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Do working hours affect health? Evidence from statutory workweek regulations in Germany

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ABSTRACT

This study estimates the causal effect of working hours on health. We deal with the endogeneity of working hours through instrumental variables techniques. In particular, we exploit exogenous variation in working hours from statutory workweek regulations in the German public sector as an instrumental variable. Using panel data, we run two-stage least squares regressions controlling for individual-specific unobserved heterogeneity. We find adverse consequences of increasing working hours on subjective and several objective health measures. The effects are mainly driven by women and parents of minor children who generally face heavier constraints in organizing their workweek.

1. Introduction

Recent decades witnessed a general trend towards shorter working hours. Between 1970 and 2015, OECD countries experienced a decrease in the average working time by approximately 11% (OECD, 2017).[1] This declining trend is to some extent induced by legal workweek reductions, usually introduced to mitigate unemployment with the argument of work-sharing among workers (e.g., Goux et al., 2014; Hunt, 1999). A further important motivation for a shorter workweek is to protect and improve the quality of life and health of workers (Lee et al., 2007).

A crucial question from a policy perspective is whether and how working time actually affects health. On the one hand, extensive literature documents strong links between long working hours and chronic diseases, unhealthy behaviors, such as smoking and alcohol consumption, and poor mental health (e.g., Ahn, 2015; Llena-Nozal, 2009; Virtanen et al., 2012). So far, however, the majority of empirical studies have yielded only correlational evidence about this issue. On the other hand, related research emphasizes that health and well-being suffers from underemployment and particularly unemployment (e.g., Aghion et al., 2016; Cygan-Rehm et al., 2017; Winkelmann and Winkelmann, 1998; Wunder and Heineck, 2013), as well.

Identifying the causal effect of working hours on health is particularly challenging due to the endogeneity of working time. Causal evidence from quasi-experimental designs is still scarce. Notable exceptions are Ahn (2015) and Berniell and Bietenbeck (2017) who exploit legislative changes in the standard workweek in Korea and France, respectively. While both studies conclude about adverse health consequences of additional working hours, their focus is predominantly on health-related behaviors (e.g., smoking, physical activity, body mass index). Related research points to positive effects of statutory workweek reductions on workers' satisfaction from life, job and leisure (e.g., Hamermesh et al., 2014; Lepinteur, 2016), but none of the studies provides evidence on the potential impact on health-related well-being.

This study extends the literature on the link between working hours and health by investigating the causal effects on a wide range of subjective and objective health outcomes. Subjective measures, such as self-assessed health (SAH) or satisfaction with own health, provide valuable insights into short-term effects because they might respond more quickly to changes in working time than objective indicators, such as the frequency of doctor visits or sickness absence from work. Our identification strategy exploits various moderate increases and decreases in the statutory workweek in the German public sector, which create substantial variation in working hours over time, across federal states, and employee groups. We merge individual-level data from the German Socio-Economic Panel (SOEP) with state-level information on the statutory workweek length for the period between 1985 and 2014. Following Ahn (2015), we exploit the panel dimension of our data and the exogenous variation in workweek regulations by combining the fixed-effects and instrumental variable techniques. Our main contribution is to provide a comprehensive picture of the causal impact of working time on

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[1] Average annual working hours decreased from 1,982 in 1970 to 1,766 in 2015 across OECD countries.

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various dimensions of health. Nevertheless, our large data set allows us also to shed more light on whether the effects differ for men and women as often suggested in earlier research (e.g., Sparks et al., 1997).

We find that a one-hour increase in the statutory workweek significantly raises individuals' working hours, on average, by almost half an hour per week, thereby providing a relevant instrument. Our results show that an increase in working time negatively impacts health along various dimensions. Specifically, one extra hour of work deteriorates SAH by nearly 2% and raises the number of doctor visits by about 13%, which points to considerable health care costs. These effects are highly robust in alternative specifications testing the validity of the key identifying assumption. We also detect corresponding adverse effects on satisfaction with own health and sickness absence. In contrast, we do not find any compelling evidence for substantial effects on health-related behaviors such as physical activity or smoking habits. Following earlier research, we test for potentially heterogeneous effects across gender. This analysis reveals that the negative health responses to longer working hours are mainly driven by women, which might be consistent with female workers being more time constrained due to family responsibilities (e.g., Goux et al., 2014). To shed more light on this issue, we also split the sample by the presence of children. Indeed, we find more pronounced effects among individuals living with minors in the household, which might be related to the complexity of reconciling longer working hours and parenting (Paull, 2008). We conclude that the adverse consequences of increased working hours on health are mainly driven by workers who already face heavy time constraints in organizing their workweek.

The paper proceeds as follows. Section 2 summarizes prior findings on the link between working hours and health. Section 3 gives relevant institutional details. Section 4 introduces our empirical strategy and Section 5 describes our data. Section 6 shows our results and discusses their robustness. Section 7 concludes.

2. Literature

This paper builds on an extensive literature investigating the role of working hours in determining health and well-being. However, the understanding of the causal effects is still limited as the research to date is often based on cross-sectional data and only recently longitudinal data. Only few authors apply quasi-experimental designs. This section starts with a concise overview of previous evidence on the effects of working hours on objective health outcomes and health-related behaviors. We then turn to findings on measures of subjective health and well-being.

In general, numerous studies show that long working hours are significantly related to adverse health outcomes such as cardiovascular diseases, diabetes, disability retirement, and poor physical health (e.g., Amagasa and Nakayama, 2012; Virtanen et al., 2012). Van der Hulst (2003) provides a systematic review of the medical and psychological literature. More recently, an extensive meta-analysis by Kivimaki et al. (2015) concludes that the association between long working hours and coronary heart disease is rather weak, but workers with long working hours have a significantly higher probability of stroke than those working standard hours. Using pooled cross-sectional data for 15 European countries, Cottini and Lucifora (2013) show further that working more than 40 h per week is strongly related to a higher probability of mental health problems. The authors estimate also probit IV regressions, which yield that demanding job characteristics lead to worse mental health. However, the IV analysis aggregates an indicator for working long hours and six other job characteristics into a summary measure of job demands, thereby providing limited insights into a separate causal effect of working hours on health.

A meta analysis by Sparks et al. (1997) investigates the effects of working hours on both physiological and psychological health. Their findings support a statistically significant correlation between long working hours and ill-health, though small in magnitude. The authors argue that risky behaviors such as smoking and drinking represent an important mechanism through which adverse health effects occur. Later research generally confirms the relationship between such maladaptive behaviors and long working hours (e.g., Taris et al., 2011; Xu, 2013).

Notable exceptions contributing quasi-experimental evidence for the effect of working hours on health provide Ahn (2015) and Berniell and Bietenbeck (2017). Both studies focus on health-related behaviors and exploit variation from a four-hour reduction in the workweek standard in Korea (from 44 to 40) and France (from 39 to 35), respectively. By combining the fixed-effects and IV approaches, Ahn (2015) shows that one additional working hour increases the incidence of smoking by 2.4% (compared to the sample mean), which is driven by men. He also finds a similarly sized reduction in the probability of exercising regularly, mainly among women, and substantial decreases in drinking participation regardless of gender. Berniell and Bietenbeck (2017) use a difference-in-differences strategy and focus only on male workers with close to full-time working hours. They confirm that increasing working time raises smoking probability; the relative effect size is 4–7% per additional hour of work. Further results suggest also small adverse effects on self-reported health and BMI, but the estimates are imprecise due to a small sample. While applying a similar empirical strategy as Ahn (2015), we contribute new encompassing evidence on the causal impact of working hours on health by investigating a wide range of objective and subjective outcome measures.

Turning to prior findings on the effects of working hours on subjective well-being, the research largely focuses on job-related satisfaction and documents a negative relationship with longer working hours (e.g. Clark et al., 1996; Fahr, 2011; Sousa-Poza and Sousa-Poza, 2003). A related strand of literature yields similar results for life satisfaction (e.g. Pouwels et al., 2008), though Rätzel (2012) finds rather an inverted U-shaped pattern suggesting that longer working hours benefit workers as long as working hours are not too long. While his fixed-effects approach captures unobserved time-invariant heterogeneity, the estimates might be biased by time-varying shocks and reverse causality. Few studies address the endogeneity issue by exploring legislated reductions in working hours. Hamermesh et al. (2014) find increased life satisfaction among affected workers in Japan and Korea. Similarly, Lepinteur (2016) shows that reduced workweek significantly improves job and leisure satisfaction in France and Portugal. Using the same changes in statutory workweek in the German public sector as we do, Collewet and Loog (2015) find suggestive evidence of an inverted U-shaped effect of working hours on life satisfaction. However, none of the quasi-experimental studies provides evidence on the potential effects of working time on health-related well-being.

3. Institutional background

In 2015, the German public sector employed more than 4.5 million people (DESTATIS, 2015), which accounted for 11% of the total labor force. The size of the public sector has remained relatively constant since the considerable downsizing due to the privatization of railways and postal services in the mid 1990s (e.g., Derlien et al., 2005). Nearly 96% of public employment is concentrated around two status groups: civil servants (*Beamte*) and public employees (*Angestellte*).[2]

Civil servants account for about 36% of the total public sector employment (DESTATIS, 2015). They enjoy a special legal status that historically and functionally derives from their specific service and loyalty relationship with the state defined by the German Basic Law (Art. 33) (Hammerschmid et al., 2013). Civil servants are appointed by public law, usually for lifetime, and their rights and duties are governed by the Parliament (*Bundestag*). Another implication of the special loyalty to the

[2] The remaining 4% comprise judges, state attorneys, members of the Federal Government, and soldiers who in the legal sense, are not civil servants. However, given that they enjoy similar rights, most statistics treat them equivalently to civil servants.

Table 1
Selected characteristics of public sector employment.

	Civil servants	Public employees
Administrative level:		
Federal	11%	5%
State	76%	38%
Local (municipalities)	11%	45%
Indirect public service	2%	12%
Female	50%	63%
Part time	24%	39%
Age	44.2	44.9
Monthly gross earnings in EUR	3,660[a]	2,880
Total number:	1,671,010	2,808,190

Source:DESTATIS (2015).
[a] *Note:* includes salaries of judges, state attorneys, and regular soldiers.

state is the ban on strikes for civil servants, which intends to ensure uninterrupted and reliable functioning of the public administration (e.g., BMI, 2014).

With employment share of 60% (DESTATIS, 2015), public employees are the largest group in the public sector. They work under private law contracts, so that they underlie the same general labor law as private sector employees. Specific working conditions of this group are set out in collective agreements negotiated between the public employers and the responsible labor unions. In contrast to civil servants, public employees do not enjoy protection from job transfers between agencies or services of the same employer under the existing contract (e.g., BMI, 2014).

In practice, the distinction between civil servants and public employees has converged in many aspects. For example, the position of public employees is both secure and of equal status with that of civil servants (BMI, 2014). Both groups exhibit low intersectoral mobility (Derlien, 2008). Both civil servants and public employees work for public employers at different administrative levels: federal, state, or local (municipalities and rural districts). In addition, several legally independent administrative bodies such as the German Central Bank and various social insurance agencies (e.g., the Federal Employment Agency) form the indirect public service. Each authority has a certain scope for decisions about the extent to which its staff consists of civil servants and public employees (BMI, 2014).

Table 1 summaries the distribution of the civil servants and public employees across the various levels of administration and highlights some average characteristics of the two status groups. The majority of civil servants (76%) are employed at the state level, while the public employees are concentrated among the state (38%) and the local (45%) level of government. The gender ratio is balanced among the civil servants and skewed towards a higher percentage of women (63%) among the public employees. The gender composition to some extent might explain the higher incidence of part-time employment among the public employees. With average gross monthly salaries of 3,600 euro, civil servants earn more than public employees (2880 euro).

The different legal status of civil servants and public employees implies that the statutory working hours differ across the two status groups. The working conditions of civil servants are determined by the public law at the federal and state level, depending on the employer.[3] The procedure to change the respective bill is initiated once the collective agreement has been reached for public employees. These agreements are negotiated between the public employers at different levels and the responsible labor unions (BMI, 2014).

Since mid1980′s, both status groups experienced several changes in the statutory working hours. Panel A in Table 2 shows the regulations for civil servants employed at different administrative levels. These numbers apply to full-time employment and are proportionately binding for part-time contracts. We observe a substantial variation over time and across states. Overall, the working time decreased systematically from 40 to 38.5 h between 1985 and 1991. Afterwards, we observe step-wise increases, even up to 42 h in Bavaria and Hesse. However, in 2011 and 2012, the Bavarian parliament reduced the workweek standard for civil servants to 41 and finally 40 h again. Panel B in Table 2 describes the development of statutory workweek for public employees. There is less variation given that only since November 2006, the working time regulations differ across states.

4. Empirical strategy

This paper investigates the causal effect of working hours on health. Standard OLS regressions yield biased estimates for the effect of interest if unobserved factors correlate with both working hours and health outcomes. To identify the causal effect, we apply a two-stage least squares (2SLS) approach. We use changes in the statutory workweek in the German public sector as a source of exogenous variation in working hours and estimate the following two-equations model:

$$y_{it} = \beta h_{it} + \mathbf{x}_{it}{}'\gamma + \alpha_i + \epsilon_{it}, \tag{1}$$

$$h_{it} = \pi hs_{it} + \mathbf{x}_{it}{}'\delta + \mu_i + \upsilon_{it}. \tag{2}$$

y is the health outcome of individual i at time t. h denotes working hours and $\mathbf{x}$ is a vector of observed socio-economic characteristics. The variable hs refers to the statutory working hours. α_i and μ_i represent individual-specific time-invariant factors. π, δ, β, and γ are the parameters to be estimated, where the coefficient π gives the direct (first-stage) effect of workweek regulations on labor supply. υ and ϵ represent error terms. The working hours predicted from the first-stage Eq. (2) enter subsequently the regression in Eq. (1). Given that our instrumental variable hs corresponds to an interaction term between an individual's status group, state of residence, and the interview's year and month, the main effects of these variables are included as a set of indicator variables in $\mathbf{x}$ in all regressions.

Our empirical strategy combines panel data techniques with the instrumental variables (IV) approach. The key identifying assumptions are the relevance and the exogeneity of the instrument. We test the relevance condition in Section 6. The exogeneity assumption is satisfied if the instrument is unrelated to ϵ. Thus, under the exclusion restriction, workweek regulations affect health only via their effect on labor supply. Since the changes in working hours for civil servants are decreed by public law, the instrument is highly unlikely to correlate with any unconsidered factors that affect both working intensity and health outcomes. For public employees, the working conditions are a result of collective agreements. We argue that the potential influence of an individual's preference on the final agreement is negligible, so that we view the standard workweek for this group also as largely exogenous. We discuss potential threats to the exclusion restriction in Section 6.3. Under the relevance and the exogeneity assumptions, the main parameter of interest β identifies the "total" effect of increased working hours on health. It incorporates any potential channels through which increased working time might affect health such as, e.g., changes in worker's tasks and pressure at work. Due to data limitations, we cannot investigate the relative role of various channels.

5. Data

We combine individual-level data on employees' characteristics and working hours with state-level information on the statutory workweek length from Table 2. Individual-level information comes from the German Socio-Economic Panel (SOEP) for years from 1985 through 2014 (SOEP, 2016). The SOEP is a longitudinal survey of private households conducted annually since 1984 (Wagner et al., 2007). The data provide

[3] Nevertheless, state parliaments need to follow framework provisions, issued at the federal level, which specify the basic structures of legislation related to civil servants employed by state and local authorities (BMI, 2014).

Table 2
Standard workweek hours in the German public sector since 1985.

Administrative level	'85-'88	'89	'90	'91-'93	'94-'95	'96	'97	'98-'00	'01	'02	'03	'04	'05	'06-'07	'08-'09	'10-'11	'12	'13-'14
Panel A: Civil servants																		
Federal	40	40	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	40[10]	40	41[3]	41	41	41	41
Baden-Wurttemberg	40	39[4]	38.5[4]	38.5	38.5	40[10]	40	40	40	40	41[9]	41	41	41	41	41	41	41
Bavaria	40	39[4]	38.5[4]	38.5	40[1]	40	40	40	40	40	40	42[9]	42	42	42	42	41[8]	40[8]
Bremen	40	39[4]	38.5[4]	38.5	38.5	38.5	40[4]	40	40	40	40	40	40	40	40	40	40	40
Hamburg	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	40[8]	40	40	40	40	40	40	40	40
Hesse	40	40	40	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	42[1]	42	42	42	42	42	42
Lower Saxony	40	39[4]	38.5[4]	38.5	38.5	40[4]	40	40	40	40	40	40	40	40	40	40	40	40
North Rhine-Westphalia	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	41[1]	41	41	41	41	41	41
Rhineland-Palatinate	40	39[4]	38.5[4]	38.5	38.5	38.5	40[1]	40	40	40	40	40	40	40	40	40	40	40
Saarland	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	40[1]	40	40	40	40	40	40	40	40	40
Schleswig-Holstein	40	40	38.5[4]	38.5	39.5[1]	39.5	39.5	39.5	39.5	40[1]	40	40	40	41[8]	41	41	41	41
Local (municipalities)	See standard workweek as in the respective federal state.																	
Panel B: Public employees																		
Federal	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39[10]	39	39	39	39	39
Baden-Wurttemberg	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39.5[11]	39.5	39.5	39.5	39.5
Bavaria	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	40.1[11]	40.1	40.1	40.1	40.1
Bremen	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39.2[11]	39.2	39.2	39.2	39.2
Hamburg	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39[11]	39	39	39	39
Hesse	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	40[1]	40	40
Lower Saxony	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39.8[11]	39.8	39.8	39.8	39.8
North Rhine-Westphalia	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39.84[11]	39.84	39.84	39.84	39.84
Rhineland-Palatinate	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39[11]	39	39	39	39
Saarland	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	39.5[11]	39.5	39.5	39.5	39.5
Schleswig-Holstein	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.7[11]	38.7	38.7	38.7	38.7
Local (municipalities)	40	39[4]	38.5[4]	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38-40[4]*	39[7]	39	39	39

Source: In Panel A, the information about the standard workweek hours of civil servants are collected from the administrative orders of the respective federal states (*Arbeitszeitverordnungen*) and from dbb (2017). The data in Panel B are from DESTATIS (2017b) and Bispinck et al. (2017).
Note: The superscripts denote the months in which the changed workweeks became effective. *The range and timing varies across the states.

detailed information on individuals' socio-demographic characteristics and employment including working hours. Public sector employees also report their current status group. We restrict the sample to civil servants and public employees living in West Germany because the former German Democratic Republic (GDR) is not in the data before 1990 and there is no variation in the standard workweek across the East German states. We focus on the core labor force ages between 25 and 50 to ensure that individuals completed their education and are not yet affected by early-retirement programs. Moreover, in some states, there are specific working time regulations for older employees.

The SOEP provides rich information on health outcomes such as individuals' satisfaction with health, SAH, number of doctor visits, number of days absent from work due to sick leave, number of nights spent in hospital, and summary measures for mental and physical health.[4] In supplementary analyses, we consider also health-related behaviors, such as physical activity, body mass index (BMI), and smoking. Unfortunately, several of the health measures are not available for the entire analyzed period. Thus our sample sizes vary across outcomes. Table A.1 in the appendix defines the health variables and shows their availability over time. The variable satisfaction with health is available for every survey year and thus determines our largest sample.

Our main explanatory variable of interest is the number of hours actually worked per week, which includes any overtime. Further, we assign to each individual the information on the standard working hours from Table 2 depending on the current status group (Panel A or B), the date of the interview (year and month), and the federal state of residence.

Unfortunately, the SOEP does not provide information on the state of the workplace, which might introduce some imprecision in linking the state-level information on standard workweek hours to the respondents.[5] However, this measurement error should be small as only 6% of employees in Germany cross the state boarder on their way to work (DESTATIS, 2017a). The SOEP does also not ask respondents about the administrative level of the public employer. Thus, we assume that all individuals work for the states, so that our instrument does not perfectly match the standard workweek for individuals employed at the federal and municipality level. Nevertheless, Table 2 suggests that in many cases the changes in working hours across the levels were parallel. For example, the regulations for civil servants (Panel A) employed by municipalities match the standard workweek in the respective federal state, so that for this group, we do not have any measurement error in the instrument due to the missing information on the administrative level. For public employees (Panel B), until October 2005, the standard workweek changes affected equally all administrative levels. From October 2005 until April 2006, 38.5 working hours still applied to all states and municipalities. Thus, for more than two-thirds of our observation period, the missing information on the administrative level does not lead to measurement error also for this group. Importantly, even a nonclassical measurement error in the instrument does not bias our final results because it should simultaneously attenuate the first-stage and the reduced-form coefficients and these biases cancel out in the IV estimate (e.g., Pischke and von Wachter, 2008).

In addition to individuals' working time, we make use of information on the relevant socio-economic characteristics such as age, education, marital status, number of children, tenure, and labor income. We excluded about 3% of observations because of missing information on the key variables, or because they were still in education, or held an additional job. Our final sample comprises nearly 27,500 observations on approximately 6,500 individuals. Panel A of Table A.2 in the appendix provides summary statistics for the health outcomes and Panel B for the main covariates. Given the panel structure of the data, we also provide several measures of workers' mobility in Panel C.

Our focus on public sector workers might raise the question of selectivity of our sample. We thus also compared our sample to the remaining workers employed in the private sector. We found no clear patterns indicating a positive or negative selection with respect to health outcomes. Specifically, individuals in our sample report by 13% more doctor visits and days of sick leave compared to private sector workers. We found no significant differences across the groups for the remaining health outcomes we focus on in Section 6.2, though public sector workers live a slightly healthier lifestyle (have lower weight, smoke less, and do more sports). We acknowledge that those differences might limit simple extrapolations of our findings to other institutional settings.

Table 3
Effect of standard workweek on actual working hours (first stage).

	(1)	(2)	(3)
Panel A: Fixed effects			
Standard workweek	0.478***	0.432***	0.457***
	(0.141)	(0.104)	(0.102)
F statistic	11.5	17.2	20.2
Panel B: Random effects			
Standard workweek	0.449***	0.392***	0.444***
	(0.133)	(0.093)	(0.090)
Chi-square statistic	11.5	17.9	24.2
Year, month, state, civil servant	x	x	x
Job characteristics		x	x
Demographic characteristics			x
Observations		27,484	
Persons		6,660	

Notes: The first stage corresponds to estimating equation 2 with FE or RE, respectively. Job characteristics comprise tenure (in months), indicator variable for part-time employment, gross labor income. Demographic characteristics include age, education (years), number of children, indicator for marital status. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.

6. Results

6.1. First-stage effect of statutory workweek on actual working hours

We first investigate the first-stage relationship between the endogenous variable actual working hours and our instrument by estimating Eq. (2). Panels A and B in Table 3 show the first-stage results from fixed-effects (FE) and random-effects (RE) regressions, respectively. Column 1 starts with a specification that controls only for indicators for the year and month of interview, state of residence, and the current status group because our instrument is an interaction term of these variables. We then step-wise adjust for job-related characteristics and socio-demographic covariates in columns 2 and 3. In both panels, the estimates vary only slightly across columns, suggesting that the changes in statutory workweek were largely independent of observable characteristics. Nevertheless, we follow the most conservative approach and include all covariates in the subsequent IV regressions. Comparing the estimates across panels, we find that RE models yield slightly lower and more precisely estimated first-stage coefficients compared to FE, but the magnitude of the effects is comparable across panels; an one-hour extension of standard workweek increases the actual working time on average by roughly 0.45 h. The first-stage F and χ^2-square statistics generally confirm the relevance of the instrument in our main sample.

[4] The Mental Health Component Summary Scale and Physical Health Component Summary scales capture various domains of psychological and physical health. The two measures are calculated using exploratory factor analysis based on a standard 12-item short-form (SF-12) health survey. The details are provided by Andersen et al. (2007).

[5] Although the SOEP asks respondents for their commuting behavior (e.g., frequency, distance in km), this information does not allow us to infer in which state the workplace is located.

Table 4
The effect of an one-hour increase in working hours on health.

	Fixed effects			Random effects				
	Estimated effect	First stage		Estimated effect	First stage			
Outcome	(FE-IV)	Coefficient	F stat.	(RE-IV)	Coefficient	χ^2	# nT	# n
Satisfaction with health	−0.107	0.457***	20.2	−0.128**	0.444***	24.2	27,484	6,660
	(0.069)	(0.102)		(0.064)	(0.090)			
Self-assessed health (SAH)	−0.059*	0.450***	18.7	−0.071**	0.454***	23.7	22,640	5,987
	(0.035)	(0.104)		(0.032)	(0.093)			
No. of doctor visits (last 3 months)	0.290*	0.427***	17.5	0.361**	0.425***	22.0	26,049	6,514
	(0.155)	(0.102)		(0.146)	(0.091)			
No. of days of sick leave (current year)	1.432	0.371***	12.0	1.903*	0.379***	15.7	22,859	5,688
	(1.363)	(0.107)		(1.147)	(0.096)			
No. of nights spent in hospital (current year)	0.524	0.396***	14.2	0.419	0.402***	18.2	23,868	5,781
	(0.369)	(0.105)		(0.266)	(0.094)			
Mental health summary scale	−2.035*	0.420***	6.9	−1.239*	0.371***	7.2	7,163	3,508
	(1.211)	(0.160)		(0.699)	(0.138)			
Physical health summary scale	0.046	0.420***	6.9	−0.221	0.371***	7.2	7,163	3,508
	(0.551)	(0.160)		(0.447)	(0.138)			

Notes: The first stage corresponds to estimating equation 2 with FE or RE, respectively. All regressions include indicators for state, year, month of interview, and civil servant, job and demographic characteristics as in Table 3. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.

6.2. Effect of working hours on health

Table 4 shows our main regression results for the effect of working hours on various health outcomes. Each estimated effect is from a separate 2SLS regression. All regressions include the full set of covariates (i.e. indicator variables for state, year and month of interview, civil servant, job characteristics, and demographic characteristics). The differences between the FE and RE results are practically negligible as the point estimates are of similar magnitude, with overlapping 95% confidence intervals. Although the RE estimates are more efficient, our interpretation focuses predominantly on the more conservative FE results, which rely on weaker assumptions.

Overall, the results suggest that increasing working time has adverse effects on subjective health. Although the FE-IV estimate of the effect on health satisfaction of 0.11 slightly misses the 10% level of significance, it indicates that one additional working hour leads to a decline in health satisfaction by more than 1.5%, evaluated at the sample mean of 7.2 (see Table A.2). The significant estimate for SAH shows a similar effect size, as SAH decreases by about 0.06 scale points, which translates to a 1.6% reduction compared to the sample mean. For comparison, Berniell and Bietenbeck (2017) find a relative effect size on self-reported health of less than 1%. Putting our effect magnitude into a broader perspective, it is approximately equivalent to a decline in subjective health assessment associated with ageing from 40 to 41.3 i.e., by 1.3 years.[6]

Considering objective health indicators, we find further evidence for adverse health effects of an additional working hour. The number of doctor visits in the last three months raises by about 0.29, which translates to a sizable increase of 13% compared to the mean of 2.3 visits. This finding suggests that longer working hours lead to considerable costs for health insurers. The results for the effect on the number of days absent from work due to sick leave corresponds to a similar relative increase (13%) and is comparable to the effect of aging from 40 to 43.1 years. However, the point estimate is statistically insignificant in the FE estimation. The effect on hospitalizations is also imprecisely estimated, but its direction points to adverse health consequences of increased working hours as well.

Finally, the results for the summary scales suggest that it is mental health that suffers from longer working hours rather than physical health. However, the considerably reduced samples challenge the estimates. Given that the first-stage F- and χ^2-statistics are below ten for these outcomes, we interpret the significant effect on mental health with caution as it might be biased due to the weak instrument problem. Fortunately, the remaining effects of working hours on subjective and objective health measures discussed above do not suffer from this concern, as the first-stage results support the relevance of our instrument.

For comparison, we present the estimates from alternative empirical approaches in Table A.4 in the appendix. The OLS results in column 1 suggest that longer working hours are significantly related to worse outcomes in most of the analyzed health dimensions. While the OLS regressions completely ignore the endogeneity of working intensity, the FE estimates in column 2 account for any unobservable time-constant factors and mostly yield smaller and insignificant coefficients. A brief comparison with our main FE-IV findings from Table 4 suggests that the simple FE estimates are biased towards zero due to time-variant heterogeneity. Finally, the standard IV estimates in column 3 in Table A.4 in the appendix underpin our main conclusions about the adverse causal effects of working hours on SAH and the number of doctor visits. The pooled IV approach provides also a significant increase in the sickness absence. The similar findings from the FE-IV and IV estimations support the exogeneity of the changes in statutory workweek. We still prefer the FE-IV approach, which is more conservative.

We also investigate the effects of working hours on other health-related outcomes available in the SOEP such as weight, BMI, physical activity, smoker status, and the number of cigarettes smoked per day. Table A.3 in the appendix reports the results. The 2SLS point estimates are generally small and insignificant throughout. The results for responses in weight and BMI might be to some extent driven by a weak instrument problem, but the first-stage F-statistic for physical activity and smoking probability are satisfactory. Thus, in contrast to the Korean study by Ahn (2015), we do not find any evidence that increasing working time substantially affects health-related behaviors.

So far, we have assumed that the effects of working time emerge already in a short-run and are constant across working hours. To investigate whether the main results in Table 4 hide important non-linear or delayed effects, we considered a lagged and quadratic specification for working hours, respectively. For the latter, we use the square of the fitted value from the first stage regression of actual hours on standard hours as an additional instrument (see Wooldridge, 2010, p. 267). None

[6] Our regressions include a second-order polynomial of age. This example refers to the partial effect of age on SAH for a 40-year-old person.

Table 5
Heterogeneous effects of working hours on health.

	Estimated effect		First stage			
Outcome	(FE-IV)	Coefficient	F stat.	Mean	# nT	# n
Panel A: men						
Satisfaction with health	−0.064	0.466***	14.0	7.22	12,127	2,717
	(0.092)		(0.124)			
Self-assessed health (SAH)	−0.026	0.403***	10.6	3.67	9537	2,361
	(0.051)		(0.124)			
No. of doctor visits (last 3 months)	0.137	0.409***	10.8	1.85	11,440	2,665
	(0.183)		(0.125)			
No. of days of sick leave (current year)	0.860	0.370***	8.3	9.73	10,056	2,313
	(1.794)		(0.128)			
No. of nights spent in hospital (current year)	0.670	0.362***	8.2	0.80	10,487	2,349
	(0.661)		(0.126)			
Panel B: women						
Satisfaction with health	−0.117	0.476***	9.1	7.15	15,357	3,943
	(0.098)		(0.158)			
Self-assessed health (SAH)	−0.092*	0.507***	10.1	3.62	13,103	3,626
	(0.050)		(0.160)			
No. of doctor visits (last 3 months)	0.399*	0.471***	8.8	2.62	14,609	3,849
	(0.238)		(0.159)			
No. of days of sick leave (current year)	1.784	0.417**	6.1	11.52	12,803	3,375
	(1.723)		(0.169)			
No. of nights spent in hospital (current year)	0.300	0.467***	8.0	1.17	13,381	3,432
	(0.318)		(0.165)			
Panel C: without children ($\leq$ 16 years of age)						
Satisfaction with health	−0.228	0.364**	5.0	7.15	12,460	3,574
	(0.162)		(0.162)			
Self-assessed health (SAH)	−0.272	0.160	0.9	3.64	9,994	3,083
	(0.330)		(0.170)			
No. of doctor visits (last 3 months)	0.668	0.338**	4.2	2.42	11,742	3,497
	(0.462)		(0.166)			
No. of days of sick leave (current year)	1.007	0.310*	3.1	11.37	10,312	3,067
	(2.572)		(0.176)			
No. of nights spent in hospital (current year)	1.462	0.313*	3.5	1.15	10,776	3,114
	(1.303)		(0.167)			
Panel D: with children ($\leq$ 16 years of age)						
Satisfaction with health	-0.169*	0.506***	13.0	7.20	15,024	4,191
	(0.094)		(0.140)			
Self-assessed health (SAH)	-0.065*	0.577***	15.9	3.64	12,646	3,799
	(0.037)		(0.145)			
No. of doctor visits (last 3 months)	0.317*	0.483***	11.7	2.17	14,307	4,101
	(0.188)		(0.141)			
No. of days of sick leave (current year)	2.153	0.428***	8.3	10.21	12,547	3,606
	(1.799)		(0.149)			
No. of nights spent in hospital (current year)	0.063	0.468***	10.1	0.88	13,092	3,669
	(0.341)		(0.147)			

Notes: The first stage corresponds to estimating equation 2 with FE. All regressions include indicators for state, year, month of interview, and civil servant, job and demographic characteristics as in Table 3. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.

of the regressions yielded evidence that our main model specification is too restrictive and we thus do not report the alternative results.[7]

Earlier research frequently found substantial differences in the relationship between working hours and health for men and women (e.g., Sparks et al., 1997), which might be due to gender-specific labor supply patterns, health behaviors, or traditional family roles. Thus, we next investigate whether our main results also cover potentially heterogeneous effects for men and women. We focus here on the more conservative FE-IV estimates, but the corresponding RE-IV regressions are even more precisely estimated and lead to similar conclusions. Table 5 documents the results.

Panels A and B suggest that there are substantial gender-specific differences in the effects of working time on health. Generally, the point estimates tend to be more pronounced for women compared to men. In particular, the statistically significant coefficients for the effect of SAH and the number of doctor visits are roughly three times larger for women than for men. For a 40-year-old woman, these effect sizes are approximately equivalent to a decline in SAH associated with aging by two years and an increase in doctor visits corresponding to ten additional age years. We relate the estimated effect sizes to the corresponding sample means for men and women because the health outcomes might differ across gender.[8] By doing so, we calculate that one working hour increases the number of doctor visits by 15% for women and 7% for men. The relative effect sizes on SAH are 2.5% and 0.7%, respectively. Hence, the gender-specific heterogeneity in the health effects of working time are substantial even after adjusting for average level differences in the outcomes. Note that for most outcomes, the sample split still yields a reasonable F-statistic, so that the small and insignificant 2SLS coefficients for men are not due to a weak first stage.

[7] Even if the linear model is misspecified, it yields a consistent estimate of a weighted average of all per-unit effects (see, e.g., Angrist and Imbens, 1995; Lochner and Moretti, 2015).

[8] For example, women tend to report poorer health than men (e.g., Idler, 2003). The gender difference in SAH might be partly explained by gender-specific reporting behavior (e.g., Schneider et al., 2012).]

Table 6
Robustness analyses.

Outcome	Estimated effect (FE-IV)	First stage Coefficient	F stat.	Mean	# nT	# n
Panel A: control variables excluded						
Satisfaction with health	−0.102	0.478***	11.5	7.18	27,484	6,660
	(0.070)		(0.141)			
Self-assessed health (SAH)	−0.064	0.423***	8.5	3.64	22,640	5,987
	(0.041)		(0.145)			
No. of doctor visits (last 3 months)	0.285*	0.444***	10.0	2.28	26,049	6,514
	(0.162)		(0.141)			
No. of days of sick leave (current year)	1.490	0.361**	5.9	10.73	22,859	5,688
	(1.462)		(0.148)			
No. of nights spent in hospital (current year)	0.577	0.374***	6.6	1.00	23,868	5,781
	(0.424)		(0.145)			
Panel B: stayed in federal state						
Satisfaction with health	−0.110	0.458***	20.0	7.18	27,263	6,631
	(0.070)		(0.102)			
Self-assessed health (SAH)	−0.058*	0.456***	19.0	3.64	22,447	5,961
	(0.034)		(0.105)			
No. of doctor visits (last 3 months)	0.286*	0.428***	17.4	2.28	25,838	6,488
	(0.155)		(0.103)			
No. of days of sick leave (current year)	1.628	0.374***	12.0	10.70	22,678	5,670
	(1.343)		(0.108)			
No. of nights spent in hospital (current year)	0.502	0.404***	14.6	1.01	23,679	5,764
	(0.362)		(0.106)			
Panel C: stayed in status group						
Satisfaction with health	−0.135*	0.445***	18.9	7.17	27,110	6,645
	(0.075)		(0.102)			
Self-assessed health (SAH)	−0.067*	0.429***	16.6	3.64	22,317	5,970
	(0.038)		(0.105)			
No. of doctor visits (last 3 months)	0.345**	0.409***	15.8	2.29	25,690	6,497
	(0.172)		(0.103)			
No. of days of sick leave (current year)	1.633	0.346***	10.2	10.78	22,541	5,670
	(1.512)		(0.108)			
No. of nights spent in hospital (current year)	0.532	0.378***	12.7	1.01	23,534	5,764
	(0.386)		(0.106)			
Panel D: stayed in work						
Satisfaction with health	−0.121	0.433***	18.2	7.18	26,552	6,439
	(0.075)		(0.102)			
Self-assessed health (SAH)	−0.062	0.419***	16.1	3.64	21,862	5,789
	(0.038)		(0.104)			
No. of doctor visits (last 3 months)	0.322*	0.396***	15.1	2.22	25,176	6,303
	(0.173)		(0.102)			
No. of days of sick leave (current year)	0.791	0.344***	10.4	10.19	22,108	5,502
	(1.269)		(0.106)			
No. of nights spent in hospital (current year)	0.152	0.370***	12.5	0.86	23,006	5,561
	(0.241)		(0.105)			
Panel E: stayed in public sector						
Satisfaction with health	−0.146*	0.401***	15.4	7.18	25,550	6,131
	(0.083)		(0.102)			
Self-assessed health (SAH)	−0.073*	0.384***	13.7	3.65	20,928	5,473
	(0.043)		(0.104)			
No. of doctor visits (last 3 months)	0.323*	0.372***	13.2	2.28	24,215	6,000
	(0.184)		(0.102)			
No. of days of sick leave (current year)	2.178	0.323***	9.0	10.72	21,285	5,214
	(1.653)		(0.107)			
No. of nights spent in hospital (current year)	0.675	0.352***	11.1	0.99	22,171	5,280
	(0.439)		(0.106)			
Panel F: restricted time period (1994 - 2011)						
Satisfaction with health	-0.084	0.401***	14.0	7.16	17,678	4,800
	(0.091)		(0.107)			
Self-assessed health (SAH)	-0.062	0.398***	13.8	3.64	17,663	4797
	(0.043)		(0.107)			
No. of doctor visits (last 3 months)	0.407**	0.399***	13.9	2.21	17,632	4,796
	(0.200)		(0.107)			
No. of days of sick leave (current year)	1.509	0.299***	7.2	10.32	15,178	4,098
	(2.039)		(0.111)			
No. of nights spent in hospital (current year)	0.432	0.334***	9.2	0.89	16,033	4,179
	(0.343)		(0.110)			

Notes: The first stage corresponds to estimating equation 2 with FE. All regressions include indicators for state, year, month of interview, and civil servant, job and demographic characteristics as in Table 3. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.

Although the standard errors reflect some uncertainty in our estimates, we interpret the emerged patterns for both subjective and objective health outcomes as indicative of larger health effects of working hours among women compared to men. The larger negative consequences of longer working hours for women's health are consistent with the common finding that women are more constrained by family responsibilities than men (e.g., Goux et al., 2014). Since women's workforce participation is considered as a stressor that affects health and well-being (e.g., Bratberg et al., 2002; Williams and Kurina, 2002), we expect that the dual role in home and paid work is a potential moderator of the gender-specific effect of long working hours.

To further investigate this issue, in Panels C and D, we split the sample by the presence of children under the age of 16 in the household. While it might appear high, this age threshold is particularly relevant as parenting is not limited to childcare during preschool age. In contrast, school attendance might be associated with additional parental time demands and the complexity of organizing care around normal school hours (Paull, 2008). Notably, in Germany, the school day traditionally ends at lunchtime and formal after-school care is less available than full-time kindergarten slots (Gambaro et al., 2016).[9] The estimates in Panel C for individuals without dependent children suggest no significant effects of extended working hours on subjective health outcomes. However, all F-statistics for this group fall far below ten, thereby pointing to a relatively weak first stage. Therefore, the corresponding FE-IV estimates in the first column should be read with caution as they might suffer from bias due to the weak instrument problem. Panel D generally confirms negative effects on subjective health measures and the number of doctor visits for individuals who live with at least one minor child in the household. Importantly, these effects do not suffer from a weak first stage and their magnitude is somewhat stronger compared to the effects for the full sample in Table 4. Only the estimated (insignificant) effect on the number of nights spent in a hospital is substantially smaller in magnitude. This finding might appear surprising given the evidence for several negative effects in other dimensions. A potential explanation could be that parents generally do not extend their hospital stays (whether necessary or not) because e.g., a longer time out of home might go along with the effort of re-organizing childcare arrangements within the household. Overall, the heterogeneity analysis suggests that longer working hours have adverse health consequences especially for individuals who already face tight time constraints outside work.

6.3. Robustness

In this section, we test the sensitivity of our main results to sample and specification changes. The identifying assumption underlying our main estimates is that unobserved characteristics are uncorrelated to the timing of the changes in the statutory workweek. We thus start with providing evidence that our instrument is not systematically related to observed job-related and demographic characteristics. To do so, we drop these covariates from the estimations in Panel A in Table 6 where we still control for an individual-specific fixed effect. Comparing the results from the models with and without control variables, we find no notable differences in the magnitude of the point estimates. The virtually unchanged estimates support the argument that *observable* individual characteristics are largely orthogonal to our instrument. Nevertheless, comparing the standard errors, we conclude that our main specification in Table 4, which includes the controls, yields clear efficiency gains.

The identifying assumption would be also violated in the presence of self-selection into different workweek regimes; for example, if individuals move to another federal state or change the status group to obtain the preferred workweek standard. Regional mobility is rare because only about 0.8% of the individuals in our sample lived in another state previous year. Relatively uncommon are also transfers to the other status group as they affect only 1.4% of our sample, while the typical transition is from public employee to civil servant status and not the other way around. In Panels B and C of Table 6, we test whether our main findings are robust to excluding the movers from the analysis and obtain nearly identical results.

Our identification strategy would also fail if our sample was biased due to selective job changes into the private sector or even moving out of the labor force. We observe that 7% of observations move into private sector jobs and 3.4% out of labor force in the following year. We test whether this future leaving of the public sector affects our main result by dropping the leavers. Panels D and E in Table 6 illustrate that our estimates remain robust, which implies that switching sectors is not endogenously related to our instrument.

Finally, we examine to what extent the effects depend on the analyzed time period and on the definition of the instrument. Specifically, as shown in Table 2, standard workweek hours gradually decreased from 1985 up to early 1990s. In contrast, starting from 1994, standard workweek has been generally extended, save for the most recent reductions for civil servants in Bavaria in 2012 and 2013. Unfortunately, we cannot directly compare whether the effects generated by increasing and decreasing workweek standards are symmetric because the sample size for the latter is too small. Instead, we repeat the estimations using a sample restricted to the period of workweek extensions i.e., 1994–2011. Panel F of Table 6, demonstrates that despite the reduced sample size, these estimates support our main results. Thus, indirectly we find no evidence against the hypothesis of symmetric effects.

7. Conclusions

This paper estimates the causal effect of working hours on health. Prior research has largely produced ambiguous results. Moreover, most of the previous evidence is based on observational studies that do not take account of the endogeneity of labor supply. In contrast, we contribute causal evidence by exploiting exogenous variation in working hours from changes in the statutory workweek regulations in the German public sector. Specifically, we use the statutory workweek as an instrumental variable and estimate two-stage least squares regressions controlling for individual-specific unobserved factors.

We find that longer working hours are detrimental for health. In particular, our results show that an increase in working time leads to lower satisfaction with own health, a decline in self assessed health (SAH), and a higher number of doctor visits. While the estimated deterioration of subjective health (satisfaction and SAH) is rather moderate (less than 2%), the relative increases in the number of doctor visits of about 13% directly translates into considerably higher health care costs. We argue that working hours affect health particularly through increased time pressure, particularly outside of the workplace. Three findings support this interpretation. First, adverse health responses are more pronounced among women and parents of minor children who generally face tight time constraints in organizing the workweek (e.g., Goux et al., 2014; Paull, 2008). Second, extended working hours seem to deteriorate rather mental health and not the physical health. Third, we do not find any evidence that the negative health effects emerge from adjustments in health-related behaviors such as physical activity or smoking habits.

Our results on the heterogeneous effects have immediate relevance for policies designing working time arrangements for modern workplaces. Current demographic trends, advances in technology, and requirements of the global economy raise the demand for labor from underexploited resources, particularly among women and parents. While the optimal design of family-work policies remains a much disputed issue within politics and research (e.g., Blau and Kahn, 2013), so far, the debate has largely ignored the potentially detrimental health effects of increasing labor supply among the target groups. It remains open for further research whether, for example, flexible working time arrange-

[9] We also considered lower age thresholds e.g, six, which corresponds to preschool children. We do not report these results as they suffered from a weak fist stage, which considerably limited the interpretation of the 2SLS estimates.

ments might mitigate the negative health effects of extended working time.

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Supplementary material

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