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Using the life satisfaction approach to value daylight savings time transitions. Evidence from Britain and Germany

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Abstract

Daylight savings time (DST) represents a public good with costs and benefits. We provide the first comprehensive examination of the welfare effects of the spring and autumn transitions for the UK and Germany. Using individual-level data and a regression discontinuity design, we estimate the effect of the transitions on life satisfaction. Our results show that individuals in both the UK and Germany experience deteriorations in life satisfaction in the first week after the spring transition. We find no effect of the autumn transition. We attribute the negative effect of the spring transition to the reduction in the time endowment and the process of adjusting to the disruption in circadian rhythms. The effects are particularly strong for individuals with young children in the household. We conclude that the higher the shadow price of time, the more difficult is adjustment. Presumably, an increase in flexibility to reallocate time could reduce the welfare loss for individuals with binding time constraints.

JEL classification: H41, I31

Keywords: daylight savings time, life satisfaction, regression discontinuity, UK, Germany.

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1 Introduction

"... [this great reform] enlarge[s] the opportunities for the pursuit of health and happiness among the millions of people who live in this country."
— Winston Churchill, *1934*

Transitions in and out of daylight savings time (DST) are a common but widely disputed practice in many countries. DST represents a public good with costs and benefits. On the one hand, the benefits of DST may contribute to people's welfare, most importantly through energy savings. Further benefits may arise from an increase in effective time available for daylight activities that can be extended to the early evening, such as outdoor sports activities. On the other hand, transitions in and out of DST generate costs which decrease people's welfare. Such costs are particularly caused by the reallocation of time following the change in the total time endowment and the adjustment process in the aftermath of the disruption to the normal circadian rhythms.

To assess whether DST is a useful measure that contributes to the overall welfare of the population, costs have to be weighed against benefits. Previous economic research focused on potential benefits from DST. Studies examine, for instance, the effects of DST on energy savings, road or workplace accidents, and health (for an overview, see Section 2). However, there is no systematic inquiry of private costs and benefits resulting from the reallocation of time and the adjustment processes. In consequence, we have no clear knowledge of what the welfare effects of DST transitions are and how high the costs for private households are.

This paper aims at valuing transitions in and out of DST to assess the short-term net effects on people's welfare. The welfare effects of DST transitions are, however, difficult to quantify because preferences for DST cannot directly be observed. In particular, revealed preference methods can obviously not be applied to valuing DST transitions because households do not make a decision about whether and how much DST to use. Since DST affects all households in the same way, there is no behavioural choice.

This paper takes up the life satisfaction approach (LSA) to valuing DST transitions (Frey et al., 2009). The LSA offers two options to assess public goods. First, it allows to evaluate welfare effects directly in terms of life satisfaction (or utility). Here, the approach refers to recent developments in the economics of happiness and uses reported life satisfaction as an approximation for individual utility (see, e.g., Kahneman et al., 1997; Frey and Stutzer, 2002; Kahneman and Sugden, 2005). Technically, the LSA includes the public good as an explanatory variable in a life satisfaction regression and interprets the estimated coefficient as the marginal utility of the public good. Second, with income as an additional covariate in the regression, we are able to calculate the marginal rate of substitution between income and the public good. This allows us to calculate net costs of DST transitions in monetary terms. Examples for studies that use the LSA to value the externalities of public goods include applications to airport noise (Van Praag and Baarsma, 2005), air pollution (Welsch, 2006), or the welfare effects of the Euro cash changeover (Wunder et al., 2008). To the best of our knowledge, Kountouris and Remoundou (2014) is the only study that examines the effects of DST on life satisfaction.[1]

The valuation of DST transitions is important for a number of reasons. First, the change in the time endowment induces a reallocation of time. In particular, the transition to DST disrupts the circadian rhythms, i.e., the adaptation of the human rest-activity cycle with the earth's light-dark cycle, and thus also affects sleep patterns. From a public policy and health perspective, such disruptions may induce enormous societal costs, particularly in societies that suffer from chronic sleep-deprivations (Bonnet and Arand, 1995; Coren, 1997). For instance, Coren (1996b) argues that sleep insufficiencies represent a major public health issue as the sleep-related costs of accidents have been estimated to exceed $56 billion in 1988 alone (Leger, 1994). Furthermore, sleep research shows that even minor disruptions in circadian rhythms can cause mood disorders, attention deficits, and errors in judgement. Coren (1997) links sleep insufficiencies to catastrophes that have costly long-term negative externalities, such as the Exxon Valdez oil spill or the nuclear accident in Chernobyl. Second, the transition to DST biannually affects about 1.6 billion people (Kantermann et al., 2007), which are mainly located in Western industrialised countries. In addition to those directly affected, DST may even create

[1]The study investigates spring DST transition only and finds a negative effect of the transition, particularly for those in full-time employment.

negative externalities for individuals in countries without DST, for instance due to international trade. Indeed, Kamstra et al. (2000) show that DST negatively affects stock market returns in the US, UK, and Germany.

Using nationally representative survey data for Germany and the UK, we adopt a regression-discontinuity design and compare the average life-satisfaction of individuals just before and after DST transitions. Our paper makes the following contributions to the literature. First, we provide evidence on the effects of the transition on well-being in novel detail. Specifically, we use micro-data for two large European countries, the UK and Germany, and examine life satisfaction trajectories on a daily basis during the transition period. Second, we investigate the effects of both the beginning and the end of DST. Third, we examine heterogeneous effects for groups that we hypothesise to differ in their response to the transition. Fourth, we provide a back-of-the-envelope calculation to estimate the costs of the transition in terms of the compensating income variation.

Consistent with economic theories on the allocation of time, we demonstrate that the transition to DST reduces life satisfaction in the first week after the transition. Investigating the detailed effects for specific weekdays, we find negative effects on the days immediately after the transition. These results hold for both the UK and Germany. We show that DST effects are particularly large for individuals living with young children in the household, as predicted by theoretical considerations about time stress. Shifting the clocks back in autumn does not lead to changes in life satisfaction. Since the welfare effects of transitions to DST are significantly negative, we conclude that the short-term adjustment costs outweigh the short-term benefits.

The paper proceeds as follows. In Section 2, we review the literature on DST effects on different outcomes, and summarise findings from sleep research on the mechanisms, e.g., how DST affects sleep and functioning. Section 3 provides the theoretical framework that we use to derive our hypotheses. Section 4 discusses the empirical framework and identification strategy. In Section, 5 we describe the data sets and variables used in our analysis. Section 6 presents descriptive results and results from our multivariate regression analyses. The section also provides a number of sensitivity checks validating the robustness of our results. Section 7 concludes the paper with a summary of the main findings and further policy implications.

2 Previous literature

2.1 DST outcomes

In this section, we summarise the main findings from studies that examine the effects of DST transitions on various outcomes, including traffic accidents, workplace accidents, health outcomes, electricity usage, and financial markets.

The international evidence on the effect of DST on traffic accidents is mixed. Overall, most studies find a negative effect on the Monday following the spring transition, and no effect on the Monday following the autumn transition. Most studies do not examine the impact on other weekdays limiting the scope of their analysis. For the US, Ferguson et al. (1995) use data for 1987-1991 and compare the number of pedestrian fatalities due to motor vehicle accidents on the Monday before and after the DST transitions in spring and autumn. The study show that DST may decrease the amount of traffic accidents due to more daylight for both transitions. Using data from 1986-1995 and comparing traffic fatalities for the Mondays before and after the transition, Coren (1998) reports a significant increase in the number of traffic deaths of about 17% following the spring transition, but no significant effect for the autumn transition. Using data from 1975-1995, Varughese and Allen (2001) also report a significant increase in traffic deaths for the Monday following the spring transition, but also find an increase for the Sunday following the autumn transition. Coate and Markowitz (2004) examine the effect of DST using county-level data on hourly pedestrian and car occupant fatalities for the US between 1998 and 1999. The study highlights the importance of confounding light patterns that partially explain the changes in accidents following the DST transitions.

Outside the US, Coren (1996b) uses Canadian data on weekly traffic accidents from 1991-1992 and finds that the transition into DST increases the number of accidents by 8%. For the autumn transition, he finds no statistically significant effect on traffic accidents. Vincent (1998), however, updates the analysis using more data (1984-1993) and does not find an effect of either transition on collision rates. For Sweden, Lambe and Cummings (2000) examine traffic accidents for the period 1984 to 1995 on the Monday before and after the DST transitions. The authors find no statistically significant difference on the Monday following the transition.

Similarly, Lahti et al. (2010) find no effect of the DST transitions on traffic accidents using data for Finland from 1981 through 2006.

Examining administrative data on all accidental deaths in the US between 1986-1988, Coren (1996a) finds a significant increase in deaths (+6.6%) following the spring transition, but no significant change following the autumn transition. Holland and Hinze (2000) use data from 1990-1996 for the state of Washington and find an increase in the number of accidents in the construction sector on the Monday following the spring transition, although the study lacks precision. Examining workplace injuries in the US mining industry for the years 1983-2006, Barnes and Wagner (2009) find an increase in the number and severity of accidents on the Monday following the spring transition, but no effect following the autummn transition. Using data for Finland from 2002-2006, Lahti et al. (2011) find no effect on the number of workplace accidents.

A small literature investigates the effects of DST on health, particularly mental health and the incidence of acute myocardial infarctions (AMI). For instance, Shapiro et al. (1990) study the effect of daylight saving time on mental health using administrative data from Scotland for the years 1970-1987. Although previous research finds a strong correlation between disruptions of the circadian rhythm and depression (van Cauter and Turek, 1986), Shapiro et al. (1990) find no evidence for an increase in rates of incidence for different measures of mental health. Similarly, Lahti et al. (2008) find no effect of DST transitions on hospital treatments due to manic episodes in Finland for the years 1987-2003. For Australia, Berk et al. (2008) find a small increase in the number of suicides for males following the weeks after the transition into DST, but not for women.

For AMIs and using registry data for Sweden, Janszky and Ljung (2008) and Janszky et al. (2012) compare the daily incidence of AMIs during the week following the transition to the average daily incidences in the two weeks prior and after the transition. The studies find a significant increase in the week following the spring transition, particularly on Tuesday, and a significant decrease following the autumn transition the Monday but no other weekday. Following the same methodology, Jiddou et al. (2013) find a marginally significant increase in the incidence of AMIs in the week after the spring transition, but no significant effect after the autumn transition. The study finds the strongest increases on the Sunday and Tuesday in the week following the spring transition.

Finally, some literature examines the effects of DST on electricity usage, with ambiguous results summarised by Mirza and Bergland (2011). There is some literature examining the effects of DST on financial markets, with ambiguous results (e.g., see Kamstra et al., 2000, 2002; Pinegar, J. Michael, 2002; Gregory-Allen et al., 2010).

2.2 DST mechanisms

In this section we review some studies that examine two potential mechanisms through which the transition to DST may affect utility: sleep and the cognitive functioning of individuals.

First, only a few number of behavioural studies document the effects of the transition to DST on the duration and quality of sleep. First, Monk and Folklard (1976) study the autumn transition for a small sample (65 participants) in the UK. They find that individuals adapt to the transition within 5 days. The study also reports a slight increase in perceived alertness in the mornings following the transition. In a follow-up study, Monk and Aplin (1980) study both the spring and autumn transitions and find that waking-up times adapt within about one week from the transition. The study also documents different effects: whereas individuals reported lower mood on awakening and worse sleep quality following the spring transition, the study indicates positive effects on mood and sleep quality following the autumn transition.

For Finland, some research investigates the effects of the summer time transition on sleep duration (Lahti et al., 2006). The studies show that the summer time transitions decrease both the sleep duration and "efficiency" of participants.[2] Finally, Barnes and Wagner (2009) examine the effect of DST on sleep duration using nationally representative time-diary for the US. The study finds that individuals on average sleep 40 minutes less in the week following the spring transition, and no significant difference following the autumn transition, and that the sleep loss is greatest at the beginning of the week. The study highlights the similarity in disruptions to the circadian rhythm caused by DST and other disruptions, e.g. jet lags or rotating work shifts. That sleep patterns adjust more quickly to the autumn transition is consistent with evidence

[2]The study defines sleep efficiency as the ratio of actual sleeping time to total time in bed.

from studies examining the effects of jet lags (Klein et al., 1972; Monk et al., 2000; Flower et al., 2003). For instance, Waterhouse (2002) show that individuals find it easier to adjust to westward-shifts than to eastward-shifts, corresponding to the delays and advances in time associated with the autumn and spring transition, respectively. Lahti et al. (2011) argue that DST causes sleep disruptions that lead to symptoms, comparable to a minor jet-lag, such as fatigue, attention deficit, or decreased motivation.

Finally, some research suggests that a person's chronotype, i.e., a person's preference for performance of activities during the time of the day, affects the process of adaptation to the new schedule (Kantermann et al., 2007). The study finds that individuals' sleep and activity schedules adapt quickly after the autumn transition, but not after the spring transition, especially for late-chronotypes ("owls").

A large literature investigates the general relationship between sleep quantity and quality on human behaviour, particularly cognitive performance (see, e.g., Pilcher and Huffcutt, 1996; Harrison and Horne, 2000).[3] Indeed, many studies find evidence for an inverse relationship and link sleep insufficiencies to decreased attention and cognitive performance (Dijk et al., 1992; Beaumont et al., 2001; Caldwell et al., 2004; Falleti et al., 2003; Smith et al., 2002). Graeber (1994) provides evidence that sleep insufficiencies and disruptions of the circadian rhythm negatively affect cognitive functioning. Mitler et al. (1988) investigate how sleep insufficiencies contribute to errors in human performance and/or judgement and argue that even small disturbances in sleep cycles can increase the risk of accidents even for routine activities that may result in large catastrophes. In an experimental study, Maquet et al. (1997) find a positive effect of sleep on brain functioning and show that sleep deprivation has immediate effects on the brain's areas responsible for the management of emotions or decision-making processes. Maquet (2001), Peigneux et al. (2001), and Diekelmann and Born (2010) provide evidence linking sleep to learning and memory functioning, although the precise mechanisms are still not understood.

[3]For a recent review using neuroimaging to describe brain functioning during sleep, see Dang-Vu et al. (2007).

3 Hypotheses

In this section, we argue that DST transitions change individuals' time endowment and affect welfare (or utility) through a reallocation of time. We begin with a short review of the economic approach to model the allocation of time. After that, we formulate three hypotheses about how welfare may respond to DST transitions.

In his seminal work, Becker (1965) models the allocation of time as a utility maximisation problem. The key idea is that households maximise utility which they derive from basic commodities, such as "children, prestige and self esteem, health, altruism, envy and pleasures of the senses" (Becker, 1998, p. 8). Households use time and market goods to produce commodities. Therefore, economic models of the allocation of time use a time constraint in addition to a goods constraint.

The economic models of time have been applied to a wide range of questions concerning the allocation of time, most importantly to labour supply choices (for an overview, see, Killingsworth, 1983). As another example, Biddle and Hamermesh (1990) extend the theoretical framework and derive a demand function for sleep. Interestingly, Becker (1965) already assumed that households produce sleep which "depends on the input of a bed, house (pills?) and time" (p. 495). Thus, sleep can be interpreted as a commodity that directly enters the utility function as an additional argument.

Developing an economic theory of time stress, Hamermesh and Lee (2007) show that an increase in the total time endowment decreases the shadow price of time. Their theoretical model assumes, in contrast to our setting, that hours in the day are fixed. The authors argue that households may achieve higher efficiency in home production, e.g., through technological changes that allow a more efficient time use. Thus, technological change may relax an individual's time constraint due to an increase in effective time available for the production of commodities. Furthermore, the authors argue that time stress is positively related with the shadow price of time.

Our first hypothesis about the effect of DST transitions on utility derives from the real changes in time endowments (endowment effect). By moving clocks forward by one hour, the transition to DST reduces the total time available and tightens the time constraint. If we assume that hours of work are fixed in the short-term, the transition reduces the time available for producing household commodities, including sleep. In consequence, we hypothesise that transitions to DST lead to a decrease in utility due to the increase in the shadow price of time. In contrast, we expect that the transition from DST to standard time relaxes the time constraint. Moving clocks back by one hour reduces time stress, effectively decreasing the shadow price of time, and may lead to an increase in utility.

The endowment effect may occur on the day of the transition. In particular, daily activities, such as sleeping, are directly affected on the day of transition. Moreover, the endowment effect may affect the week of transition if households decide on the allocation of time on a weekly basis. For instance, if the change in the weekly total time endowment affects the weekly demand for sleep, we expect to see a disruption of the circadian rhythm. Empirical evidence for this shows that individuals require about 5-7 days to adjust to disruptions in their sleeping patterns (Monk and Folklard, 1976; Monk and Aplin, 1980). Thus, DST transitions will not only affect the day of transition, but are likely to have effects on the following weekdays until individuals have adapted and returned to a stable sleeping pattern. We therefore hypothesise that the endowment effect does not only affect the allocation of time and utility on the transition day, but also on the days following the transition.

The second hypothesis relates to another mechanism: DST may affect utility through the quantity of sunlight in the evening and the quality of leisure time. During the summer, the sunlight available in the evening is expected to relax the goods constraint, as households save energy. This effect can be viewed as an intended effect of DST. Furthermore, based on the model by Hamermesh and Lee (2007), an increase in the quantity of sunlight may relax an individual's time constraint by increasing the amount of effective time available for the production of commodities. Thus, once individuals have adapted their circadian rhythms, we hypothesise that individuals experience positive effects on utility due to the increase in daylight exposure following the transition to DST. Conversely, individuals experience negative effects due to the decrease in daylight exposure following the transition from DST to standard time.

Finally, our third hypothesis is about heterogeneous responses to DST transitions among population subgroups. Hamermesh and Lee (2007) predict that time stress is more prevalent in households with higher earnings and longer work hours or with longer hours in household production. Thus, we hypothesise that the effects of DST transitions are more pronounced for individuals with a higher shadow price of time. Although we cannot observe the shadow price of time, we argue that an individual's family and employment statuses are useful proxies to identify whether an individual has a particularly binding time constraint. These constraints, e.g., fixed waking up times due to work or childcare responsibilities, are likely to translate into higher shadow prices of time. Presumably, individuals in employment and / or with children have stricter time schedules, and a higher shadow price of time, compared to individuals not in employment and / or without children.[4] Hence, we hypothesise that the endowment effect is stronger for the employed and / or individuals with children due to more binding time constraints.

In addition, parents may experience spillover effects from their children. A large literature documents a negative association between children's sleep insufficiencies and levels of tiredness, focus of attention, emotional stability, and cognitive functioning (e.g., see Dahl, 1996; Buckhalt et al., 2007). Hence, we may expect that the spring transition to DST negatively affects children's circadian rhythms and that the effects will be felt by parents of young children.

4 Empirical framework and strategy

Our identification strategy mimics a natural experiment that exploits the transition to DST as an exogenous shock to individuals' time endowments. Similar to a regression discontinuity design, our identifications strategy assumes that individuals are randomly interviewed just before (i.e., the control group) and just after (i.e., the treatment group) the transition date. Hence, identification of average effects requires comparing mean outcomes of individuals just before and after the transition. The main assumption underlying the identification strategy is that the interview date is random, i.e., that unobserved determinants of individuals' well-being do not systemat-

[4]Some literatures also shows that individuals in employment and / or with children have higher sleep deficits. For both mothers and fathers, Gay et al. (2004) documents the increased fatigue and sleep loss after child birth. For workers, Roenneberg et al. (2004) show that working people on average accumulate a sleep deficit during the week, and catch up on lost sleep during on weekends.

ically correlate with the transition week. Although Taylor (2006) shows that individuals have preferences over the weekday of the interview, we argue that it is unlikely that individuals systematically favour being interviewed before or after the DST transition based on unobservables. Moreover, interviews are scheduled well in advance and we observe individuals within a short time window around the transition date.

To check the plausibility of the identification strategy, we first evaluate the randomisation property by comparing individuals from the control and treatment groups on characteristics that may correlate with well-being. We run two different tests: first, we run the equivalent of a t-test by regressing each characteristic, x, on indicator variables for the pre- and post-DST periods:

$$x_{it} = \beta_0 preDST_{it} + \beta_1 postDST_{it} + \epsilon_{it}. \tag{1}$$

We cluster standard errors at the individual level to take account of correlation due to repeated observations on the same individuals. We then test for differences in the means of all relevant characteristics between the treatment and control groups, i.e., we test $H_0 : \beta_1 - \beta_0 = 0$ against $H_1 : \beta_0 \neq \beta_1$.

Second, since a t-test is sensitive to the sample size and may reveal statistically significant differences for economically small differences, we follow Imbens and Wooldridge (2009, p. 24) and also report the normalised difference for each observable characteristic, Δ_x, that is not affected by the sample size:

$$\Delta_x = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s_1^2 + s_2^2}} \tag{2}$$

where $s_d^2 = \sum_{i:D_i=d}(x_i - \bar{x})^2/(N_d - 1)$ represents the sample variance of x for the pre-($d = 0$) and post-($d = 1$) DST periods. Imbens and Wooldridge (2009) argue that a normalised difference of less than 0.25 may serve as a rule-of-thumb indicator that linear regression models will not be sensitive to the model specification.

Given that we compare individuals before and after the transition, we need to specify a time window for the analysis. Ideally we would examine only those data points that are as close as possible to the transition date. However, we face a classic bias-variance trade-off when choosing the width of the time window. We therefore use a two week window for our main analysis to minimise the variance at the potential cost of larger bias. As a robustness check, we perform the analysis for a stricter one week window and report the corresponding regression results in Section 6.5.

Having examined descriptive differences between the groups, we proceed to estimate the effect of the DST transition on life-satisfaction for the two week window:

$$LS_{it} = \alpha_0 + \alpha_1 DST1w_{it} + \alpha_2 DST2w_{it} + \boldsymbol{\delta}' year_t + \boldsymbol{\beta}'\mathbf{X}_{it} + \mu_{it} \tag{3}$$

where the dependent variable LS_{it} represents the life satisfaction of individual i at time t. $DST1w_{it}$ equals 1 if the individual was interviewed in the first week after the transition, and 0 otherwise. Similarly, $DST2w_{it}$ represents an indicator variable for the second week after the transition. We estimate two versions of the model: one without any additional covariates, and one with some control variables and time fixed effects. Given randomisation of individuals before and after the transition to DST, the estimates for α_1 and α_2 should not change much with the inclusion of the observed characteristics. To account for serial correlation of errors within individuals, we cluster the standard errors on the individual level.

To investigate the adjustment patterns, we also estimate a more flexible model that compares individuals on a daily basis:

$$\begin{aligned} LS_{it} = & \sum_{s=1}^{7} \gamma_s dow_{its} + \boldsymbol{\delta}' year_t + \boldsymbol{\beta}'\mathbf{X}_{it} \\ & + \sum_{s=1}^{7} \alpha_{1s} dow_{its} DST1w_{it} + \sum_{s=1}^{7} \alpha_{2s} dow_{its} DST2w_{it} + \nu_{it} \end{aligned} \tag{4}$$

where dow_{its} represents a vector of indicator variables for each weekday of the control week period (omitting a constant). We interact the weekday indicators with the indicator variables for each week after the transition. The coefficients α_{1s} and α_{2s}, $s \in \{1, ..., 7\}$, hence identify daily mean differences in life-satisfaction of individuals before and in the first (second) week after the transition to DST.

5 Data and variable definitions

For this paper, we use three nationally representative household data sets: for Germany, we use the German Socio-Economic Panel (SOEP) covering the years 1984-2004 (Wagner et al., 2007; SOEP, 2010).[5] For the UK, we use the British Household Panel Study (BHPS), covering the years 1991-2009, and its follow-up survey, Understanding Society (US), collected for the years 2009-2012 (for a more detailed documentation, see, Buck and McFall, 2011). Both the SOEP and the BHPS are longitudinal studies surveying the same individuals repeatedly over time. Due to the timing of the fieldwork, we can only use the SOEP to identify the effect of the spring transition. Similarly, the fieldwork timing for the BHPS means that we can use the BHPS to investigate only the autumn transition. However, the US data surveys individuals uniformly throughout the year allowing us to examine the spring transition using a small sample of British data as well.

Since panel and learning effects may affect answers to subjective survey questions (Landua, 1993; Ehrhardt et al., 2000), we drop the first three interviews of each respondent in the SOEP and BHPS. We are not able to drop interviews from the US for the spring transition given that the US provides a maximum of three interviews per individual.

Next, we discuss in more detail the variables used in the analysis. All surveys include information on life satisfaction, although the questions differ slightly. In the BHPS/US, individuals are asked "How dissatisfied or satisfied are you with your life overall?" and respond on a scale from 1 (not satisfied at all) to 7 (completely satisfied). In the SOEP, individuals respond to the question "We would like to ask you about your satisfaction with your life in general. How satisfied are you with your life, all things considered?" on a scale from 0 (completely dissatisfied) to 10 (completely satisfied).

To check for any endogenous sorting around the discontinuity, we also control for some socio-economic characteristics that Dolan et al. (2008) show to correlate with life satisfaction.

[5] Due to changes in the fieldwork of the SOEP, we have excluded the period from 2005 onwards from our main analysis. Since 2005, the start of the fieldwork is February, which is one month later than before 2005. In 2008, incentives to participate in the survey were changed (Sozialforschung, 2012). Because we observe a peak in the density of interviews at the end of March for the years 2005-2012 compared to previous years that we cannot explain, we present results for the time period 2005-2012 separately in Table A.8.

For both data sets, we use control variables for sex, age (and its square), employment status (full-time work, part-time work, retired), education (years of education in the SOEP, categorical variables for highest educational attainment in the BHPS/US), marital status (married, widowed, divorced, with single as the reference category), (log of) net household income, (log of) household size, and categorical variables for the region of residence.[6]

For our subgroup analysis, we also use information on an individual's employment status and the age of children resident in the household to identify the following six groups: 1) working, with young children, 2) not working, with young children, 3) working, with older children, 4) not working, with older children, 5) working, with no children, and 6) not working, with no children. We define young children as those in pre-school age ($<$6 in Germany, $<$5 in the UK), and older children as those aged 5/6-16.

6 Empirical analyses

6.1 Descriptive statistics

We begin our empirical analysis by examining the descriptive statistics for the treatment and control groups for the two week time window. Tables 1 and 2 present the summary statistics for the spring transition for Germany and the UK, respectively. Table 3 provides the same statistics for the autumn transition in the UK.

We begin the discussion with the German sample in Table 1. Overall, we find some statistically significant differences between the treatment and control groups. Surprisingly, the treatment group is about 1 year younger than the control group, which can potentially be explained by the Easter school holidays. We pursue this potentially confounding factor in Section 6.5. The t-tests suggest that the treatment group differs slightly from the control group in terms of employment, education, household size, number of children, and region of residence. However, most of the regional differences amount to less than 1 percentage point. Considering our second test, the normalised differences for each variable are considerably smaller than the value (0.25) suggested by Imbens and Wooldridge (2009). This scale-free difference, that is not sen-

[6] For a detailed documentation of generated variables in the SOEP, such as years of education, see, SOEP Group (2013).

sitive to the sample size, provides evidence that the we should not overvalue the statistically significantly differences between the treatment and control groups. Overall, the normalised differences suggest that the small differences in observable characteristics should not affect our results substantially.

We find a similar pattern for the spring transition in the UK (see Table 2). The treatment group is also on average about one year younger than the control group and differs slightly in terms of income, employment status, household size, and region of residence. Despite some statistically significant differences, most of these differences are economically rather small and the normalised difference amounts, again, to less than 0.25 for all characteristics.

Finally, we observe similar differences for the autumn transition in the UK (see Table 3). The treatment groups differ from the control group in terms of some observable characteristics, notably age, but most of the differences are estimated very precisely due to the large sample size. Hence, the t-test finds differences of less than 1 percentage point to be significant at the 5% level.

Overall, the descriptive statistics do not provide evidence supporting complete randomisation around the transition date. However, the normalised differences all are well below the critical value (Imbens and Wooldridge, 2009) which implies that controlling for them should not affect the results substantially. In the next section, we examine whether these characteristics are potentially confounding factors in the analysis.[7]

6.2 Effects of the spring transition

We first examine the effect of the spring transition on life-satisfaction. Table 4 presents results for different specifications using a symmetric two week time window around the transition date. We begin with the average weekly differences in Panel A which presents results for the two weeks after the transition. First, comparing the specifications without any and with all controls, we find that the estimates do not change qualitatively with the inclusion of relevant control variables. This coefficient stability supports our identification strategy by showing that

[7]Tables A.1 to A.3 present the summary statistics for the stricter 1 week window. On average, the differences are smaller for the 1 week window compared to the 2 week window, as expected. Furthermore, the statistics show very similar qualitative patterns.

the interview date does not correlate strongly with a wide range of individual characteristics that are identified as determinants of life satisfaction in the literature.

Second, we find that the transition to DST reduces average life-satisfaction in the first week after the transition in both the UK and Germany. Focusing on the regressions with control variables, we find that individuals in the first week after the transition experience a decline in life-satisfaction of about 0.077 in the UK, and 0.069 in Germany. This finding is consistent with our hypothesis about the endowment effect which tightens the time constraint for individuals. However, we also find that the UK and Germany differ in the second week after transition. Whereas Germany conforms with our hypothesis about no effect of the transition in the second week, the UK data reveals a significant effect also in the second week after the transition (-0.096). This pattern suggests that Germans adapt to DST within one week while the British experience transition costs also in the second week.

Next, we investigate the adjustment patterns. Panels B and C present the results from the model in equation (4) that splits up the average weekly effect into daily effects. First, we do not find any evidence for a negative effect on the Sunday of the transition week. However, the clear deterioration in life satisfaction in both the UK and Germany in the days following the transition provides evidence for an adjustment process. Although the patterns differ slightly, household production is strongly affected in the week after DST transitions. Whereas the UK experiences the strongest deterioration on Tuesday (-0.281), the German data show deteriorations over a three day period from Tuesday until Thursday, peaking on the Thursday of the transition week (-0.159). These patterns are consistent with our hypothesis about a negative endowment effect that may affect the entire week of transition.

Examining the results for the second week, we find mixed evidence for our second hypothesis about beneficial DST effects from additional daylight exposure. For Germany, individuals experience a significant increase in life satisfaction on the Sunday after the transition, as we hypothesised due to higher daylight exposure. The positive effect seems to be short-lived as the data shows no significant effect of the transition in the second week any more. The British data provides more ambiguous evidence. We do not find any positive effect after the transition and even negative effects in the second week after the transition. Although the patterns for the first week are consistent with our first hypothesis for both countries, individuals in the UK do not seem to experience any benefits following the transition.

To put these effects into perspective, we calculate the compensating income variation (CIV). The CIV can be regarded as a measure of the monetary equivalent of a world with DST. For Germany, the coefficient of the (logarithm of the) household income is estimated to be 0.635, and 0.183 for the UK (see Table 6). This correlation suggests that the marginal utility of income is positive which has been found by many studies (Blanchflower and Oswald, 2000). Therefore, the utility losses in life satisfaction from switching to DST are equivalent to an decrease in household income of approximately 10% in Germany, and 34% in the UK.[8]

6.3 Effects of the autumn transition

Next, we examine the effects of the autumn transition for the UK only. We follow the same methodology and present results in Table 5. As before, we observe almost no difference in the estimated treatment effect when we add controls for observable characteristics. However, and in contrast to the spring transition, Panel A shows no significant weekly differences between individuals before and after the transition. In contrast to our first hypothesis, individuals apparently do not benefit from the relaxed time constraint due to an additional hour on the Sunday of the transition. Conversely, individuals on the Sunday of the transition even report lower life satisfaction compared to individuals before the transition. Although economic theory suggests utility gains through an increase in effective time available, reductions in daylight exposure or disruptions in circadian rhythms apparently outweigh the hypothesised positive effects from an additional hour.

Moreover, we find mixed evidence for individual weekdays in the first week after transition. Whereas individuals report an increase in life satisfaction on the Thursday, we find a deterioration in life satisfaction for the Friday and Saturday following the transition. Taken together, these effects offset each other and contribute to an aggregate weekly effect of zero. However, the results for Friday and Saturday are consistent with our second hypothesis as the reduction in daylight exposure reduces the amount of sunlight and thus potentially the quality of leisure.

[8] Calculated as $(\exp(-0.069/0.635) - 1) \cdot 100\%$ and $(\exp(-0.077/0.183) - 1) \cdot 100\%$, respectively.

Consistent with previous studies showing that individuals adapt more easily to the autumn transition, it appears that individuals adapt to the new time endowment fairly quickly as we observe no effect in the second week after the transition.

6.4 Examining heterogeneous responses

In Section 3, we hypothesised stronger effects of the transition to DST for individuals with a higher shadow price of time: individuals with children, and/or in employment. We estimate the flexible daily model separately for these six groups and present the coefficients for the daily differences graphically for ease of interpretation.[9] Given that we the costs and benefits for the autumn transition cancel out, we examine heterogeneous responses only for the spring transition.

Figure 1 shows the results for the German sample. The graphs show that the mid-week dip is mainly driven by individuals with the stronger restrictions, particularly by individuals with children in the household. For individuals with young children in the household, we can identify a clear pattern of a strong mid-week dip that fades out and and turns into a positive effect on the Sunday following the transition. This pattern is consistent with our hypotheses regarding a higher shadow price of time for these groups. We also find evidence confirming our second hypothesis as these groups benefit from the extra hour of daylight on the Sunday after the transition. For these groups, we also observe the effect to disappear in the second week.

Contrarily, individuals with the lowest shadow price of time, i.e., no children and no work, reveal no reaction to the spring transition in either the first or second week after the transition. This also confirms our hypothesis about heterogeneous responses that depend on the shadow price of time.

Moreover, the analysis shows that employed individuals with older or no children do not respond strongly to the transition. Thus, the presence of young children in the household appears to impose the strongest time constraint influencing individuals' ability to adapt to the new time endowment.

For the UK, the results presented in Figure 2 show a similar but less precise pattern due to

[9]Full estimation results for the six groups are presented in the Appendix in Table A.4.

the small sample size. Importantly, we find a similar pattern in support of our hypothesis as individuals with young children in the household also experience a dip in life satisfaction for the first half of the week. The effect is particularly strong on the Tuesday of the transition week for employed parents of young children, i.e., the group we hypothesised to have the highest shadow price of time. The effect, however, turns around and is again positive on the Sunday following the transition, although it is not estimated precisely. In the second week, the effect generally hovers around 0 again.

As in Germany, employed individuals without children show almost no reaction to the transition. We find no significant effect for the employed group with older children. Thus, it appears that the presence of young children, rather than the employment status, leads to the strongest time constraints.

Surprisingly, those with the fewest restrictions, i.e., with no children and no work, respond immediately positively on the Sunday of the transition. One potential explanation is that this group is able to freely reallocate their activities and to adjust instantly to the new time endowment. Moreover, this group thus appears to benefit from the additional sunlight exposure immediately. However, the group also experiences a decline in life satisfaction on the Monday and particularly the Tuesday of the transition week.

6.5 Robustness checks

This section performs additional robustness checks that validate the key assumption of our identification strategy, i.e., that the transition week does not correlate with the unobserved determinants of life satisfaction. Note that we have already provided evidence supporting our identification strategy by adding potentially confounding characteristics, which were not fully balanced between the treatment and control groups, to the raw model in Tables 4 and 5. Although these characteristics are highly significant predictors of life satisfaction (see Table 6), the estimated coefficients for the week following the transition change only marginally. This lends credibility to our assumption that individuals individuals before and after the transition date do not systematically differ in terms of many known determinants of life satisfaction (Dolan et al., 2008).

Furthermore, we want to rule out that the Easter school holidays, which traditionally take place around the spring date transition, bias our results. Indeed, if the school holidays systematically overlap with the transition week, we would not identify the effect of the transition but of the school holidays. Since Easter school holidays do not overlap with the transition date for the observed period in the UK, we can only test this threat to identification for the German data. Given that school holidays vary over time and federal states, we generate an additional indicator variable, $Easter_{it}$, that equals 1 if an individual lives in a federal state (at time t) where the school holidays begin on the weekend of the spring transition.[10] We then include additional interaction terms between this variable and the day of the week following the transition as in equation (5):

$$
\begin{aligned}
LS_{it} = &\sum_{s=1}^{7} \gamma_s dow_{its} + \boldsymbol{\delta}' year_t + \boldsymbol{\beta}' \mathbf{X}_{it} + \gamma Easter_{it} \\
&+ \sum_{s=1}^{7} \alpha_{1s} dow_{its} DST1w_{it} + \sum_{s=1}^{7} \alpha_{2s} dow_{its} DST2w_{it} \\
&+ \sum_{s=1}^{7} \gamma_{1s} dow_{its} DST1w_{it} Easter_{it} + \sum_{s=1}^{7} \gamma_{2s} dow_{its} DST2w_{it} Easter_{it} + \eta_{it} \qquad (5)
\end{aligned}
$$

The results in Table 7 show that our main conclusions are robust to the inclusion of these additional interaction terms. Hence, potential overlaps between the school holidays and the transition do not bias our results.

To check for any correlation with unobserved determinants of life satisfaction, we also run placebo regressions. We simulate four different placebo treatments by pretending that the transition happened 4 and 8 weeks before, and after, the actual transition date. These placebo treatments should have no effect on life satisfaction. If the placebo estimates turn out to be significant, then it is likely that our estimates pick up a systematic correlation between the unobserved determinants of life satisfaction and time. For instance, the weather may represent one unobserved determinant of life satisfaction that may also correlate with the transition week

[10]We collected information about school holidays from `http://www.schulferien.org/Schulferien_nach_Jahren/2010/schulferien_2010.html`.

(Connolly, 2013; Kämpfer and Mutz, 2013). Importantly, estimating the effect of placebo treatments should also uncover any systematic weather effects, if these exist. The results from the placebo regressions shown in Table 8 provide strong support for our identification strategy. The estimates for both the BHPS/US and SOEP show that most of the placebo treatments are significantly not different from zero, particularly in the first week of the transition. Although we find some statistically significant estimates in the second week in the SOEP, these do not correspond to a systematic pattern that invalidates our findings. Furthermore, none of the placebo treatments find a consistent midweek dip. Thus, the placebo tests shifting the transition dates confirm that unobserved determinants of life satisfaction do not bias our estimated causal effects.

We perform another placebo test, this time using a placebo outcome. For instance, in the absence of selection around the interview date, we do not expect the transition to have an effect on the incidence of chronic disabilities. Hence we repeat our analysis using an indicator variable for having a chronic condition as the dependent variable. The results shown in Table A.5 confirm that no systematic selection takes place in the SOEP, and that any potential selection in the BHPS is removed by adding control variables.[11]

Our identification strategy uses information about the exact interview date. To assess the robustness of results with regards to sorting around the discontinuity caused by re-scheduling of interviews, we also use information about the number of calls an interviewer needed to schedule the interview. To establish consistency between the data sets, we top-code the number of calls at 9. The average number of calls for the BHPS is 3.18 and 2.73 in the SOEP. For both surveys, roughly 90% of interviews required 5 calls or less to arrange the interview. As a robustness check, we dropped individuals who required more than 5 calls. Our main results remain qualitatively unchanged as shown in Table A.6.

Furthermore, we also drop the extreme values of the life satisfaction scale as a robustness check to take account of the boundedness of the scale. Individuals who report ten can report no higher values, even if their underlying well-being rose in response to the DST transition. Similar reasoning applies to those who report zero. The results shown in Table A.7 confirm that the results are not driven by these extreme observations.

[11] The control variables of course do not include a measure of health.

Finally, Table A.9 shows that our results are robust to the width of the time window. We reach the same conclusions regarding the weekly pattern if we use a stricter one week time window, even though this window does not allow us to examine the effects in the second week.

7 Conclusion

This study applies the life satisfaction approach (Frey et al., 2009) to value DST transitions and uses self-reports of subjective well-being as a proxy for individual utility. To estimate the effect of the transition into and out of DST on life satisfaction, we use a regression discontinuity design which exploits the fact that individuals are randomly interviewed just before and after the DST transitions. We show that the raw correlation between life satisfaction and the DST transition does not change qualitatively when adding standard determinants of life satisfaction. This supports our identifying assumption that individuals do not systematically schedule their interviews before or after the transition date.

Our analysis shows that individuals in both the UK and Germany experience utility losses in the week after the spring transition to DST. This response is consistent with economic theory which suggests that individuals should experience lower utility due to a tightening of individuals' time constraints. Conversely, we do not find evidence of utility gains when the clocks move back in autumn suggesting that the costs and benefits cancel out. Moreover, the finding is consistent with evidence from studies which show that individuals cope more easily with time delays (e.g., the autumn transition) than time advances (e.g., the spring transition).

We also find evidence for our hypothesis that individuals need to adjust, i.e., that the transition impacts on other weekdays. In both the UK and Germany, individuals experience utility losses in the first few days after the spring transition. For the UK, the negative effect is strongest on the Tuesday in the week after the spring transition. In Germany, the effect is strongest on the Wednesday and Thursday after the spring transition. For both the UK and Germany, we find that individuals with young children in the household respond the most strongly to the spring transition. Individuals with older children do not respond as strongly, and neither do those without children in the household. Our results therefore suggest that the presence of young children in the household impose the most binding time constraints.

The findings from our study provide new evidence that the transition to DST causes negative welfare effects in the short-run. The short-term costs are considerable, particularly in the UK, and for families with young children. We do not interpret our evidence in support of claims to abolish the adoption of DST. Instead, the policy implication of our analysis relates to individuals' ability to reallocate their time. If, for instance, working families with young children find it most difficult to adapt to the new time endowment, then these groups could be compensated for their higher costs of adjustment. The compensation need not be financial, but could relate to more flexible workplace arrangements that facilitate families' ability to cope with the adjustment period during the first week of transition.

This study has provided new evidence on the welfare effects of the transition to and out of DST. Although we have identified similar patterns in two large micro-data sets, our study raises further questions. First, our study is limited by the data availability. We are only able to examine the spring transition in the UK for the period 2009-2012, and cannot examine the autumn transition for Germany using the SOEP. Future research should validate the results using a longer time frame for the UK, and contribute evidence for the autumn transition in Germany. Second, we have provided evidence for heterogeneous effects, particularly that families with young children respond most strongly to the transition. Although we are able to pool many waves of data, the sample size does not allow us to detect statistically significant differences between the analysed subgroups. Further work is needed to examine whether these heterogeneous effects hold for other countries as well. Finally, further research is needed on previously neglected outcomes to enhance our understanding of the overall effects of the DST transition. Future work could, for instance, evaluate the health care costs of the transition by using administrative data on hospital admissions, or examine the effects on performance outcomes, such as workplace productivity.

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Table 1: Summary statistics, SOEP, spring transition. 2 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	45.31	44.219	-1.091	**	-0.0294
	(0.179)	(0.202)	[0.000]		
Male (0/1)	0.492	0.503	0.011		0.0089
	(0.006)	(0.007)	[0.103]		
ln(income)	7.55	7.558	0.008		0.0511
	(0.005)	(0.007)	[0.217]		
Working (0/1)	0.627	0.639	0.012	†	-0.0151
	(0.005)	(0.006)	[0.055]		
In training (0/1)	0.012	0.013	0.001		-0.011
	(0.001)	(0.001)	[0.435]		
Not employed (0/1)	0.373	0.361	-0.012	†	-0.0265
	(0.005)	(0.006)	[0.055]		
Education (years)	11.185	10.962	-0.222	**	-0.0072
	(0.032)	(0.037)	[0.000]		
Household size	3.038	3.178	0.14	**	-0.0027
	(0.015)	(0.02)	[0.000]		
Number of children	0.64	0.716	0.076	**	0.0174
	(0.011)	(0.014)	[0.000]		
Married, living together (0/1)	0.709	0.705	-0.004		0.0615
	(0.005)	(0.006)	[0.491]		
Married, separated (0/1)	0.015	0.016	0.001		-0.0692
	(0.001)	(0.001)	[0.485]		
Not married (0/1)	0.177	0.18	0.003		-0.0539
	(0.004)	(0.005)	[0.529]		
Divorced (0/1)	0.044	0.046	0.002		-0.0322
	(0.002)	(0.003)	[0.44]		
Widowed (0/1)	0.051	0.048	-0.003		0.0063
	(0.003)	(0.003)	[0.287]		
Schleswig - Holstein	0.023	0.03	0.007	**	-0.0058
	(0.002)	(0.003)	[0.005]		
Hamburg	0.008	0.015	0.007	**	-0.0067
	(0.001)	(0.002)	[0.000]		
Lower Saxony	0.087	0.078	-0.009	**	0.0098
	(0.004)	(0.004)	[0.01]		
Bremen	0.007	0.008	0.001		-0.0101
	(0.001)	(0.001)	[0.655]		
North Rhine-Westphalia	0.271	0.25	-0.021	**	-0.0306
	(0.006)	(0.006)	[0.000]		
Hesse	0.087	0.099	0.012	**	-0.0444
	(0.004)	(0.004)	[0.002]		
Rhineland-Palatinate	0.072	0.059	-0.013	**	0.0228
	(0.003)	(0.003)	[0.000]		
Baden-Wuerttemberg	0.159	0.207	0.048	**	-0.0042
	(0.004)	(0.006)	[0.000]		
Bavaria	0.157	0.155	-0.002		0.0339
	(0.005)	(0.005)	[0.741]		
Saarland	0.005	0.003	-0.002	*	-0.028
	(0.001)	(0.001)	[0.026]		
Berlin	0.033	0.038	0.005	*	0.0383
	(0.002)	(0.003)	[0.044]		
Brandenburg	0.014	0.007	-0.007	**	-0.0873
	(0.001)	(0.001)	[0.000]		
Mecklenburg-West Pomerania	0.008	0.007	-0.002		0.0031
	(0.001)	(0.001)	[0.114]		
Saxony	0.039	0.027	-0.012	**	0.0193
	(0.002)	(0.002)	[0.000]		
Saxony-Anhalt	0.016	0.01	-0.006	**	-0.0189
	(0.001)	(0.001)	[0.001]		
Thuringia	0.015	0.01	-0.005	**	0.0502
	(0.001)	(0.001)	[0.001]		
N	18878	10775	29653		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table 2: Summary statistics, UK, spring transition. 2 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	46.731	45.436	-1.296	**	0.0514
	(0.297)	(0.343)	[0.001]		
Male (0/1)	0.441	0.446	0.005		-0.0076
	(0.008)	(0.01)	[0.634]		
ln(income)	7.89	7.968	0.078	**	-0.069
	(0.012)	(0.015)	[0.000]		
Working (0/1)	0.555	0.595	0.04	**	-0.0568
	(0.008)	(0.009)	[0.000]		
Unemployed (0/1)	0.056	0.048	-0.008	†	0.0253
	(0.003)	(0.004)	[0.094]		
Retired (0/1)	0.217	0.184	-0.034	**	0.0596
	(0.007)	(0.008)	[0.000]		
Maternity leave (0/1)	0.009	0.006	-0.003		0.0236
	(0.001)	(0.001)	[0.12]		
Looking after family (0/1)	0.059	0.054	-0.005		0.0152
	(0.004)	(0.004)	[0.324]		
Full-time student (0/1)	0.064	0.082	0.018	**	-0.0491
	(0.004)	(0.005)	[0.002]		
Long-term sick or disabled (0/1)	0.039	0.031	-0.008	*	0.0318
	(0.003)	(0.003)	[0.047]		
Degree (0/1)	0.228	0.246	0.017	†	-0.0288
	(0.007)	(0.009)	[0.078]		
Other higher qual. (0/1)	0.115	0.12	0.005		-0.0115
	(0.005)	(0.006)	[0.463]		
A level or equiv. (0/1)	0.198	0.212	0.014		-0.0242
	(0.007)	(0.008)	[0.13]		
GCSE or equiv. (0/1)	0.211	0.211	0.000		0.0008
	(0.007)	(0.008)	[0.961]		
Other qualificaton (0/1)	0.102	0.095	-0.008		0.018
	(0.005)	(0.006)	[0.251]		
Household size	2.811	2.894	0.083	*	-0.0414
	(0.022)	(0.028)	[0.01]		
Number of children	0.508	0.503	-0.005		0.0037
	(0.015)	(0.017)	[0.813]		
Single	0.147	0.14	-0.008		0.0155
	(0.006)	(0.007)	[0.342]		
Married	0.52	0.511	-0.008		0.0117
	(0.008)	(0.01)	[0.464]		
Divorced	0.093	0.095	0.002		-0.0045
	(0.005)	(0.006)	[0.777]		
Widowed	0.058	0.045	-0.013	*	0.04
	(0.004)	(0.004)	[0.014]		
Yorkshire	0.092	0.08	-0.012	*	0.0311
	(0.005)	(0.005)	[0.049]		
East Midlands	0.082	0.071	-0.011	†	0.0293
	(0.005)	(0.005)	[0.063]		
West Midlands	0.072	0.067	-0.005		0.0137
	(0.004)	(0.005)	[0.404]		
England East	0.099	0.091	-0.008		0.0199
	(0.005)	(0.006)	[0.211]		
London	0.121	0.14	0.019	*	-0.0402
	(0.005)	(0.007)	[0.013]		
South East	0.117	0.119	0.002		-0.0052
	(0.005)	(0.006)	[0.735]		
South West	0.083	0.063	-0.02	**	0.053
	(0.005)	(0.005)	[0.001]		
Wales	0.064	0.076	0.012	*	-0.0338
	(0.004)	(0.005)	[0.032]		
Scotland	0.098	0.107	0.009		-0.0218
	(0.005)	(0.006)	[0.163]		
Northern Ireland	0.07	0.099	0.03	**	-0.0752
	(0.004)	(0.006)	[0.000]		
N	5578	3372	8950		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table 3: Summary statistics, UK, autumn transition. 2 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	44.906	43.61	-1.296	**	0.0536
	(0.164)	(0.173)	[0.000]		
Male (0/1)	0.456	0.46	0.004		-0.0051
	(0.005)	(0.005)	[0.508]		
ln(income)	7.768	7.767	-0.001		0.0012
	(0.007)	(0.008)	[0.876]		
Working (0/1)	0.629	0.647	0.017	**	-0.0255
	(0.004)	(0.005)	[0.001]		
Unemployed (0/1)	0.032	0.035	0.003	†	-0.0135
	(0.001)	(0.002)	[0.075]		
Retired (0/1)	0.174	0.151	-0.023	**	0.0444
	(0.004)	(0.004)	[0.000]		
Maternity leave (0/1)	0.005	0.005	0.000		-0.0004
	(0.001)	(0.001)	[0.958]		
Looking after family (0/1)	0.07	0.068	-0.002		0.0044
	(0.002)	(0.002)	[0.562]		
Full-time student (0/1)	0.052	0.058	0.006	*	-0.0181
	(0.002)	(0.002)	[0.015]		
Long-term sick or disabled (0/1)	0.039	0.037	-0.002		0.0072
	(0.002)	(0.002)	[0.355]		
Degree (0/1)	0.161	0.167	0.006		-0.0121
	(0.004)	(0.004)	[0.12]		
Other higher qual. (0/1)	0.251	0.244	-0.007		0.0122
	(0.004)	(0.005)	[0.111]		
A level or equiv. (0/1)	0.139	0.149	0.011	**	-0.0217
	(0.003)	(0.004)	[0.005]		
GCSE or equiv. (0/1)	0.235	0.226	-0.009	†	0.0143
	(0.004)	(0.004)	[0.066]		
Other qualificaton (0/1)	0.042	0.04	-0.002		0.0065
	(0.002)	(0.002)	[0.401]		
Household size	2.897	2.932	0.035	*	-0.0178
	(0.013)	(0.014)	[0.02]		
Number of children	0.546	0.551	0.006		-0.0042
	(0.009)	(0.01)	[0.584]		
Single	0.128	0.123	-0.006		0.0123
	(0.003)	(0.003)	[0.111]		
Married	0.553	0.54	-0.013	*	0.0187
	(0.005)	(0.005)	[0.015]		
Divorced	0.061	0.06	-0.001		0.0018
	(0.002)	(0.002)	[0.814]		
Widowed	0.054	0.049	-0.006	*	0.0177
	(0.002)	(0.002)	[0.023]		
Yorkshire	0.065	0.068	0.003		-0.0086
	(0.002)	(0.003)	[0.257]		
East Midlands	0.071	0.071	0.000		-0.0006
	(0.003)	(0.003)	[0.932]		
West Midlands	0.062	0.06	-0.003		0.008
	(0.002)	(0.003)	[0.281]		
England East	0.077	0.061	-0.016	**	0.045
	(0.003)	(0.003)	[0.000]		
London	0.064	0.058	-0.006	*	0.0183
	(0.002)	(0.002)	[0.014]		
South East	0.114	0.097	-0.016	**	0.0379
	(0.003)	(0.003)	[0.000]		
South West	0.079	0.076	-0.003		0.0091
	(0.003)	(0.003)	[0.241]		
Wales	0.14	0.13	-0.009	*	0.0193
	(0.003)	(0.004)	[0.014]		
Scotland	0.151	0.179	0.028	**	-0.0539
	(0.004)	(0.004)	[0.000]		
Northern Ireland	0.097	0.13	0.033	**	-0.0744
	(0.003)	(0.004)	[0.000]		
N	21265	15679	36944		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table 4: The effect of the beginning to DST on life-satisfaction.

	BHPS		SOEP	
	(1)	(2)	(3)	(4)
Panel A: Weekly averages after the transition				
First week (DST1w)	-0.054	-0.077 *	-0.067 *	-0.069 **
	(0.040)	(0.038)	(0.027)	(0.026)
Second week (DST2w)	-0.074 †	-0.096 *	0.033	0.036
	(0.042)	(0.041)	(0.030)	(0.029)
Panel B: First week after the transition				
Sunday	0.055	0.025	0.066	-0.012
	(0.167)	(0.159)	(0.111)	(0.109)
Monday	-0.056	-0.112	-0.025	-0.016
	(0.082)	(0.080)	(0.063)	(0.061)
Tuesday	-0.280 **	-0.281 **	-0.120 †	-0.085
	(0.095)	(0.090)	(0.064)	(0.062)
Wednesday	0.039	-0.001	-0.123 *	-0.123 *
	(0.089)	(0.084)	(0.061)	(0.059)
Thursday	0.048	0.015	-0.142 †	-0.159 *
	(0.091)	(0.087)	(0.073)	(0.072)
Friday	0.082	0.083	-0.054	-0.070
	(0.124)	(0.124)	(0.073)	(0.071)
Saturday	-0.039	-0.080	0.052	0.020
	(0.146)	(0.147)	(0.077)	(0.075)
Panel C: Second week after the transition				
Sunday	0.111	0.042	0.202 †	0.232 *
	(0.178)	(0.173)	(0.120)	(0.116)
Monday	0.027	0.014	0.019	0.042
	(0.100)	(0.097)	(0.076)	(0.074)
Tuesday	-0.134	-0.143	0.025	0.037
	(0.098)	(0.095)	(0.069)	(0.068)
Wednesday	-0.153	-0.178 †	-0.066	-0.059
	(0.102)	(0.097)	(0.068)	(0.066)
Thursday	-0.072	-0.092	-0.014	0.005
	(0.097)	(0.095)	(0.074)	(0.071)
Friday	-0.003	-0.045	0.045	0.034
	(0.119)	(0.112)	(0.077)	(0.076)
Saturday	-0.135	-0.139	0.129 †	0.090
	(0.138)	(0.129)	(0.075)	(0.072)
N	8950	8950	29653	29653
Controls included for				
Year indicators		✔		✔
Region indicators		✔		✔
Socio-demographics		✔		✔

Notes: Panel A shows estimates for the parameters α_1 and α_2 in equation 3. Panels B and C show estimates for the parameters $\boldsymbol{\alpha}'_1$ and $\boldsymbol{\alpha}'_2$ in equation 4. Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table 5: The effect of the end of DST on life-satisfaction, UK.

	(1)	(2)
Panel A: Weekly averages after the transition		
First week	0.016	0.016
	(0.017)	(0.016)
Second week	-0.013	-0.011
	(0.018)	(0.017)
Panel B: First week after the transition		
Sunday	-0.101	-0.110
	(0.089)	(0.087)
Monday	0.041	0.036
	(0.035)	(0.034)
Tuesday	-0.026	-0.009
	(0.037)	(0.035)
Wednesday	0.049	0.055
	(0.036)	(0.035)
Thursday	0.092 *	0.095 *
	(0.040)	(0.038)
Friday	-0.089	-0.081
	(0.055)	(0.053)
Saturday	-0.112	-0.136 †
	(0.075)	(0.072)
Panel C: Second week after the transition		
Sunday	0.086	0.050
	(0.083)	(0.079)
Monday	0.002	0.007
	(0.039)	(0.037)
Tuesday	-0.026	-0.007
	(0.041)	(0.038)
Wednesday	-0.017	-0.018
	(0.041)	(0.039)
Thursday	0.003	0.006
	(0.044)	(0.041)
Friday	-0.069	-0.051
	(0.055)	(0.053)
Saturday	-0.057	-0.086
	(0.074)	(0.071)
N	36944	36944
Controls included for		
Year indicators		✔
Region indicators		✔
Socio-demographics		✔

Notes: Panel A shows estimates for the parameters α_1 and α_2 in equation 3. Panels B and C show estimates for the parameters $\boldsymbol{\alpha}'_1$ and $\boldsymbol{\alpha}'_2$ in equation 4. Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table 6: The effect of DST on well-being, regression coefficients.

	UK			Germany
	Spring transition	Autumn transition		Spring transition
DST1w	-0.077	0.016	DST1w	-0.069
	(0.038)	(0.016)		(0.026)
DST2w	-0.096 *	-0.011	DST2w	0.036
	(0.041)	(0.017)		(0.029)
Age	-0.038 **	-0.034 **	Age	-0.068 **
	(0.007)	(0.004)		(0.007)
Age squared	0.000 **	0.000 **	Age squared	0.001 **
	(0.000)	(0.000)		(0.000)
ln(hhincome)	0.183 **	0.132 **	ln(hhincome)	0.635 **
	(0.026)	(0.014)		(0.034)
Unemployed	-0.340 **	-0.523 **	Not employed	-0.035
	(0.087)	(0.051)		(0.102)
Self employed	0.074	0.089 **	Part-time work	-0.096 *
	(0.062)	(0.030)		(0.048)
Retired	0.104	0.112 **	Student	-0.057
	(0.073)	(0.038)		(0.072)
Maternity leave	0.101	0.315 **	Education (years)	0.019 **
	(0.196)	(0.078)		(0.006)
Family carer	-0.149 †	-0.192 **	Male	-0.104 **
	(0.080)	(0.038)		(0.034)
Student	0.283 **	0.176 **	ln(household size)	-0.335 **
	(0.079)	(0.037)		(0.039)
Long-term sick	-1.224 **	-1.171 **	Married, separate	-0.762 **
	(0.119)	(0.056)		(0.103)
Male	-0.057	-0.047 **	Not married	-0.299 **
	(0.035)	(0.018)		(0.048)
ln(household size)	-0.069	-0.158 **	Divorced	-0.409 **
	(0.045)	(0.022)		(0.071)
Degree	0.157 *	-0.033	Widowed	-0.261 **
	(0.069)	(0.035)		(0.081)
Other higher qual.	0.059	-0.065 *	Hamburg	-0.566 **
	(0.076)	(0.032)		(0.181)
A level	0.022	-0.042	Lower Saxony	-0.234 *
	(0.069)	(0.035)		(0.111)
GCSE	0.000	-0.041	Bremen	-0.146
	(0.069)	(0.032)		(0.267)
Other qual.	0.015	0.014	North Rhine-Westphalia	-0.187
	(0.078)	(0.051)		(0.103)
Living as couple	-0.370 **	-0.103 **	Hesse	-0.099
	(0.089)	(0.028)		(0.110)
Widowed	-0.214 *	-0.450 **	Rhineland-Palatinate	-0.142
	(0.087)	(0.051)		(0.114)
Divorced	-0.315 **	-0.484 **	Baden-Wuerttemberg	-0.218 *
	(0.068)	(0.044)		(0.104)
Separated	-0.516 **	-0.720 **	Bavaria	-0.331 **
	(0.116)	(0.061)		(0.106)
Never married	-0.238 **	-0.300 **	Saarland	-0.035
	(0.053)	(0.029)		(0.183)
North West	-0.123 †	0.016	Berlin	-0.858 **
	(0.074)	(0.039)		(0.133)
Yorkshire	-0.173 *	0.048	Brandenburg	-0.926 **
	(0.081)	(0.038)		(0.144)
East Midlands	-0.009	0.083 *	Mecklenburg-West-Pomerania	-0.489 **
	(0.074)	(0.039)		(0.146)
West Midlands	-0.077	-0.052	Saxony-Anhalt	-0.83 **
	(0.080)	(0.042)		(0.121)
East of England	-0.084	0.034	Saxony-Anhalt	-0.779 **
	(0.074)	(0.041)		(0.144)
London	-0.222 **	-0.109 **	Thuringia	-0.798 **
	(0.070)	(0.041)		(0.142)
South East	-0.046	-0.059 †		
	(0.070)	(0.034)		
South West	-0.088	0.010		
	(0.081)	(0.040)		
Wales	0.066	0.022		
	(0.082)	(0.033)		
Northern Ireland	0.048	0.195 **		
	(0.077)	(0.033)		
constant	4.641 **	5.121 **	constant	3.986 **
	(0.264)	(0.149)		(0.304)
N	8950	36944		29653

Notes: Cluster robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$, † $p<0.1$

Table 7: Robustness to potential confounders: the role of school holidays. SOEP only.

	(1)	(2)
Panel A: Week 1 after the transition		
Sunday	0.066	-0.012
	(0.111)	(0.109)
Monday	-0.025	-0.016
	(0.063)	(0.061)
Tuesday	-0.120 †	-0.085
	(0.064)	(0.062)
Wednesday	-0.123 *	-0.123 *
	(0.061)	(0.059)
Thursday	-0.142 †	-0.159 *
	(0.073)	(0.072)
Friday	-0.054	-0.070
	(0.073)	(0.071)
Saturday	0.052	0.020
	(0.077)	(0.075)
Panel B: Week 2 after the transition		
Sunday	0.202 †	0.232 *
	(0.120)	(0.116)
Monday	0.019	0.042
	(0.076)	(0.074)
Tuesday	0.025	0.037
	(0.069)	(0.068)
Wednesday	-0.066	-0.059
	(0.068)	(0.066)
Thursday	-0.014	0.005
	(0.074)	(0.071)
Friday	0.045	0.034
	(0.077)	(0.076)
Saturday	0.129 †	0.090
	(0.075)	(0.072)
N	29653	29653
Controls included for		
Year indicators	✔	✔
Region indicators	✔	✔
Socio-demographics	✔	✔
School holidays/Easter		✔

Notes: Column 1 shows estimates for the parameters α'_1 and α'_2 in equation 4. Column 1 shows estimates for the parameters α'_1 and α'_2 in equation 5. Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table 8: Robustness: The effect of pseudo-DSTs on life-satisfaction.

	BHPS				SOEP			
	-8 weeks	-4 weeks	+4 weeks	+8 weeks	-8 weeks	-4 weeks	+4 weeks	+8 weeks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sunday	0.043	-0.108	-0.056	-0.022	0.071	-0.034	-0.146	0.147
	(0.104)	(0.108)	(0.139)	(0.164)	(0.062)	(0.065)	(0.124)	(0.200)
Monday	-0.136	-0.010	0.098	0.132	-0.033	-0.022	-0.099	0.141
	(0.109)	(0.116)	(0.144)	(0.169)	(0.047)	(0.038)	(0.081)	(0.116)
Tuesday	-0.082	-0.034	0.058	0.131	-0.062	-0.049	0.201 *	0.019
	(0.053)	(0.053)	(0.064)	(0.086)	(0.048)	(0.038)	(0.084)	(0.113)
Wednesday	0.035	-0.036	-0.106	0.038	-0.104 *	0.026	0.069	0.202 †
	(0.063)	(0.059)	(0.131)	(0.083)	(0.047)	(0.037)	(0.098)	(0.121)
Thursday	0.000	-0.093	-0.086	0.059	-0.074	0.033	-0.123	0.374 **
	(0.058)	(0.063)	(0.067)	(0.067)	(0.053)	(0.040)	(0.090)	(0.127)
Friday	-0.029	0.023	-0.181 *	0.028	-0.063	0.012	-0.015	0.153
	(0.064)	(0.062)	(0.076)	(0.077)	(0.053)	(0.039)	(0.094)	(0.129)
Saturday	-0.068	0.006	-0.003	-0.001	-0.092 *	0.004	0.059	0.176
	(0.061)	(0.061)	(0.068)	(0.072)	(0.047)	(0.040)	(0.108)	(0.142)
Sunday	-0.039	0.045	-0.019	-0.068	-0.115 *	-0.112 †	-0.058	-0.031
	(0.062)	(0.059)	(0.067)	(0.074)	(0.057)	(0.061)	(0.125)	(0.184)
Monday	0.059	-0.043	0.003	-0.097	-0.097 *	-0.007	0.155 †	-0.147
	(0.062)	(0.064)	(0.071)	(0.063)	(0.046)	(0.036)	(0.088)	(0.158)
Tuesday	-0.030	-0.032	0.192 *	0.069	-0.151 **	-0.058	0.049	0.122
	(0.067)	(0.059)	(0.075)	(0.068)	(0.046)	(0.039)	(0.088)	(0.118)
Wednesday	-0.055	0.050	-0.019	-0.099	-0.006	-0.105 **	-0.212 *	-0.069
	(0.074)	(0.066)	(0.103)	(0.108)	(0.046)	(0.038)	(0.100)	(0.122)
Thursday	-0.104	-0.061	-0.050	-0.108	-0.008	-0.036	0.044	-0.218
	(0.070)	(0.073)	(0.088)	(0.087)	(0.047)	(0.043)	(0.095)	(0.161)
Friday	0.053	-0.088	0.021	-0.019	-0.028	-0.050	-0.006	0.207 †
	(0.079)	(0.093)	(0.120)	(0.143)	(0.046)	(0.042)	(0.093)	(0.114)
Saturday	-0.104	-0.090	-0.212 *	-0.031	-0.087 †	-0.152 **	-0.252 *	0.117
	(0.091)	(0.104)	(0.103)	(0.099)	(0.045)	(0.047)	(0.101)	(0.111)
N	14368	13681	10514	9927	24193	75692	22326	1422

Notes: The table shows estimates for the parameters α_1' in equation 4 for pseudo-treatments that shift the treatment by the indicated number of weeks. Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Figure 1: Adjustment patterns to spring transition, by subgroups, Germany.

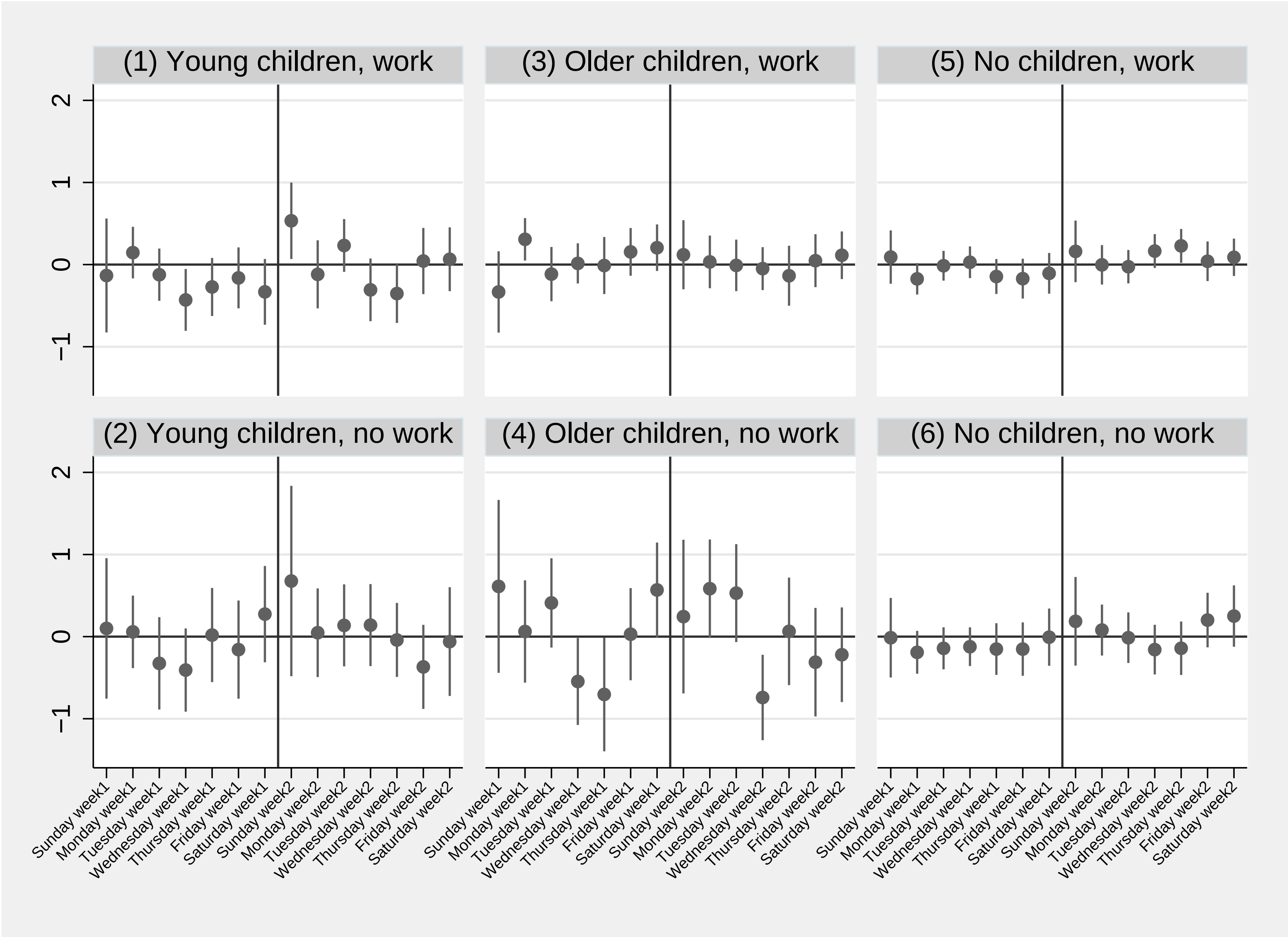
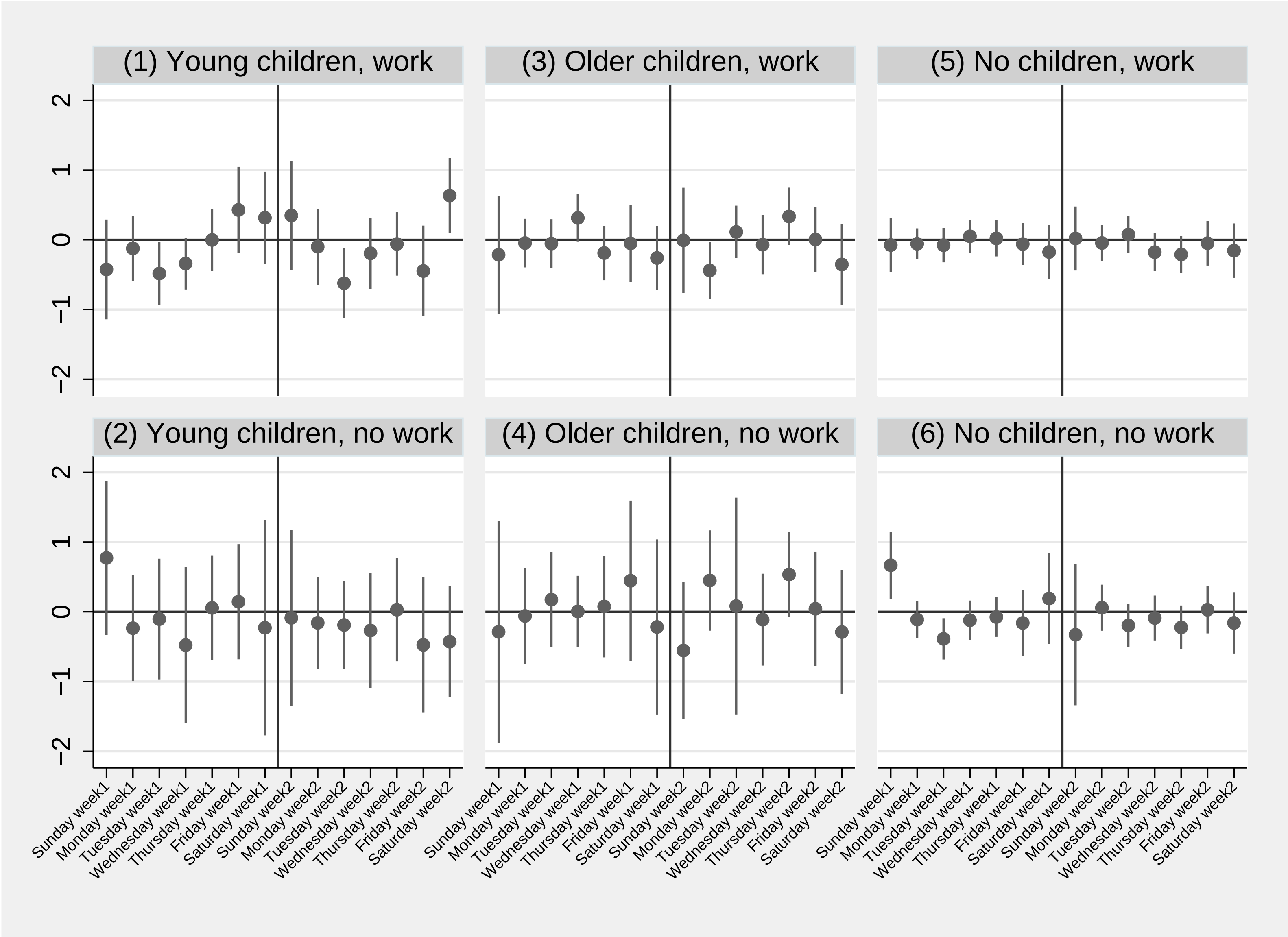


Figure 2: Adjustment patterns to spring transition, by subgroups, UK.



APPENDIX

Table A.1: Summary statistics, SOEP, spring transition. 1 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	45.209	44.252	-0.957	**	0.0214
	(0.223)	(0.239)	[0.000]		
Male (0/1)	0.497	0.506	0.009		0.0022
	(0.008)	(0.008)	[0.314]		
ln(income)	7.539	7.566	0.027	**	0.0448
	(0.007)	(0.008)	[0.002]		
Working (0/1)	0.631	0.643	0.011		-0.0124
	(0.007)	(0.007)	[0.174]		
In training (0/1)	0.01	0.013	0.003		-0.038
	(0.001)	(0.002)	[0.197]		
Not employed (0/1)	0.369	0.357	-0.011		-0.0116
	(0.007)	(0.007)	[0.174]		
Education (years)	11.065	11.067	0.002		-0.0165
	(0.038)	(0.044)	[0.959]		
Household size	3.058	3.17	0.112	**	-0.0153
	(0.019)	(0.024)	[0.000]		
Number of children	0.658	0.712	0.054	**	0.0165
	(0.014)	(0.017)	[0.002]		
Married, living together (0/1)	0.713	0.706	-0.007		-0.0006
	(0.006)	(0.007)	[0.406]		
Married, separated (0/1)	0.015	0.015	0.000		-0.0553
	(0.002)	(0.002)	0.000		
Not married (0/1)	0.176	0.18	0.004		-0.0385
	(0.005)	(0.006)	[0.527]		
Divorced (0/1)	0.043	0.045	0.003		-0.0379
	(0.003)	(0.003)	[0.468]		
Widowed (0/1)	0.049	0.049	0.000		0.0102
	(0.003)	(0.003)	[0.927]		
Schleswig - Holstein	0.023	0.027	0.004		-0.0078
	(0.002)	(0.003)	[0.194]		
Hamburg	0.01	0.011	0.002		-0.0086
	(0.001)	(0.002)	[0.23]		
Lower Saxony	0.084	0.078	-0.006		-0.0011
	(0.004)	(0.004)	[0.169]		
Bremen	0.006	0.004	-0.002		0.0058
	(0.001)	(0.001)	[0.19]		
North Rhine-Westphalia	0.266	0.257	-0.009		-0.019
	(0.007)	(0.008)	[0.253]		
Hesse	0.095	0.101	0.006		-0.0131
	(0.004)	(0.005)	[0.219]		
Rhineland-Palatinate	0.068	0.059	-0.009	*	0.0163
	(0.004)	(0.004)	[0.034]		
Baden-Wuerttemberg	0.173	0.194	0.022	**	0.0178
	(0.006)	(0.007)	[0.002]		
Bavaria	0.158	0.16	0.003		0.0142
	(0.006)	(0.006)	[0.686]		
Saarland	0.006	0.002	-0.004	**	-0.0144
	(0.001)	(0.001)	[0.001]		
Berlin	0.032	0.039	0.007	*	0.0266
	(0.003)	(0.003)	[0.024]		
Brandenburg	0.011	0.006	-0.005	**	-0.0394
	(0.001)	(0.001)	[0.000]		
Mecklenburg-West Pomerania	0.007	0.009	0.002		-0.0051
	(0.001)	(0.001)	[0.187]		
Saxony	0.033	0.03	-0.004		0.0406
	(0.002)	(0.003)	[0.222]		
Saxony-Anhalt	0.016	0.012	-0.004	*	-0.0274
	(0.002)	(0.002)	[0.045]		
Thuringia	0.013	0.01	-0.003	†	0.0407
	(0.001)	(0.001)	[0.059]		
N	8087	5963	14050		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table A.2: Summary statistics, UK, spring transition. 1 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	46.089	45.029	-1.06	†	0.0431
	(0.39)	(0.451)	[0.054]		
Male (0/1)	0.439	0.446	0.007		-0.0104
	(0.011)	(0.013)	[0.642]		
ln(income)	7.925	8.002	0.077	**	-0.0688
	(0.017)	(0.02)	[0.002]		
Working (0/1)	0.583	0.603	0.02		-0.0286
	(0.011)	(0.013)	[0.2]		
Unemployed (0/1)	0.054	0.047	-0.007		0.0238
	(0.005)	(0.005)	[0.274]		
Retired (0/1)	0.196	0.174	-0.022	†	0.0405
	(0.009)	(0.01)	[0.071]		
Maternity leave (0/1)	0.008	0.008	0.000		0.001
	(0.002)	(0.002)	[0.962]		
Looking after family (0/1)	0.053	0.057	0.004		-0.0136
	(0.005)	(0.006)	[0.54]		
Full-time student (0/1)	0.064	0.082	0.019	*	-0.0503
	(0.005)	(0.007)	[0.025]		
Long-term sick or disabled (0/1)	0.042	0.029	-0.013	*	0.0499
	(0.004)	(0.004)	[0.027]		
Degree (0/1)	0.245	0.251	0.007		-0.0106
	(0.01)	(0.011)	[0.636]		
Other higher qual. (0/1)	0.109	0.116	0.008		-0.0174
	(0.007)	(0.008)	[0.438]		
A level or equiv. (0/1)	0.201	0.214	0.013		-0.0223
	(0.009)	(0.011)	[0.321]		
GCSE or equiv. (0/1)	0.213	0.21	-0.003		0.0047
	(0.009)	(0.011)	[0.832]		
Other qualificaton (0/1)	0.094	0.099	0.006		-0.0131
	(0.007)	(0.008)	[0.549]		
Household size	2.782	2.92	0.138	**	-0.0715
	(0.029)	(0.037)	[0.002]		
Number of children	0.524	0.503	-0.022		0.0171
	(0.02)	(0.023)	[0.445]		
Single	0.14	0.123	-0.017		0.0354
	(0.008)	(0.008)	[0.114]		
Married	0.517	0.514	-0.003		0.0044
	(0.011)	(0.013)	[0.843]		
Divorced	0.098	0.092	-0.006		0.0139
	(0.007)	(0.007)	[0.517]		
Widowed	0.047	0.04	-0.007		0.0242
	(0.005)	(0.005)	[0.274]		
Yorkshire	0.086	0.078	-0.009		0.0219
	(0.006)	(0.007)	[0.325]		
East Midlands	0.084	0.082	-0.002		0.0063
	(0.006)	(0.007)	[0.776]		
West Midlands	0.072	0.078	0.006		-0.0161
	(0.006)	(0.007)	[0.479]		
England East	0.098	0.08	-0.017	*	0.0432
	(0.007)	(0.007)	[0.042]		
London	0.124	0.13	0.006		-0.0126
	(0.008)	(0.009)	[0.579]		
South East	0.105	0.123	0.018	†	-0.0392
	(0.007)	(0.008)	[0.07]		
South West	0.08	0.065	-0.015	†	0.0404
	(0.006)	(0.006)	[0.065]		
Wales	0.064	0.073	0.01		-0.0269
	(0.006)	(0.007)	[0.238]		
Scotland	0.106	0.101	-0.005		0.0123
	(0.007)	(0.008)	[0.578]		
Northern Ireland	0.083	0.102	0.019	*	-0.0467
	(0.006)	(0.008)	[0.037]		
N	2487	1805	4292		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table A.3: Summary statistics, UK, autumn transition. 1 week time window.

	pre-DST (β_0)	post-DST (β_1)	Difference		Normalised difference
Age	44.256	43.455	-0.801	**	0.0333
	(0.211)	(0.211)	[0.002]		
Male (0/1)	0.455	0.463	0.008		-0.0112
	(0.006)	(0.007)	[0.286]		
ln(income)	7.766	7.777	0.011		-0.0098
	(0.009)	(0.01)	[0.347]		
Working (0/1)	0.637	0.659	0.022	**	-0.0326
	(0.006)	(0.006)	[0.002]		
Unemployed (0/1)	0.032	0.033	0.001		-0.0039
	(0.002)	(0.002)	[0.718]		
Retired (0/1)	0.163	0.144	-0.019	**	0.038
	(0.005)	(0.004)	[0.000]		
Maternity leave (0/1)	0.005	0.005	0.000		-0.0009
	(0.001)	(0.001)	[0.931]		
Looking after family (0/1)	0.067	0.066	-0.001		0.0037
	(0.003)	(0.003)	[0.724]		
Full-time student (0/1)	0.055	0.058	0.003		-0.009
	(0.003)	(0.003)	[0.39]		
Long-term sick or disabled (0/1)	0.041	0.035	-0.005	†	0.0199
	(0.002)	(0.002)	[0.056]		
Degree (0/1)	0.156	0.163	0.008		-0.0152
	(0.005)	(0.005)	[0.153]		
Other higher qual. (0/1)	0.254	0.257	0.003		-0.0049
	(0.005)	(0.006)	[0.637]		
A level or equiv. (0/1)	0.14	0.148	0.008		-0.0162
	(0.004)	(0.005)	[0.124]		
GCSE or equiv. (0/1)	0.238	0.229	-0.009		0.0148
	(0.005)	(0.005)	[0.162]		
Other qualificaton (0/1)	0.041	0.035	-0.006	†	0.0202
	(0.002)	(0.002)	[0.06]		
Household size	2.925	2.945	0.019		-0.0096
	(0.018)	(0.017)	[0.358]		
Number of children	0.547	0.54	-0.007		0.0054
	(0.012)	(0.012)	[0.611]		
Single	0.128	0.119	-0.009	†	0.0198
	(0.004)	(0.004)	[0.063]		
Married	0.538	0.539	0.001		-0.0013
	(0.006)	(0.006)	[0.898]		
Divorced	0.061	0.057	-0.003		0.01
	(0.003)	(0.003)	[0.347]		
Widowed	0.054	0.048	-0.006	†	0.0191
	(0.003)	(0.003)	[0.077]		
Yorkshire	0.066	0.073	0.007	†	-0.0185
	(0.003)	(0.003)	[0.077]		
East Midlands	0.075	0.075	0.001		-0.0019
	(0.003)	(0.004)	[0.854]		
West Midlands	0.062	0.061	-0.001		0.0033
	(0.003)	(0.003)	[0.744]		
England East	0.072	0.062	-0.01	**	0.0292
	(0.003)	(0.003)	[0.004]		
London	0.063	0.059	-0.004		0.0119
	(0.003)	(0.003)	[0.237]		
South East	0.102	0.1	-0.003		0.0059
	(0.004)	(0.004)	[0.571]		
South West	0.082	0.078	-0.004		0.0106
	(0.004)	(0.004)	[0.316]		
Wales	0.142	0.127	-0.014	**	0.0296
	(0.004)	(0.004)	[0.005]		
Scotland	0.157	0.181	0.025	**	-0.0465
	(0.005)	(0.005)	[0.000]		
Northern Ireland	0.102	0.113	0.011	*	-0.0261
	(0.004)	(0.004)	[0.015]		
N	9687	8585	18272		

Notes: Columns (1)-(2) present means for control variables in $\mathbf{X}$ in equation (3). The means derive from a regression as in equation (1). Standard errors are shown in parentheses. Column (3) presents the mean differences and corresponding p-values for the $H_0 : \beta_0 = \beta_1$ in brackets. Column (4) presents the normalised difference as in equation (2). ** p<0.01, * p<0.05, † p<0.1

Table A.4: The effect of the spring DST transition on life-satisfaction, subgroup analysis.

	BHPS						SOEP					
	Youngest child: < 6		Youngest child: ≥ 6		No children		Youngest child: < 6		Youngest child: ≥ 6		No children	
	Work	No work	Work	No work	Work	No work	Work	No work	Work	No work	Work	No work
Panel A: Week 1 after the transition												
Sunday	-0.480	0.845	-0.315	-1.169	-0.218	0.689 *	-0.133	0.100	-0.333	0.612	0.091	-0.013
	(0.406)	(0.600)	(0.525)	(0.982)	(0.224)	(0.273)	(0.354)	(0.436)	(0.252)	(0.536)	(0.166)	(0.247)
Monday	-0.270	0.250	-0.098	0.116	-0.078	-0.176	0.146	0.058	0.308 *	0.062	-0.173 †	-0.191
	(0.265)	(0.400)	(0.208)	(0.369)	(0.125)	(0.153)	(0.160)	(0.225)	(0.132)	(0.317)	(0.098)	(0.133)
Tuesday	-0.607 *	-0.381	-0.065	0.176	-0.145	-0.512 **	-0.123	-0.325	-0.116	0.411	-0.014	-0.142
	(0.267)	(0.530)	(0.206)	(0.388)	(0.153)	(0.176)	(0.162)	(0.287)	(0.168)	(0.277)	(0.093)	(0.130)
Wednesday	-0.356	-0.704	0.296	-0.009	0.138	-0.128	-0.430 *	-0.407	0.014	-0.546 *	0.028	-0.123
	(0.281)	(0.886)	(0.205)	(0.293)	(0.141)	(0.170)	(0.192)	(0.258)	(0.125)	(0.270)	(0.098)	(0.120)
Thursday	-0.038	0.009	-0.261	0.150	0.077	-0.024	-0.272	0.020	-0.011	-0.704 *	-0.145	-0.151
	(0.300)	(0.451)	(0.226)	(0.441)	(0.146)	(0.152)	(0.180)	(0.292)	(0.177)	(0.353)	(0.109)	(0.161)
Friday	0.488	0.055	-0.031	0.750	0.002	-0.123	-0.162	-0.158	0.155	0.030	-0.171	-0.152
	(0.345)	(0.505)	(0.319)	(0.650)	(0.171)	(0.264)	(0.189)	(0.305)	(0.148)	(0.286)	(0.124)	(0.166)
Saturday	0.074	-0.794	-0.261	-0.735	-0.156	0.150	-0.332	0.274	0.206	0.568 †	-0.107	-0.007
	(0.407)	(0.745)	(0.267)	(0.866)	(0.215)	(0.383)	(0.204)	(0.299)	(0.145)	(0.294)	(0.126)	(0.178)
Panel B: Week 2 after the transition												
Sunday	0.269	0.428	0.092	-0.691	0.132	-0.833	0.534 *	0.677	0.120	0.244	0.161	0.187
	(0.376)	(0.477)	(0.409)	(0.550)	(0.247)	(0.666)	(0.237)	(0.591)	(0.215)	(0.477)	(0.191)	(0.275)
Monday	-0.151	-0.031	-0.471 *	0.340	0.123	0.229	-0.119	0.048	0.033	0.584 †	-0.003	0.080
	(0.374)	(0.405)	(0.228)	(0.442)	(0.139)	(0.207)	(0.211)	(0.275)	(0.164)	(0.305)	(0.122)	(0.158)
Tuesday	-0.615 *	-0.292	0.076	-0.718	0.031	-0.221	0.233	0.137	-0.010	0.530 †	-0.026	-0.013
	(0.290)	(0.437)	(0.222)	(0.797)	(0.152)	(0.187)	(0.164)	(0.254)	(0.160)	(0.304)	(0.104)	(0.157)
Wednesday	0.006	0.154	-0.279	-0.008	-0.252	-0.182	-0.307	0.140	-0.049	-0.741 **	0.165	-0.158
	(0.321)	(0.490)	(0.245)	(0.373)	(0.169)	(0.172)	(0.195)	(0.254)	(0.133)	(0.265)	(0.105)	(0.154)
Thursday	-0.158	0.071	0.246	0.677 *	-0.173	-0.249	-0.353 †	-0.040	-0.136	0.064	0.228 *	-0.141
	(0.279)	(0.414)	(0.235)	(0.312)	(0.155)	(0.179)	(0.182)	(0.230)	(0.186)	(0.334)	(0.105)	(0.166)
Friday	-0.559	-0.668	0.266	0.117	-0.025	0.032	0.044	-0.369	0.047	-0.311	0.040	0.202
	(0.398)	(0.664)	(0.284)	(0.498)	(0.190)	(0.195)	(0.206)	(0.261)	(0.164)	(0.337)	(0.123)	(0.169)
Saturday	0.672 *	-0.221	-0.221	-0.004	-0.092	-0.223	0.065	-0.060	0.114	-0.221	0.089	0.250
	(0.284)	(0.737)	(0.343)	(0.464)	(0.212)	(0.254)	(0.198)	(0.337)	(0.148)	(0.294)	(0.116)	(0.191)
N	758	462	1262	538	3083	2847	3019	1743	5192	1621	10518	7560

Notes: Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1.

Table A.5: Robustness - pseudo outcome: the effect of the beginning to DST on chronic illness.

	BHPS		SOEP	
	(1)	(2)	(3)	(4)
Panel A: Weekly averages after the transition				
First week (DST1w)	-0.035 **	-0.003	-0.003	0.004
	(0.012)	(0.011)	(0.005)	(0.005)
Second week (DST2w)	0.001	0.019	-0.007	0.001
	(0.013)	(0.012)	(0.005)	(0.005)
Panel B: First week after the transition				
Sunday	0.051	0.041	0.019	0.028
	(0.054)	(0.049)	(0.019)	(0.017)
Monday	-0.042 †	-0.005	-0.021 †	-0.016
	(0.025)	(0.023)	(0.011)	(0.011)
Tuesday	-0.049 †	0.006	-0.015	-0.008
	(0.026)	(0.024)	(0.011)	(0.010)
Wednesday	-0.060*	-0.033	-0.005	0.004
	(0.028)	(0.025)	(0.011)	(0.010)
Thursday	0.002	0.023	0.007	0.014
	(0.029)	(0.026)	(0.013)	(0.012)
Friday	-0.054	-0.019	0.006	0.017
	(0.037)	(0.034)	(0.013)	(0.013)
Saturday	-0.030	-0.017	0.004	0.008
	(0.042)	(0.038)	(0.014)	(0.013)
Panel C: Second week after the transition				
Sunday	-0.098 †	-0.038	0.019	0.020
	(0.054)	(0.051)	(0.022)	(0.021)
Monday	-0.025	0.031	0.004	0.006
	(0.031)	(0.028)	(0.014)	(0.013)
Tuesday	-0.021	0.052 *	-0.014	-0.011
	(0.029)	(0.026)	(0.012)	(0.012)
Wednesday	0.010	0.023	0.001	0.012
	(0.031)	(0.028)	(0.012)	(0.011)
Thursday	0.007	-0.006	-0.017	-0.007
	(0.028)	(0.024)	(0.012)	(0.012)
Friday	0.064 †	0.015	0.008	0.019
	(0.037)	(0.032)	(0.014)	(0.013)
Saturday	0.032	0.013	-0.030*	-0.016
	(0.040)	(0.036)	(0.012)	(0.012)
N	10549	10549	29721	29721
Controls included for				
Year indicators		✔		✔
Region indicators		✔		✔
Socio-demographics		✔		✔

Notes: Cluster robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$, † $p<0.1$

Table A.6: The effect of the beginning to DST on life-satisfaction. Dropping those with $\geq$ 6 calls.

	BHPS		SOEP	
	(1)	(2)	(3)	(4)
Panel A: Weekly averages after the transition				
First week (DST1w)	-0.009	-0.032	-0.068 *	-0.071 **
	(0.047)	(0.044)	(0.028)	(0.027)
Second week (DST2w)	-0.055	-0.080 †	0.026	0.030
	(0.051)	(0.048)	(0.031)	(0.030)
Panel B: First week after the transition				
Sunday	0.131	0.074	0.077	-0.011
	(0.190)	(0.180)	(0.115)	(0.114)
Monday	-0.003	-0.044	-0.024	-0.030
	(0.097)	(0.093)	(0.064)	(0.062)
Tuesday	-0.180 †	-0.187 †	-0.123 †	-0.079
	(0.105)	(0.101)	(0.065)	(0.064)
Wednesday	0.164 †	0.105	-0.139 *	-0.137 *
	(0.099)	(0.091)	(0.062)	(0.060)
Thursday	0.052	0.009	-0.169 *	-0.180 *
	(0.111)	(0.104)	(0.076)	(0.074)
Friday	0.006	-0.003	-0.077	-0.103
	(0.163)	(0.158)	(0.075)	(0.073)
Saturday	-0.030	-0.093	0.116	0.088
	(0.184)	(0.185)	(0.079)	(0.076)
Panel C: Second week after the transition				
Sunday	0.248	0.135	0.180	0.202 †
	(0.195)	(0.196)	(0.119)	(0.114)
Monday	0.100	0.090	0.045	0.068
	(0.122)	(0.119)	(0.079)	(0.077)
Tuesday	-0.121	-0.165	0.027	0.041
	(0.122)	(0.118)	(0.071)	(0.070)
Wednesday	-0.157	-0.182	-0.069	-0.057
	(0.125)	(0.117)	(0.071)	(0.069)
Thursday	-0.021	-0.048	-0.028	-0.004
	(0.114)	(0.111)	(0.076)	(0.073)
Friday	-0.022	-0.051	0.013	0.001
	(0.135)	(0.126)	(0.080)	(0.078)
Saturday	-0.138	-0.143	0.109	0.068
	(0.158)	(0.148)	(0.078)	(0.075)
N	6654	6654	28191	28191
Controls included for				
Year indicators		✔		✔
Region indicators		✔		✔
Socio-demographics		✔		✔

Notes: Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table A.7: Robustness - no extreme values. The effect of the beginning to DST on life-satisfaction.

	BHPS		SOEP	
	(1)	(2)	(3)	(4)
Panel A: Weekly averages after the transition				
First week (DST1w)	-0.054	-0.076 *	-0.075 **	-0.071 **
	(0.036)	(0.035)	(0.025)	(0.024)
Second week (DST2w)	-0.052	-0.072 †	0.004	0.023
	(0.039)	(0.038)	(0.028)	(0.027)
Panel B: First week after the transition				
Sunday	-0.066	-0.073	0.058	-0.025
	(0.161)	(0.155)	(0.098)	(0.096)
Monday	-0.085	-0.134 †	-0.066	-0.059
	(0.076)	(0.074)	(0.059)	(0.057)
Tuesday	-0.294 **	-0.303 **	-0.096	-0.063
	(0.089)	(0.085)	(0.059)	(0.057)
Wednesday	0.108	0.089	-0.076	-0.075
	(0.082)	(0.078)	(0.057)	(0.055)
Thursday	0.079	0.052	-0.127 †	-0.13 9*
	(0.083)	(0.081)	(0.069)	(0.068)
Friday	0.096	0.071	-0.108	-0.135 *
	(0.115)	(0.115)	(0.068)	(0.067)
Saturday	-0.122	-0.158	0.047	0.010
	(0.133)	(0.133)	(0.073)	(0.070)
Panel C: Second week after the transition				
Sunday	0.220	0.175	0.139	0.149
	(0.172)	(0.168)	(0.113)	(0.106)
Monday	0.032	0.009	0.037	0.059
	(0.090)	(0.090)	(0.070)	(0.069)
Tuesday	-0.028	-0.060	-0.000	0.015
	(0.089)	(0.087)	(0.064)	(0.063)
Wednesday	-0.063	-0.074	-0.046	-0.040
	(0.094)	(0.090)	(0.064)	(0.061)
Thursday	-0.053	-0.067	-0.007	0.013
	(0.089)	(0.087)	(0.070)	(0.067)
Friday	-0.148	-0.158	-0.046	-0.069
	(0.113)	(0.107)	(0.073)	(0.072)
Saturday	-0.200	-0.195	0.161 *	0.119 †
	(0.130)	(0.123)	(0.071)	(0.067)
N	7708	7708	27974	27974
Controls included for				
Year indicators		✔		✔
Region indicators		✔		✔
Socio-demographics		✔		✔

Notes: Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table A.8: The effect of the b to DST on life-satisfaction. SOEP 2005-20012 only.

	(1)	(2)
Panel A: Weekly averages after the transition		
First week (DST1w)	0.063 *	0.039
	(0.029)	(0.028)
Second week (DST2w)	0.019	-0.022
	(0.032)	(0.030)
Panel B: First week after the transition		
Sunday	-0.015	0.030
	(0.109)	(0.104)
Monday	0.040	0.032
	(0.070)	(0.067)
Tuesday	0.140 *	0.077
	(0.068)	(0.065)
Wednesday	0.033	0.028
	(0.067)	(0.065)
Thursday	0.062	0.053
	(0.085)	(0.082)
Friday	0.022	-0.016
	(0.081)	(0.076)
Saturday	0.052	0.049
	(0.084)	(0.081)
Panel C: Second week after the transition		
Sunday	0.103	0.082
	(0.116)	(0.113)
Monday	-0.082	-0.128 †
	(0.077)	(0.073)
Tuesday	0.076	0.050
	(0.071)	(0.068)
Wednesday	0.079	0.023
	(0.076)	(0.071)
Thursday	-0.081	-0.115
	(0.083)	(0.079)
Friday	0.087	-0.006
	(0.083)	(0.080)
Saturday	-0.008	0.028
	(0.098)	(0.091)
N	22484	22484
Controls included for		
Year indicators	✔	✔
Region indicators	✔	✔
Socio-demographics	✔	✔
School holidays/Easter		✔

Notes: Cluster robust standard errors in parentheses. ** p<0.01, * p<0.05, † p<0.1

Table A.9: The effect of the beginning to DST on life-satisfaction. 1 week window.

	BHPS		SOEP	
	(1)	(2)	(3)	(4)
Panel A: Weekly averages after the transition				
First week (DST1w)	-0.068	-0.090 *	-0.036	-0.049 †
	(0.045)	(0.043)	(0.031)	(0.030)
Panel B: First week after the transition				
Sunday	-0.020	-0.023	0.019	-0.048
	(0.190)	(0.187)	(0.123)	(0.121)
Monday	-0.018	-0.077	0.063	0.066
	(0.094)	(0.091)	(0.072)	(0.070)
Tuesday	-0.314 **	-0.340 **	-0.121 †	-0.098
	(0.105)	(0.101)	(0.072)	(0.070)
Wednesday	-0.056	-0.087	-0.137 †	-0.141 *
	(0.103)	(0.098)	(0.071)	(0.069)
Thursday	0.048	0.039	-0.106	-0.148 †
	(0.104)	(0.101)	(0.083)	(0.081)
Friday	0.207	0.193	0.035	0.031
	(0.145)	(0.144)	(0.090)	(0.087)
Saturday	-0.146	-0.171	0.051	0.026
	(0.163)	(0.164)	(0.091)	(0.087)
N	4292	4292	14050	14050
Controls included for				
Year indicators		✔		✔
Region indicators		✔		✔
Socio-demographics		✔		✔

Notes: Cluster robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$, † $p<0.1$