The Effect of the Clock on Health in Russia

Pavel Jelnov

Abstract

Let there be light? And when? This paper is concerned with the causal effect of time on health of adults. To this end, I utilize a unique natural experiment - twenty years of time changes in Russia. I utilize two sources of clock variation in a large longitudinal dataset collected since 1994. The small variation is driven by the different duration of summer time along years and the big variation is driven by time reforms. I find that a three-year-long exposure to a later clock is associated with an increased incidence of depression, development of chronic diseases, and with a lower life satisfaction. On the other hand, high blood pressure is less likely with a later clock and respondents spend more time walking. In addition to linear regression analysis, I explore the unique structure of clock variation in Russian data in order to exclude spurious correlations.

JEL codes: I12, I18

Kewords: time zones, clock, health, Russia, chronic disease, life satisfaction, depression

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1 Introduction

Time zones and daylight saving time are differently managed around the globe and discussions around time take place in many countries. The most recent example is a debate over abandonment of the daylight saving time in the European Union. Managing time is a political issue. China decreased the number of its time zones from five to one following the victory of the Communsits in the civil war. However, China also provides an interesting case when two time zones are used parallel in the westernmost province of Xinjiang and the split is along ethnic lines. Spain lives in the unnatural Central European Time since the Franco regime tried to show in 1942 its solidarity with Hitler's new order in central Europe. Venezuela shifted its clock by half a hour during the Chávez regime to distinguish itself from neighbors just to have the time set back after his death. North Korea shifted its time by half a hour to align with the South just a week after the April 2018 summit. The leader of the North considered the clock alignment as "the first practical step for national reconciliation and unity." In Israel, the duration of daylight saving time is a stumbling block between religious and secular parties for a list of reasons most important of which is whether the public transportation starts to run on Saturday before or after Shabbat is over. On the other hand, time as a factor of economic growth is related to the old discussions about the relationship between geography and development (Acemoglu et al. (2001)). By managing time, politicians sometimes face the trade-off between nature and politics. Shifting the clock may have political consequences but may also affect the fit between humans and nature and have socio-economic consequences.

There are direct and indirect channels that may link time to health. The first direct channel is the effect of a longer duration of exposure to daylight when the human's and the nature's schedules coincide. Studies, some of which are cited in the literature section below, show the positive effect of exposure to the natural light on humans' performance. The second direct channel is the cyrcadian rhytm. The times of sunrise and sunset affect the duration of our sleep and other health-related time uses. This channel may be extended and be considered as an indirect channel that links time to our habits and life style. It would include smoking, drinking, eating, exercising, socializing, and spending time out.

I take an advantage of a long natural experiment, taking place in Russia, to directly measure the effect of time reforms on health. Russia is a big time laboratory. Not only that Russia, differently from any other country in the world,[1] covers eleven time zones, but its frequent reforms with regard to the clock allow a unique quasi-experimental setup. The identification of the causal effect relies on the fact that Russia is a large but centralized country. Time reforms are exogenous in the sense that they are generally driven by interrelationship between regions rather than by regional socio-economic trends. For example, in 2010, the Russian government reduced the number of time zones from eleven to nine. As a result, five Russian regions had to move to a neighbouring time zone. The declared purpose of the reform was to improve the governability of the country. The implementation was simply eliminating time zones with a small number of regions. This choice has little to do with regional trends. The map of Russian time zones reveals domination of several time zones, mostly the Moscow time that is used in most of European Russia. Neighbouring time zones, for example Samara time, struggle to exist and in some cases completely disappear from the map for a few years until the next shock. The discussion over time zones in Russia raises arguments in favor of better governability when the clock in certain regions is equalized versus issues of health and crime suggestively related to the daylight timing. The public opinion is generally on the side of a later clock.

The existing literature mostly relies on the daylight saving time (DST) transitions in different countries as an exogenous variation in the clock. In DST, the clock is shifted by one hour twice a year, in spring and in autumn. The limitation in using the DST transitions is that by definition the discontinuity event occurs in two specific seasons, similarly every year. Thus, it is difficult to estimate the time's long-run effect.[2] The current study overcomes this shortcoming and focuses on the long-run effects.

Most importantly, this study is innovate in utilizing a special feature of Russian data that helps to exclude spurious correlations. The data is the individual-level Russian Longitudinal Monitoring Survey (RLMS), collected yearly starting with 1994 in 41 regions located in 34 out of 85 federal subjects.[3] The unique feature is the presence of two sources of clock variation that remain in data after removal of fixed and dynamic effects. These two sources are variation driven by the different length of DST along years and variation driven by time reforms. The idea in this study is that the two sources of variation are complementary. The reforms-driven clock variation is big but is limited to only few regions after fixed and dynamic effects are removed. The DST-driven variation is small but is present in all observations. Together the two sources

[1] Ignoring the overseas territories of France that are spread over twelve time zones.

[2] To be precise, the length of DST may vary from year to year. This is one of the sources of clock variation in Russian data, but its statistical power is small.

[3] 83 federal subjects if one excludes Crimea and Sevastopol.

generate a sufficient amount of long-run clock variation and can be used to consider robustness of the effects.

I utilize this special structure of the variance by implementing the partialling out technique. In this method, the outcome variable is plotted against residual clock stripped from the effects of all controlling variables. The residual clock clearly distinguishes between the two sources of variation, especially when one considers the average clock over a long period of time. Variation driven by the DST duration generates small residuals with many observations while variation driven by reforms generates large residuals with few observations. The latter can be clearly seen in the partialling out plots as points far away from zero. This semi-parametric approach shows the relationship between each of the sources of clock varation and the outcome.

The analysis is limited to adult urban residents. A later clock is found to be associated with several health and health-related problems. Chronic diseases are more common after a long exposure to a later clock. Furthermore, I find a positive relationship between clock and incidence of depression and a negative relationship with life satisfaction. I also consider a battery of habits as potential channels. Not all of the outcomes incriminate the later clock. Intensity of smoking (among smokers) decreases and individuals spend more time walking for daily needs. The effect of a later clock on alcohol consumption is unclear. However, frequent coffee drinking among middle-age respondents is strongly and positively related to a later clock.

The remainder of this paper proceeds as follows. Section 2 briefly addresses the literature. Section 3 provides background on Russian time reforms of the past two decades. Section 4 presents the data and the empirical strategy, illustrating it with an example of coffee habits. Section 5 is dedicated to the main results. Section 6 concludes.

2 Related literature

The existing time literature is divided into three branches and two of them are not directly related to the current paper.[4] The first group of studies is concerned with the difference between time zones of two locations. The considered outcomes are mutual trade (Kikuchi (2006), Kikuchi and Marjit (2010), Kikuchi and Van Long

[4] In addition, White (2005) provides an intersting discussion on the establishment of time zones in the United States and Canada in 1883. He explains why this is a beautiful example of economic theory in action. The American time standardization was a private initiative, driven by economic interests of a small group of people (railroad managers), which had no legal force until 1918, and nevertheless changed a centuries-old social norm of local time.

(2010), Christen (2015)), foreign direct investment (Stein and Daude (2007), Hattari and Rajan (2012)), or time use activities affected by watching live television shows (Hamermesh et al. (2008)). The second group of studies considers the daylight saving time (DST) transitions as a discontinuity quazi-experimental setup where the treatment is sleep deprivation, crime, and other outcomes. These studies establish a short-run effect of sleep deprivation on happiness (Kountouris and Remoundou (2014), Kuehnle and Wunder (2014)), health (Jin and Zebarth (2015b), Toro et al. (2015); see footnote 2 in Jin and Zebarth (2015b) for a list of references for medical studies linking DST transitions to short-run health changes), and performance of stock markets (Kamstra (2000)). There is evidence of reduced crime following the spring transition (Munyo (2018)). Some of the estimated effects last for no more than few days. In some studies, the effect is observed only in the "bad" DST transition in spring but in other studies it is observed also/only in the "good" transition in autumn (Kuehnle and Wunder (2014), Kuehnle and Wunder (2014), Jin and Zebarth (2015b,a)).

The bunch of literature mostly related to the current paper is the small third group of papers which consider the effect of daylight. A few studies in this group use geographical variation to estimate the effect of daylight on health (Markusen and Røed (2015)) and productivity (Figueiro et al. (2002), Gibson and Shrader (2014)). Using Norwegian data, Markusen and Røed (2015) report that longer daylight is associated with an increased entry rate to absenteeism but also with a higher recovery rate. The overall effect is positive (less absenteeism) but small (0.3%). Figueiro et al. (2002) collect data from a software development company located in NewYork City and find that workers in offices with windows spend more time working on computers than workers in offices without natural light. Because the visual system performs similarly well in both environments, the authors speculate that the reason for the observed difference is a better circadian regulation when a human is exposed to daylight. Gibson and Shrader (2014) estimate the wage retutns to sleep, instrumented by sunset time, and find that a one-hour-later sunset decreases the 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. **?** use the spatial discontinuity around the time zones borders in the U.S. to estimate the effect of the clock-related reduced sleep on health and income. Their findings are, roughly speaking, in line with mine ones: a later clock is associated with worse health. Recently, 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 a longer daylight on crime. Doleac and Sanders (2015) find a 7% decrease in robberies in the U.S. as a result of the additional hour of daylight. Dmonguez and Asahi (2016) report a large 18% decrease in overall crime in Chile, driven by decrease in robbery, and Toro et al. (2016) find a 14% decrease in homicide in Brasil.

3 Clock Reforms in Russia

3.1 Introduction

Russia differs from any other country in the world by the very long distance between its eastern and western ends. The longitude of the capital of the most western of the Russian 85 federal subjects, Kaliningrad Oblast, is 20.5° E. The longitude of the capital of the most eastern region, Chukotka, is 177.5° E. The difference is 157° which corresponds to 11 natural (nautical) time zones. However, as many other countries do, Russia does not strictly implement its natural time zones. In fact, in the period between 1990 and 2015, out of 2,162 region-year cases, only in 196 (9%) the time zone in power during most of the year was equal to the natural one. Between 1995 and 2014, the number is only 20 out of 1,662, which constitutes 1% of the cases. Almost in all of the other cases the time zone is higher than the natural one. Between 1990 and 2015, in 52% of the cases the time zone was higher by one hour than the natural one, and in 38% of the cases it was higher by two hours.

Russia differs from other countries also in the relatively frequent reforms with regard to its clock. 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 until the present. For example, in 1930, the Soviet government introduced "decree time". By this decree, all clocks in the Soviet Union were permanently shifted one hour ahead of standard time for each time zone. The daylight saving time was introduced in 1981 and existed until 2011. Between 1981 and 1991, the Soviet government gradually eliminated the decree time but de-facto reintroduced it already in the end of 1991. The considerations in these and other reforms have been always a mix of geographical and political ones. Examples are the time zone change in Altai Repuplic and Altai Krai in 1995, and the change in Tomsk in 2002, which were reasoned by economic dependence on a strong neighbor, Novosibirsk. Some reforms, such as the ones of 1919, 1930, 1991, 2011, and 2014 affected the whole country, while other reforms (such as the ones of 1947, 1957, 1981, 1995, 2010, and 2016) affected only a subset of regions.

Starting with 1957, many regions moved “back in time”, adopting a lower time zone. This policy coincides with destalinization that started one year earlier and may be related to a gradual withdraw from the "Stalin's" decree time. Especially, the wish to have a more "western" clock was strong in 1991 when the Soviet Union collapsed following its democratization.

Despite its definition as a federation, Russia is a very centralized country. Particularly, at any point in time, about 50 federal subjects out of the total of 85[5] have the same time zone as Moscow. Correspondingly, as stated in the president's annual address to the parliament, the goal of the 2010 reform was to make the Russian distant regions "closer" to Moscow, which should improve the coordination between the local and the central governments. As a result of the reform, the number of regions with the Moscow time zone increased from 50 to 52 (and increased further to 54 in 2014). 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. The whole country moved one time zone up and eliminated the daylight saving time. The further reform of 2014 actually cancelled the one of 2011. Later, the reform of 2016 attempted to “correct” the one of 2014.

3.2 Reforms in the considered period

The current study focuses on the period between 1994 and 2015 because of the utilized longitudinal dataset that has been collected since 1994. The following is the list of time reforms that took place during this period:

1. May 28, 1995 - Altai Krai and Altai Republic move from UTC+7 to UTC+6.
2. March 30, 1997 - Sakhalin Oblast moves from UTC+11 to UTC+10.
3. May 1, 2002 - Tomsk Oblast moves from UTC+7 to UTC+6.
4. March 28, 2010 - Russia reduces the number of its time zones from 11 to 9. Udmurt Republic and Samara Oblast move from UTC+4 to UTC+3. Kemerovo Oblast moves from UTC+7 to UTC+6. Chukotka and Kamchatka Krai move from UTC+12 to UTC+11.
5. August 31, 2011 - Russia eliminates the daylight saving time. The summer time that was in power in 2011 was declared to be the permanent time. It formally means moving one time zone up. In practice, the change affected only the five winter months of the year.

[5] 83 without Crimea.

6. October 26, 2014 - The whole country except of seven federal subjects moves one time zone down. Magadan Oblast and Zabaykalsky Krai move two time zones down. The five federal subjects affected by the 2010 reform do not move.

7. March 27 to December 4, 2016 - a period which is not covered in the empirical analysis of the current paper - 10 federal subjects move to a higher time zone: Astrakhan Oblast, Saratov Oblast, and Ulyanovsk Oblast move from UTC+3 to UTC+4. Altai Krai, Altai Republic, Novosibirsk Oblast, and Tomsk Oblast move from UTC+6 to UTC+7. Zabaykalsky Krai moves from UTC+8 to UTC+9. Magadan Oblast and Sakhalin Oblast move from UTC+10 to UTC+11.

In addition to these changes, on March 30, 2014, few days after annexation of Crimea and Sevastopol to Russia, the time zone in these two regions was changed from UTC+2 to UTC+4.[6] Finally, in a 2018 referendum in Volgograd Oblast, the majority voted in favor of changing the region's time zone from UTC+3 to UTC+4, but the final decision should be made by the Russian government.

Figure 1 presents the time zones map as of 2018. The map and the reforms listed above reveal the extent to which time is political. For example, Samara Time (UTC+4) is "struggling" to exist, pushed away by the dominant Moscow Time (UTC+3). Samara Time did not exist between 2011 and 2014 and it included only two federal subjects between 2014 and 2016 when it was expanded to inlcude five federal subjects.

Figure 2 plots, as an example of the impact of reforms, the yearly-average time zone (with respect to the daylight saving time) in four federal subjects, starting with 1994. The figure illustrates the cross-region variation in the trend.

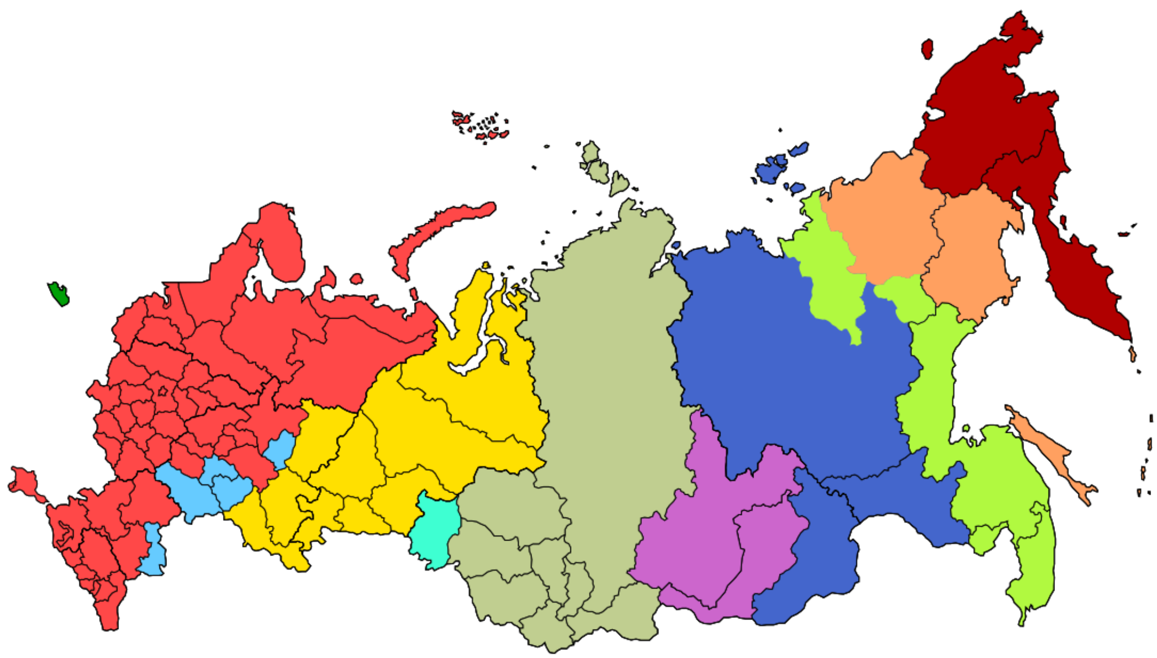
Note that the time zone in power most of the year is not always the official time zone. In particular, until 2011 the daylight saving time was in power for seven months from end of March to end of October. Note also that in some cases, the region shifts by two time zones. This happened in 2014 in Crimea and Sevastopol and later the same year in Magadan Oblast and Zabaykalsky Krai.

3.3 Exogeneity of the reforms

Three of the reforms affect the data used in the current study - the reforms of 1995, 2002, and 2010. Sakhalin, affected by the reform of 1997, is not represented in the RLMS dataset. The reform of 2011 and the permanent

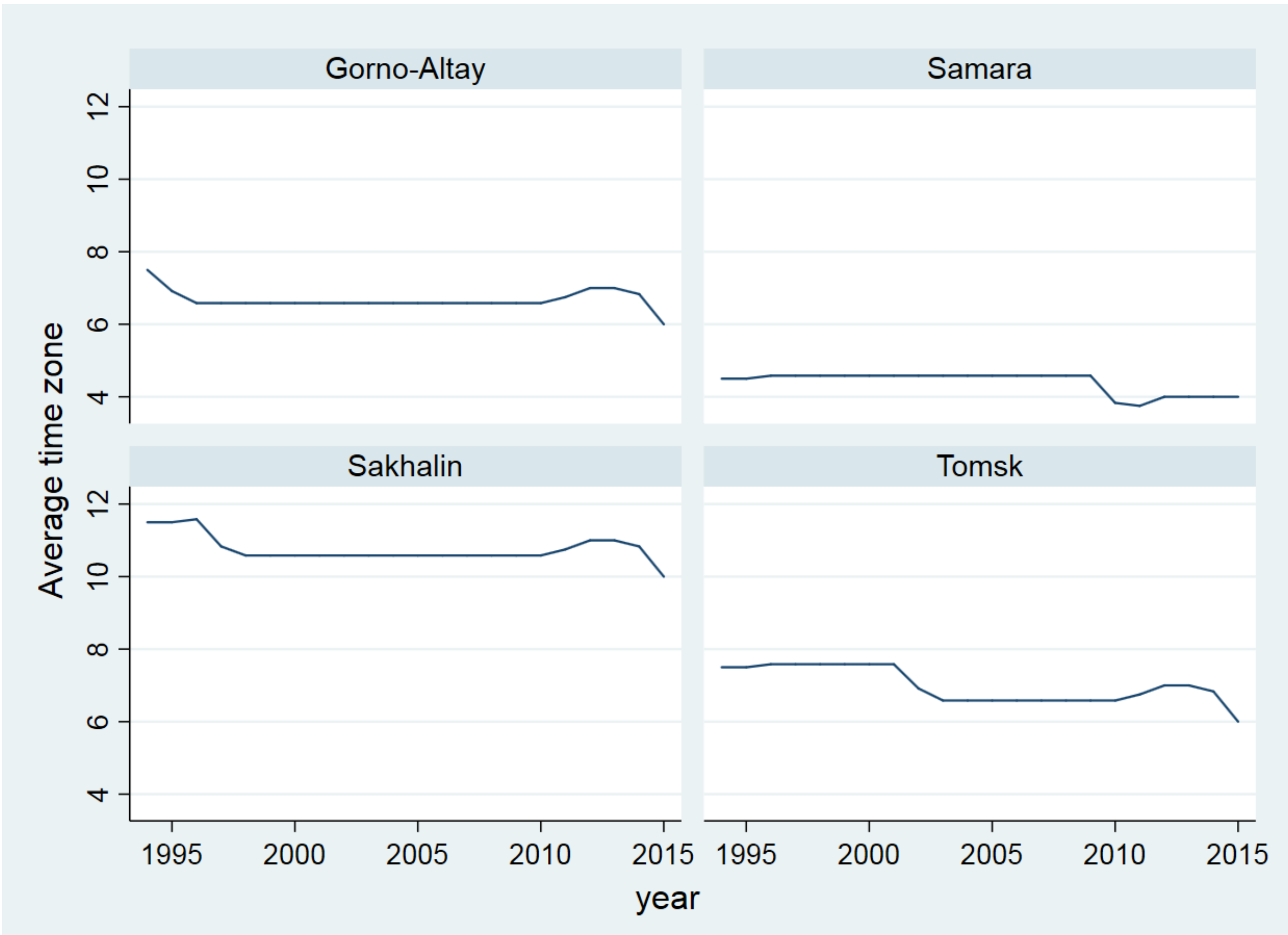
[6] During the considered period, also minor changes in the administrative division of Russia took place.

Figure 1: Times 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.

Figure 2: The time zone in four federal subjects, yearly average in 1994 to 2016



differences between regions are flattened by fixed and dynamic effects in the econometric model.

The three reforms are exogenous in the sense that they were not driven by considerations related to regional trends. Both the 1995 reform in Altai and the 2002 reform in Tomsk followed, with some delay, the 1993 time change of their strong neighbor, Novosibirsk. Many workers travel frequently between Altai, Tomsk, and Novosibirisk. The importance of the train schedule led to coordination of the neighbor's clocks. In its letter to the Prime Minister of Russia from 2001, Tomsk regional legislature states that "The socio-economic infrastructure of (Tomsk) oblast depends on the transportation network ... of Novosibirsk oblast ... " and, additionaly, that ""...(the change in the time zone downward) will lead to a shorter interval between getting up of most of the population and the sunrise." Furthermore, the 2010 reform in five regions followed the president's speech where he voiced the idea that reducing the number of time zones in Russia from 11 to 9 should improve governability. Reduction of the number of time zones was clearly exogenous on regional level because it was done by simply eliminating time zones with the smallest number of regions in mainland Russia.[7]

4 Data and Empirical Strategy

4.1 Data

The data in this research is the Russian Longitudinal Monitoring Survey (RLMS). This is a rich panel that started in 1994. It covers, by average, 15,000 individuals from 41 regions in 34 out of 85 Russian federal subjects. Up until 2015, RLMS accumulated 300,000 individual-level and 110,000 houlehold-level observations. Of all individual-level observations, almost 160,000 are observations of urban adults, who are the target population in this study. Data is divided into individual and household questionnaries. The location of RLMS regions is shown on a map in Figure 3.

One third of RLMS respondents are rural residents. There are good reasons ro assume that urban and rural residents are differently affected by time. However, RLMS includes only several dozens of rural residents in the regions affected by the reforms that generate residual clock variation (the reforms of 1995, 2002, and 2010). Thus, I restrict the sample to urban residents.

[7]By mainland Russia, I mean all regions excluding Kaliningrad that shares no border with other Russian regions.

Figure 3: Location of RLMS respondents

Furthermore, the anaysis is focused on adults. Summary statistics of the considered outcomes are reported in Table 1 separated by gender and by age group (18-44 years old versus 45+ years old). The means in the table show that chronic disease is much rarer among young individuals than among the older ones. Thus, in the regressions below I consider chronic diseases only for individuals who are at least 40 years old. For other outcomes reported in Table 1, the regressions are estimated for all individuals who are at least 18 years old.

4.2 Empirical strategy

4.2.1 Regression model

The considered econometric model is

$$Y_{ijt} = \beta_0 + \beta_1 averageClock_{jt} + \beta_2 sunrise_{jt} + \beta_3 sunset_{jt} + \gamma_i + \delta_t + \varepsilon_{ijt} \quad (1)$$

where Y_{ijt} is the outcome of individual i in region j at time t. The long-run effect of the clock is captured by the average clock over the three years preceeding the interview *averageClock*. I use the word "clock" because over three years, the correlation between the average sunrise and sunset times is one. This paper is focused on long-run effects and the main coefficient of interest is β_1. The *sunrise* and *sunset* times on the day of the interview serve as control variables. All time variables are measured in hours. The individual

Table 1: Summary statistics

	Men				Women			
	18-44 y.o.		45+ y.o.		18-44 y.o.		45+ y.o.	
chronic disease (0=no, 1=yes)								
	Mean	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**
heart	0.039	32544	0.234	23029	0.044	38239	0.346	40776
lung	0.039	32569	0.095	23065	0.031	38289	0.092	40895
liver	0.038	32528	0.085	23024	0.049	38226	0.19	40759
kidney	0.029	32519	0.077	22991	0.073	38211	0.158	40681
stomach	0.114	32488	0.214	23023	0.149	38176	0.296	40769
spinal	0.095	32513	0.234	23038	0.106	38187	0.309	40808
other(1)	0.086	32247	0.193	22713	0.128	37894	0.279	40118
diabetes	0.009	38013	0.059	27031	0.014	44648	0.128	47099
high blood pressure	0.162	32407	0.478	22967	0.17	38143	0.662	40874
other health outcomes								
	Mean	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**
depression	0.087	16046	0.106	11455	0.144	18704	0.168	20579
BMI (kg/m^2)	24.717	35973	26.397	25349	23.948	42510	28.82	43019
life satisfaction (rather of fully satisfied)(2)	0.449	37917	0.364	26980	0.418	44568	0.316	47025
life satisfaction (partiallly, rather, or fully satisfied)	0.696	37917	0.587	26980	0.677	44568	0.535	47025
addictive habits and physical activity								
	Mean	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**
daily num. of cigarettes(3)	16.285	23541	17.601	13282	10.616	10878	11.752	4092
drinking vodka	0.624	28134	0.753	17820	0.336	26652	0.468	18422
drinking beer	0.727	14429	0.461	9076	0.485	13954	0.267	8893
drinking wine	0.222	21335	0.18	13400	0.562	20665	0.489	13681
drinking coffee	0.782	9848	0.6	7143	0.773	11641	0.53	11576
drinking coffee often(4)	0.763	7652	0.694	4276	0.767	8969	0.683	6120
physically acrive	0.32	34248	0.2	24460	0.266	40332	0.198	42860
walking (daily minutes)(5)	155.9	132.8	139.0	124.7	140.2	117.1	129.7	116.6

Notes:
(1) Other chrinic disease with respect to the six variables above.
(2) Life satisfaction is defined as answering "fully satisfied", "rather satisfied", or "both yes and no" versus "less than satisfied" or "not at all satisfied" when asked to evaluate satisfaction with life at present. In the following row, the answer "both yes and no" is added to the positive category.
(3) Smokers only.
(4) Drinking at least four times a week, conditional on drinking coffee.
(5) Walking for daily needs, excluding exercise. Values are censored to no more than 600 minutes.

fixed effect is γ_i and this effect absorbs also regional effects because migrants are not tracked in RLMS. The monthly dynamic effect is δ_t. The standard errors are clustered on individual level. All estimations are least squares regressions with standard errors clustered on individual level.

4.2.2 Partialling out

An important advantage of the presence of reforms in data is not only in the exogenous time variation but also in its magnitde. Some observations have a large deviation from the mean time even controlling for fixed and dynamic effects. These large deviations can be very useful in figuring out the functional relationship between the clock and the outcomes and in filtering spurious correlations. Thus, in addition to the linear regression analysis, I use a semi-parametric technique of partialling out that separates two sources of long-run time variation in RLMS data.

The first source is the fact that the interviews take place on almost every date between September and March. The date of interview is important because of the daylight saving time (DST) transition scheme[8] that was in use in Russia until 2011, when DST was eliminated. The spring transition took place on the last Sunday of March and the autumn transition took place on the last Sunday of October. This sheme creates variation in the length of DST over years. For example, the spring transition in 2001 took place on March, 25, and the autumn transition took place on October, 28. In the next year, 2002, the spring transition took place on March, 31, and the autumn transition took place on October, 27. Thus, the DST was 7 days longer in 2001 than in 2002. As a result, respondents who were interviewed before and after the transition have a slightly different history of time. This small variation affects most observations, but is not sufficiently powerful to show alone effects on the outcomes.

The second source of variation are the reforms, mentioned in Section 3. However, only three of the reforms generate variance after fixed and dynamic effects are removed: the reform of 1995 in Altai, the reform of 2002 in Tomsk, and the reform of 2010 in five federal subject, of which one, Udmurt Republic, is represented in RLMS.[9] Hereafter, I name these three regions "special." Figure 4 shows the variation in the *residual* average clock. This is the 3-years average clock stripped of controlling variables, fixed and dynamic effects

[8]There exists, additionally, a negligble (up to few minutes) variation over years in sunrise and sunset times even in absence of DST.

[9]This list should include the 1997 reform in Sakhalin, but this regions is not covered in RLMS.

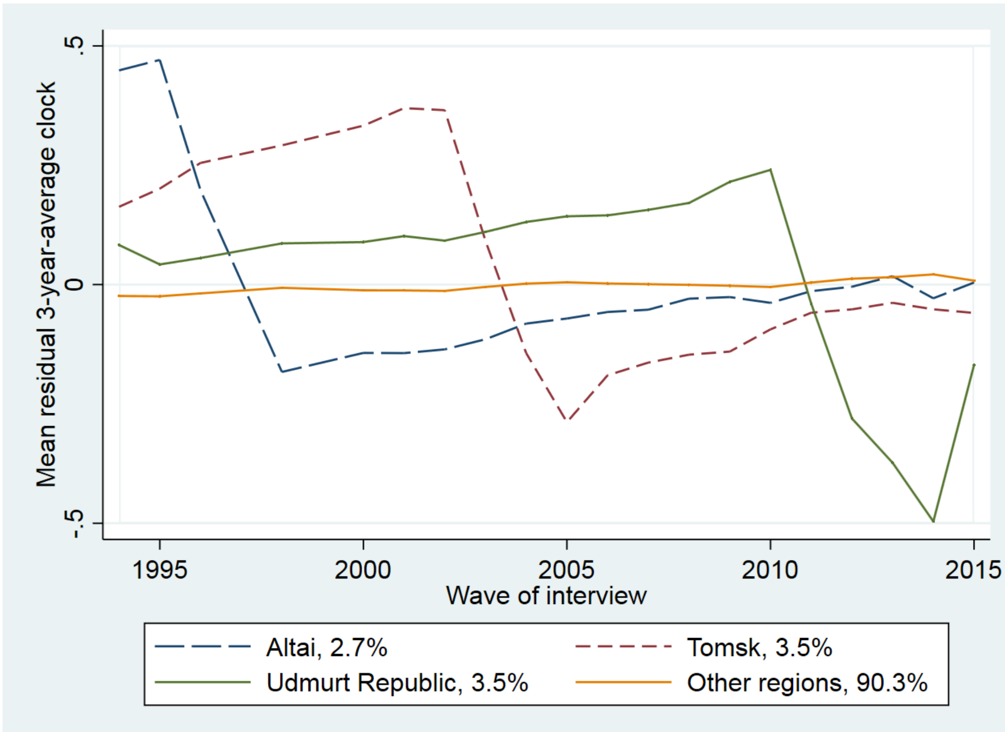
in Equation (1). The figure shows the annual mean residual. The variation of the residual along years in all but three regions is small. In the three regions the variation clearly follows the reforms, with a sharp drop after the decrease of the region's time zone. Table 2 decomposes the variance of the residuals. The three special regions account only for 9.6% of the observations but generate 87.8% of the variation in the residual clock. Almost two thirds of the special regions residual clock variation is explained by year of interview, and, additionaly, slightly more than one quarter is explained by the range of years the respondent appears in RLMS. Thus, 90% of the residual clock variation in the three special regions is explained by year. This is the effect of the reforms. By contrast, 56% of the residual variation in other regions is explained by date of interview *within* year.

I use this structure of time variation in the following way. I construct partialling out plots where the outcome is plotted against the residual clock. The term partialling out means that a simple linear regression of the outcome on the residuals generates the same slope as the regression coefficient of the clock in the full model. In the partialling out plots, the two sources of variation can be distinguished. Roughly speaking, small residuals with many observations come from the other regions and large residuals with few observation come from the special regions. Each of the two groups of regions does not have the sufficient statistical power to identify most of the effects. The special regions lack a large sample and the other regions lack a big clock variation. However, the full sample does have this power. I use this semi-parametric method to consider the consistency of the estimated effects along the range of the residuals.[10] Moreover, the partialling out plots show the functional form of the effect.

In order to provide robust results, I limit the list of considered outcomes to those with both sources of clock variation. It means that I do not consider many potentially interesting outcomes, such as sleep duration, simply because they have not been covered by RLMS for enough years to provide a wide range of residual clock.

[10]The term semi-parametric here means that the residuals are derived from a linear regression of the clock on other covariates, but the relationhsip between the outcome and the residuals can be of any shape.

Figure 4: Yearly mean residual 3-year-average clock in RLMS data



Note: The graph shows the annual mean residual of the 3-years-average sunrise time after removal of control variables, fixed, and dynamic effects in Equation (1). The percentages represent the weight of each region in the RLMS dataset.

Table 2: Decomposition of the variance of the residual long-run average time (RLMS data, urban, 18+)

Total of the variance explained by ...	Special regions	Other regions	All regions
region × year of interview	55.0% (62.7%)	2.6% (21.4%)	57.6%
region × date of interview (within year)	7.6% (8.7%)	6.8% (55.8%)	14.4%
region × range of individual's years in RLMS	24.4% (27.8%)	2.1% (16.8%)	26.5%
Total explained by all variables above	87.1% (99.2%)	11.5% (94.1%)	98.5%
Total sum of squares	**866 (87.8%)**	**121 (12.2%)**	**986.5 (100%)**
Number of observations	15,138 (9.6%)	142,147 (90.4%)	157,285 (100%)
Root MS	0.239	0.029	0.079

Note: Special regions are Altai, Tomsk, and Udmurt Republic. The percentages in the upper part of the table indicate the proportion of variance of the residual 3-years average clock explained by each of the factors. The numbers in parentheses indicate the proportion of the explained variance out of the total of this group of regions (three special regions versus all the other).

4.3 Example: coffee habits

Let us see an example of this analysis. Two of the RLMS questions addresses coffee drinking habits. First, respondents are asked whether they drink coffee. If the answer is positive, they are asked a multiply choice question of the frequency of coffee drinking. There are six alternative answers to the latter question. I define frequently drinking coffee as drinking it at least four times a week.[11] What is the effect of current and long-run clock on coffee habits and is this effect spurious or robust? Table 3 presents the results of estimating Equation (1) for urban individuals of ages 30 to 50. The estimation is for all regions, for the three special regions (Altai, Tomsk, and Udmurt Republic), and for all other regions.

Columns 1-3 report the resutls for the question whether the respondent drinks coffee and columns 4-6 report the results for the question whether she or he drinks it frequently. With regard to the first question, the only statistically significant coefficients are related to the current sunrise and sunset times in the special regions and, as one could expect, the sunrise time is positively related to incidence of drinking coffee, showing a 12 percentage points effect. There is no statistically significant effect of the three years average clock. For the second question, the regression results show a strong, positive, and statistically significant relationship between the sunrise time and frequent coffee drinking for the full sample. The current sunrise time has a 3 percentage points effect on the propensity to drink coffee frequently and the effect of the 3-years average clock is ten times as strong. This result would probably not contradict the common intuition. However, the results for two subsamples - speicial are other regions, which together constitute the full sample, are confusing. They do not show any clear and consistent relationship. Should we relate the strong coefficient in the first row of column 4 as a spurious correlation? To answer this question, I construct a partialling out plot for the long-run average clock. The partialling out analysis is the following two-stages procedure:

(1) Regress the average 3- years clock on the full set of covariates in Equation (1).[12]

(2) Plot the outcome of interest against the residuals from the regression in stage 1.

A simple linear regression of the outcome on the residuals generates a slope which is identical to the coefficient in Equation (1). More informative is a graphical representation of the relationship. It shows, first, whether the relatioship is consistent along the small residuals, driven by variation in the date of interview,

[11] The only stronger alternative would be to define frequently drinking as drinking every day.
[12] The sample is limited to observations that have a record of the outcome of interest.

Table 3: Regression results - coffee habits (ages 30-50)

	(1)	(2)	(3)	(4)	(5)	(6)
	Drinking coffee			Drinking coffee at least four times a week		
	All regions	Special regions	Other regions	All regions	Special regions	Other regions
three years average clock (sunrise)	0.0213	0.0283	1.205	0.282***	0.114	-0.277
	(0.0536)	(0.0719)	(1.251)	(0.0851)	(0.108)	(1.746)
current sunrise time	-0.00228	0.121***	-0.0129	0.0285*	0.0118	0.0233
	(0.0118)	(0.0390)	(0.0126)	(0.0158)	(0.0556)	(0.0172)
current sunsset time	0.000549	-0.0892***	0.00983	-0.0159	0.00262	-0.0224*
	(0.00786)	(0.0267)	(0.00885)	(0.0106)	(0.0404)	(0.0119)
Observations	16,233	1,671	14,562	12,364	1,203	11,161
Number of individuals	5,212	479	4,733	4,634	436	4,198

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Conditional on answering "yes" to the previous question in the questionnary, which is "Do you drink coffee?".

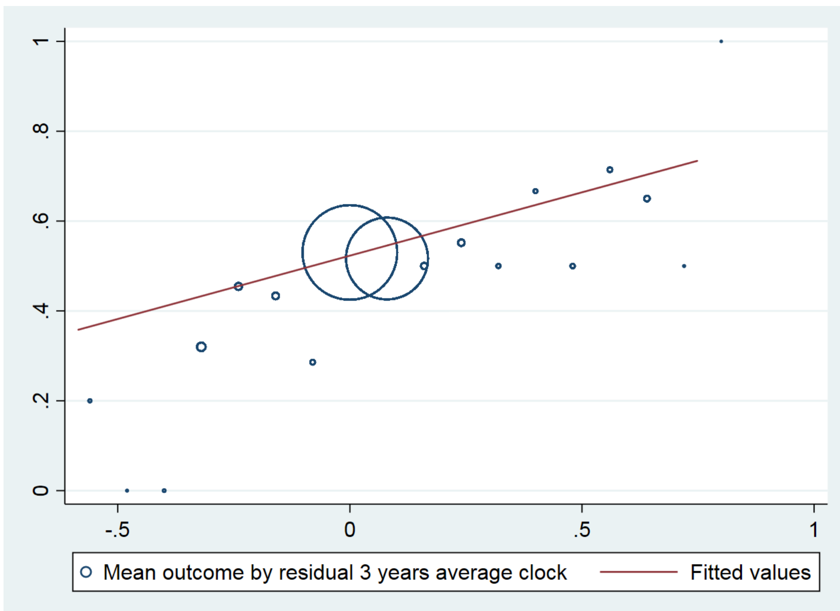
and the large residuals, driven by reforms, and, second, the functional form of the relationship.

The plot, corresponding to the first row in column 4 of Table 3 is presented in Figure 5. We observe a clear, consistent, and linear relantionship between the incidence of frequent coffee drinking and the residual long-run average clock, for the whole range of the residuals. This pattern confirms that the coefficient is not a spurious correlation. The fact that subsamples do not show this relantioship may be attributed to the small sample in the special regions and the small time variation in other regions. The full sample, however, has the sufficient statistical power to show the effect. We may conclude that the sunrise time affects coffee drinking frequency. Considering the current and the long-run sunrise time, we conclude that the effect of sunrise on coffee drinking is not transitory and may be transformed into a long-run habit.

4.4 Interpretation

The plot in Figure 5 is in complete agreement with the regression coefficient in the first row in column 4 of Table 3. However, this is not always the case. The results for many outcomes, discussed below, show disagreement between the regression results and the partialling out plot. This is the case when the relationship between the residuals and the outcome is not monotonic along the range of values of the residuals. Masses

Figure 5: Drinking coffee at least four times a week (ages 30-50)



Note: The range of the residual clock values is divided into 50 bins. The size of the circe represents the number of observations in each bin. The slope of the linear fit between the outcome and the residuals is identical to the regression coefficient of the 3-years average clock for all regions, reported in column 4 of Table 3.

of observations may dominate the regression coefficients but not be prominent in the plot because a much wider range of residual values may show an opposite relantionship with the outcome. There are two possible ways to address such results. The first alternative would be to relate the partialling out as a transparent and reliable tool and let it outweigh the regression results. The second alternative is to consider the plot as complementary to the regression results and to seek agreement between the two. Throughout the discussion of the results below, I adopt the former altenative, but more circumspect readers may prefer the latter one.

5 Main results

5.1 Chronic diseases

5.1.1 Regression results

Table 4 presents the regression results of Equation (1) for chronic deseases. RLMS asks for 20 questions that are formulated as "Do you have a chronic desease of ... ?" and for 19 of the outcomes there are sufficiently many observations to estimate the model. However, the questionnaries differ from year to year. I limit the list of considered outcomes to those that were collected both before and after the reforms in the three special regions. In addition, I include the questions "Were you ever diagnosed with diabetes?" and "Did a medical doctor ever tell you that you have a high blood pressure?" Table 4 reports the estimated coefficient β_1 of Equation (1), which corresponds to the 3-years average clock, a variable relevant for long-run health conditions. Two comments should be made with regard to this variable. First, as mentioned above, when the clock is averaged over a long period of time, the correlation between the average sunrise and the average sunset times is one. Thus, I simply use the term "average clock" but technically use the average sunrise time. Second, the choice of three years is arbitrary but one should remember that the longer the period of time is, the smaller the variance of the average is. Thus, averaging over longer periods of time may mechanically inflate the regression coefficients.

Panel A of the table corresponds to all regions. The regression results show a positive relationship between the clock and the chronic deseases, especially those of liver, kidney, and spine. The effect consitutes about three to five percentage points. These effects are roughly one half of the mean incidence for men and one quarter of the mean incidence for women of the relevant ages (see summary statistics in Table 1). There are similar but not statistically significant effects for stomach and heart disease, and for high blood pressure. The answer to the question "Do you have other chronical disease?" (asked with respect to the diseases in columns 1-6) is an exception with a negative and statistically significant coefficient of almost five percentage points. This coefficient is examined in the partialling out analysis below.

Panel B presents the results for the three special regions. None of the effects are statistically significant even though some of them have a similar magnitude to the correspondidng effects in panel A. Finally, panel C presents the results for all other regions. The only statistically significant coefficient is the exceptionally strong coefficient in column 7 that explains the strange corresponding coefficient in the full sample, observed in panel A.

5.1.2 Partialling out

Figure 6 shows the partialling out plots for chronic deseases. The plots correspond to the results in panel A of Table 4. The horizontal axis is the residual three years average clock. The observations are grouped in 50 bins represented by circles and the size of each circle corresponds to its weight in data. The slope of the linear fit is identical to the corresponding coefficient in panel A of Table 4. Clearly, the small residuals, driven by variation in the date of interview, are heavily represented in data. By contrast, the residuals outside the (-0.1, 0.1) range are driven by reforms and come from Altai, Tomsk and Udmurt Republic. Their weight in data is small but their magnitude is large.

One can observe that the partialling out plots support the positive and statistically significant coefficients for liver, kidney, and spinal chronical diseases, presented above in the regression results. The positive relationship between the clock and the incidence of the disease is observed along the whole range of the residual clock values. For kidney diesease, the large residual values suggest a non-linear relationship with a marginally increasing slope. For heart and stomach diseases, even though the corresponding regression coefficients are not statistically significant, their positive sign and magnitude are supported by the plot. On the other hand, the plot that corresponds to column 7 in Table 4 explains the exceptional negative regression coefficient. This coefficient is clearly spurious, driven by large masses of observations around zero. The full range of residuals shows that the true relationship is strictly positive. This positive relationship has not enough sta-

Table 4: Regression results - chronic disease (yes/no questions, age 40+)

	(1) heart	(2) lung	(3) liver	(4) kidney	(5) stomach	(6) spinal	(7) other[1]	(8) hypertension	(9) diabetes
	A. All regions								
three years average clock	0.0340 (0.0217)	0.00331 (0.0126)	0.0325* (0.0187)	0.0548*** (0.0137)	0.0249 (0.0212)	0.0467** (0.0219)	-0.0456** (0.0226)	0.0226 (0.0262)	0.00266 (0.0136)
Observations	75,480	75,659	75,447	75,336	75,444	75,524	74,384	75,486	88,119
Number of ind.	15,079	15,090	15,084	15,082	15,083	15,087	15,015	15,087	16,905
	B. Special regions (Altai, Tomsk, and Udmurt Republic)								
three years average clock	0.0388 (0.0296)	0.00982 (0.0160)	0.0174 (0.0243)	0.0209 (0.0185)	0.00385 (0.0287)	-0.0203 (0.0310)	-0.00690 (0.0311)	0.0320 (0.0322)	-0.0140 (0.0156)
Observations	6,971	6,979	6,943	6,938	6,951	6,969	6,906	6,939	8,101
Number of ind.	1,236	1,237	1,236	1,235	1,239	1,237	1,236	1,238	1,375
	C. Other regions								
three years average clock	-0.104 (0.303)	-0.270 (0.201)	-0.131 (0.249)	-0.175 (0.237)	-0.245 (0.324)	-0.196 (0.339)	-0.650** (0.266)	0.428 (0.336)	0.168 (0.204)
Observations	68,509	68,680	68,504	68,398	68,493	68,555	67,478	68,547	80,018
Number of ind.	13,843	13,853	13,848	13,847	13,844	13,850	13,779	13,849	15,530

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note:
(1) Other chronical disease with respect to columns (1)-(6).

tistical power in the regressions, but it is revealed by the partialling out visualization. In addition, the plot for hypertension shows that the magnitude, but not the sign, of its relationship with the clock is different from the regression coefficient. The negative relationship, observed in the plot, is much stronger than in the regression. Finally, the regression coefficients for lung disease and diabetes are weak and not statistically significant and the corresponding partialling out plots indeed show no relationship with the clock.

5.2 Depression and body mass index

Let us proceed to two long-run outcomes that are relevant for all ages. These are the incidence of depression and the body mass index (BMI).[13] The regression results for the 3-years-average clock are reported in Table 5 and the partialling out plots are shown in Figure 7.

For the incidence of depression within one year before the interview (columns 1-3 of Table 5), the 3-years average clock in the full sample regression has a positive and statistically significant coefficient of seven percentage points. The subsamples of the special and other regions do not show this result. Thus, we rely on the partialling out plot in the left panel of Figure 7 to decide whether the regression coefficient is spurious or not. It is not. Not only that the mean outcome rises along the whole range of the residuals, but the functional form of this relationship is non-linear with a marginally increasing slope.

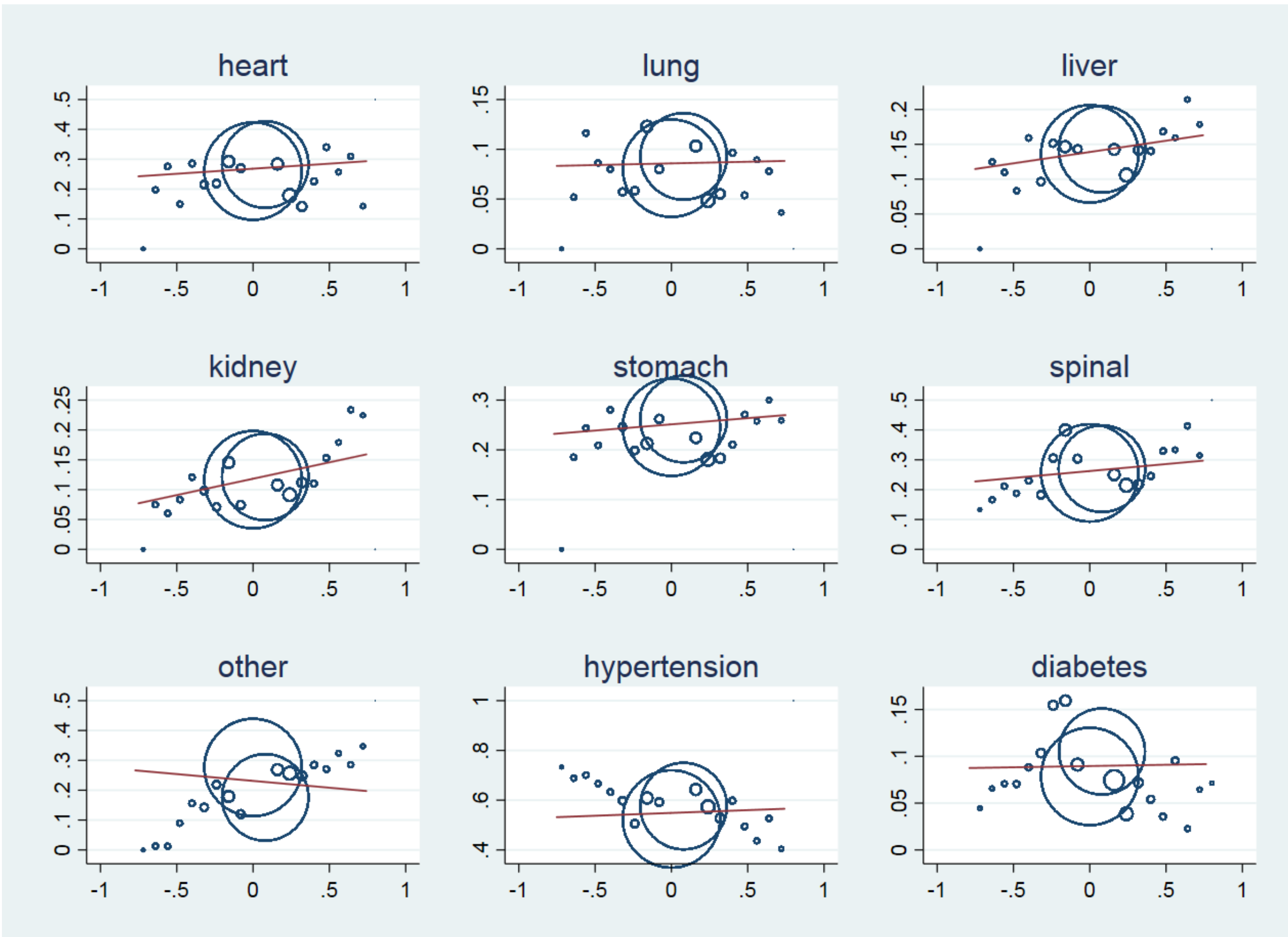
The results for BMI are reported in columns 5-6 of Table 5. The negative coefficient appears in the full sample and the special regions regressions but only in the former it is statistically significant and constitutes -0.3 (5% of the BMI's standard deviation in the RLMS data). This inconsistency across subsamples is again solved by the partialling out plot, presented in the right panel of Figure 7. The partialling out plot shows indeed a decreasing slope, consistent over the whole range of the residuals. This slope has a stronger magnitude than the full sample regression coefficient.

5.3 Addictive habits and physical activity

Let us now turn to some potential channels. RLMS data is not fit to estimate the direct effect of exposure to daylight but it can be used to consider the relantionship between time and some addictive habits and physical

[13]BMI is weight in kilograms divided by squared height in meters.

Figure 6: Chronic diseases, age 40+



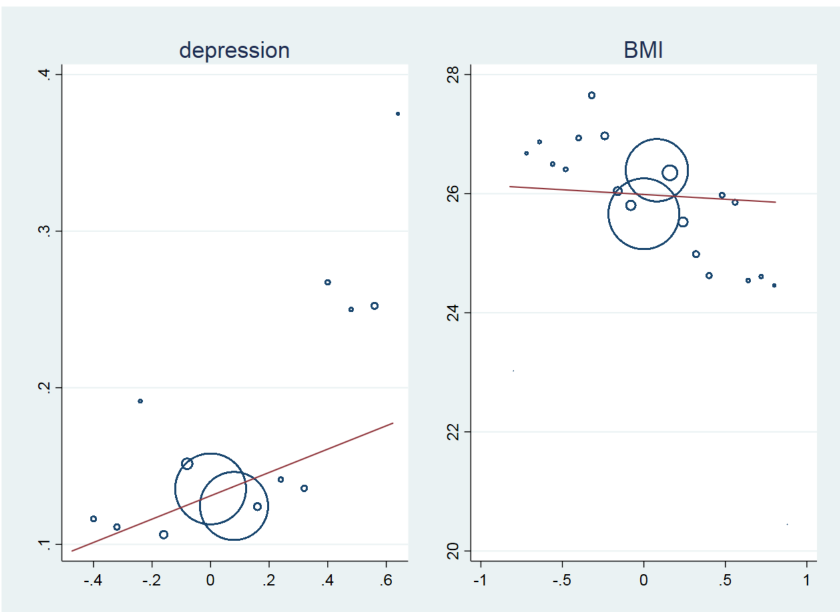
Note: The range of the residual clock values is divided into 50 bins. The size of the circe represents the number of observations in each bin. The slope of the linear fit between the outcome and the residuals is identical to the regression coefficients reported in panel A of Table 4.

Table 5: Regression results - other long-run outcomes (age 18+)

	(1)	(2)	(3)	(4)	(5)	(6)
	Depression (within last year)			Body Mass Index (BMI)		
	All regions	Special regions	Other regions	All regions	Special regions	Other regions
three years	0.0745***	0.0649	-0.314	-0.160	-0.275*	1.334
average clock	(0.0269)	(0.0403)	(0.227)	(0.122)	(0.154)	(1.575)
Observations	66,784	6,523	60,261	146,822	13,934	132,888
Number of individuals	21,772	1,988	19,784	30,963	2,687	28,276

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 7: Depression and BMI (age 18+)



Note: The range of the residual clock values is divided into 50 bins. The size of the circe represents the number of observations in each bin. The slope of the linear fit between the outcome and the residuals is identical to the regression coefficients, reported in columns 1 and 4 of Table 5.

activity. I already discussed coffee habits in Section 4.3 and I proceed with some other habits - smoking, alcohol consumption, and physical activity.

Table 6 reports the regression results. The outcomes are interesting not only with regard to the long run but also with regard to the current clock at the day of interview. Thus, the table reports the coefficients of all time variables in Equation (1). Panel A reports the regression results for the full sample, panel B reprts the results for the special regions, and panel C reports the results for other regions. The corresponding partialling out plots appear in Figure 8.

The first outcome is smoking intensity of smokers, measured as daily number of cigarettes.[14] The coefficient of the 3-years average clock for the full sample and for the special regions is statistically significant and constitutes a decrease of slightly more tnan one cigarette for each hour. However, it is difficult to explain this effect by the effect of the current sunrise and sunset times, because their coefficients are not statistically significant and are not consistent across the subsamples. Thus, we can be again assisted by the partialling out plot. It shows that for most values of the residual clock, except of the very low ones, the relationship of smoking intensity and time is indeed negative.

Alcohol consumption is a painful issue in Russia, frequently related to the low life expectancy of Russian men and to other social problems. RLMS states a list of yes/no questions with regard to consumption of alcoholic beverages. In columns 2-4 of Table 6, I consider the main alcoholic beverages consumed in Russia - vodka, beer, and wine. Similarly to the results for smoking, the regression coefficients are mixed. The effect of the 3-years average clock on the incidence of vodka drinking is negative but this negative effect is not supported by the current clock coefficients. The effect of the 3-years average clock on beer and wine drinking is, oppositely, positive, but of a mixed sign across subsamples. Thus, regressions are not revealing any consistent relationship between time and alcohol consumption. The partialling out plots show that indeed for vodka and beer the relationship between the clock and the incidence of drinking is unclear. For wine, however, the positive regression coefficient for the full sample is supported by the trend observed in the partialling out plot.

The two last outcomes are the incidence of physical activity and duration of daily walking for all but sportive purposes. The results are reported in columns 5-6 of Table 6. For physical activity, the regression

[14] Whether the person is a smoker or not is found not to be related to clock and this outcome is excluded from the reported results.

coefficients for all subsamples show a negative effect of a later sunrise and a positive effect of a later sunset. These two effects could be expected, but they may cancel each other. The question is what is their sum effect and how the long run habits are affected. However, the only statistically significant coefficient of the 3-years clock is the negative coefficient of four percentage points, derived by the special regions regression (first row in Panel B, column 5.) Is this coefficient spurious or robust? The answer is that it is not robust. The partialling out plot does not show any clear relantionship of the long run residual clock and physical activity incidence.

However, for daily walking duration, measured in minutes and counting walking for daily needs (excluding exercise), the partialling out plot is very informative. None of the regression coefficients are statistically significant and their magnitude is chaotic across subsamples. But the partialling out plot is clear. It shows a strong, consistent, and positive relationship between the long-run clock and daily walking with a slope larger than one. It means that a one-minute later clock may lead to a larger than one minute increase in the daily walking.

Life satisfaction

Finally, RLMS states the question whether the respondent is satisfied with her life in general. The answer is on a one to five scale from fully satisfied to completely unsatisfied. I estimate the effect of the clock on life satisfaction and report the results for two tresholds. The first treshold cuts the two top answers (rather or fully satisfied), while the second treshold adds the middle category of partial satisfaction. The regression results are reported in Table 7 and the partialling out plots are presented in Figure 9.

The only statistically significant regression coefficients are the positive coefficient of a long-run clock and the negative coefficient of the current sunset in the special regions subsample. Is the positive coefficient of the long run clock robust to the partialling out method? It is not. Partialling out plots show a strict, monotonic, negative relationship of the residual clock and life satisfaction. The slope in the graphs is of -0.3, meaning a 30 percentage points lower propensity to be satisfied with life after a 3-years-long exposure to a one-hour-later clock.

Table 6: Regression results - addictive habits and physical activities (age 18+)

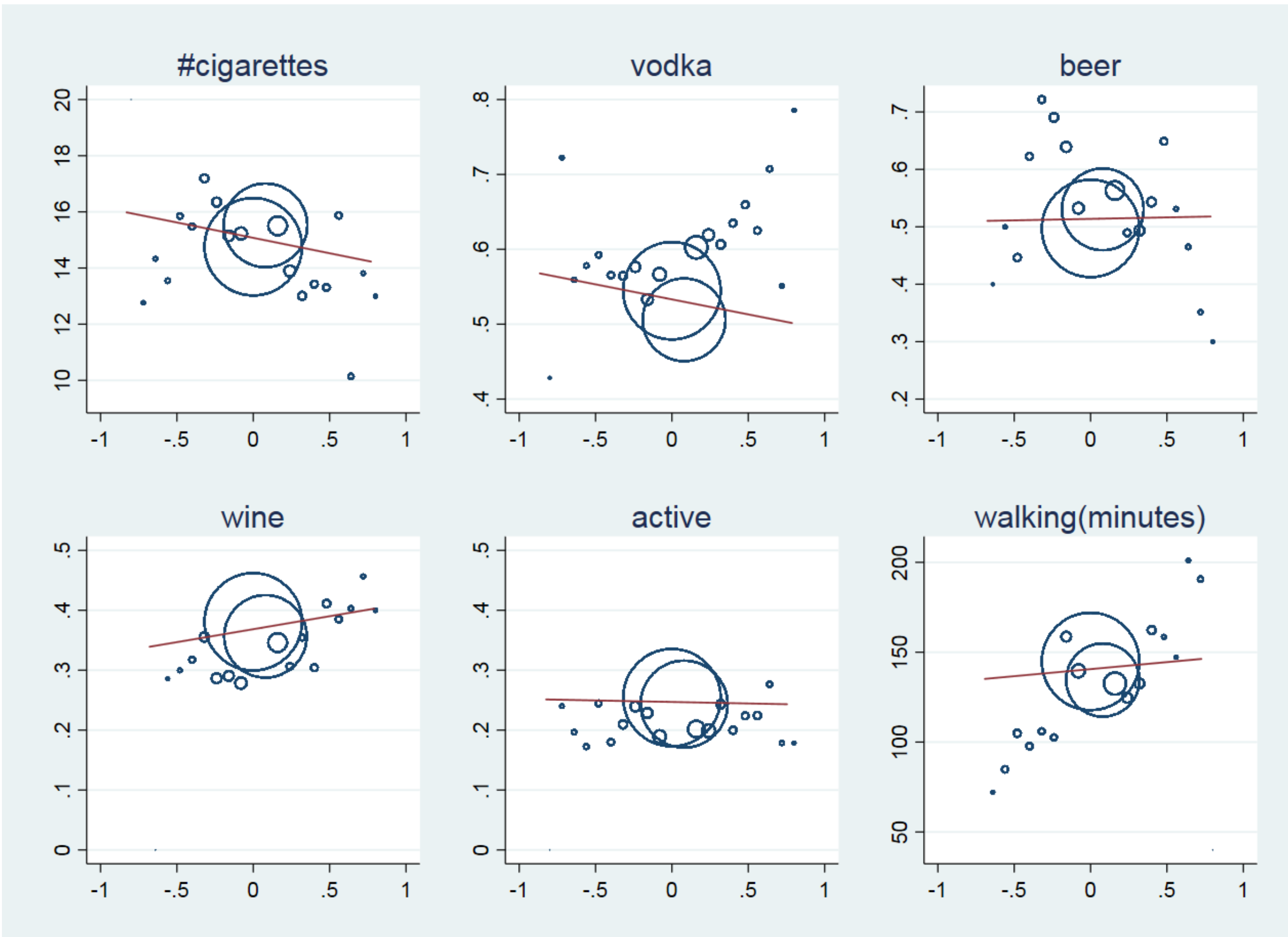
	(1) daily num. of cigarettes[1]	(2) drinking vodka	(3) drinking beer	(4) drinking wine[2]	(5) phyisically active (yes/no)	(6) walking (daily minutes)[3]
	A. All regions					
three years average clock	-1.095***	-0.0401**	0.00519	0.0432*	-0.00508	7.832
	(0.396)	(0.0197)	(0.0265)	(0.0249)	(0.0140)	(5.469)
current sunrise time	-0.0833	0.00473	-0.00393	-0.00297	-0.00282	0.294
	(0.0928)	(0.00514)	(0.00768)	(0.00602)	(0.00372)	(1.824)
current sunsset time	0.104	0.00813**	0.0150***	-0.00723*	0.0137***	1.694
	(0.0722)	(0.00398)	(0.00514)	(0.00432)	(0.00280)	(1.193)
Observations	51,779	91,011	46,336	69,064	141,894	61,823
Number of individuals	12,963	23,554	13,751	19,726	30,186	20,763
	B. Special regions (Altai, Tomsk, and Udmurt Republic)					
three years average clock	-1.329**	-0.0537*	0.0695*	0.0423	-0.0378**	-3.537
	(0.516)	(0.0277)	(0.0382)	(0.0352)	(0.0188)	(8.837)
current sunrise time	0.0178	0.0264*	0.0262	-0.0229	-0.0225**	5.237
	(0.284)	(0.0143)	(0.0236)	(0.0174)	(0.0106)	(5.342)
current sunsset time	0.229	-0.00481	0.0143	0.00130	0.0225***	0.387
	(0.241)	(0.0107)	(0.0152)	(0.0123)	(0.00820)	(3.474)
Observations	5,223	9,796	4,867	7,329	13,636	6,012
Number of individuals	1,217	2,183	1,247	1,825	2,637	1,853
	C. Other regions					
three years average clock	1.443	-0.0189	-1.039	-1.428*	0.0938	226.4
	(7.232)	(0.395)	(1.240)	(0.835)	(0.272)	(280.0)
current sunrise time	-0.0695	0.00213	-0.00601	0.00100	-0.00220	-1.750
	(0.102)	(0.00577)	(0.00828)	(0.00655)	(0.00414)	(1.999)
current sunsset time	0.102	0.00853*	0.0129**	-0.00855*	0.0117***	1.592
	(0.0772)	(0.00444)	(0.00571)	(0.00475)	(0.00306)	(1.344)
Observations	46,556	81,215	41,469	61,735	128,258	55,811
Number of individuals	11,746	21,371	12,504	17,901	27,549	18,910

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes:
(1) Conditional on smoking.
(2) A positive answer to either "Do you drink wine?" or "Do you drink strong wine?"
(3) Walking for all but sportive needs, excluding exercise, and censored to no more than 600 minutes a day.

Figure 8: Addictive habits and physical activities (age 18+)



Note: The range of the residual clock values is divided into 50 bins. The size of the circe represents the number of observations in each bin. The slope of the linear fit between the outcome and the residuals is identical to the 3-years average clock regression coefficients, reported in panel A of Table 6.

Table 7: Regression results - life satisfaction (age 18+)

	(1)	(2)	(3)	(4)	(5)	(6)
	Fully, rather, or partially satisfied			Rather or fully satisfied		
	All regions	Special regions	Other regions	All regions	Special regions	Other regions
three years average clock	0.00483	0.0529**	-0.233	-0.00287	0.0541**	0.0714
	(0.0151)	(0.0225)	(0.276)	(0.0153)	(0.0222)	(0.296)
current sunrise time	0.000978	0.0152	-0.00305	-0.00172	0.0156	-0.00319
	(0.00401)	(0.0120)	(0.00442)	(0.00399)	(0.0117)	(0.00440)
current sunsset time	2.84e-05	-0.00694	-0.00103	-0.000745	-0.0199**	0.00193
	(0.00315)	(0.00881)	(0.00348)	(0.00307)	(0.00897)	(0.00335)
Observations	156,455	15,066	141,389	156,455	15,066	141,389
Number of individuals	31,614	2,753	28,861	31,614	2,753	28,861

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 9: Life satisfaction (age 18+)

Note: The range of the residual clock values is divided into 50 bins. The size of the circe represents the number of observations in each bin. The slope of the linear fit between the outcome and the residuals is identical to the regression coefficients, reported in columns 1 and 4 of Table 7.

6 Conclusions

This is an empirical study providing new evidence of the relationship between time and people. Some mental and physical problems become more frequent with a later clock. This includes chronic health conditions, depression, and a decreased life satisfaction. On the other hand, physical activity increases and smoking decreases.

The effects, observed in the current study, are related not only to well-being but also to human capitals' formation. The policy of gradually drifting Russian clock “to the west” by shifting time zones downward started in 1957 but changes in the other direction also took place, in particular in 2011 and 2016. New reforms are introduced almost every year. Disputes on time are not settled also in many other countries, especially but not only around the daylight saving time. Particularly, as currently about 70 countries implement the 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 remains actual around the world. Recent examples include the European Union debate on abandonment of the daylight saving time and the discussion in Spain around its time zone. Hopefully, this paper sheds new light on the consquences of time policy. Understanding the effect of the clock should ease but may also complicate the discussion of what is optimal for the country. Such debates around the globe feed the demand for further time-related research.

References

Acemoglu, Daron, Johnson, Simon, Robinson, James A., 2001. The colonial origins of comparative development. American Economic Review 91 (5): 1369–1401.

Christen, Elisabeth. "Time zones matter: The impact of distance and time zones on services trade." The World Economy (2015).

Doleac, Jennifer L., and Nicholas J. Sanders. "Under the cover of darkness: How ambient light influences criminal activity." Review of Economics and Statistics 97.5 (2015): 1093-1103.

Domínguez, Patricio, and Kenzo Asahi. "Daylight and Criminal Behavior: Evidence from Chile." Available at SSRN 2752629 (2016).

Figueiro, Mariana G., et al. "Daylight and productivity-a possible link to circadian regulation." Proceedings of the Fifth International LRO Lighting Research Symposium. 2002.

Gibson, Matthew, and Jeffrey Shrader. "Time use and productivity: The wage returns to sleep." (2014).

Giuntella, Osea, and Fabrizio Mazzonna. "Sunset time and the economic effects of social jetlag. Evidence from US time zone borders." Unpublished manuscript, Department of Economics, University of Pittsburgh, Pittsburgh, PA. Google Scholar (2017).

Giuntella, Osea, Wei Han, and Fabrizio Mazzonna. "Circadian Rhythms, Sleep, and Cognitive Skills: Evidence From an Unsleeping Giant." Demography 54.5 (2017): 1715-1742.

Hamermesh, Daniel S., Caitlin Knowles Myers, and Mark L. Pocock. "Cues for timing and coordination: Latitude, Letterman, and longitude." Journal of Labor Economics 26.2 (2008): 223-246.

Hattari, R. and R. Rajan (2012), 'Sources of FDI Flows to Developing Asia: The Roles of Distance and Time Zones', China Economic Policy Review, 1, 2, 1301–16.

Jin, Lawrence, and Nicolas R. Ziebarth. "Does Daylight Saving Time Really Make Us Sick?." (2015).

Jin, Lawrence, and Nicolas R. Ziebarth. *Sleep and Human Capital: Evidence from Daylight Saving Time*. No. 15/27. HEDG, c/o Department of Economics, University of York, 2015.

Kamstra, Mark J., Lisa A. Kramer, and Maurice D. Levi. "Losing sleep at the market: The daylight saving anomaly." The American Economic Review 90.4 (2000): 1005-1011.

Kikuchi, Toru. "Time zones, outsourcing and patterns of international trade." Economics Bulletin 6.15 (2006): 1-10.

Kikuchi, Toru, and Sugata Marjit. "Time zones and periodic intra-industry trade." (2010).

Kikuchi, Toru, and Ngo Van Long. "A simple model of service offshoring with time zone differences." The North American Journal of Economics and Finance 21.3 (2010): 217-227.

Kountouris, Yiannis, and Kyriaki Remoundou. "About time: Daylight saving time transition and individual well-being." Economics Letters 122.1 (2014): 100-103.

Kuehnle, Daniel, and Christoph Wunder. "Using the Life Satisfaction Approach to Value Daylight Savings Time Transitions: Evidence from Britain and Germany." Journal of Happiness Studies (2014): 1-31.

Markussen, Simen, and Knut . "Daylight and absenteeism–Evidence from Norway." Economics & Human Biology 16 (2015): 73-80.

Munyo, Ignacio. "Daylight saving time and crime: Does tiredness also affect criminal behavior?." Journal of Applied Biobehavioral Research (2018): e12115.

Stein, Ernesto, and Christian Daude. "Longitude matters: Time zones and the location of foreign direct investment." Journal of International Economics 71.1 (2007): 96-112.

Toro, Weily, Robson Tigre, and Breno Sampaio. "Daylight Saving Time and incidence of myocardial infarction: Evidence from a regression discontinuity design." Economics Letters 136 (2015): 1-4.

Toro, Weily, Robson Tigre, and Breno Sampaio. "Ambient Light and Homicides." Available at SSRN (2016).

White, Matthew. "The economics of time zones." Unpublished paper, Wharton School, University of Pennsylvania (2005).