and income effects of wages and non-labor income on the demand for sleep. Their econometric analysis of time use data for the US shows that sleeping time is lower if working time and education are larger. Moreover, Biddle / Hamermesh (1990) report evidence that the wage is negatively correlated with sleep time, which supports the view that the wage rate is an opportunity cost. The results for non-labor income are however statistically and economically not significant. In addition to the simple demand for sleep, Yaniv (2004) developed a model of the bedtime decision taking into account psychological stress and insomnia levels. The bedtime decision and the biological clock are, however, out of this paper's scope.

In recent years, the determinants of sleep have received increasing attention. For example, Hale (2005) examines time use diary data for the US. She finds that married people are more likely and less educated people are less likely to report a midrange sleep time (6.5 – 8.5 hours per night), which would be beneficial from a medical point of view. Furthermore, she confirms that more working hours are correlated with less sleep. Szalontai (2006) uses time use data for South Africa and finds that daily sleep time is lower for more educated workers and for workers with higher wages, which indicates to some degree the impact of economic factors on the demand for sleep. Haley and Miller (2014) report evidence for the US that flexible working arrangements can reduce work stress and sleeping difficulties. Brochu et al. (2012) analyze Canadian time use data and find that sleep time is lower if general stress is higher and if the regional unemployment rate is lower. Antillon et al. (2014) use time use data for the US. They find evidence that sleep time is lower and the probability to report sleeplessness is higher if the regional unemployment rate is lower. Moreover, their findings suggest that sleeping time is lower for more educated people, for fulltime employed workers, for workers with shift-work, and for higher household income classes. Knudsen et al. (2007) report evidence for fulltime employed workers in the US that the number of days with difficulties falling asleep, staying asleep and waking up for work are larger in case of work overload, repetitive work and role conflict, whereas annual earnings are not significantly correlated with the quality of sleep outcomes.

I add to this stream of the literature by analyzing the nexus between the individual perception of being unfairly paid and measures for the quantity and quality of sleep, namely, hours of sleep during workweek and during weekend, happiness with sleep, and sleep disorders diagnosed by a doctor. In this context, I also include hourly wages, household income, and working hours in addition to a large set of control variables. The discussion about fair wages has received increasing attention in economics since the 1980s, which has been largely inspired by the insight that fairness considerations are part of the wage setting process (Rees, 1993) and by the fair wage-effort hypothesis (Akerlof / Yellen, 1990). That fair wages, which are often analyzed in the context of social comparison and relative income positions, have significant effects on productivity (e.g., Clark et al., 2010), job satisfaction (e.g., Clark et al., 2009), quit behavior and intentions (e.g., Pfeifer / Schneck, 2012; Kersting / Pfeifer, 2013), and other outcomes has been studied in laboratory experiments as well as with large survey and administrative data. But the effects of unfair pay on health-related outcomes has received remarkably little attention – except for a recent paper by Falk et al. (2014).[2] Falk et al. (2014) provide experimental evidence that unfair pay decreases the heart rate variability and, consequently, affects negatively the cardiovascular system. Additionally, they present evidence from German survey data that unfair perceived wages are negatively correlated with the subjective health status in general. Unfair perceived wages are, furthermore, positively correlated with the body mass index and with the probability of specific

[2] Note that Falk et al. (2014) use the same data set as in this paper, namely the German Socio-Economic Panel (SOEP). But they only use the cross-section for the year 2009, whereas I use panel data for the years 2009, 2011, and 2013. More importantly is however that Falk et al. (2014) do not at all consider sleep in their analysis.

diseases diagnosed by a doctor (e.g., heart disease, high blood pressure, and diabetes). Falk et al. (2014) argue that the lower heart rate variability reflects stress due to unfair perceived pay that negatively affects health. Therefore, it is reasonable to assume that unfair wage perceptions might also negatively affect sleep, because of increased stress.

In this paper, I apply several pooled and panel regression techniques using large-scale German household panel data, the German Socio-Economic Panel (SOEP), for the years 2009, 2011 and 2013. My main findings are that unfair wage perceptions and the number of working hours are negatively correlated with the number of hours of sleep during the workweek and with the probability to report a midrange sleep time of 7 to 9 hours. Although the hourly wage rate has the expected negative and household income the expected positive signs, the estimated coefficients are not statistically significant. The correlation with sleep during the weekend is less pronounced than during the workweek and not always significant for the work-related variables. Satisfaction with sleep is also significantly lower for workers who perceive their wage as unfair and who work more hours, whereas the coefficients for the wage rate and household income have positive signs but are not statistically significant. Sleep disorders diagnosed by a doctor are also significantly more likely for workers who perceive their wage as unfair. The coefficient for working hours has the expected positive sign and the coefficients for the wage rate and household income have negative signs; but neither is statistically significant. Overall, the findings suggest that unfair wage perceptions have a significant negative impact on the quantity and quality of workers' sleep.

The remainder of the paper is structured as followed. Section 2 describes the data set, variables and basic estimation approach. The regression analysis is presented in Section 3. The paper concludes with a short summary and discussion of the findings in section 4.

2. Data Set and Variables

I use the German Socio-Economic Panel (SOEP) for the years 2009, 2011 and 2013.[3] The SOEP is a large representative panel survey of private households and persons in Germany, which provides a rather stable set of core questions asked every year (e.g., employment, education, income) and yearly topics with additional detailed questions (Wagner et al., 2007). As questions about fairness perceptions of own income and about sleep behavior are only included in the years 2009, 2011 and 2013, I restrict my analysis to these years. Due to the nature of the topic, I further restrict my estimation sample to employed blue-collar and white-collar workers, who are no civil servants[4], who are not

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[3] Socio-Economic Panel (SOEP), data for years 1984–2013, version 30, SOEP, 2014, doi:10.5684/soep.v30.

self-employed, who are not in education, and who are between 18 and 65 years of age. Moreover, observations with missing values in the used variables are dropped from the sample. The number of observations for the total estimation sample is n = 18,485 for N = 10,277 individuals in an unbalanced panel for the years 2009, 2011 and 2013 with an average panel length of T = 1.8.

The SOEP includes several variables about sleep, which serve as outcome variables in the subsequent regression analysis. At first, the quantitative dimension of sleep is analyzed, i.e., the normal number of hours of sleep during the workweek and during the weekend. In the pooled estimation sample, employed individuals sleep on average about 6.8 hours per night during the workweek (SD = 0.99) and about 8 hours during the weekend (SD = 1.22). In order to account for the fact that too much sleep might also not be beneficial[5], a dummy variable was generated that takes the value one if a person sleeps between 7 and 9 hours and zero if a person sleeps less or more hours. About 65.4 percent in the sample belong to the group with such midrange sleep time during the workweek. In the reference group, the majority reports less than 7 hours of sleep and only 92 observations (0.5 percent) in the sample report ten or more hours of sleep during the workweek. During the weekend about 80.5 percent report a midrange sleep time, whereas 9 percent sleep less than 7 hours and 10.4 percent sleep ten hours or more. In the next step, the qualitative dimension of sleep is added by analyzing the satisfaction with sleep, which is measured on a 11-point Likert scale (0: very dissatisfied, 10: very satisfied). Average satisfaction with sleep is 6.9 (SD = 2.15) in the estimation sample. At last, sleep disorders diagnosed by a doctor are analyzed.[6] This information is only available for the years 2011 and 2013 so that the sample reduces to n = 13,040 observations of N = 8,824 individuals in an unbalanced panel design (T = 1.5). About 6.9 percent of the observations in this sample report that a doctor has ever diagnosed a sleep disorder for them.

The determinants of the above sleep variables are estimated by using different regression methods that acknowledge the different character of the dependent variables and the panel nature of the data. These regression methods will

[4] Note that wages are not directly comparable between civil servants and other employee groups due to special arrangements in health insurance and pension system for civil servants in Germany.

[5] Buxton and Marcelli (2010) report for example large-scale empirical evidence for the US that daily sleep of 7 to 8 hours is correlated with a lower risk of obesity, diabetes, hypertension, and cardiovascular disease.

[6] Other diseases diagnosed by a doctor (heart disease, high blood pressure, diabetes, depression, cancer, asthma, apoplectic stroke, and migraine) have been analyzed by Falk et al. (2014) for the year 2009. Note that the question in the SOEP relates to ever diagnosed and not to the current state of the disease. Consequently, fixed effects models would not be very meaningful. Moreover, the timing of events is unknown, i.e., the wage might have been or not been perceived as unfair, when the sleep disorder has been diagnosed, but not anymore at the time of the interview.

be shortly discussed along with the results for the different outcomes of sleep in the next section. For all outcomes three specifications are estimated. All specifications include a dummy variable that takes the value one if the own wage is perceived as unfair and zero otherwise[7], the real hourly net wage in Euros (base year 2006, consumer price index), real monthly net household income in 1000 Euros (base year 2006, consumer price index), and actual weekly working hours. About 38.5 percent of the observations in the pooled sample perceive their wage as unfair. The average hourly wage is about 9.6 Euros (SD = 5.11) and the average monthly household income is about 3010 Euros (SD = 1708.04). Actual working hours are on average 39.4 hours per week (SD = 10.63).

The control variables in the first specification include dummy variables for being female and having children under 16 in the household, the number of persons in the household, 5 marital status categories, a German citizenship dummy, secondary schooling degrees, apprenticeship degree, university degree, age in years, tenure in years, experience part-time employment in years, experience full-time employment in years, experience unemployment in years, 11 job categories, 7 firm size categories, 62 sectors (NACE), 16 federal states, and the survey years.[8] In the second specification, the subjective health status (5 categories) is added as control variable. According to Falk et al. (2014), the subjective health status is negatively affected by unfair wage perceptions so that the inclusion as control variable is likely to absorb part of the effect of unfair wages and other variables on sleep. Nevertheless, this check allows to analyze if unfair wage perceptions affect sleep even after controlling for differences in subjective health status. The third specification for every sleep outcome takes into account the panel nature of the data by the inclusion of person specific fixed-effects or by estimating random-effects models in order to mitigate biases due to unobserved heterogeneity. Also note that the panel nature of the data is further taken into account by clustering the standard errors at the individual level in all regressions.

3. Regression Analysis

The number of hours of sleep is estimated by using ordinary least squares (OLS) and Poisson models, because the dependent variable is a count variable. In order to make the estimated coefficients comparable between both models, the log of the number of hours of sleep serves as dependent variable in OLS. Thus, the coefficients of the OLS and of the Poisson models can be interpreted as relative changes. An advantage of the OLS over the Poisson model is

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[7] The corresponding question asked to the respondents in the SOEP is: “Is the income that you earn at your current job just, from your point of view?”.

[8] The complete regression results and descriptive statistics for the control variables can be requested from the author.

that OLS can take into account person specific fixed-effects directly, whereas the Poisson model uses a conditional fixed-effects estimator.

The results for sleep during the workweek are presented in Table 1. Let us at first turn to the OLS results for sleep during the workweek. The first specification without controlling for the subjective health status indicates that workers, who perceive their own wage as unfair, sleep on average about 2.5 percent less during the workweek, which are about 10 minutes less sleep per night.[9] The coefficient for the hourly wage has a negative sign, which accords with the expectation that the wage is an opportunity cost of sleeping, and the coefficient for the monthly household income has a positive sign, which is in line with the income effect. But the coefficients are neither significant for the hourly wage nor for the household income. Workers with more working hours sleep significantly less during the workweek. Sleep during the workweek is on average about 0.19 percent lower for workers who work one hour more per week, which corresponds with about one percent less sleep for one hour more work per day under the assumption of a five-day week. The results change only slightly by the inclusion of subjective health as additional control variable in the second specification. Unfair wage perceptions are correlated with 2 percent and one more working hour with 0.18 percent less sleep. The hourly wage and the household income have the expected signs but are not significant. In the third specification, individual fixed-effects are included to deal with potential unobserved heterogeneity such as stable sleep preferences and different biological sleep needs. The effect size of unfair wages and working hours is reduced to 1.3 percent for unfair wages and to 0.13 percent for one working hour. But both are still of statistical significance, whereas the hourly wage and the household income have again the expected signs and are not significant. The Poisson regressions, which take explicitly into account that the dependent variable is a count variable, support the OLS results with respect to effect size and statistical significance. Overall, the results indicate that unfair wage perceptions significantly reduce sleep during the workweek by 1.2 to 2.5 percent, which has about the same size as 10 working hours more per week or 2 working hours more per day under the assumption of a five-day week.

A further robustness check is performed by using a dummy variable that takes the value one if a person sleeps between 7 and 9 hours and zero if a person sleeps less or more hours.[10] The binary character of reporting a mid-

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[9] The average relative effects in percent can be used to compute the average time in minutes by multiplying the relative effect by the mean number of sleeping hours and then by 60 minutes (e.g., $0.025 \times 6.822 \times 60 = 10.233$ minutes).

[10] Even though the use of midrange sleep is quite common in the health literature, two sensitivity checks have been performed. First, I have used a different definition of the outcome variable, namely sleep at least 7 hours. Second, observations with sleep of ten hours or more have been dropped from the estimation sample. The results have virtually not changed.

Table 1

Hours of Sleep During Workweek

	OLS (coefficients): log number of hours			Poisson (coefficients): number of hours			Probit (average mfx): 7 ≤ hours sleep ≤ 9		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Sleep during workweek									
Unfair wage (dummy)	–0.025	–0.020	–0.013	–0.023	–0.018	–0.012	–0.071	–0.056	–0.065
(Mean = 38.5 %)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.008)	(0.008)	(0.010)
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
Hourly wage (Euros)	–0.0001	–0.0002	–0.0004	–0.0001	–0.0002	–0.0003	–0.001	–0.001	–0.002
(Mean = 9.6 Euros; SD = 5.1)	(0.0004)	(0.0003)	(0.001)	(0.0003)	(0.0003)	(0.001)	(0.001)	(0.001)	(0.002)
	[0.676]	[0.553]	[0.475]	[0.719]	[0.606]	[0.557]	[0.401]	[0.328]	[0.199]
Monthly household income (1000 Euros)	0.001	0.0003	0.001	0.001	0.0001	0.001	0.005	0.003	0.007
(Mean = 3.010 *1000 Euros; SD = 1.708)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)
	[0.197]	[0.699]	[0.729]	[0.319]	[0.860]	[0.707]	[0.095]	[0.319]	[0.113]
Actual weekly working hours	–0.002	–0.002	–0.001	–0.002	–0.002	–0.001	–0.006	–0.005	–0.007
(Mean = 39.4 hours; SD = 10.6)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.001)	(0.001)	(0.001)
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
Control variables without health	Yes	No	No	Yes	No	No	Yes	No	No
Control variables with health	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Fixed-effects	No	No	Yes	No	No	Yes	No	No	No
Random-effects	No	No	No	No	No	No	No	No	Yes
R^2, log likelihood	0.050	0.072	0.030	–36151.48	–36126.22	–13332.35	–11501.08	–11341.42	–10469.00
Mean (SD) dependent variable	1.909	1.909	1.909	6.822	6.822	6.822	0.654	0.654	0.654
	(0.155)	(0.155)	(0.155)	(0.987)	(0.987)	(0.987)			

Notes: SOEP 2009 / 2011 / 2013. Number of observations is n = 18,485 for N = 10,277 individuals in an unbalanced panel T = 1.8. Identification of fixed-effects OLS and Poisson models only for individuals with T ≥ 2 (n = 13547, N = 5339, T = 2.5). The probit model in (3) is a random-effects estimator. For the computation of the average marginal effects a mean random-effect of zero is assumed. Robust standard errors clustered at individual level in parentheses and p-values in squared brackets. R^2 for OLS and log likelihood for Poisson and probit models. The control variables include dummy variables for being female and having children under 16 in the household, the number of persons in the household, 5 marital status categories, a German citizenship dummy, secondary schooling degrees, apprenticeship degree, university degree, age in years, tenure in years, experience part-time employment in years, experience full-time employment in years, experience unemployment in years, 11 job categories, 7 firm size categories, 62 sectors (NACE), 16 federal states, the survey years, and the subjective health status (5 categories).

range sleep is taken into account by using probit models. In order to facilitate the interpretation of the results, average marginal effects are presented. If a worker perceives his wage as unfair, the probability of reporting a midrange sleep during the workweek is about 7 percentage points (0.071/0.654 = 10.8 percent) lower in the first specification, about 5.6 percentage points (0.056/0.654 = 8.6 percent) lower in the second specification and about 6.5 percentage points (0.065/0.654 = 9.9 percent) lower in the third specification, which uses a random-effects probit estimator. The hourly wage rate and the household income have again the expected signs, but are not significant. The weekly working hours are negatively correlated with the probability of reporting a midrange sleep. Ten working hours more per week reduce the probability by about 5.5 to 7 percentage points, which is comparable in size with the unfair wage effect.

The results for sleep during the weekend in Table 2 reveal some interesting differences to sleep during the workweek. The unfair wage effect is significantly smaller and not statistically significant in the fixed-effects models. In the pooled OLS and Poisson regressions for sleep during the weekend, the size of the unfair wage coefficients is less than half of the coefficients for sleep during the workweek. The average marginal effects in the probit models are also significantly smaller. They indicate only a 1 to 2 percentage points (1.5 to 2.5 percent) lower probability of reporting a midrange sleep during the weekend, if a worker perceives the wage as unfair. The hourly wage is positively but not significantly correlated with sleep during the weekend. The household income is positively and in most regressions also significantly correlated with sleep during the weekend, which indicates that the income effect is stronger on sleep during the weekend than during the workweek. Weekly working hours are not significantly correlated with the number of hours of sleep during the weekend in the OLS and Poisson models. In the probit models, weekly working hours have still a significant and negative effect on reporting a midrange sleep, which is however only a third of the size of the effect during the workweek. Overall, the results indicate that workers' sleep seems to be primarily negatively affected by work-related characteristics during the workweek and not so strongly during the weekend.

In the next step, workers' satisfaction with sleep is analyzed, which combines the quantitative and the qualitative dimensions of sleep. The literature about the determinants of satisfaction has shown that the cardinality or ordinality assumption is not crucial so that OLS is appropriate (Ferrer-i-Carbonell/Frijters, 2004). Of larger concern is unobserved heterogeneity that might bias the results so that the use of person specific fixed-effects is considered as important when analyzing satisfaction. The regression results are presented in Table 3. The first specification indicates that satisfaction with sleep is about 0.35 points (0.348/6.914 = 5 percent) lower if a worker perceives the wage as unfair, whereas the hourly wage itself is not significantly correlated with sleep satisfaction. The household income has a rather small effect, as 1000 Euros more monthly

Table 2

Hours of Sleep During Weekend

	OLS (coefficients): log number of hours			Poisson (coefficients): number of hours			Probit (average mfx): $7 \leq$ hours sleep ≤ 9		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Sleep during weekend									
Unfair wage (dummy)	–0.011	–0.008	0.001	–0.010	–0.007	0.001	–0.020	–0.013	–0.011
(Mean = 38.5 %)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.007)	(0.007)	(0.006)
	[<0.001]	[0.009]	[0.791]	[<0.001]	[0.013]	[0.768]	[0.003]	[0.057]	[0.070]
Hourly wage (Euros)	0.0002	0.0001	0.0003	0.0001	0.0001	0.0003	0.002	0.002	0.001
(Mean = 9.6 Euros; SD = 5.1)	(0.0004)	(0.0004)	(0.001)	(0.0004)	(0.0003)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.691]	[0.776]	[0.635]	[0.693]	[0.769]	[0.630]	[0.222]	[0.255]	[0.124]
Monthly household income (1000 Euros)	0.003	0.002	0.002	0.002	0.002	0.002	0.007	0.005	0.005
(Mean = 3.010 *1000 Euros; SD = 1.708)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
	[0.002]	[0.011]	[0.318]	[0.003]	[0.015]	[0.286]	[0.018]	[0.054]	[0.046]
Actual weekly working hours	–0.0002	–0.0002	0.0002	–0.0001	–0.0001	0.0001	–0.002	–0.002	–0.002
(Mean = 39.4 hours; SD = 10.6)	(0.0002)	(0.0002)	(0.0004)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0004)	(0.0004)
	[0.244]	[0.369]	[0.661]	[0.491]	[0.643]	[0.678]	[<0.001]	[<0.001]	[<0.001]
Control variables without health	Yes	No	No	Yes	No	No	Yes	No	No
Control variables with health	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Fixed-effects	No	No	Yes	No	No	Yes	No	No	No
Random-effects	No	No	No	No	No	No	No	No	Yes
R^2, log likelihood	0.058	0.069	0.034	–37982.52	–37968.46	–14071.22	–8764.55	–8687.35	–8358.07
Mean (SD) dependent variable	2.070	2.070	2.070	8.026	8.026	8.026	0.805	0.805	0.805
	(0.164)	(0.164)	(0.164)	(1.225)	(1.225)	(1.225)			

Notes: SOEP 2009/2011/2013. Number of observations is n = 18,485 for N = 10,277 individuals in an unbalanced panel T = 1.8. Identification of fixed-effects OLS and Poisson models only for individuals with $T \geq 2$ (n = 13547, N = 5339, T = 2.5). The probit model in (3) is a random-effects estimator. For the computation of the average marginal effects a mean random-effect of zero is assumed. Robust standard errors clustered at individual level in parentheses and p-values in squared brackets. R^2 for OLS and log likelihood for Poisson and probit models. The control variables include dummy variables for being female and having children under 16 in the household, the number of persons in the household, 5 marital status categories, a German citizenship dummy, secondary schooling degrees, apprenticeship degree, university degree, age in years, tenure in years, experience part-time employment in years, experience full-time employment in years, experience unemployment in years, 11 job categories, 7 firm size categories, 62 sectors (NACE), 16 federal states, the survey years, and the subjective health status (5 categories).

household income is only correlated with 0.05 points more satisfaction with sleep. Weekly working hours are significantly and negatively correlated with sleep satisfaction. If we compare the coefficients for unfair wages and working hours, the unfair wage effect has approximately the same size as working 38 hours more per week. In the second specification, which controls additionally for the health status, the size of the estimated coefficients is significantly reduced. The unfair wage effect is only –0.14 points (0.142/6.914 = 2 percent) and the effect for one additional working hour per week is only –0.007 points. Thus, the unfair wage effect has approximately the same size as working about 20 hours more per week. Neither the coefficient for the hourly wage nor the coefficient for the household income are significant. In the third specification,

Table 3

Satisfaction with Sleep

	OLS (coefficients): satisfaction with sleep (0–10)		
	(1)	(2)	(3)
Unfair wage (dummy)	–0.348	–0.142	–0.089
(Mean = 38.5 %)	(0.040)	(0.035)	(0.047)
	[<0.001]	[<0.001]	[0.061]
Hourly wage (Euros)	0.002	0.0001	0.004
(Mean = 9.6 Euros; SD = 5.1)	(0.005)	(0.005)	(0.011)
	[0.653]	[0.985]	[0.727]
Monthly household income (1000 Euros)	0.045	0.014	0.006
(Mean = 3.010 *1000 Euros; SD = 1.708)	(0.014)	(0.013)	(0.026)
	[0.001]	[0.284]	[0.818]
Actual weekly working hours	–0.009	–0.007	–0.008
(Mean = 39.4 hours; SD = 10.6)	(0.002)	(0.002)	(0.004)
	[<0.001]	[0.002]	[0.057]
Control variables without health	Yes	No	No
Control variables with health	No	Yes	Yes
Fixed-effects	No	No	Yes
R^2	0.043	0.213	0.078
Mean (SD) dependent variable	6.914	6.914	6.914
	(2.150)	(2.150)	(2.150)

Notes: SOEP 2009/2011/2013. Number of observations is n = 18,485 for N = 10,277 individuals in an unbalanced panel with T = 1.8. Identification of fixed-effects model only for individuals with T ≥ 2 (n = 13547, N = 5339, T = 2.5). Robust standard errors clustered at individual level in parentheses and p-values in squared brackets. The control variables include dummy variables for being female and having children under 16 in the household, the number of persons in the household, 5 marital status categories, a German citizenship dummy, secondary schooling degrees, apprenticeship degree, university degree, age in years, tenure in years, experience part-time employment in years, experience full-time employment in years, experience unemployment in years, 11 job categories, 7 firm size categories, 62 sectors (NACE), 16 federal states, the survey years, and the subjective health status (5 categories).

person specific fixed-effects are added. The unfair wage effect is further reduced to –0.09 points (0.089/6.914 = 1.3 percent). The effect for one additional working hour per week is –0.008 points so that the unfair wage effect has approximately the same size as working about 10 hours more per week. The coefficients for the hourly wage and for the household income are again not significant. Overall, the results indicate that the satisfaction with sleep is negatively affected by unfair wage perceptions and by working more hours, but not significantly affected by the hourly wage and the household income.

At last, sleep disorders diagnosed by a doctor are analyzed. The binary character of having a sleep disorder is taken into account by using probit models. In order to facilitate the interpretation of the results, average marginal effects are presented in Table 4. Workers, who perceive their wage as unfair, have a

Table 4

Sleep Disorder Diagnosed by Doctor

	Probit (average mfx): sleep disorder diagnosed		
	(1)	(2)	(3)
Unfair wage (dummy)	0.025	0.013	0.005
(Mean = 38.9%)	(0.005)	(0.005)	(0.002)
	[<0.001]	[0.006]	[0.031]
Hourly wage (Euros)	–0.001	–0.0004	–0.0002
(Mean = 9.7 Euros; SD = 5.3)	(0.001)	(0.001)	(0.0003)
	[0.421]	[0.543]	[0.462]
Monthly household income (1000 Euros)	–0.003	–0.0002	–0.0001
(Mean = 3.0163 *1000 Euros; SD = 1.788)	(0.002)	(0.002)	(0.0001)
	[0.201]	[0.908]	[0.882]
Actual weekly working hours	0.0003	0.0002	0.0001
(Mean = 39.3 hours; SD = 10.5)	(0.0003)	(0.0003)	(0.0001)
	[0.268]	[0.535]	[0.398]
Control variables without health	Yes	No	No
Control variables with health	No	Yes	Yes
Random-effects	No	No	Yes
log likelihood	–3076.63	–2849.94	–2932.27
Mean dependent variable	0.069	0.069	0.069

Notes: SOEP 2011/2013. Number of observations is n = 13,040 for N = 8,824 individuals in an unbalanced panel with T = 1.5. The probit model in (3) is a random-effects estimator. For the computation of the average marginal effects a mean random-effect of zero is assumed. Robust standard errors clustered at individual level in parentheses and p-values in squared brackets. The control variables include dummy variables for being female and having children under 16 in the household, the number of persons in the household, 5 marital status categories, a German citizenship dummy, secondary schooling degrees, apprenticeship degree, university degree, age in years, tenure in years, experience part-time employment in years, experience full-time employment in years, experience unemployment in years, 11 job categories, 7 firm size categories, 62 sectors (NACE), 16 federal states, the survey years, and the subjective health status (5 categories).

2.5 percentage points (0.025 / 0.069 = 36 percent) higher probability to have a diagnosed sleep disorder in the first specification. The inclusion of the subjective health status in the second specification reduces the unfair wage effect to 1.3 percentage points (0.013 / 0.069 = 19 percent). In the random-effects probit model in the third specification, the unfair wage effect is 0.5 percentage points (0.005 / 0.069 = 7 percent). In none of the specifications, hourly wages, household income or working hours are significantly correlated with a diagnosed sleep disorder.

In order to check the sensitivity of the results, several robustness checks have been performed with respect to the specifications. At first, I have re-estimated all regressions once without the unfair wage variable and once without the hourly wage variable. The results do not change notably, i.e., the unfair wage is still significantly and the hourly wage is still not significantly correlated with the sleep outcomes when not controlling for the other. Moreover, the results do not change notably if the logs of hourly wage and of household income are used instead of their real monetary values in Euros. I have also added squared and cubed terms of working hours, which are not statistically significant and do not change the results. Furthermore, I have re-estimated all regressions separately for men and women, which does not indicate noteworthy differences with respect to the variables of interest. At last it should be mentioned that all fixed-effects OLS models have been tested against their random-effects counterparts. The Hausman specification tests have rejected the null hypothesis that the random-effects estimator is consistent for all comparisons so that only fixed-effects OLS models have been presented in this paper.

Although the results are quite robust, the estimated parameters are not necessarily causal effects. The inclusion of person specific fixed-effects deals with unobserved time invariant heterogeneity such as personality traits. But unobserved time variant heterogeneity might still bias the results. An example might be an occurring mental disorder during the observation period that is not completely controlled for by the subjective health status variable. A more crucial problem might be reverse causality, i.e., a worse sleep could increase the subjective perception of being unfairly paid. In order to deal with such a reverse causality issue, future research is needed, which might use natural experiments or convincing instrumental variables that affect the fairness perceptions of pay.

4. Conclusion

The empirical analysis has shown that workers, who perceive their own wage as unfair, sleep significantly less, are significantly less satisfied with their sleep and are significantly more likely to have sleep disorders diagnosed by a doctor. Moreover, workers with more weekly working hours sleep significantly less during the workweek and are significantly less satisfied with their sleep. The hourly wage is however not significantly correlated with any of the sleep outcomes in any regression and the household income seems also of minor importance, even though the estimated coefficients have the expected signs implied by substitution (opportunity cost of sleep) and income effects. Thus, it seems as if the fairness perception of the wage is more important than the size of the wage. Fairness perceptions themselves do not simply depend on the size of the wage but also on procedural justice aspects such as communication of the rationales behind and employee participation in the wage setting process (e.g., Pfeifer, 2014; Schneck, 2014). Consequently, firms have the chance to influence the fairness perceptions of wages by engaging in procedural justice activities that might not increase labor costs as much as potential wage increases in order to accomplish the same fairness level.

The overall findings support the idea that fairness perceptions are important determinants of workers' sleep that in turn affects workers' health and productivity. The estimation of different specifications has further shown that controlling for workers' health status absorbs part of the unfair wage effect, which indirectly indicates a negative correlation between unfair wage perceptions and subjective health status as discussed in Falk et al. (2014). The differences between sleep during the workweek and during the weekend further suggest that workers' sleep seems to be primarily affected by work-related characteristics such as unfair wages and working hours during the workweek and not during the weekend. An implication of this finding is that leisure time at the weekend is necessary for workers in order to recover from work stress during the workweek.

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