When Should the Sun Shine? The Effect of the Time Zone on Health

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Abstract

This paper uses forty years of time zone reforms and individual longitudinal data to explore the effect of time institutions on health in two regions of Russia. In both regions, a forward-shifted clock leads to a healthier lifestyle, but deteriorates certain other outcomes. In particular, darkness in the morning negatively affects self-evaluated health and increases the incidence of hypertension, whereas light in the evening increases physical activity and leads to a lower body mass index. These results suggest that given an objective function of health, time institutions can be optimized.

Keywords: daylight saving time, health, Russia, time zone

JEL codes: I12, I18

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"Let there be light."

Genesis 1:3

"Early to bed and early to rise makes a man healthy, wealthy, and wise."

English proverb

1 Introduction

Few natural resources are as important as daylight. Yet modern institutions that accommodate society to daylight, i.e., time zones and daylight saving time (DST), remain variable and their efficiency remains uncertain. Recently, the European Union conducted a poll that supported the abolition of DST and the adoption of a permanent annual time. The people of California voted for a similar reform. In Israel, the duration of DST is a bone of contention between the religious and the liberal parties. Time institutions are also manipulated by autocrats for symbolic reasons. For example, China decreased the number of its time zones from five to one following the victory of the Communists in the civil war.[1] The life in Spain is heavily affected by the use of Central European Time since Franco's show of solidarity with Nazi Germany. Chávez distinguished Venezuela by setting its clock half an hour back. North Korea set its clock half an hour ahead to align its time with South Korea's a week after a summit of the two countries' leaders. These examples from both democracies and autocracies show that in many cases management of time institutions is far from being scientific.

Yet medical studies find a direct positive effect of exposure to daylight on mood and health.[2] Moreover, the fit between time institutions and daylight may affect health also indi-

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[1] Nevertheless, China also provides an interesting case where two time zones (with a two-hour difference between them) are used in parallel in the Xinjiang province and the split is along ethnic lines.

[2] I analyze only health, but mention other daylight-related issues in the literature review (see Section 3).

rectly through lifestyle, i.e., habits such as smoking, drinking, eating, exercising, socializing, sleeping, and spending time outdoors in the fresh air.

Can time institutions be optimized given an objective function of health? I attempt to answer this question with arguably the best existing natural experiment on time institutions and the best individual-level data that can be used to analyze this experiment. Russia is a big time laboratory: it has eleven time zones, and it frequently changes their borders. For example, in 2010, the government temporarily reduced the number of time zones from eleven to nine.

This paper is novel in two significant respects. First, the identification strategy relies on a comparison of the effect of time institutions on health across two independent sources of clock variation within the same country. Moreover, each of the two sources of variation consists of several subsources. In particular, a series of time zone reforms affected Western Siberia between 1991 and 2002 and in 2016 and another series of reforms affected the region between the Volga River and the Ural Mountains (a region that I will refer to as Northern Volga) between 1989 and 1992 and in 2010 and 2014. Thus, the identification strategy enables a comparison of the effects in two distinct regions of Russia, each exposed to different time zone reforms.

The second novelty relates to the analysis of the long-run effects of the time zone on health. I use the large Russian Longitudinal Monitoring Survey (RLMS), collected since 1994 and merged with sunrise and sunset times since 1974. I limit the sample to individuals who are at least twenty years old and take into account their twenty-year-long experience of time zone changes. By contrast, most existing studies rely on short periods of time. In particular, many studies treat the DST transitions (i.e., when the clock is moved one hour back in autumn and one hour ahead in spring) as an exogenous clock variation. By definition, these discontinuity events do not enable estimation of long-run effects.

In the first stage of the analysis, I identify the periods in the twenty years preceding each interview with a RLMS respondent that consistently affect her health and lifestyle outcomes. That is, I look for nonzero effects that are comparable between Northern Volga and Western Siberia. I find such effects for seven out of seventeen outcomes. Of these seven outcomes, four present a positive (beneficial for health) effect of a forward-shifted clock and three present a negative effect. The positive effect is observed for physical activity, non-exercise-related walking, body mass index, and chronic stomach disease. The negative effect is observed for self-evaluated health, high blood pressure, and chronic kidney disease.

In the second stage of the analysis, I identify the specific hours of the day when daylight mediates the above-mentioned effects. In particular, I replace the variable of the average clock during the relevant period in the individual's past (the period when the effect is identified in the first stage) by the proportion of days with daylight at a particular hour of the day during this period. Thus, I identify whether it is the later sunrise or the later sunset that drives the first-stage result.

The bottom line is rather optimistic. Although the empirical analysis does not produce a full list of consistent, robust, and statistically significant coefficients that combine in a formula that generates optimal time institutions, it does identify some important effects. In particular, daylight at 7am and 8am, the hours when most people commute to work or school, has a positive effect on self-evaluated health and blood pressure, while daylight at 6pm has a positive effect on physical activity and is associated with a lower body mass index. Hence, time institutions can be considered within a formal optimization framework.

The paper is organized as follows. Section 2 presents the motivating idea of designing optimal time institutions. Section 3 reviews the literature. Section 4 discusses the history of Russian time zone reforms and the use of these reforms for identification. Section 5 introduces the data. Section 6 describes the estimation procedure. Section 7 discusses the results. Section 8 concludes.

2 Motivating Framework

The empirical analysis in this paper should be considered in the context of optimal time institutions. Generally speaking, it can be any policy, e.g., shifting the time zone every day such that the sunrise is always at 6am. In practice, two institutions are used: a constant time zone and the dates (which can be empty) of DST transitions. Let us denote by j a set of time institutions at a given location. The steady-state reduced-form effect of time institutions on outcome i is given by

$$x_{ji} = \int_{0}^{24} p_j(t) e_i(t) dt, \tag{1}$$

where $p_j(t)$ is the proportion of days with daylight at hour t under policy j, and $e_i(t)$ is the effect of daylight at hour t on outcome i. This reduced-form effect includes both the direct effect of exposure to daylight and the indirect effect through other outcomes. For example, daylight may affect the risk of obesity, which is both a separate health outcome and a risk factor of other health problems.

The optimal set of time institutions is defined as the one that maximizes an objective function H of effects on health

$$j^* = argmax_j H(x_{j1}, x_{j2}, ..., x_{jk}), \tag{2}$$

where k is the number of outcomes that the policy maker is concerned with.

The empirical strategy in this paper is to estimate $e_i(t)$ using the variation in $p_j(t)$ that was generated by reforms that took place in two large regions of Russia.

3 Related Literature

Economic literature

There are three groups of economic studies that address the effect of time. The first group is related to coordination. It is concerned with the difference in time between two locations. The considered outcomes are mutual trade (Kikuchi (2006), Kikuchi and Marjit (2010), Kikuchi and Van Long (2010), Christen (2017)),[3] foreign direct investment (Stein and Daude (2007), Hattari and Rajan (2012)), and time use (Hamermesh et al. (2008)).

The second group of studies considers daylight saving time (DST) transitions as a quasi-experimental discontinuity setup and investigates the short-run effect of sleep deprivation on outcomes such as happiness (Kountouris and Remoundou (2014), Kuehnle and Wunder (2014)), health (Jin and Zebarth (2015b), Toro et al. (2015); see also the references in footnote 2 in Jin and Zebarth (2015b)), performance of stock markets (Kamstra et al. (2000)), and crime (Munyo (2018)). Some of the estimated effects last for no more than a few days.

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[3] For a comprehensive review of the trade-related literature on the role of time zones, see Prasad et al. (2017).

In some studies, the effect is observed only in the "unfriendly" DST transition in spring (when individuals lose one hour of sleep) but in other studies it is observed also/only in the "friendly" transition in autumn (Kuehnle and Wunder (2014), Jin and Zebarth (2015a,b), Munyo (2018)).

The third group of studies, which includes the present paper, is concerned with the effect of daylight on humans. With regard to health, Markusen and Røed (2015) report that longer daylight hours are associated with a higher rate of entry into absenteeism but also with a faster recovery. The overall effect is positive (less absenteeism) but small. Guintella and Mazzona (2017) use spatial discontinuity around the time zone borders in the U.S. to estimate the effect of clock-related reduced sleep on health and income. They find that, roughly speaking, a later clock is associated with worse health.

With regard to productivity, Figueiro et al. (2002) collect data from a software development company and find that workers in offices with windows spend more time working on computers than workers in offices without natural light, even though the visual system performs similarly in both environments. Gibson and Shrader (2014) estimate the wage return to sleep, instrumented by sunset time, and find that a one-hour-later sunset decreases short-run wages by 0.5% and long-run wages by 4.5%. In a related paper, Giuntella et al. (2017) use location as an instrument for sleep duration in China to estimate the effect of sleep on cognitive skills.

With regard to crime, Doleac and Sanders (2015), Dmonguez and Asahi (2016), and Toro et al. (2016) use regression discontinuity around the day of DST transition to establish the effect of longer daylight hours. Doleac and Sanders (2015) find a 7% decrease in robbery in the U.S. as a result of the additional hour of daylight, Dmonguez and Asahi (2016) report an 18% decrease in overall crime in Chile, driven by a decrease in robbery, and Toro et al. (2016) find a 14% decrease in homicide in Brazil.

The present paper differs from the related economic studies by several respects. I use a large longitudinal data and estimate a long-run effect of time institutions. Moreover, the list of health and lifestyle outcomes that I analyze is longer than in any previous study. Finally, the identification of consistent effects relies on comparison of two regions, each of which was exposed to different shocks on time institutions.

Medical literature

Numerous studies in medical sciences explore the effect of light on health. In almost all of the studies (except of Richmond et al. (2018)), the researchers monitor a small sample for a short period of time.

Blue light is found to be more beneficial than others (Viola et al. (2008)). This can explain the superiority of exposure to morning light to exposure to evening light: morning light is richer in blue light. For example, in an interesting quasi-experimental paper, Benedetti et al. (2001) find that patients with bipolar depression need a shorter hospitalization if they are randomly assigned to a room on the side of the corridor exposed to morning light. Cheung et al. (2016) find that exposure to blue light affects metabolism and may be related to weight loss. Reid et al. (2014) find a positive correlation between the hour of the day when humans are exposed to light and body mass index, which means that exposure to light in the morning is associated with the lowest body mass index. Furthermore, morning light is found to be a stronger antidepressant in winter depression treatment compared to evening light (Lewy et al. (1998)). Richmond et al. (2018) find in the large UK Biobank dataset that women who are early risers ("larks") are less likely to develop breast cancer. Finally, Vandewalle et al. (2010) suggest a possible interaction effect of exposure to blue light with exposure to voice. All these findings suggest a careful investigation of *when* the sun should shine.

4 Time Zone Reforms in Russia

Russia differs from any other country by the very long distance between its eastern and western ends. The longitudinal difference between the westernmost province, Kaliningrad Oblast, and the easternmost province, Chukotka, is 157°, which corresponds to 11 natural (nautical) time zones. A natural time zones should place the sun in the zenith around 12am. However, in the period between 1990 and 2015, the time zone was equal to the natural one in only 196 out of 2,162 province-year cases. Between 1995 and 2014, the number was only 20 out of 1,662. In almost all of the other cases, the time zone exceeds the natural one. Between 1990 and 2015, the time zone exceeded the natural one by one hour in 52% of the province-year cases, and by two hours in 38% of the cases. This means that sunrise and sunset in Russia are, roughly speaking, institutionally late.

Russia differs from other countries also by its relatively frequent time zone reforms. The time zones were introduced in 1919 and were expanded to the whole territory of the Soviet Union in 1924. The introduction of the time zones was followed by a long list of changes that continue to this day. In the summer of 1930, the Soviet government set the clocks in the country one hour ahead by a decree. The decree was planned to be in power for only three months, but in practice the clocks were not set back. Nevertheless, starting in 1957, many regions set their clocks back, adopting a lower time zone. The frequency of time zone reforms has been particularly high since the 1980s, especially in the years around the dissolution of the Soviet Union and since 2010. The present study utilizes a longitudinal dataset collected since 1994. However, I consider an individual history of twenty years preceding the interview. Thus, the earliest relevant point in time is 1974 and the earliest relevant reform went into effect in 1981. Table 1 shows the list of time zone reforms during the relevant period.

An example of political considerations that led to an unpopular time zone reform is the reform of 2010. Despite its constitutional definition as a federation, Russia is a centralized country. In particular, at any point in time, about 50 out of the total[4] of 85 provinces use Moscow Time. The president stated in his annual address to the parliament in 2009 that distant regions should be set "closer" to Moscow, which should improve the coordination between the local governments and the central one. In the following year, the number of provinces in the Moscow Time Zone increased from 50 to 52 and increased further to 54 in 2014. However, the implementation of the 2010 reform led to some popular protest. The reform was recognized as a failure already in 2011 and a new reform was initiated. Later, a 2014 reform revised the one of 2011. In turn, a 2016 reform attempted to correct the one of 2014. The map in Figure 1 presents the Russian time zones following the reform of 2016, which is the last reform that is integrated in this paper's data.

To illustrate the dynamics of the time zones with a graphical example, Figure 2 plots the yearly average time zone (with respect to daylight saving time) in four provinces, starting from 1974. Data from three of the provinces is used in the empirical part of the paper (Altai and Tomsk belong to Western Siberia, while Udmurtia belongs to Northern Volga) and data from the fourth province, Moscow, is shown as a reference (selection of the regions used for

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[4] Including Crimea and Sevastopol, which were annexed in 2014.

estimation is discussed below). The figure illustrates the variation in time, generated by reforms, across regions and over years.

The discontinuous time can be plotted also on micro level. Tomsk is one of the RLMS locations in Western Siberia. Figure 3 shows the sunrise and sunset times in Tomsk in 2002, a year when this province experienced a time zone reform. The first discontinuity observed in the figure is the daylight saving time transition that took place in March. The second discontinuity is the reform that took place in May and decreased Tomsk's time by one hour. The third discontinuity is the October shift back from daylight saving time.

Use of the reforms for identification

A look at the list of the reforms in Table 1 reveals that while some reforms, such as the introduction and abolition of daylight saving time, affect many or all of the regions, other reforms involve only a few. Mainly, these are provinces in the orbit of strong neighbors but located far away from them. Time coordination with a remote strong city requires a bigger compromise in terms of sunrise and sunset timing than when the strong city is close. Thus, the trade-off between time coordination and other considerations is bigger in these regions, leading to lower satisfaction with any solution and, as a result, to more frequent reforms.

For example, the Samara Time Zone (UTC+4), which runs along the eastern border of European Russia, covers a relatively small region. Struggling to exist, alongside the dominant Moscow Time Zone (UTC+3), the Samara Time was completely extinct between 2011 and 2014, included only two provinces in 2014, and was expanded to five provinces in 2016. Hence, this region, bounded by the Volga River and the Ural Mountains, is subject to frequent time zone reforms. Among the locations monitored in RLMS, Udmurtia, which was affected by reforms between 1989 and 1992, in 2010, and in 2014, belongs to this region. Another part of the country that is subject to relatively frequent reforms includes regions in the orbit of the city of Novosibirsk in Western Siberia. Between 1991 and 2002 and in 2016, different provinces in this region experienced changes to their time zone.

The reforms in Northern Volga and Western Siberia are exogenous in the sense that most of them were driven by coordination with a strong city or, in opposite, by disappointment with such a coordination. For instance, the 1995 reform in Altai and the 2002 reform in Tomsk followed, after some delay, the 1993 time zone change of their strong neighbor, Novosibirsk. Many workers travel frequently between Altai, Tomsk, and Novosibirsk. The importance of the train schedule led to coordination of the neighbors' clocks. In a letter to the prime minister of Russia from 2001, the Tomsk regional legislature stated that "The socioeconomic infrastructure of (Tomsk) Oblast depends on the transportation network ... of the Novosibirsk Oblast," but also noted that "... (the shift to a lower time zone) would lead to a shorter interval between the wake-up time of most of the population and the sunrise."

Another example of an exogenous shock is the above-mentioned 2010 reform in five provinces following the president's speech in which he expressed the idea that reducing the number of time zones in Russia from eleven to nine would improve governability. In this case, reduction of the number of time zones was clearly exogenous on the regional level because it was executed by simply eliminating the time zones with the smallest number of provinces in mainland Russia.[5] One of the time zones with a small number of provinces was the above-mentioned Samara Time Zone that included the RLMS-monitored Udmurtia. This time zone was among the two that were eliminated in 2010 (but reinstalled later).

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[5] By mainland Russia, I mean all provinces excluding the Kaliningrad exclave.

Many reforms are of less importance for this paper. Reforms that affect all RLMS locations, such as the one of 2011, and permanent time zone differences between regions are flattened by year and location fixed effects, respectively. Also of no importance for this paper are reforms that take place in regions not monitored in RLMS. Finally, reforms that took place in the 1980s and in 2016, although they are integrated in the history of RLMS respondents in many locations, generate little statistical power, because their timing relative to the core years of RLMS is remote. Hence, I limit the sample to the two regions affected by time zone reforms more frequently than others. After controlling for regional and year fixed effects, other regions do not contribute much to the time variation in my data. Moreover, the two regions lie far away from each other. This geographic feature allows *comparison* and identification of consistent effects across independent sources of time zone variation.

The map in Figure 4 shows the RLMS locations across Russia. The two circled areas in the map represent the regions considered for estimation. Northern Volga is my name for the region between the Volga River and the Ural Mountains. Specifically, it is the region that lies within a 500 km radius of the RLMS-monitored town Glazov in Udmurtia, one of the provinces affected by the 2010 shrink of the number of time zones from eleven to nine. This region includes, in addition to Glazov, four locations monitored in RLMS. A region of comparable size is Western Siberia, which was exposed to special reforms in Altai, Krasnoyarsk, Novosibirsk, and Tomsk. This region includes six RLMS locations. Together, these two regions account for one-fourth of all RLMS observations. They are comparable not only in terms of size, but also have a similar number of RLMS respondents.[6]

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[6] The coordinates of the Northern Volga region lie between 46.5°E and 56.8°E and between 55.5°N and 61.6°N. The coordinates of the Western Siberia region lie between 82.4°E and 92.9°E and between 51.6°N and 56.5°N.

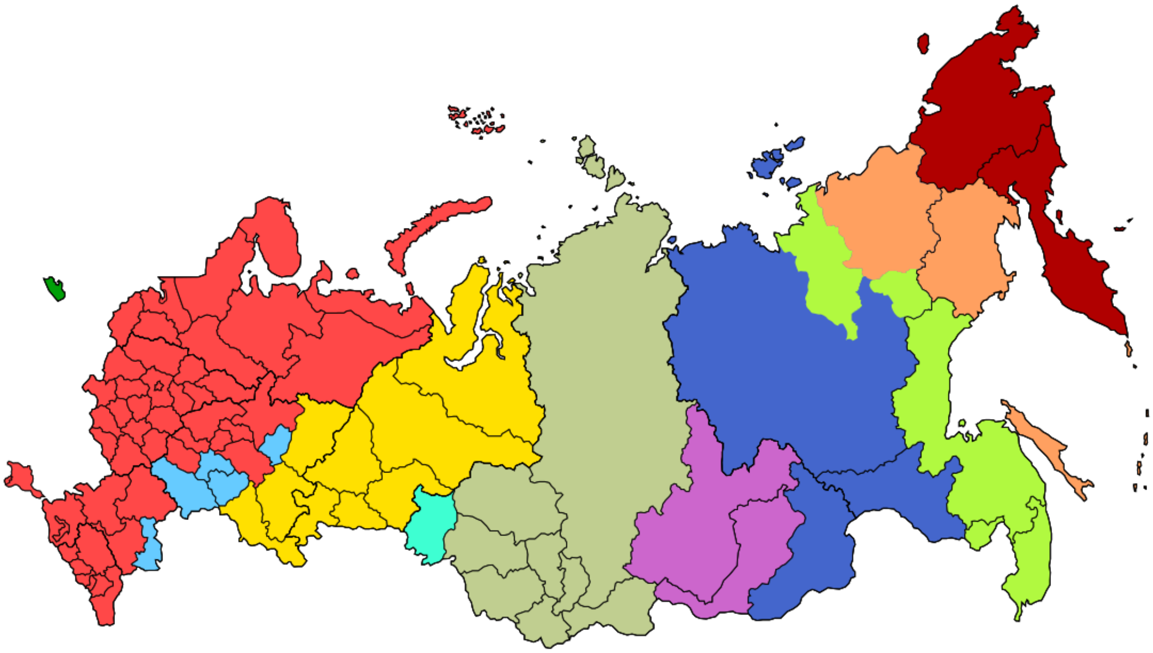
Table 1: Time zone reforms in Russia in the relevant period

Date	Affected regions	Direction (if any time zones changed)	Remarks
April 1, 1981	All	↑	First DST transition
April 1, 1982	Chukotka	↓	
March 27, 1988	Volgograd, Saratov	↓	
March 26, 1989	6 provinces	↓	
March 31, 1991	78 provinces	↓	
October 30, 1991	Samara, Udmurtia	↑	
January 19, 1992	75 provincesions	↑	
March 29, 1992	Astrakhan, Volgograd	↓	
May 23, 1993	Novosibirsk	↓	
May 28, 1995	Altai Krai, Altai Republic	↓	
March 30, 1997	Sakhalin	↓	
May 1, 2002	Tomsk	↓	
March 28, 2010	5 provinces	↓	The number of time zones decreases from 11 to 9.
August 31, 2011	All	↑	Elimination of DST
March 30, 2014	Crimea, Sevastopol	⇑	
October 26, 2014	80 provinces	↓ (78 provinces) ⇓ (2 provinces)	
March 27 to December 4, 2016	10 provinces	↑	

Notes: (1) ↑ and ↓ correspond to a shift of one time zone, ⇑ and ⇓ correspond to a shift of two time zones.

(2) The number of affected provinces is given in accordance with the administrative division of Russia in 2018.

Figure 1: Time zones in Russia as of 2018



KALT Kaliningrad Time UTC+2 (MSK–1), MSK Moscow Time UTC+3 (MSK±0), SAMT Samara Time UTC+4 (MSK+1), YEKT Yekaterinburg Time UTC+5 (MSK+2), OMST Omsk Time UTC+6 (MSK+3), KRAT Krasnoyarsk Time UTC+7 (MSK+4), IRKT Irkutsk Time UTC+8 (MSK+5), YAKT Yakutsk Time UTC+9 (MSK+6), VLAT Vladivostok Time UTC+10 (MSK+7), MAGT Magadan Time UTC+11 (MSK+8), PETT Kamchatka Time UTC+12 (MSK+9).
Source: https://en.wikipedia.org/wiki/Time_in_Russia#/media/File:Map_of_Russia_-_Time_Zones_(2016).svg.
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Figure 2: The time zone in four provinces, yearly average in the period 1974-2017

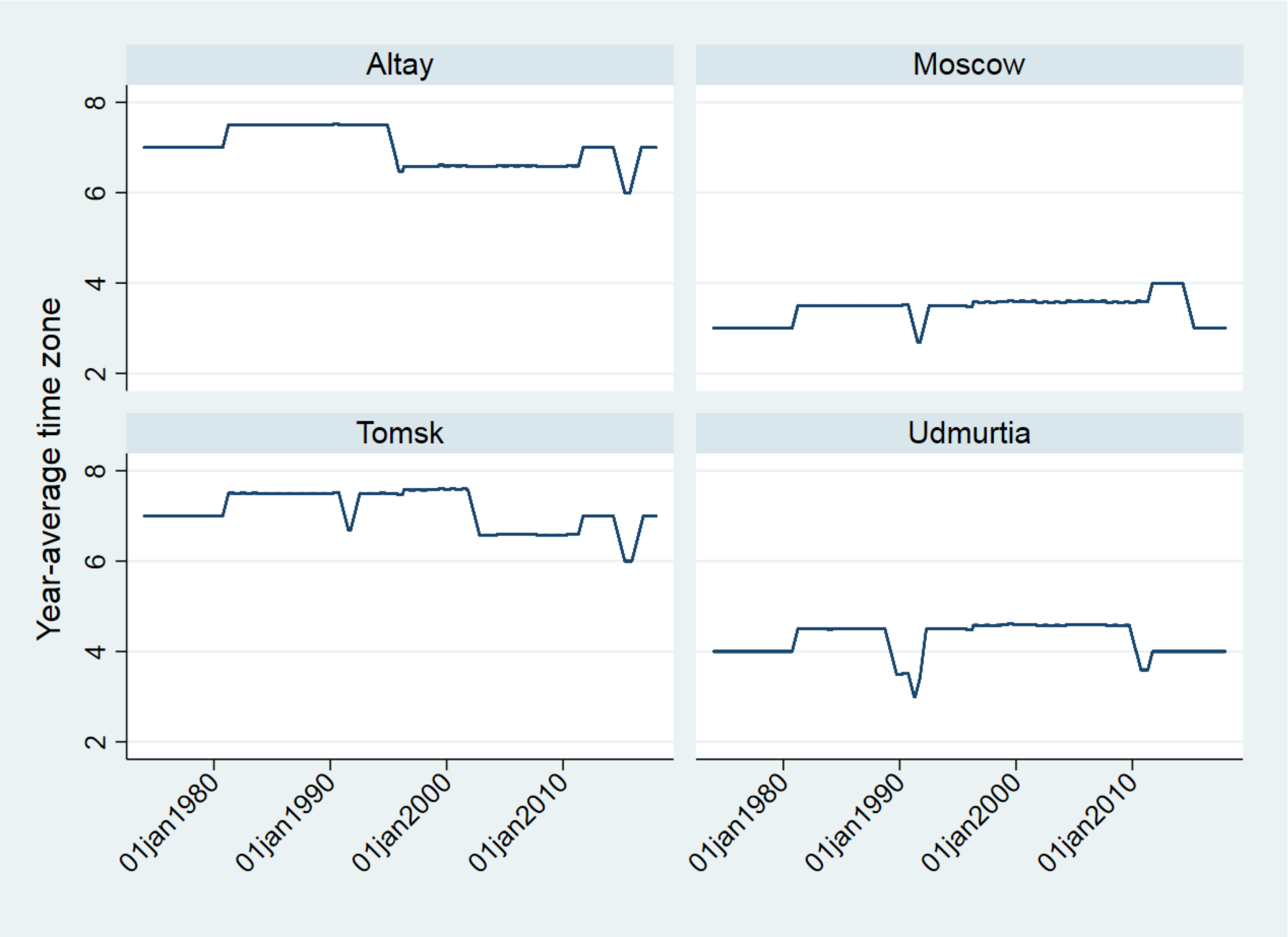
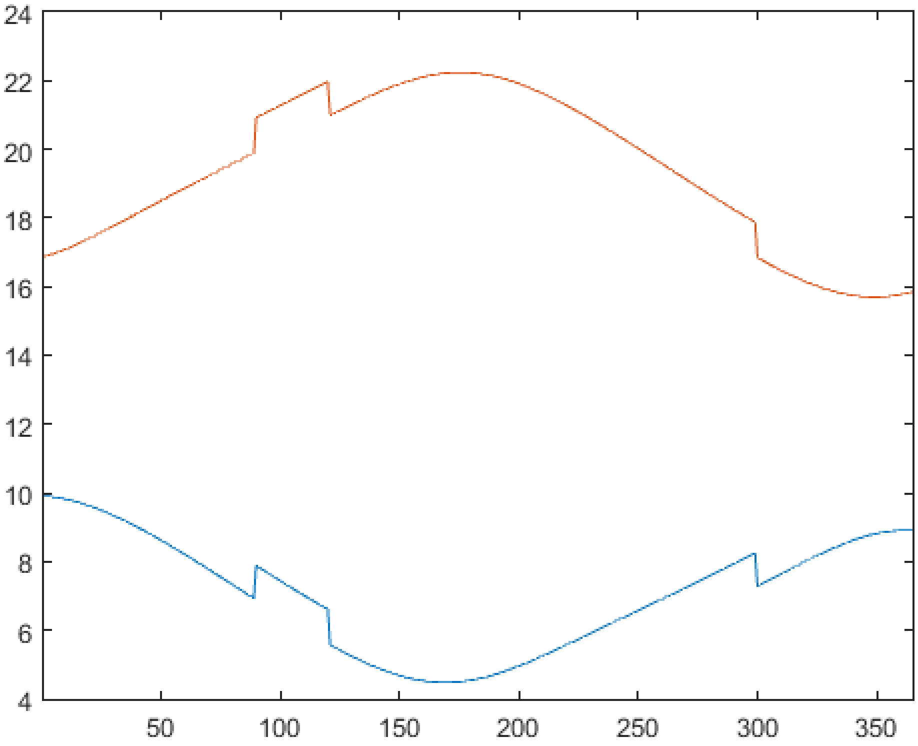


Figure 3: Sunrise and sunset times in Tomsk, 2002



Note: The horizontal axis represents the days of the year, starting from January 1.

Figure 4: RLMS locations and the regions used for estimation

5 Data

The utilized data is the Russian Longitudinal Monitoring Survey (RLMS). This is a rich panel that was initiated in 1994. It covers around 15,000 individuals from 40 locations in 33 out of the 85 provinces. Up till 2017, RLMS accumulated 325,000 individual-level and 125,000 household-level observations. It is worth noting that I am not aware of a more suitable dataset for investigation of individual-level outcomes across Russia than RLMS.

I merge RLMS data with sunrise and sunset times at each of the locations every day starting from 1974. Then I compute for each of the locations the average sunrise and sunset times over periods of up to twenty years before each day of data collection. I compute also the proportion of days when sunrise was later than a certain hour (6am, 7am, 8am, or 9am) and with proportion of days when sunset was later than a certain hour (5pm, 6pm, 7pm, 8pm, or 9pm). The sunrise and sunset times, which should smoothly change over the year, are interrupted by time zone reforms, and these discontinuities drive the identification of causal effects of daylight at a particular hour on health and lifestyle outcomes.

Outcomes

The outcomes considered in this paper include all health-related questions that are asked in RLMS for sufficiently many years. I consider the share of individuals with a particular health problem and not the probability of contracting this problem because the panel has many gaps. Some respondents disappear for one or more years only to reappear, making it impossible to find the exact timing of change in their health conditions.

One should remember that the share of individuals with a particular health problem depends not only on the probability of contracting a disease but also on survival rates that are not identical in the two regions. Roughly speaking, individuals with a chronic disease survive for more years in the sample in Western Siberia than in Northern Volga. Thus, the consistent coefficients should be similar to some extent in the two regions, but do not have to be very close.

The first outcome is the own health evaluation, which is covered in all years since 1994. There are five possible responses to this question: "very good," "good," "average," "bad," and "very bad." I define a binary outcome "good self-evaluated health." It receives a value of one if the answer is "very good" or "good" and zero otherwise. The second outcome is body mass index (BMI); weight and height, from which BMI is derived, are covered in all years. BMI has two particular cutoffs of interest: 25 as the cutoff for being overweight[7] and 30 as the cutoff for being obese. Thus, in addition to BMI as a continuous outcome, I define two binary outcomes, which are monotonic transformations of BMI: "overweight" and "obese." Two more health outcomes are covered in all years - being diagnosed with diabetes and having suffered a heart attack.

Seven binary health outcomes are covered since 2000. They include being diagnosed with high blood pressure (hypertension) and heart, lung, liver, kidney, stomach, and spinal disease.

In addition, there are a few outcomes that inquire about the lifestyle of the respondent. They include a binary outcome for smoking and the daily number of cigarettes for the smokers, a binary outcome for alcohol consumption and intensity of drinking in the last month, a binary outcome for physical activity, and the daily number of minutes of walking for needs other than exercise. All but the last outcome are covered in all years since 1994, while walking

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[7] Strictly speaking, an overweight person is the one with BMI between 25 and 29. However, I am interested in a monotonic transformation of BMI into a binary outcome.

is covered from 1995 to 2012.

The summary statistics of the outcomes are presented in Table 2, separately for Northern Volga and Western Siberia. The two regions are fairly balanced in terms of sample size. The means of good self-evaluated health, a heart attack event, and a diabetes diagnosis are very similar in the two regions. BMI is slightly higher in Western Siberia. All chronic diseases (other than diabetes) are also more frequent in Western Siberia, which may be due not only to a higher incidence of new cases but also to a higher survival rate. The means of the lifestyle outcomes are similar in the two regions, with the exception of walking time, which is twenty minutes longer in Western Siberia.[8]

The above-listed outcomes do not include some interesting ones that are considered in other studies (using other data), such as duration of sleep and depression. These outcomes are monitored in RLMS but for only few years, without sufficient exposure to the time reforms.

6 Estimation

First stage

The motivation of the empirical analysis is to estimate the reduced-form effect of the time zone on as many health and lifestyle outcomes as possible. The first stage of the analysis aims to identify the outcomes affected by time. The econometric model is

$$Y_{ijt} = CH_{ijt}\beta + X_{ijt}\gamma + \varepsilon_{ijt}, \tag{3}$$

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[8] This outcome has many suspiciously high values in data and I consider a log of it in the regressions. Censoring the exceptionally high values does not affect the results.

Table 2: Summary statistics

	Northern Volga			Western Siberia			
	Mean	**Std.**	**N**	**Mean**	**Std.**	**N**	**Years**
Health							
Health - good or very good	0.284	0.451	31929	0.281	0.449	33171	1994-2017
Suffered a heart attack	0.023	0.149	32036	0.027	0.163	33289	1994-2017
Diagnosed with diabetes	0.052	0.222	31936	0.054	0.226	33221	1994-2017
BMI	25.736	5.157	28761	26.206	5.734	30828	1994-2017
Obese (BMI>30)	0.178	0.383	28761	0.214	0.41	30828	1994-2017
Overweight (BMI>25)	0.491	0.5	28761	0.527	0.499	30828	1994-2017
Diagnosed with hypertension	0.388	0.487	27963	0.417	0.493	29485	2000-2017
Chronic heart disease	0.149	0.356	28089	0.163	0.369	29554	2000-2017
Chronic lung disease	0.061	0.239	28121	0.076	0.265	29620	2000-2017
Chronic liver disease	0.082	0.275	28047	0.127	0.333	29509	2000-2017
Chronic kidney disease	0.075	0.264	28016	0.106	0.308	29498	2000-2017
Chronic stomach disease	0.184	0.387	28082	0.196	0.397	29481	2000-2017
Chronic spinal disease	0.175	0.38	28162	0.226	0.418	29512	2000-2017
Lifestyle							
Smokes	0.312	0.463	32063	0.34	0.474	33344	1994-2017
Daily # of cigarettes	14.711	7.545	9735	15.189	7.895	11255	1994-2017
Physically active	0.222	0.416	29265	0.205	0.404	30502	1994-2017
Walking (min. per day)	154.522	138.725	11182	177.056	163.703	11454	1995-2012
Drinks alcohol	0.689	0.463	26116	0.665	0.472	27762	1994-2017
Drinks several times a week	0.175	0.38	18495	0.152	0.359	19164	1994-2017

where Y_{ijt} is the outcome of individual i in location j on date t. The vector CH_{ijt} consists of clock history variables, discussed below, and X_{ijt} is a vector of fixed effects. For health-related outcomes, X_{ijt} includes year and individual fixed effects. The individual fixed effects can be replaced by random effects complemented by location fixed ones. The two alternatives generate very similar coefficients with only slightly stronger statistical significance for the random effects model. For lifestyle-related outcomes (i.e., habits such as smoking, drinking, and physical activity), I add seasonal month effects.

The clock history CH_{ijt} is the average sunrise time over some period of time in the individual's past. Astronomy does not depend on human institutions and the correlation between average sunrise and sunset times over a period of one or more years is always one. Thus, only one of these variables can be included in a regression. I include the average sunrise time and throughout the results section I simply use the term "average clock" to refer to it. The problem of full correlation between average sunrise and sunset times exists only for averages over long periods of time. The sunrise and sunset times on the day of the interview can be included together in a regression.

The variation in clock history, generated by time zone reforms, is illustrated in Figure 5. The figure shows the clock history in four RLMS locations. Altai and Tomsk belong to Western Siberia, Udmurtia belongs to Northern Volga, while Moscow, used as a reference, is not as "special" as the others in terms of time zone reforms. The first panel shows the clock history of the previous year. For example, the one-year history on January 1, 2005, is the average sunrise time from January 1, 2004 to December 31, 2004. The second panel shows the clock history of the second to fourth years. For example, the two-to-four-year history on January 1, 2005, is the average sunrise time from January 1, 2001 to December 31, 2003.

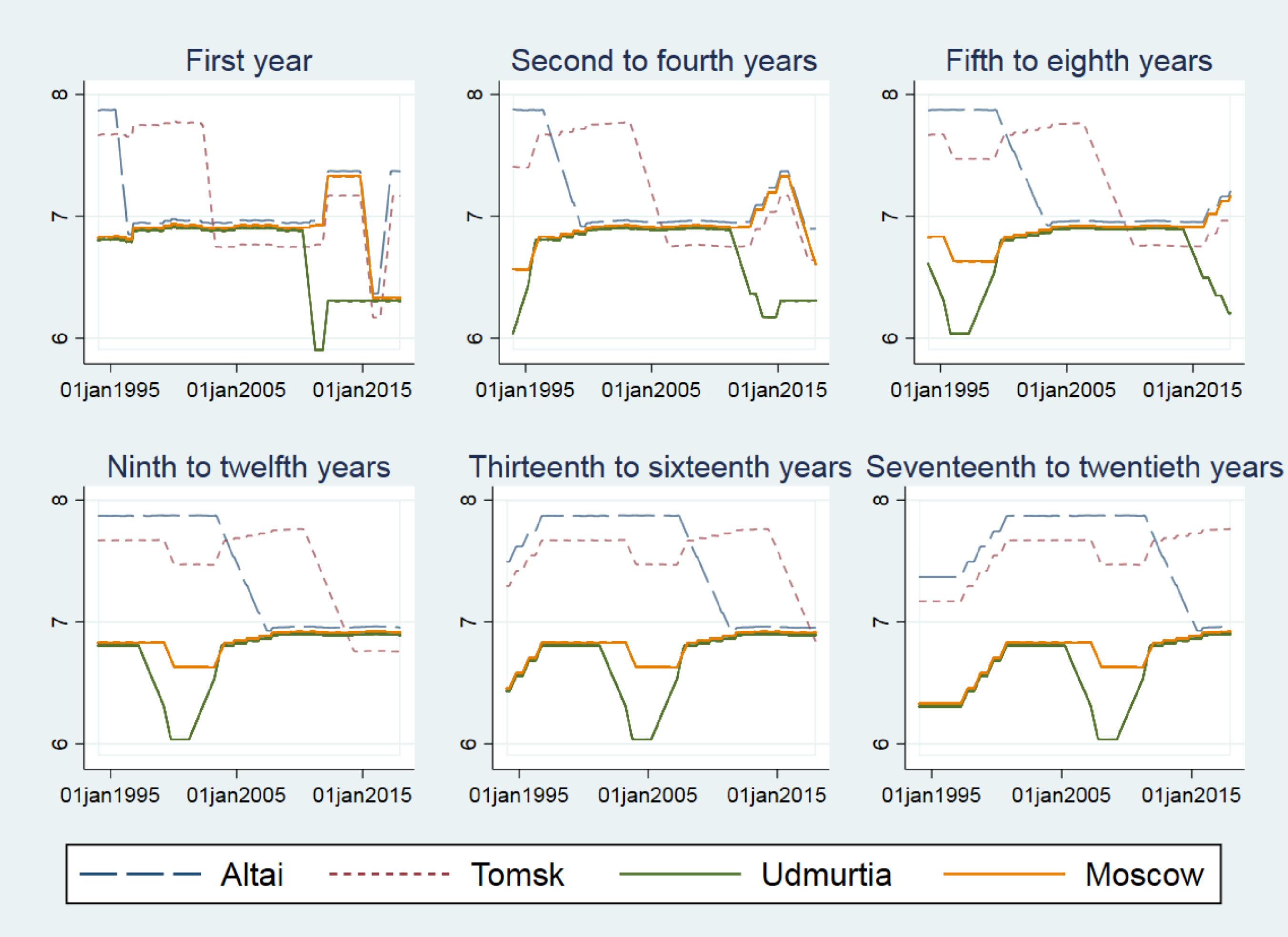
Similarly, one can interpret the clock history of the fifth to eighth years and so on. The variation in the clock history, observed in the figure across locations and over time, drives the identification of the effects.

I consider the clock history of up to twenty years before the day of the interview. The vector of clock history variables is slightly different for chronic and temporary disease-related outcomes. For the chronic outcomes, I group the twenty years preceding the interview into five four-year variables. For self-evaluated health, which may vary in the short run, I decompose the first four years into two variables: the first year and the second to fourth years. The four other four-year variables remain unchanged. For lifestyle-related outcomes, I consider a shorter history of four years (the first year and the second to fourth years) and include also the sunrise and sunset times on the day of the interview because these outcomes are the produce of a long trend, but may also vary from day to day. The sample is restricted to all individuals who were at least twenty years old on the day of the interview, which means that the individual clock history is post-natal.

Second stage

In the second stage of the empirical analysis, I limit the list of outcomes to those that were found to be affected by time in the first stage and I attempt to identify the specific hours of the day that mediate the effect. For example, one of the results of the first stage is that self-evaluated health is perceived to be worse when the average clock over the past year is later. However, a later clock means both a later sunrise and a later sunset. Which of the two times generates the negative effect on self-evaluated health? Unfortunately, one cannot include in the regression both average sunrise and sunset times because, as mentioned

Figure 5: Clock history in four RLMS locations



above, the correlation between these two averages over a period of one or more years is one. However, one can overcome this problem by replacing the average clock with probabilities that sunrise is later than a certain hour and sunset is later than a certain hour. There is no full correlation between these two probabilities. Thus, in the second stage, I replace the average clock over the relevant period with the proportion of days when sunrise was later than a certain hour (6am, 7am, 8am, or 9am) and with proportion of days when sunset was later than a certain hour (5pm, 6pm, 7pm, 8pm, or 9pm). The model is estimated separately for each combination of a morning and an evening hour. Other variables remain unchanged. The model is

$$Y_{ijt} = D(t_1, t_2, h)_{ijt}\alpha + CH(-h)_{ijt}\beta + X_{ijt}\gamma + \varepsilon_{ijt}, \tag{4}$$

where Y and X have the same meaning as in Equation (3). The vector $D(t_1, t_2, h)$ consists of two variables: the proportion of days with darkness (for $t_1 =$ 6am, 7am, 8am, or 9am) and light (for $t_2 =$ 5p, 6pm, 7pm, 8pm, or 9pm) over the period h in the individual's past that in the first stage was found to be relevant for the outcome. The vector $CH(-h)$ is the same as CH from Equation (3), except that it excludes the average clock over period h, because this period is already accounted for by $D(t_1, t_2, h)$.

One might think that the first stage is unnecessary because the second stage can be estimated for all hours, for all periods, and for all outcomes. However, beside computational considerations, the critical hours of daylight cannot be successfully identified in the second stage for all of the outcomes that were found to be affected by time in the first stage. This means that for some of the outcomes the first stage is the only one where consistent nonzero effects are identified.

Inference

In order to keep the interpretation of the coefficients consistent, I estimate Equations (3) and (4) as a linear model for all outcomes, both binary and continuous, with standard errors clustered at the location level. There are only five locations in Northern Volga and six locations in Western Siberia (see the map in Figure 4).[9] This is a very small number of clusters. Thus, the ratios of the coefficients and their standard errors are not t-distributed. I compute the p-values for the null hypotheses using the wild bootstrap procedure with Webb weights. This procedure is recommended in Cameron et al. (2008) for analyses with few clusters, tested in Cameron and Miller (2015) for over-rejection of null hypotheses (including the case of only five clusters), and implemented in Roodman et al. (2018) for STATA.

The baseline estimation of Equations (3) and (4) includes year and individual fixed effects. However, in order to increase the power of statistical inference, I also consider a model where individual fixed effects are replaced by random effects complemented by location fixed effects.[10] This specification generates coefficients very similar to the ones with individual fixed effects.[11]

The small number of clusters leads to a generally low power of the statistical tests and would create a serious problem in a study that relies on a single source of clock variation.

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[9] Including more locations in the estimation would erode the econometric design where two distinct regions are compared and would not solve the issue of the small number of clusters, because the total number of locations in RLMS is only 40.

[10] In practice, the STATA function *boottest* (Roodman et al. (2018)), which I use, does not support the random effects model. Thus, I execute the following procedure: (1) estimate the model with random effects; (2) save the predicted random effects; (3) estimate the model using OLS with the predicted random effects as an additional variable. This procedure generates coefficients similar to the random effects estimation, but *boottest* can be used as a post-estimation function after OLS.

[11] This is an informal comparison. There is little statistical power in performing a formal Hausman test with a very few clusters.

Moreover, the true structure of correlation between the outcomes across individuals may be more complex than location-level clusters and include, for instance, spatial correlation between locations within the same region (see the theoretical discussion in Barrios et al. (2012)). Yet my conclusions rely not only on the statistical significance of the coefficients[12] but also on the comparison between the two regions with independent clock variation. A result is considered consistent if the two regions, Northern Volga and Western Siberia, show comparable nonzero effects for some periods of clock history and the corresponding coefficients are statistically significant in at least one of the regions. This similarity is not driven by common trends, because, given the long distance between Northern Volga and Western Siberia, any common trends can be attributed to the regional year fixed effects. Thus, my conclusions rely on a conjecture that any similarity in the coefficients between the regions implies a consistent effect of the clock history.

7 Results

The first stage: Identification of affected outcomes

Table 3 informally summarizes the results of both stages of the analysis. This table reports the sign of the identified effects and refers to the tables with full regression outputs for each of the outcomes. The full regression outputs of the first stage are reported in Tables 6-22 of the Appendix. Estimating the first stage (Equation (3)), I identify a consistent effect of clock history on seven outcomes. That is, for seven outcomes the effect is nonzero and comparable between Northern Volga and Western Siberia. In addition to the summary in

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[12] In the results tables, in addition to the common significance levels of 0.01, 0.05, and 0.1, I also report the 0.2 level.

Table 3 and the full outputs reported in the Appendix, Table 4 reports the five identified first-stage effects on health outcomes and Table 5 reports the two identified first-stage effects on lifestyle outcomes.

Three health outcomes are negatively affected by a later clock. First, self-evaluated health is perceived to be worse when the average clock *over one year* preceding the interview is later. In particular, a one-hour-later average clock over the past year is associated with a 7-8 percentage points lower probability of reporting good or very good health in Northern Volga. The corresponding effect is half as much in Western Siberia. Second, high blood pressure is more likely with a later clock in the *first to fourth years* preceding the interview in Northern Volga and the *fifth to eighth years* preceding the interview in Western Siberia. In Northern Volga, the effect is five percentage points (even though it is not statistically significant), while in Western Siberia it constitutes nine percentage points and is statistically significant. The third negatively affected outcome is chronic kidney disease. It is known to be related to high blood pressure[13] and, indeed, the effect on the incidence of chronic kidney disease is observed for the same periods of clock history as the effect on the incidence of high blood pressure. This effect constitutes one-and-a-half percentage points in both Northern Volga and Western Siberia.

However, four outcomes are positively affected by a later clock. First, the body mass index is lower when the average clock is later. The comparable effect constitutes about 0.3 points in *each* of the four-year-long periods preceding the interview in Northern Volga and in the *fifth to eighth years* preceding the interview in Western Siberia. Second, a one-hour-later sunset *on the day of the interview* is associated in both regions with 4% more

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[13] According to Fresenius Kidney Care, 29% of all chronic kidney disease cases are caused by high blood pressure.

walking for needs other than exercise. Third, a one-hour-later clock *over one year* preceding the interview is associated with 3-4 percentage points higher probability of being physically active. Finally, the chronic stomach disease is less likely with a later clock in *each* of the four-year-long periods preceding the interview in Northern Volga (with large coefficients of up to 20 percentage points) and in *the ninth to twentieth years* preceding the interview in Western Siberia (with much lower coefficients of up to 5 percentage points). The remaining outcomes are not affected in a consistent way by clock history. These include diabetes, chronic diseases of organs other than kidney and stomach, heart attacks, smoking, and drinking alcohol.

The second stage: Identification of critical daylight hours

The last column of Table 3 summarizes the results of the estimation of Equation (4) for outcomes that were found to be affected by time in the first stage of the analysis. Unfortunately, it is hard to present the identified effects for the second stage as concisely as the identified effects for the first stage are presented in Tables 4 and 5. Full second-stage regression outputs can be found in Tables 23-31 of the Appendix.

As explained in Section 6, in the second stage I attempt to identify the critical hours of the day when exposure to daylight during the relevant period (the years that are identified in the first stage) drives the effect. That is, I look for the hours of the day that are associated with comparable nonzero effects in both Northern Volga and Western Siberia. To summarize the results of the second stage, most of the negative effects of a later clock are driven by darkness in the morning, while the positive effects are related to longer daylight in the evening.

In particular, the first identified result is that the lower probability of self-evaluated good health is driven by darkness at 7am and 8am, i.e., the hours when most individuals commute

Table 3: Summary of the results

		First stage			Second stage	
		Regression	Identified periods in time history		Regression	Critical hours
Outcome	Effect of a later clock	output	Northern Volga	Western Siberia	output	
Health						
Health - good or very good	negative	Table 6	1 year	1 year	Table 23	7am-8am
Diagnosed with hypertension	positive (higher rate)	Table 7	years 1-4	years 5-8	Table 24	6am-9am
Experienced a heart attack	none	Table 8				
Diagnosed with diabetes	none	Table 9				
BMI	negative (lower BMI)	Table 10	years 1-20	years 5-8	Table 25	6pm
Overweight (BMI>25)	negative (lower rate)	Table 10	years 1-20	years 5-8	Table 26	unclear
Obese (BMI>30)	negative (lower rate)	Table 10	years 1-20	years 5-8	Table 27	6pm
Chronic heart disease	none	Table 11				
Chronic lung disease	none	Table 12				
Chronic liver disease	none	Table 13				
Chronic kidney disease	positive (higher rate)	Table 14	years 1-4	years 5-8	Table 28	7pm-8pm
Chronic stomach disease	negative (lower rate)	Table 15	years 1-20	years 9-20[1]	Table 29	unclear
Chronic spinal disease	none	Table 16				
Lifestyle						
Physically active	positive	Table 17	1 year	1 year	Table 30	5pm-7pm
Walking (min. per day)	positive	Table 18	current sunset	current sunset	Table 31	6pm
Smokes	none	Table 19				
Daily # of cigarettes	none	Table 20				
Drinks alcohol	none	Table 21				
Drinks several times a week	none	Table 22				

Notes: (1) No identified effect for years 13-16.

Table 4: First stage: Identified effects on health

Average clock over ... before the interview	Northern Volga		Western Siberia	
	RE model	FE model	RE model	FE model
	Self-evaluated health - good or very good			
1 year	-0.0654	-0.0756	-0.0361	-0.0346
	(0.00405)***	(0.00520)**	(0.0122)**	(0.0189)†
	Hypertension			
1-4 years	0.0517	0.0546		
	(0.0224)	(0.0252)		
5-8 years			0.0860	0.0912
			(0.00766)***	(0.0102)**
	Body Mass Index			
1-4 years	-0.275	-0.268		
	(0.0454)†	(0.0664)†		
5-8 years	-0.361	-0.395	-0.264	-0.288
	(0.0552)	(0.0824)	(0.105)**	(0.115)**
9-12 years	-0.886	-0.944		
	(0.194)	(0.230)		
13-16 years	-0.674	-0.722		
	(0.109)†	(0.148)		
17-20 years	-0.343	-0.358		
	(0.0619)†	(0.0687)		
	Chronic kidney disease			
1-4 years	0.0153	0.0148		
	(0.00377)†	(0.00360)		
5-8 years			0.0118	0.0149
			(0.00540)*	(0.00527)*
	Chronic stomach disease			
1-4 years	-0.0121	-0.0118		
	(0.0198)	(0.0238)		
5-8 years	-0.0790	-0.0790		
	(0.0239)	(0.0287)		
9-12 years	-0.200	-0.202	-0.0503	-0.0486
	(0.0171)*	(0.0216)†	(0.0180)**	(0.0222)†
13-16 years	-0.132	-0.136		
	(0.0164)†	(0.0168)†		
17-20 years	-0.0425	-0.0465	-0.0323	-0.0313
	(0.0253)	(0.0277)	(0.00780)**	(0.0110)**

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2
Full results can be found in Tables 6-16 of the Appendix.

Table 5: First stage: Identified effects on lifestyle

	Northern Volga		Western Siberia	
	RE model	FE model	RE model	FE model
Average clock over ... before the interview	*Physically active*			
1 year	0.0363 (0.00624)**	0.0410 (0.00719)**	0.0304 (0.0138)**	0.0250 (0.0168)†
On the day of the interview	*Log of daily walking in minutes for needs other than exercise*			
Sunset time	0.0449 (0.00746)**	0.0407 (0.0114)**	0.0405 (0.0170)*	0.0414 (0.0283)†

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$
Full results can be found in Tables 17-22 of the Appendix.

to work and studies. Correspondingly, the medical literature, cited in Section 3, shows that exposure to morning light is healthy and eases mood disorders. A later sunrise means that individuals are more likely to wake up and commute in darkness, which suggestively leads to the negative effect of a later clock on self-evaluated health.

Second, an increased incidence of high blood pressure is also associated with darkness in the morning. The range of critical hours is from 6am to 9am, a wider range than for self-evaluated health.

All positive effects of a later clock are related to longer daylight in the evening. The lower body mass index and the reduced incidence of obesity are associated with daylight at 6pm. Accordingly, the increased duration of non-exercise-related walking is also related to daylight at 6pm and the higher incidence of being physically active is related to daylight in the 5pm to 7pm range.

The critical daylight hours for other affected outcomes are not as easily interpretable as the results above. First, chronic kidney disease is found to be related to evening daylight (7pm and 8pm), despite the fact that the expected channel can be assumed to be associated with high blood pressure, which is found to be affected by morning light. Second, chronic stomach disease has similar negative coefficients for both darkness in the morning and light in the evening. Finally, the hours that drive the effect on the incidence of being overweight (differently from BMI and obesity) are not clearly identified.

8 Conclusions

This paper presents an empirical study that provides an investigation of the relationship between time and humans. The econometric model is novel as it considers a long individual clock history and two geographic regions with independent sources of long-run time zone variation within the same country. Arguably, the results derived in this paper can be identified only in Russia, due to the multiple independent sources of variation in time institutions across the large country and over the decades.

I find fewer consistent effects than existing studies, which generally rely on a single source of clock variation. On the one hand, a later clock is associated with more non-exercise-related walking, higher rates of physical activity, and a lower body mass index. On the other hand, the later clock harms, in the short run, self-evaluated health and increases, in the eight-year horizon, the incidence of high blood pressure and chronic kidney disease. I find evidence that the negative effects can be attributed to morning darkness, in particular at 7am-8am. Indeed, medical studies find a positive effect of exposure to morning light on health. Meanwhile, the positive effects of a later clock can be attributed to the evening light, especially around

6pm. One should remember in this regard that shifting the time forward or backward affects the probability of exposure to daylight during active hours differently with respect to one's geographic position.

The policy of gradually drifting Russia "to the west" by setting clocks back started sixty years ago, but changes in the other direction have also taken place. New reforms are introduced almost every year. Disputes over time institutions are ongoing also in many other countries, especially (but not only) with regard to the daylight saving time transitions. In particular, as currently about 70 countries implement daylight saving time, while other countries do not (in the U.S. and Canada, most regions implement it but some do not), the issue of daylight utilization remains unresolved around the world. Recent examples include but are not limited to the debates in Europe and California.

The question that motivates this paper is whether time institutions can be optimized with respect to an objective function of health. The general answer is positive, because the effect of time and the hours of the day when exposure to daylight matters can be identified for several important outcomes.

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Appendix: Full results

The first stage: Identification of affected outcomes

Table 6: Self-evaluated health: Good or very good

Average clock over ... before the interview	Northern Volga		Western Siberia	
	-0.0654	-0.0756	-0.0361	-0.0346
1 year	(0.00405)***	(0.00520)**	(0.0122)**	(0.0189)†
	0.0286	0.0245	0.00139	-0.000183
2-4 years	(0.0104)	(0.0147)	(0.0152)	(0.0205)
	0.0862	0.0739	-0.0117	-0.0161
5-8 years	(0.0214)†	(0.0256)†	(0.0246)	(0.0314)
	0.0989	0.107	-0.0408	-0.0477
9-12 years	(0.0408)	(0.0465)	(0.0178)*	(0.0202)†
	0.134	0.126	0.00799	0.00814
13-16 years	(0.0421)	(0.0501)	(0.0129)	(0.0155)
	-0.0931	-0.111	0.0223	0.0139
17-20 years	(0.0125)**	(0.0148)**	(0.0166)	(0.0228)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	31,929		33,171	
No. of individuals	4,551		5,703	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 7: High blood pressure (hypertension)

Average clock over ... before the interview	Northern Volga		Western Siberia	
	0.0517	0.0546	-0.0133	-0.0159
1-4 years	(0.0224)	(0.0252)	(0.0186)	(0.0280)
	-0.00951	-0.00870	0.0860	0.0912
5-8 years	(0.01000)	(0.0136)	(0.00766)***	(0.0102)**
	0.124	0.111	-0.0397	-0.0353
9-12 years	(0.0218)†	(0.0204)†	(0.00963)**	(0.00817)**
	0.0257	0.0235	0.00989	0.0112
13-16 years	(0.0216)	(0.0250)	(0.0221)	(0.0283)
	0.0147	0.0241	-0.0388	-0.0351
17-20 years	(0.0186)	(0.0182)	(0.0117)**	(0.0150)*
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	27,963		29,485	
No. of individuals	4,551		5,141	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 8: Ever experienced a heart attack

Average clock over ... before the interview	Northern Volga		Western Siberia	
1-4 years	0.00673	0.00721	0.00396	0.00227
	(0.00377)	(0.00521)	(0.00326)	(0.00599)
5-8 years	-0.0115	-0.0106	0.00149	0.00193
	(0.00328)	(0.00477)	(0.00504)	(0.00738)
9-12 years	-0.0339	-0.0326	0.00260	0.00418
	(0.00770)	(0.0110)	(0.00418)	(0.00560)
13-16 years	-0.00561	-0.00486	0.00512	0.00589
	(0.00772)	(0.0105)	(0.00387)	(0.00626)
17-20 years	-0.0108	-0.00828	0.00867	0.0108
	(0.00348)†	(0.00614)	(0.00221)**	(0.00350)**
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	32,036		33,289	
No. of individuals	4,553		5,707	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 9: Diabetes

Average clock over ... before the interview	Northern Volga		Western Siberia	
1-4 years	0.0207	0.0229	-0.0114	-0.0116
	(0.00715)	(0.0105)	(0.00825)	(0.0129)
5-8 years	-0.0263	-0.0243	0.00125	0.00334
	(0.00887)	(0.0111)	(0.00285)	(0.00368)
9-12 years	-0.0399	-0.0397	-0.0120	-0.0111
	(0.0124)	(0.0160)	(0.00599)	(0.00868)
13-16 years	-0.0423	-0.0414	-0.00229	-0.00211
	(0.00984)	(0.0118)	(0.00278)	(0.00476)
17-20 years	-0.0149	-0.0106	-0.000454	0.00252
	(0.00816)	(0.00922)	(0.00870)	(0.0137)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	31,936		33,221	
No. of individuals	4,551		5,703	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 10: Body Mass Index

	BMI		Overweight (BMI>25)		Obese (BMI>30)	
Average clock over ...	Northern Volga	Western Siberia	Northern Volga	Western Siberia	Northern Volga	Western Siberia
	-0.268	-0.0677	-0.0135	-0.00470	-0.0275	-0.00538
1-4 years	(0.0664)†	(0.184)	(0.0128)	(0.00613)	(0.00383)*	(0.00895)
	-0.395	-0.288	-0.0345	-0.0137	-0.0440	-0.0222
5-8 years	(0.0824)	(0.115)**	(0.0191)	(0.00644)†	(0.00448)†	(0.00681)**
	-0.944	0.288	-0.0797	0.0284	-0.0718	0.00487
9-12 years	(0.230)	(0.200)	(0.0141)†	(0.00559)***	(0.0115)†	(0.00581)
	-0.722	-0.154	-0.0316	-0.0102	-0.0965	0.000361
13-16 years	(0.148)	(0.171)	(0.0138)	(0.0141)	(0.0138)†	(0.00750)
	-0.358	0.253	-0.0390	0.0134	-0.0418	0.00575
17-20 years	(0.0687)	(0.120)**	(0.0103)	(0.0116)	(0.0149)	(0.0134)
Individual FE	V	V	V	V	V	V
Year FE	V	V	V	V	V	V
Observations	28,761	30,828	28,761	30,828	28,761	30,828
No. of individuals	4,428	5,570	4,428	5,570	4,428	5,570

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 11: Chronic heart disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
1-4 years	0.0377	0.0395	0.00297	0.000459
	(0.00986)	(0.0114)	(0.00703)	(0.00776)
5-8 years	0.0279	0.0325	0.0175	0.0179
	(0.0134)	(0.0175)	(0.0114)	(0.0151)
9-12 years	-0.101	-0.106	-0.0263	-0.0236
	(0.0166)	(0.0332)	(0.00980)†	(0.0110)†
13-16 years	-0.0641	-0.0655	0.00988	0.0105
	(0.0231)	(0.0373)	(0.0105)	(0.0145)
17-20 years	-0.00942	-0.00516	-0.0134	-0.0109
	(0.0225)	(0.0295)	(0.0101)	(0.0125)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,089		29,554	
No. of individuals	4,153		5,142	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 12: Chronic lung disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
1-4 years	0.0166	0.0155	-0.0135	-0.00967
	(0.00738)	(0.00867)	(0.00718)*	(0.0114)
5-8 years	0.0346	0.0347	-0.0236	-0.0200
	(0.00432)	(0.00537)	(0.00586)†	(0.00807)
9-12 years	-0.0429	-0.0494	-0.00899	-0.00809
	(0.0110)	(0.0131)	(0.00929)	(0.0125)
13-16 years	-0.0404	-0.0448	0.000904	0.000314
	(0.00800)†	(0.00814)†	(0.00740)	(0.00833)
17-20 years	-0.000980	-0.00199	-0.00152	0.00185
	(0.00721)	(0.00839)	(0.00451)	(0.00698)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,121		29,620	
No. of individuals	4,152		5,144	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 13: Chronic liver disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
	0.0109	0.0142	0.00354	0.00545
1-4 years	(0.00974)	(0.0111)	(0.0189)	(0.0216)
	0.0124	0.0173	0.0102	0.0134
5-8 years	(0.0143)	(0.0161)	(0.0160)	(0.0181)
	-0.101	-0.103	-0.0133	-0.00771
9-12 years	(0.0398)	(0.0554)	(0.0156)	(0.0193)
	-0.0741	-0.0704	0.000655	0.00213
13-16 years	(0.0259)	(0.0426)	(0.00795)	(0.0113)
	-0.0229	-0.0254	0.00220	0.00600
17-20 years	(0.0168)	(0.0212)	(0.0112)	(0.0139)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,047		29,509	
No. of individuals	4,154		5,143	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 14: Chronic kidney disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
	0.0153	0.0148	0.00970	0.0112
1-4 years	(0.00377)†	(0.00360)	(0.0190)	(0.0268)
	-0.0232	-0.0239	0.0118	0.0149
5-8 years	(0.00914)	(0.00989)	(0.00540)*	(0.00527)*
	-0.0692	-0.0778	-0.0243	-0.0195
9-12 years	(0.00663)*	(0.0117)†	(0.0182)	(0.0262)
	-0.0689	-0.0722	0.0111	0.0116
13-16 years	(0.00581)**	(0.0106)†	(0.00642)†	(0.00750)
	-0.0114	-0.0179	0.00186	0.00401
17-20 years	(0.00634)	(0.0103)	(0.0122)	(0.0183)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,016		29,498	
No. of individuals	4,153		5,141	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 15: Chronic stomach disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
	-0.0121	-0.0118	-0.0106	-0.00448
1-4 years	(0.0198)	(0.0238)	(0.0241)	(0.0306)
	-0.0790	-0.0790	0.0136	0.0105
5-8 years	(0.0239)	(0.0287)	(0.0174)	(0.0175)
	-0.200	-0.202	-0.0503	-0.0486
9-12 years	(0.0171)*	(0.0216)†	(0.0180)**	(0.0222)†
	-0.132	-0.136	0.00635	0.00643
13-16 years	(0.0164)†	(0.0168)†	(0.0150)	(0.0193)
	-0.0425	-0.0465	-0.0323	-0.0313
17-20 years	(0.0253)	(0.0277)	(0.00780)**	(0.0110)**
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,082		29,481	
No. of individuals	4,152		5,146	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 16: Chronic spinal disease

Average clock over ... before the interview	Northern Volga		Western Siberia	
1-4 years	0.0139	0.0187	-0.0145	-0.0101
	(0.0181)	(0.0231)	(0.0186)	(0.0214)
5-8 years	-0.00283	0.000132	-0.0210	-0.0225
	(0.0283)	(0.0390)	(0.0216)	(0.0243)
9-12 years	-0.303	-0.311	-0.00602	0.00139
	(0.0211)**	(0.0440)†	(0.0241)	(0.0297)
13-16 years	-0.229	-0.236	0.00240	0.00629
	(0.0122)**	(0.0321)†	(0.0161)	(0.0219)
17-20 years	-0.108	-0.106	0.0287	0.0334
	(0.0151)*	(0.0285)	(0.00751)***	(0.00909)**
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Observations	28,162		29,512	
No. of individuals	4,152		5,146	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 17: Physically active

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	0.000611	-0.00248	-0.00485	-0.00437
	(0.00403)	(0.00498)	(0.00643)	(0.00829)
Sunset time	0.00594	0.00585	0.00673	0.00870
	(0.00473)	(0.00622)	(0.00501)	(0.00506)
Average clock over ... before the interview				
1 year	0.0363	0.0410	0.0304	0.0250
	(0.00624)**	(0.00719)**	(0.0138)**	(0.0168)†
2-4 years	0.00365	0.00142	-0.0624	-0.0573
	(0.0101)	(0.0147)	(0.0183)*	(0.0259)*
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	29,265		30,502	
No. of individuals	4,407		5,515	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 18: Log of daily walking in minutes for needs other than exercise

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	0.00160	-0.00835	0.00401	0.0275
	(0.0124)	(0.00763)	(0.00392)**	(0.0169)**
Sunset time	0.0449	0.0407	0.0405	0.0414
	(0.00746)**	(0.0114)**	(0.0170)*	(0.0283)†
Average clock over ... before the interview				
1 year	0.147	0.299	-0.0328	-0.0429
	(0.481)	(0.701)	(0.0794)	(0.108)
2-4 years	-0.422	-0.792	-0.0717	-0.0956
	(0.915)	(1.346)	(0.0817)	(0.0955)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	10,930		11,234	
No. of individuals	3,180		3,643	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 19: Smoking

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	0.00256	0.00247	-0.00193	-0.00158
	(0.00221)	(0.00269)	(0.00317)	(0.00420)
Sunset time	-0.00140	-0.00176	-0.000461	-0.000673
	(0.00146)	(0.00160)	(0.00399)	(0.00513)
Average clock over ... before the interview				
1 year	0.0192	0.0196	0.0102	0.0103
	(0.00443)†	(0.00542)†	(0.00664)	(0.00790)
2-4 years	0.00508	0.00374	-0.00118	-0.00138
	(0.00275)	(0.00351)	(0.00533)	(0.0109)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	32,063		33,344	
No. of individuals	4,551		5,708	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 20: Log of daily smoked cigarettes

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	-0.0122	-0.00958	0.00611	0.00883
	(0.0127)	(0.0163)	(0.00946)	(0.0121)
Sunset time	-0.0135	-0.0158	-0.00228	-0.00252
	(0.00923)	(0.0101)	(0.00875)	(0.0128)
Average clock over ... before the interview				
1 year	-0.0245	-0.0167	-0.0441	-0.0499
	(0.0243)	(0.0310)	(0.0230)†	(0.0321)
2-4 years	0.0166	0.0110	-0.0407	-0.0338
	(0.0212)	(0.0352)	(0.0188)*	(0.0320)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	9,735		11,255	
No. of individuals	1,848		2,457	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 21: Alcohol consumption

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	-0.00604	-0.00499	-0.00108	-0.00102
	(0.00669)	(0.00780)	(0.00971)	(0.0128)
Sunset time	-0.00120	-0.00197	-0.00323	-0.000947
	(0.00555)	(0.00751)	(0.00586)	(0.00828)
Average clock over ... before the interview				
1 year	0.113	0.109	-0.0339	-0.0414
	(0.0182)*	(0.0232)*	(0.0378)	(0.0514)
2-4 years	-0.0384	-0.0448	0.0311	0.0341
	(0.0159)	(0.0244)	(0.0327)	(0.0424)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	26,116		27,762	
No. of individuals	4,157		5,265	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 22: Drinking alcohol more frequently than once a week

On the day of the interview	Northern Volga		Western Siberia	
Sunrise time	0.00531	0.00591	-0.0124	-0.0128
	(0.00601)	(0.00675)	(0.00577)*	(0.00645)†
Sunset time	0.0102	0.00780	-0.00523	-0.00334
	(0.00650)†	(0.00707)	(0.00366)	(0.00483)
Average clock over ... before the interview				
1 year	-0.00923	-0.0108	0.0493	0.0463
	(0.00798)	(0.0117)	(0.0162)**	(0.0155)**
2-4 years	0.000687	0.00309	-0.0402	-0.0412
	(0.0122)	(0.0199)	(0.0111)**	(0.0222)
Individual FE		V		V
Location FE	V		V	
Individual RE	V		V	
Year FE	V	V	V	V
Seasonal (month) FE	V	V	V	V
Observations	18,495		19,164	
No. of individuals	3,567		4,427	

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

The second stage: Identification of critical daylight hours

Table 23: Self-evaluated health: Good or very good

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
1 year	-0.233	-0.362	-0.514	-0.121	-0.032	-0.0735	-0.091	0.118	0.146
	(0.152)	(0.082)*	(0.033)**	(0.169)	(0.189)	(0.405)	(0.143)	(0.248)	(0.274)
Observations	31,929								
Number of ind.	4,551								
	Western Siberia								
1 year	-0.187	-0.174	-0.206	-0.099	-0.095	-0.303	-0.364	-0.172	-0.187
	(0.073)*	(0.038)***	(0.080)**	(0.054)†	(0.053)†	(0.101)*	(0.094)***	(0.124)	(0.067)**
Observations	33,171								
Number of ind.	5,703								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 24: High blood pressure (hypertension)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
4 years	0.349	0.612	0.503	0.371	-0.130	0.174	-0.170	-0.097	0.095
	(0.057)**	(0.141)**	(0.118)**	(0.118)*	(0.271)	(0.287)	(0.365)	(0.300)	(0.214)
Observations	27,963								
Number of ind.	4,153								
	Western Siberia								
years 5-8	0.458	0.407	0.312	0.357	0.437	0.834	0.705	1.129	0.589
	(0.096)*	(0.048)**	(0.061)*	(0.026)***	(0.093)**	(0.243)*	(0.078)**	(0.166)**	(0.078)**
Observations	29,485								
Number of ind.	5,141								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 25: Body Mass Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
20 years	-3.411	-1.869	-5.472	-8.371	2.398	-12.96	-2.269	-8.322	-9.853
	(2.151)	(1.889)	(2.115)*	(2.974)**	(1.748)†	(2.351)**	(2.016)	(2.625)†	(2.226)**
Observations	28,761								
Number of ind.	4,428								
	Western Siberia								
years 5-8	-0.391	-0.780	-0.815	-1.754	-0.692	-2.317	-2.894	-2.128	-1.021
	(0.320)†	(0.374)**	(0.420)*	(0.651)*	(0.477)†	(0.777)**	(1.174)*	(0.759)**	(0.472)**
Observations	30,828								
Number of ind.	5,570								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 26: Overweight (BMI>25)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...		dark at					light at		
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
					Northern Volga				
20 years	-0.143	-0.0107	-0.728	-1.297	0.709	-0.0542	0.00168	-0.0304	0.0814
	(0.434)	(0.257)	(0.150)**	(0.464)*	(0.225)**	(0.577)	(0.284)	(0.344)	(0.448)
Observations					28,761				
Number of ind.					4,428				
					Western Siberia				
years 5-8	0.0369	0.0302	0.0182	-0.00444	0.0233	0.0231	0.0139	0.163	0.0464
	(0.0228)†	(0.0178)†	(0.0254)	(0.0124)	(0.0260)	(0.0394)	(0.0281)	(0.0605)*	(0.0258)†
Observations					30,828				
Number of ind.					5,570				
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 27: Obesity (BMI>30)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
20 years	-0.293	-0.239	-0.380	-0.424	-0.081	-1.174	0.038	-0.591	-0.612
	(0.134)	(0.103)†	(0.275)	(0.186)**	(0.187)	(0.308)*	(0.075)	(0.201)	(0.219)†
Observations	28,761								
Number of ind.	4,428								
	Western Siberia								
years 5-8	-0.101	-0.095	-0.110	-0.109	-0.100	-0.257	-0.211	-0.137	-0.127
	(0.029)**	(0.026)**	(0.028)**	(0.021)**	(0.048)†	(0.040)**	(0.053)	(0.081)	(0.037)**
Observations	30,828								
Number of ind.	5,570								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 28: Chronic kidney disease

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
4 years	0.0985	0.108	0.0925	0.0768	0.0661	0.150	0.167	0.118	0.130
	(0.0513)	(0.0546)	(0.0340)†	(0.0523)	(0.0596)	(0.0508)	(0.0542)†	(0.0501)†	(0.0542)
Observations	28,016								
Number of ind.	4,153								
	Western Siberia								
years 5-8	0.0723	0.0598	0.0411	0.0502	0.0182	0.205	0.155	0.242	0.0987
	(0.0356)*	(0.0304)†	(0.0254)*	(0.0333)	(0.0418)	(0.0732)**	(0.0666)**	(0.0810)*	(0.0376)*
Observations	29,498								
Number of ind.	5,141								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 29: Chronic stomach disease

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
20 years	-0.160	0.359	-1.397	-1.082	0.872	-1.517	-0.517	-0.958	-1.355
	(0.312)	(0.427)	(0.281)**	(0.397)†	(0.593)†	(1.357)	(0.250)	(0.391)	(0.407)†
Observations	28,082								
Number of ind.	4,152								
	Western Siberia								
years 9-20	-0.289	-0.262	-0.243	-0.244	-0.217	-0.486	-0.480	-0.820	-0.376
	(0.0530)*	(0.0584)*	(0.0589)*	(0.0957)†	(0.0757)*	(0.102)*	(0.149)†	(0.174)**	(0.0826)*
Observations	29,481								
Number of ind.	5,146								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.2$

Table 30: Physically active

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Probability over ...	dark at				light at				
before the interview	6am	7am	8am	9am	5pm	6pm	7pm	8pm	9pm
	Northern Volga								
1 year	0.157	0.105	-0.0264	0.0443	0.279	0.296	0.278	0.314	0.184
	(0.113)	(0.122)	(0.107)	(0.0973)	(0.064)*	(0.060)*	(0.129)†	(0.113)	(0.086)
Observations	29,265								
Number of ind.	4,407								
	Western Siberia								
1 year	0.146	0.225	0.219	0.028	0.171	0.335	0.314	0.0497	0.124
	(0.073)*	(0.041)**	(0.033)***	(0.060)	(0.049)**	(0.089)*	(0.078)**	(0.118)	(0.047)**
Observations	30,502								
Number of ind.	5,515								
Average clock over other periods	V	V	V	V	V	V	V	V	V
Location FE	V	V	V	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V	V	V	V
Year FE	V	V	V	V	V	V	V	V	V
Month FE	V	V	V	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2

Table 31: Log of daily walking in minutes for needs other than exercise

Probability	(1)	(2)	(3)	(5)	(6)	(7)
		dark at			light at	
	7am	8am	9am	5pm	6pm	7pm
	Northern Volga					
On the day of interview	0.0289	-0.0317	-0.00983	0.0419	0.0479	0.0997
	(0.0358)	(0.0397)	(0.0157)	(0.0400)	(0.00835)**	(0.0122)†
Observations	10,930					
Number of ind.	3,180					
	Western Siberia					
On the day of interview	0.0331	-0.0758	0.103	-0.00583	0.0929	-0.0107
	(0.0444)	(0.0350)†	(0.0653)*	(0.0265)	(0.0358)***	(0.0308)
Observations	11,234					
Number of ind.	3,643					
Average clock over other periods	V	V	V	V	V	V
Location FE	V	V	V	V	V	V
Individual RE	V	V	V	V	V	V
Year FE	V	V	V	V	V	V
Month FE	V	V	V	V	V	V

Notes: Standard errors are clustered by location.
The p-values are calculated using wild bootstrap with Webb weights.
*** p<0.01, ** p<0.05, * p<0.1, † p<0.2